SEMESTER III

MAT 203	DISCRETE MATHEMATICAL STRUCTURES	CATEGORY	L	T	P	CREDITS
		BSC	3	1	0	4

Preamble:

The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Generating Functions, Recurrence Relations and Algebraic Structures eventually in practical applications.

Prerequisite: A sound background in higher secondary school Mathematics

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Check the validity of predicates in Propositional and Quantified Propositional Logic using truth tables, deductive reasoning and inference theory on Propositional Logic **(Cognitive Knowledge Level: Apply)**
CO2	Solve counting problems by applying the elementary counting techniques - Rule of Sum, Rule of Product, Permutation, Combination, Binomial Theorem, Pigeonhole Principle and Principle of Inclusion and Exclusion **(Cognitive Knowledge Level: Apply)**
CO3	Classify binary relations into various types and illustrate an application for each type of binary relation, in Computer Science (**Cognitive Knowledge Level: Understand)**
CO4	Illustrate an application for Partially Ordered Sets and Complete Lattices, in Computer Science **(Cognitive Knowledge Level: Apply)**
CO5	Explain Generating Functions and solve First Order and Second Order Linear Recurrence Relations with Constant Coefficients **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓		✓						✓
CO5	✓	✓	✓	✓								✓
CO6	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Series Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Fundamentals of Logic)

Mathematical logic - Basic connectives and truth table, Statements, Logical Connectives, Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Substitution Rules . The implication - The Contrapositive, The Converse,The Inverse.

Logical Implication - Rules of Inference. The use of Quantifiers - Open Statement, Quantifier. Logically Equivalent – Contrapositive, Converse , Inverse , Logical equivalences and implications for quantified statement, Implications , Negation .

Module - 2 (Fundamentals of Counting Theory)
The Rule of Sum – Extension of Sum Rule . The Rule of Product - Extension of Product Rule . Permutations. Combinations. The Binomial Theorem (without proof). Combination with Repetition. The Pigeon hole Principle. The Principle of Inclusion and Exclusion Theorem (Without Proof) - Generalization of the Principle. Derangements.

Module - 3 (Relations and Functions)
Cartesian Product - Binary Relation. Function – domain , range-one to one function, Image-restriction. Properties of Relations- Reachability Relations, Reflexive Relations, Symmetric Relations, Transitive relations, Anti-symmetric Relations, Partial Order relations, Equivalence Relations, Irreflexive relations.

Partially ordered Set – Hasse Diagram, Maximal-Minimal Element, Least upper bound (lub), Greatest Lower bound(glb) (Topological sorting Algorithm- excluded). Equivalence Relations and Partitions - Equivalence Class.

Lattice - Dual Lattice , Sub lattice , Properties of glb and lub , Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice , Distributive Lattice.

Module - 4 (Generating Functions and Recurrence Relations)
Generating Function - Definition and Examples , Calculation techniques, Exponential generating function. First order linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Second order linear recurrence relations with constant coefficients, homogeneous, non-homogeneous Solution.

Module - 5 (Algebraic Structures)
Algebraic system-properties- Homomorphism and Isomorphism. Semi group and monoid – cyclic monoid , sub semi group and sub monoid, Homomorphism and Isomorphism of Semi group and monoids. Group- Elementary properties, subgroup, symmetric group on three symbols ,The direct product of two groups, Group Homomorphism, Isomorphism of groups, Cyclicgroup. Rightcosets - Leftcosets. Lagrange’s Theorem

Text Book

1. Discrete and Combinatorial Mathematics (An Applied Introduction), Ralph P Grimaldi, B V Ramana , 5th Edition, Pearson

Reference Books

1) Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Seventh Edition, MGH, 2011
2) Trembly J.P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2003.
3) Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, “Discrete Mathematical Structures”, Pearson Education Pvt Ltd., New Delhi, 2003
4) Kenneth H .Rosen, “Discrete Mathematics and its Applications”, 5/e, Tata Mc Graw Hill Pub. Co. Ltd, New Delhi 2003
5) Richard Johnsonbaugh, “Discrete Mathematics”, 5/e, Pearson Education Asia, NewDelhi, 2002.
6) Joe L Mott, Abraham Kandel, Theodore P Baker,“Discrete Mathematics for Computer Scientists and Mathematicians”, 2/e, Prentice-Hall India, 2009.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Show that $R \vee M$, $\neg R \vee S$, $\neg M$, $\neg S$ cannot exist simultaneously (without using truth table)
2. Represent the following statement in symbolic form “Not every city in Canada is clean”.

Course Outcome 2 (CO2):

1. How many possible arrangements are there for the letters in MASSASAUGA in which 4 A’ s are together?
2. Find the number of integers between 1 and 1000 inclusive, which are not divisible by 5, 6 or 8

Course Outcome 3 (CO3):

1. If A = {1, 2, 3, 4}, give an example of a relation R that is reflexive and symmetric but not transitive.
2. Let Z be the set of integers. R is a relation called “Congruence Modulo 3 “ defined by R = { (x,y) /x ε Z,y ε Z, x - y is divisible by 3 } . Show that R is an equivalence relation.

Course Outcome 4 (CO4):

1. Assume A ={ a, b, c}. Let P(A) be its power set and ‘≤ ‘ be the subset relation on the power set. Draw the Hasse diagram of (P(A), ≤).
2. What is meant by Bounded Lattice ? Give an example.

Course Outcome 5 (CO5):

1. Solve $a_r - 3a_{r-1} - 4a_{r-2} = 3^r$ using Generating function method; Given $a_0 = 1$, $a_1 = 2$.
2. Find the generating function for the sequence 1, 3, 3^2, 3^3 …….

Course Outcome 6 (CO6):

1. Prove that the group { 1,-1, i, -i } is cyclic with generators i and –i.
2. State and prove Lagrange’s Theorem.

Model Question Paper

QP CODE:

Reg No:______________

Name :______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT 203

Course Name: Discrete Mathematical Structures

Max.Marks :100 **Duration: 3 Hrs**

PART A

Answer all Questions. Each question carries 3 Marks

1. Show the following implication without constructing the truth table: $(P \wedge Q) \Rightarrow P \rightarrow Q$
2. Write the negation of the following statement. " If I drive, then I will not walk"
3. What is pigeon hole principle? Explain. If you select any five numbers from 1 to 8 then prove that at least two of them will add up to 9 .
4. In how many ways can the letters of the word ALLAHABAD be arranged ?
5. Show that the divisibility relation ' / ' is a partial ordering on the set Z^+.
6. Consider the functions given by $f(x) = 2x+3$ and $g(x) = x^2$. Find (g o f) and (f o g).
7. What is meant by exponential generating function? Explain.
8. Provide one example of linear homogeneous recurrence relation. Mention the degree also.
9. What is a monoid ? Explain.
10. Let (A, .) be a group. Show that $(ab)^{-1} = b^{-1}a^{-1}$

(10 x 3 = 30 Marks)

PART B

(Answer any one Question from each Module. Each question carries 14 Marks)

11.

(a) Show that $S \vee R$ is tautologically implied by $(P \vee Q) \wedge (P \rightarrow R) \wedge (Q \rightarrow S)$

(6 marks)

(b) Show that from

(ii) $(\exists x)(F(x) \wedge S(x)) \rightarrow (y)(M(y) \rightarrow W(y))$.

(iii) $(\exists y)(M(y) \wedge \neg W(y))$ the conclusion $(x)(F(x) \rightarrow \neg S(x))$ follows.

(8 marks)

OR

12.

(a) Show that $(x)(P(x) \vee Q(x)) \Rightarrow ((x)P(x) \vee (\exists x) Q(x))$ using indirect method of proof .

(6 marks)

(b) Discuss indirect method of proof . Show that the following premises are inconsistent

(i) If Jack misses many classes through illness, then he fails high school.
(ii) If Jack fails high school, then he is uneducated.
(iii) If Jack reads a lot of books, then he is not uneducated.
(iv) Jack misses many classes through illness and reads a lot of books.

(8 marks)

13.

(a) Explain binomial theorem. Determine the coefficient of x^9y^3 in the expansion of $(x+y)^{12}$, $(x+2y)^{12}$ and $(2x-3y)^{12}$ using binomial theorem.

(6 marks)

(b) How many 5 digit numbers can be formed from the digits 1,2,3,4,5 using the digits without repetition ?

(i) How many of them are even?
(ii) How many are even and greater than 30,000?

(8 marks)

OR

14.

(a) There are 8 guests in a party. Each guest brings a gift and receives another gift in return. No one is allowed to receive the gift they bought. How many ways are there to distribute the gifts?

(6 marks)

(b) Six papers are set in an examination of which two are mathematical. Only one examination will be conducted in a day. In how many different orders ,can the papers be arranged so that

(i) Two mathematical papers are consecutive?
(ii) Two mathematical papers are not consecutive?

(8 marks)

.

15

(a) Let A = { 1,2,3,4,...11,12} and let R be the equivalence relation on A x A defined by (a,b) R (c,d) iff a+d = b+c. Prove that R is an equivalence relation and find the equivalence class of (2 ,5)

(8 marks)

(b) What is a chain lattice ? Explain. Also show that every chain is a distributive lattice.

(6 marks)

OR

16.

(a) Suppose f(x) = x+2 , g(x) = x-2, and h(x) = 3x for x ε R , where R is the set of real numbers. Find (g o f) , (f o g) , (f o f) and (g o g)

(8 marks)

(b) Let R and S be two relations on a set A . If R and S are symmetric, Prove that (R∩S) is also symmetric.

(6 marks)

17.

(a) Solve the recurrence relation $a_r - 7a_{r-1} + 10a_{r-2} = 0$ for $r \geq 2$; Given $a_0 = 0$; $a_1 = 41$ using generating functions

(8 marks)

(b) Solve the recurrence relation $a_r - 4a_{r-1} + 4a_{r-2} = (r+1)^2$ using generating function.

(6 marks)

OR

18.

(a) Solve $a_n - 3a_{n-1} + 2$; $a_0 = 1$ $n \geq 1$, using generating functions.

(8 marks)

(b) Use generating function to solve the following recurrence relation $a_n = 2a_{n-1} + 2^n$; with $a_0 = 2$.

(6 marks)

19.

(a) Prove that the set 'Q' of rational numbers other than 1 forms an abelian group with respect to the operation ' * ' defined by a * b = a+b -ab.

(8 Marks)

(b) Show that the direct product of two group is a group.

(6 Marks)

OR

20.

(a) Show that the subgroup of a cyclic group is cyclic.

(8 Marks)

(b) Let (A,*) be a group. Show that (A,*) is an abelian group if and only if $a^2 * b^2 = (a*b)^2$ for all ‘a’ and ‘b’ in A

(6 Marks)

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module – 1 (Fundamentals of Logic) (9 hrs)		
1.1	Mathematical logic, Basic Connectives and Truth Table	1
1.2	Statements, Logical Connectives, Tautology, Contradiction	1
1.3	Logical Equivalence, The Laws of Logic	1
1.4	The Principle of duality, Substitution Rules	1
1.5	The implication, The Contrapositive, the Converse , the Inverse	1
1.6	Logical Implication,Rules of Inference, Logical Implication	1
1.7	The use of Quantifiers, Open Statement, Quantifier, Negation	1
1.8	Logically Equivalent, Contrapositive, The Converse, The Inverse	1
1.9	Logical Implications	1
Module - 2 (Fundamentals of Counting Theory) (9 hrs)		
2.1	The Pigeon-hole Principle	1
2.2	The Rule of Sum	1
2.3	Extension of Sum Rule	1
2.4	The Rule of Product	1
2.5	Extension of Product Rule , Permutations	1
2.6	Combinations, Combination with repetition	1
2.7	The Binomial Theorem	1
2.8	The Principle of Inclusion and Exclusion Theorem (Without Proof) Generalization of the Principle	1
2.9	Derangements	1
Module - 3 (Relations and Functions) (9 hrs)		
3.1	Cartesian Product, Binary Relation, Function, Domain, Range , One to One Function Image - Restriction	1
3.2	Properties, Reachability Relations, Reflexive Relations,Symmetric Relations,Transitive relations, Antisymmetric Relations.	1

3.3	Partial Order relations	1
3.4	Equivalence Relation, Irreflexive Relations.	1
3.5	Partially ordered Set, Hasse Diagram.	1
3.6	Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound	1
3.7	Equivalence Relations and Partitions ,Equivalence Class	1
3.8	Lattice- Dual Lattice,sub lattice , Properties of glb and lub	1
3.9	Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice, Distributive Lattice	1
Module - 4 (Generating Functions and Recurrence Relations) (9 hrs)		
4.1	Generating Function , Definition and Examples	1
4.2	Exponential Generating Function.	1
4.3	First Order Linear Recurrence Relations with Constant Coefficients (Lecture I)	1
4.4	First Order Linear Recurrence Relations with Constant Coefficients (Lecture II)	1
4.5	Homogeneous Solution	1
4.6	Non homogeneous Solution	1
4.7	Second order linear recurrence relations with constant coefficients	1
4.8	Homogeneous Solution	1
4.9	Non homogeneous Solution	1
Module - 5 (Algebraic Structures)(9 hrs)		
5.1	Algebraic System-Properties, Homomorphism and Isomorphism	1
5.2	Semi group , Monoid, Cyclic monoid	1

5.3	Sub semigroup and sub monoid	1
5.4	Homomorphism and Isomorphism of Semigroup, Monoids and Groups	1
5.5	Elementary Properties, Subgroup, Symmetric group on three symbols	1
5.6	The direct Product of two Groups	1
5.7	Group Homomorphism, Isomorphism, Cyclic group	1
5.8	Right coset, Left coset	1
5.9	Lagrange's Theorem	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET201	**CIRCUITS AND NETWORKS**	**PCC**	**2**	**2**	**0**	**4**

Preamble : This course introduces circuit analysis techniques applied to dc andac electric circuits. Analyses of electric circuits in steady state and dynamic conditions are discussed. Network analysis is introduced with network parameters and transfer functions. This course servesas the most important prerequisite of all many advanced courses in electrical engineering.

Prerequisite : **Basics of Electrical Engineering / Introduction to Electrical Engineering**

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Apply circuit theorems to simplify and solve complex DC and AC electric networks.
CO 2	Analyse dynamic DC and AC circuits and develop the complete response to excitations.
CO 3	Solve dynamic circuits by applying transformation to s-domain.
CO 4	Analyse three-phase networks in Y and Δ configurations.
CO 5	Solve series /parallel resonant circuits.
CO 6	Develop the representation of two-port networks using network parameters and analyse.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2
CO 5	3	3										2
CO 6	3	3										2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State and explain network theorems (K1)
2. Problems on solving circuits using network theorems. (K2, K3)

Course Outcome 2 (CO2):

1. Distinguish between the natural response and forced response. (K2, K3)
2. Problems on steady state and transient analysis of RL, RC and RLC series circuits with DC excitation and initial conditions. (K2, K3)
3. Problems on steady state and transient analysis of RL, RC and RLC series circuits with sinusoidal excitation. (K2, K3)

Course Outcome 3 (CO3):

1. Problems on mesh analysis and node analysis of transformed circuits in s-domain (K2, K3).
2. Problems on solution of transformed circuits including mutually coupled circuits in s-domain (K2, K3).

Course Outcome 4 (CO4):

1. Problems on analysis of unbalanced Y and Δ configurations. (K2, K3)
2. Evaluation of neutral shift voltage in unbalanced systems. (K2, K3).

Course Outcome 5 (CO5):

1. Define Bandwidth, and draw the frequency dependence of impedance of an RLC network. (K1).
2. Develop the impedance/admittance Vs frequency plot for the given RLC network. (K2).
3. Evalutate the parameters such as quality factor, bandwidth,

Course Outcome 6 (CO6):

1. Problems on finding Z, Y, h and T parameters of simple two port networks. (K2).
2. Derive the expression for Z parameters in terms of T parameters. (K1).
3. Show that the overall transmission parameter matrix for cascaded 2 port network is simply the matrix product of transmission parameters for each individual 2 port network in cascade. (K1).

Model Question paper

QP CODE:

PAGES:4

Reg. No:_______________
Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B.TECH DEGREE EXAMINATION,
MONTH & YEAR

Course Code: EET201

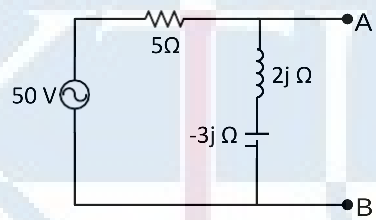
Course Name: CIRCUITS AND NETWORKS

Max. Marks: 100 Duration: 3 Hours

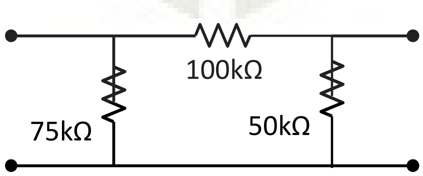
PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. State and explain superposition theorem using an example.
2. Obtain Thevenin's equivalent for the following circuit w.r.t terminals A and B:



3. Define time constant of a circuit. What is the time constant of an RL circuit?
4. How are RLC networks classified according to damping ratios? Sketch the various responses when an RLC series circuit is excited by a DC source.
5. Explain the dot convention used in coupled circuits.
6. Derive the s-domain equivalent circuit of an inductor carrying an initial current of Io.
7. Describe the variation of impedance and phase angle as a function of frequency in a series RLC circuit.
8. Define quality factor. Derive quality factor for inductive and capacitive circuits.
9. Derive the condition for symmetry & reciprocity in terms of T parameters.
10. Obtain Y parameters of the following network:



Part B -14 x 5 = 70 Marks

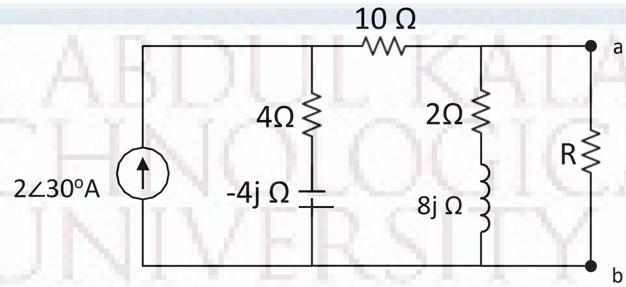
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. With respect to the following circuit,

a) Find the value of Resistor 'R' that results in maximum power transfer to it. **(10)**

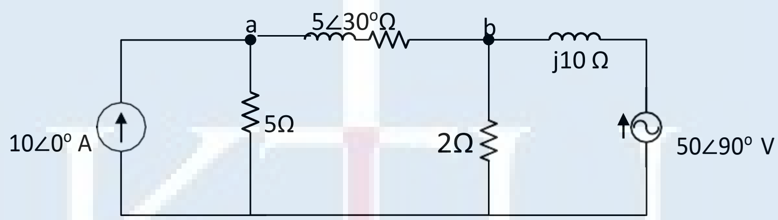
b) Find the value of maximum power transferred to 'R'. **(4)**



12. With respect to the following circuit,

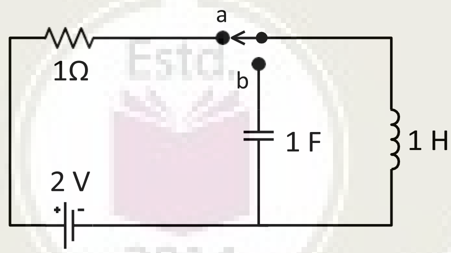
a) Find the voltages at 'a' and 'b' using superposition theorem. **(10)**

b) Obtain the active power dissipated in $5\angle 30^{o}\Omega$ impedance. **(4)**

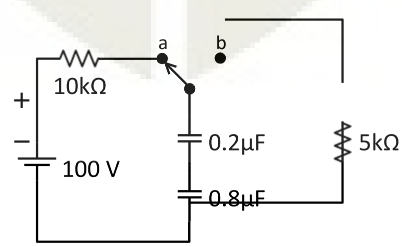


Module 2

13. a) In the following circuit, steady state exits when switch is in position 'a'. At timet = 0, the switch is moved to position 'b' .Obtain an expression for inductor currentfor time t > 0 **(6)**



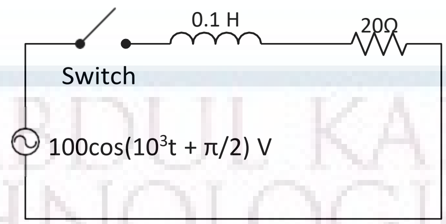
b) For the following circuit, switch 'S' is in position 'a' for a very long time. At time t = 0, the switch is thrown to position 'b'. Find the expression for current through 5kΩ. **(8)**



14. a) Given an RC circuit with zero initial charge on capacitor

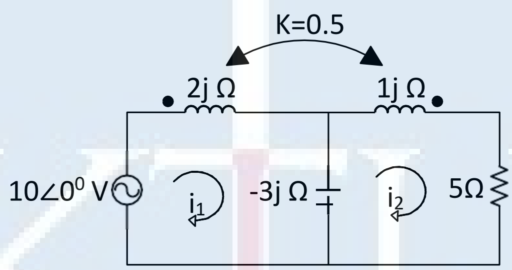
forcurrent after a DCsource 'V_{DC}' is applied to the RC network. Also determine thetime constantofthe circuit. **(4)**

b) Obtain an expression for current in the following circuit after switch is closed attime t=0. Use Laplace transform method. **(10)**

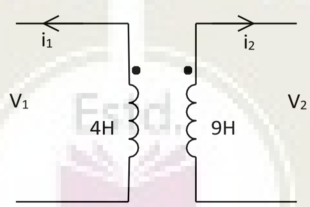


Module 3

15. a) For the following coupled circuit, the coupling coefficient, K =0.5. Write the KVL equations for currents i_1 and i_2. Also obtain the voltage drop across 5Ω resistor. **(10)**



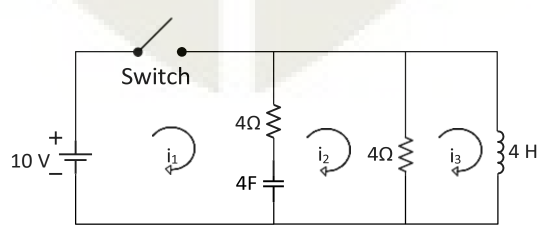
b) In figure, L_1=4H, L_2=9H, coefficient of coupling K=0.5,i_1 = 5 cos(50t-300) Amps, i_2 = 2cos(50t-300) Amps. Write the KVL equations for V_1 and V_2. Find their values at t=0 **(4)**



16. In the circuit shown, at time t = 0, the switch was closed.

a. Model the circuit in s-domain for time t > 0. **(4)**

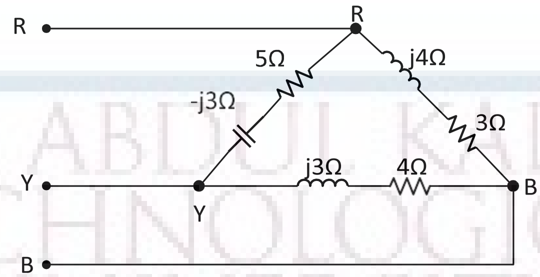
b. Through mesh analysis, obtain the time domain values of values of i_1, i_2 and i_3 Given that the capacitor and inductor were initially relaxed. **(10)**



MODULE 4

17. The following load is delta connected to a 100V three phase system. Find the phase currents, line currents and total power consumed by the load.

(14)



18. An unbalanced 4 wire, star connected load is connected to a balanced voltage of 400V.
The loads are: $Z_1 = (3 + 6j)\Omega$;$Z_2 = (2 + 2j)\Omega$;$Z_3 = (14 + 18j)\Omega$
Calculatea) Line currents **(4)**

b) Current in neutral wire **(4)**

c) Total power **(6)**

Module 5

19. a) Discuss series and parallel interconnection of 2-port networks.

(7)

b) Derive the inter-relationship between Z and Y parameters.

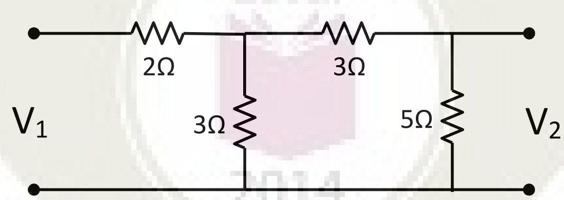
(7)

20. a) A network is given as $I_1 = 2.5V_1 – V_2$;$I_2 = -V_1 + 5V_2$
Draw its equivalentπ network.

(4)

b) Obtain h parameters of the following network:

(10)



Syllabus

Module 1

Circuit theorems: DC and Sinusoidal steady state analysis of circuits with dependent and independent sources applying Superposition principle, Source transformation, Thevenin's, Norton's and Maximum Power Transfer theorems - Reciprocity theorem.

Module 2

Analysis of first and second order dynamic circuits: Formulation of dynamic equations of RL, RC and RLC series and parallel networks with dc excitation and initial conditions and complete solution using Laplace Transforms - Time constant - Complete solution of RL, RC and RLC circuits with sinusoidal excitation using Laplace Transforms – Damping ratio – Over damped, under damped, critically damped and undamped RLC networks.

Module 3

Transformed circuits in s-domain: Transform impedance/admittance of R, L and C - Mesh analysis and node analysis of transformed circuits in s-domain. Transfer Function representation – Poles and zeros.

Analysis of Coupled Circuits: – Dot polarity convention – Sinusoidal steady state analysis of coupled circuits - Linear Transformer as a coupled circuit - Analysis of coupled circuits in s-domain.

Module 4

Three phase networks and resonance: Complex Power in sinusoidal steady state. Steady state analysis of three-phase three-wire and four-wire unbalanced Y circuits, Unbalanced Delta circuit, Neutral shift.

Resonance in Series and Parallel RLC circuits – Quality factor – Bandwidth – Impedance Vs Frequency, Admittance Vs Frequency, Phase angle Vs frequency for series resonant circuit.

Module 5

Two port networks: Driving point and transfer functions – Z, Y, h and T parameters -Conditions for symmetry & reciprocity – relationship between parameter sets – interconnections of two port networks (series, parallel and cascade) — T-π transformation.

Text Books

1. Joseph A. Edminister and MahmoodNahvi, "Theory and Problems in Electric circuits", McGraw Hill, 5th Edition, 2010.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References:

1. Hayt and Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, New Delhi, 8th Ed, 2013.
2. Van Valkenberg, "Network Analysis", Prentice Hall India Learning Pvt. Ltd., 3 edition, 1980.
3. K. S. Suresh Kumar, “Electric Circuit Analysis”, Pearson Publications, 2013.
4. Chakrabarti, "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
5. R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 2010.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Network theorems - DC and AC steady state analysis (12 hours)**	
1.1	Linearity and Superposition principle - Application to the analysis of DC and AC (sinusoidal excitation) circuits. Application of source transformation in electric circuit analysis.	2
1.2	Thevenin’s theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.3	Norton’s theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.4	Maximum power transfer theorem - DC and AC steady state analysis with dependent and independent sources.	2
1.5	Reciprocity Theorem - Application to the analysis of DC and AC Circuits.	2
2	**First order and second order dynamic circuits. (9 hours)**	
2.1	Review of Laplace Transforms – Formulae of Laplace Transforms of common functions/signals, Initial value theorem and final value theorem, Inverse Laplace Transforms – partial fraction method. *(Questions to evaluate the Laplace/inverse transforms of any function / partial fractions method shall not be given in tests/final examination. Problems with application to circuits can be given).*	2
2.2	Formulation of dynamic equations of RL series and parallel networks and solution using Laplace Transforms – with DC excitation and initial	1

	conditions. Natural response and forced response. Time constant.	
2.3	Formulation of dynamic equations of RC series networks and solution using Laplace Transforms – with DC excitation and initial conditions. Natural response and forced response. Time constant.	1
2.4	Formulation of dynamic equations of RLC series networks with DC excitation and initial conditions, and solution using Laplace Transforms – Natural response and forced response. Damping coefficient. Underdamped, Overdamped, critically damped and undamped cases.	1
2.5	Formulation of dynamic equations of RL, RC and RLC series networks and solution with sinusoidal excitation. Complete solution (Solution using Laplace transforms).	2
2.6	Formulation of dynamic equations of RL, RC and RLC parallel networks and solution using Laplace Transforms – with DC and Sinusoidal excitations. Damping ratio.	2
3	**Transformed Circuits in s-domain and Coupled circuits (9 Hours)**	
3.1	Transformed circuits in s-domain: Transformation of elements (R, L, and C) with and without initial conditions.	2
3.2	Mesh analysis of transformed circuits in s-domain.	1
3.3	Node analysis of transformed circuits in s-domain.	1
3.4	Transfer Function representation – Poles and zeros.	1
3.5	Analysis of coupled circuits: mutual inductance – Coupling Coefficient- Dot polarity convention — Conductively coupled equivalent circuits. Linear Transformer as a coupled circuit.	2
3.6	Analysis of coupled circuits in s-domain.	2
4	**Three phase networks and resonance. (6 Hours)**	
4.1	Review of power, power factor, reactive and active power in sinusoidally excited circuits. Concept of complex power.	1
4.2	Steady state analysis of three-phase unbalanced 3-wire and 4-wire Y circuits, Unbalanced Δ circuits, Neutral shift.	2
4.3	Resonance in Series and Parallel RLC circuits – Quality factor – Bandwidth – Impedance Vs Frequency, Admittance Vs Frequency and Phase angleVs frequency for series resonant circuit.	3

5	**Two port networks (9 Hours)**	
5.1	Two port networks: Terminals and Ports, Driving point and transfer functions. Voltage transfer ratio, Current transfer ratio, transfer impedance, transfer admittance, poles and zeros.	2
5.2	Z –parameters. Equivalent circuit representation.	1
5.3	Y parameters. Equivalent circuit representation.	1
5.4	h parameters. Equivalent circuit representation.	1
5.5	T parameters.	1
5.6	Conditions for symmetry & reciprocity, relationship between network parameter sets.	1
5.7	Interconnections of two port networks (series, parallel and cascade).	1
5.8	T-π Transformation.	1

<table>
<tr><td rowspan="2">CST201</td><td rowspan="2">DATA STRUCTURES</td><td>CATEGORY</td><td>L</td><td>T</td><td>P</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>PCC</td><td>3</td><td>1</td><td>0</td><td>4</td><td>2019</td></tr>
</table>

Preamble: This course aims at moulding the learner to understand the various data structures, their organization and operations. The course helps the learners to assess the applicability of different data structures and associated algorithms for solving real world problem which requires to compare and select appropriate data structures to solve the problem efficiently. This course introduces abstract concepts for data organization and manipulation using data structures such as stacks, queues, linked lists, binary trees, heaps and graphs for designing their own data structuresto solve practical application problems in various fields of Computer Science.

Prerequisite: Topics covered under the course Programming in C (EST 102)

CO1	Design an algorithm for a computational task and calculate the time/space complexities of that algorithm **(Cognitive Knowledge Level: Apply)**
CO2	Identify the suitable data structure (array or linked list) to represent a data itemrequired to be processed to solve a given computational problem and write an algorithm to find the solution of the computational problem **(Cognitive Knowledge Level: Apply**)
CO3	Write an algorithm to find the solution of a computational problem by selecting an appropriate data structure (binary tree/graph) to represent a data item to be processed (**Cognitive Knowledge Level: Apply**)
CO4	Store a given dataset using an appropriate Hash Function to enable efficient access of data in the given set (**Cognitive Knowledge Level: Apply**)
CO5	Select appropriate sorting algorithms to be used in specific circumstances (Cognitive Knowledge Level: **Analyze**)
CO6	Design and implement Data Structures for solving real world problems efficiently (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓						✓
CO2	✓	✓	✓	✓		✓						✓
CO3	✓	✓	✓	✓		✓						✓
CO4	✓	✓	✓	✓		✓						✓
CO5	✓	✓	✓	✓		✓						✓
CO6	✓	✓	✓	✓		✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40

Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module 1

Basic Concepts of Data Structures

System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms

Module 2

Arrays and Searching

Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions

Linear Search and Binary Search

Module 3

Linked List and Memory Management

Self Referential Structures, Dynamic Memory Allocation, Singly Linked List-Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List

Memory allocation and de-allocation-First-fit, Best-fit and Worst-fit allocation schemes

Module 4

Trees and Graphs

Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations

Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs

Module 5

Sorting and Hashing

Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort

Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis

Text Book

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Universities Press, Fundamentals of Data Structures in C

Reference Books

1. Samanta D., Classic Data Structures, Prentice Hall India.
2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
3. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication.
4. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.
5. Peter Brass, Advanced Data Structures, Cambridge University Press.
6. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series.
7. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall.
8. Hugges J. K. and J. I. Michtm, A Structured Approach to Programming, PHI.
9. Martin Barrett, Clifford Wagner, C And Unix: Tools For Software Design, John Wiley.

Sample Course Level Assessment Questions

Course Outcome1(CO1): Write an algorithm for matrix multiplication and calculate its time complexity.

Course Outcome 2(CO2): How a linked list can be used to represent the polynomial $5x^4y^6+24x^3y^4-17x^2y^3+15xy^2+45$.Write an algorithm to add two Bivariate polynomials represented using linked list.

Course Outcome 3(CO3): Create a Binary search Tree with node representing the following sequence 14, 15, 4, 18, 9, 16, 20, 17, 3, 7, 5, 2 and perform inorder, preorder and postorder traversals on the above tree and print the output.

Course Outcome 4(CO4): The size of a hash table is 7. The index of the hash table varies from 0 to 6. Consider the keys 89, 18, 49, 58, 25 in the order. Show how the keys are stored in the hash table using Linear probing.

Course Outcome 5(CO5): In what circumstances does Quick Sort perform over Merge sort.

Course Outcome 6(CO6): Design a reservation system for railways that includewaiting list. If the reservation is full “Display reservation full” and put the passenger in in waiting list and give a waiting list number. If a passenger cancels the ticket, then the seat should be automatically allocated to the first passenger in the waiting list.

Model Question Paper

QP CODE: PAGES:3

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 201

Course Name: DATA STRUCTURES

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Calculate the frequency count of the statement x = x+1; in the following code segment

   for (i = 0; i< n; i++)

   for (j = 0; j< n; j*=2)

   x = x + 1;

2. What is the relevance of verification in System Life Cycle?

3. Write an algorithm to insert a new element in a particular position of an array.

4. Convert the expression ((A/(B-D+E))*(F-G)*H) to postfix form. Show each step in the conversion including the stack contents

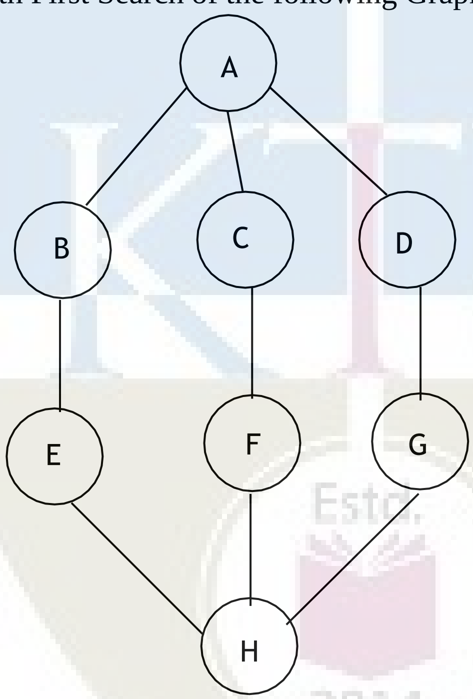
5. Write an algorithm to count the number of occurrences of a character in a linked list (each node contains only one character)

6. Write an algorithm for best-fit method of memory allocation

7. Draw the binary tree whose sequential representation is given below

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B	C	-	D	E	-	-	-	-	F	G	-	-	-

8. Find the Depth First Search of the following Graph



9. Write an algorithm to arrange n numbers in nonincreasing order.

10. Let the size of a hash table is 10. The index of the hash table varies from 0 to 9. Assume the keys 73, 54, 15, 48, 89, 66, 37, 18, 41, 22, 62 are mapped using modulo operator. Show how the keys are distributed using chaining method.

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a) Explain the System Life Cycle in detail (10)

b) How the performance of an algorithm is evaluated? (4)

OR

12. a) Write algorithms for Linear Search and Binary Search and Compare their time complexities (10)

b) Between O(nlogn) and O(logn) which one is better and why? (4)

13. a) Write algorithms to insert and delete elements from a double ended queue. Demonstrate with examples (10)

b) Compare and contrast Circular Queue with a Normal Queue (4)

OR

14. a) Write an algorithm to insert and delete elements from a Priority Queue (8)

b) Discuss an algorithm to convert an infix expression to a prefix expression (6)

15. a) Write an algorithm to multiply two polynomials represented using linked list (10)

b) How doubly linked list can be used to find palindromes ? (4)

OR

16. a) How is memory compaction (de-allocation) done in memory management ? (8)

b) Discuss the advantages and disadvantages of First-fit, Best-fit and Worst-fit allocation schemes (6)

17. a) List the properties of Binary Search Tree. Write an algorithm to search an element from a Binary Search Tree (10)

b) Write an iterative algorithm for in-order traversal of a Binary Tree (4)

OR

18. a) Give algorithms for DFS and BFS of a graph and explain with examples (8)

b) How graphs can be represented in a Computer? (6)

19. a) Write algorithms for Merge sort and Quick Sort. (10)

b) Illustrate the working of Quick sort on the following input 38, 8, 0, 28, 45, -12, 89, 66, 42 (4)

OR

20. a) With examples discuss the different hash functions used for hashing (10)

b) Apply the hash function h(x) = x mod 7 for linear probing on the data 2341, 4234, 2839, 430, 22, 397, 3920 and show the resulting hash table (4)

Teaching Plan		
Module 1 :Basic Concepts of Data Structures		(5 hours)
1.1	System Life Cycle,	1 hour
1.2	Algorithms , Performance Analysis	1 hour
1.3	Space Complexity, Time Complexity	1 hour
1.4	Asymptotic Notation (Big O Notation)	1 hour
1.5	Complexity Calculation of Simple Algorithms	1hour
Module 2 :**Arrays and Searching**		(10 hours)
2.1	Polynomial representation using Arrays	1 hour
2.2	Sparse matrix (Lecture 1)	1 hour
2.3	Sparse matrix (Lecture 2)	1 hour

2.4	Stacks	1 hour
2.5	Queues, Circular Queues	1 hour
2.6	Priority Queues,	1 hour
2.7	Double Ended Queues,	1 hour
2.8	Conversion and Evaluation of Expressions (Lecture 1)	1 hour
2.9	Conversion and Evaluation of Expressions (Lecture 2)	1 hour
2.10	Linear Search and Binary Search	1 hour
Module 3 : **Linked List and Memory Management**		(12 hours)
3.1	Self Referential Structures	1 hour
3.2	Dynamic Memory Allocation	1 hour
3.3	Singly Linked List-Operations on Linked List,	1 hour
3.4	Doubly Linked List	1 hour
3.5	Circular Linked List	1 hour
3.6	Stacks using Linked List	1 hour
3.7	Queues using Linked List	1 hour
3.8	Polynomial representation using Linked List (Lecture 1)	1 hour
3.9	Polynomial representation using Linked List (Lecture2)	1 hour
3.10	Memory de-allocation	1 hour
3.11	Memory allocation-First-fit	1 hour
3.12	Best-fit and Worst-fit allocation schemes	1hour
Module 4 :**Trees and Graphs**		(8 hours)
4.1	Trees, Binary Trees	1hour
4.2	Tree Operations, Binary Tree Representation,	1hour
4.3	Tree Traversals	1hour
4.4	Binary Search Trees	1hour
4.5	Binary Search Tree Operations	1hour
4.6	Graphs, Representation of Graphs	1hour

4.7	Depth First Search and Breadth First Search on Graphs	1hour
4.8	Applications of Graphs	1hour
	Module 5 : **Sorting and Hashing**	(10 hours)
5.1	Sorting Techniques – Selection Sort	1hour
5.2	Insertion Sort	1hour
5.3	Quick Sort	1hour
5.4	Merge Sort	1hour
5.5	Heap Sort	1hour
5.6	Hashing- Hashing Techniques	1hour
5.7	Collision Resolution	1hour
5.8	Overflow handling	1hour
5.9	Hashing functions – Mid square and Division methods	1hour
5.10	Folding and Digit Analysis methods	1hour

CST 205	OBJECT ORIENTED PROGRAMMING USING JAVA	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble: The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course covers Object Oriented Principles, Object Oriented Programming in Java, Inheritance, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course helps the learners to develop Desktop GUI Applications, Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

Prerequisite: Topics covered under the course PROGRAMMING IN C (EST 102)

Course Outcomes: After the completion of the course the student will be able to

CO1	Write Java programs using the object oriented concepts - classes, objects,constructors, data hiding, inheritance and polymorphism (Cognitive Knowledge Level: **Apply**)
CO2	Utilise datatypes, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs (Cognitive Knowledge Level: **Apply**)
CO3	Illustrate how robust programs can be written in Java using exception handling mechanism (Cognitive Knowledge Level: **Understand**)
CO4	Write application programs in Java using multithreading and database connectivity (Cognitive Knowledge Level: **Apply**)
CO5	Write Graphical User Interface based application programs by utilising event handling features and Swing in Java (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓						✓		✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (Marks %)	Test2 (Marks %)	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SYLLABUS

Object Oriented Programming Using Java

Module 1

Introduction:

Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Case Study of Automated Fire Alarm System.

Object Modeling Using Unified Modeling Language (UML) – Basic Object Oriented concepts, UML diagrams, Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram.

Introduction to Java - Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues.

Module 2

Core Java Fundamentals:

Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.

Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.

Control Statements - Selection Statements, Iteration Statements and Jump Statements.

Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, ***this*** Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command Line Arguments, Variable Length Arguments.

Inheritance - Super Class, Sub Class, The Keyword ***super***, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using ***final*** with Inheritance.

Module 3

More features of Java:

Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.

Exception Handling - Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause, Multiple ***catch*** Clauses, Nested ***try*** Statements, ***throw***, ***throws*** and ***finally***.

Input/Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Object Streams and Serialization, Working with Files.

Module 4

Advanced features of Java:

Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, using valueOf(), Comparison of StringBuffer and String.

Collections framework - Collections overview, Collections Interfaces- Collection Interface, List Interface.

Collections Class – ArrayList class. Accessing a Collection via an Iterator.

Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model.

Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.

Module 5

Graphical User Interface and Database support of Java:

Swings fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, JTextField.

Java DataBase Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.

Text Books:

1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2. Rajib Mall, Fundamentals of Software Engineering, 4th edition, PHI, 2014.
3. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.

Reference Books:

1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
4. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.
5. Sierra K., Head First Java, 2/e, O'Reilly, 2005.
6. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

Sample Course Level Assessment Questions

Course Outcome1(CO1): For the following passage develop UML diagrams and then implement it as a Java program in accordance with your UML design.

Passage: College Office collects semester fee and college bus fee for each student. A clerk at the college office collects the fees from each student. The bus fee is calculated depending on the distance of the corresponding bus stop from the college. The semester fee varies depending upon the semester as well as branch of each student. Students are supposed to pay the fees in full. Economically backward students are eligible for 50% discount in semester fee. The consolidated fees receipt is issued to each student by the clerk, which contains the student name, admission number, semester and branch of student along with details of fees collected. Students can log in and view the details of fees remitted and dues if any. The system allows students and clerk level login to the system. Clerk is able to view reports of each class showing status of fees payment of each student.

Course Outcome 2(CO2): Write a Java program to evaluate a post fix expression containing two operands and a single operator using stack. Stack should be implemented as a separate entity so as to reflect OOP concepts.

Course Outcome 3(CO3): Write a program to demonstrate the start, run, sleep and join methods in Thread class.

Course Outcome 4(CO4): Write a GUI based program with separate buttons to add, delete and display student details i.e. name, student ID, current semester and branch of study based on student ID.

Course Outcome 5(CO5): Using Swing create a JFrame with a JLabel and two JButtons. Set the texts of JButtons as “Yes” and “No” respectively. Set the JLabel’s text to the text of the button currently being pressed. Initially the JLabel’s text is blank.

Model Question Paper

QP CODE: PAGES:3

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH &

YEAR Course Code: CST205

Course Name: Object Oriented Programming using Java

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Briefly explain the portable, secure and robust features of Java.
2. Describe the concepts of object and class with a suitable Java program.
3. Explain the concept of method overriding with an example.
4. What is the use of the keyword ***final*** in Java?
5. Explain the concept of streams.
6. Explain any two applications of Serialization.
7. Distinguish the usage of "==" and ***equals()*** method when comparing String type?
8. What are Collections in Java? Explain any one Collection interface in Java.
9. Explain any two properties of Swing components in Java.
10. Explain JLabel component. With suitable examples explain any two of its constructors.

Part B

Answer any one question completely from each module

11.

(a) Describe in detail any three Object Oriented Programming principles. Illustrate with suitable examples.

(9)

(b) What is Java Runtime Environment? What is the role of Java Virtual Machine in it? (5)

OR

12.

(a) Compare and contrast Java standard edition and Java enterprise edition. (5)

(b) Why is Java considered to be platform independent? What is the role of Bytecode in making Java platform independent? (9)

13.

(a) Explain in detail the primitive data types in Java. (8)

(b) Explain automatic type conversion in Java with an example. What are the two conditions required for it? (6)

OR

14.

(a) Using a suitable Java program explain the difference between ***private*** and ***public*** members in the context of inheritance. (8)

(b) Is it possible to use the keyword ***super*** within a static method? Give justification for your answer. (6)

15.

(a) Explain in detail about byte streams and character streams with suitable code samples. (6)

(b) Describe in detail about exception handling, ***try*** block and ***catch*** clause with the help of a suitable Java program. (8)

OR

16.

(a) Explain object streams in Java. Explain the role of Serializable interface with a suitable code sample. (8)

(b) Explain ***throw***, ***throws*** and ***finally*** constructs with the help of a Java program. (6)

17.

(a) Describe in detail the creation of a thread using the Runnable interface and the Thread class with suitable examples.

(10)

(b) Explain List Interface. Mention any two exceptions thrown by its methods.

(4)

OR

18.

(a) Explain in detail the Delegation Event model for event handling in Java.

(7)

(b) Write a simple program by extending appropriate class to demonstrate the working of threads in java.

(7)

19.

(a) Write a Java program to demonstrate the use of JLabel and JButton by adding them to JFrame.

(7)

(b) Explain step-by-step procedure of using Java DataBase Connectivity in Java programs.

(7)

OR

20.

(a) Explain the class hierarchy of Java Swing components.

(7)

(b) Write a Java Program to create a student table and to add student details to it using JDBC.

(7)

Teaching Plan		
Module 1 : Introduction		(8 hours)
1.1	Approaches to Software Design- Functional Oriented Design, Object-Oriented Design, Case Study of Automated Fire Alarm System.	1 hour
1.2	Object Modeling Using UML – Basic object oriented concepts	1 hour
1.3	Basic object oriented concepts	1 hour
1.4	UML diagrams, Use case model	1hour
1.5	Class diagram, Interaction diagram	1hour
1.6	Activity diagram, State chart diagram	1hour
1.7	Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. JVM, Java compiler, Bytecode	1hour
1.8	Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues	1hour
Module 2: Core Java Fundamentals		(11 hours)
2.1	Core Java Fundamentals**:** Primitive Data types, Integers, Floating Point Types, Characters, Boolean	1 hour
2.2	Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.	1 hour
2.3	Operators: Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.	1 hour
2.4	Control Statements: Selection Statements, Iteration Statements and Jump Statements.	1 hour
2.5	Object Oriented Programming in Java**:** Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods	1 hour
2.6	Constructors, ***this*** Keyword, Method Overloading, Using Objects as Parameters	1 hour
2.7	Returning Objects, Recursion, Access Control, static Members	1 hour

2.8	Final Variables, Inner Classes, Command-Line Arguments, Variable Length Arguments	1 hour
2.9	Inheritance : Super class, Sub class, the keywords ***super***, ***protected*** Members,	1 hour
2.10	Calling Order of Constructors, Method Overriding, the Object class,	1 hour
2.11	Abstract Classes and Methods, Using ***final*** with Inheritance	1 hour
	Module 3: More features of Java	(8 hours)
3.1	Packages and Interfaces: Defining Package, CLASSPATH, Access Protection, Importing Packages	1 hour
3.2	Interfaces	1 hour
3.3	Input / Output: I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class	1 hour
3.4	Object Streams and Serialization	1 hour
3.5	Working with Files	1 hour
3.6	Exception Handling**:** Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause	1 hour
3.7	Multiple ***catch*** Clauses, Nested ***try*** Statements	1 hour
3.8	***throw***, ***throws*** and ***finally***	1 hour
	Module 4:Advanced features of Java	(10 hours)
4.1	Java Library: String Handling – String Constructors, String Length, Special String Operations	1hour
4.2	Character Extraction, String Comparison, Searching Strings, Modifying Strings Using valueOf( ), Comparison of String Buffer and String.	1hour
4.3	Collections framework – Collections overview, Collections Interfaces-Collection Interface	1hour
4.4	List Interface, Collections Class – ArrayList Class	1hour
4.5	Accessing Collections via an Iterator.	1hour
4.6	Event handling**:** Event Handling Mechanisms, Delegation Event Model	1hour
4.7	Delegation Event Model, Event Classes	1hour

4.8	Sources of Events, Event Listener Interfaces, Using the Delegation Model	1hour
4.9	Multithreaded Programming: The Java Thread Model, The Main Thread, Creating Thread	1hour
4.10	Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	1hour
Module 5: Graphical User Interface and Database support of Java		(8 hours)
5.1	Swings fundamentals, Swing Key Features	1hour
5.2	MVC, Swing Controls, Components and Containers	1hour
5.3	Swing Packages, Event Handling in Swings.	1 hour
5.4	Swing Layout Managers	1hour
5.5	Exploring Swings –JFrame, JLabel, The Swing Buttons, JTextField.	1 hour
5.6	JDBC overview, Creating and Executing Queries – create table, delete, insert, select (Basics only, DBMS course is not a prerequisite).	1hour
5.7	Creating and Executing Queries – create table, delete, insert, select.	1 hour
5.8	Creating and Executing Queries – create table, delete, insert, select.	1 hour

CSL201	DATA STRUCTURES LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The aim of the Course is to give hands-on experience for Learners on creating and using different Data Structures. Data Structures are used to process data and arrange data in different formats for many applications. The most commonly performed operations on data structures are traversing, searching, inserting, deleting and few special operations like merging and sorting.

Prerequisite: Topics covered under the course Programming in C (EST 102)

CO1	Write a time/space efficient program using arrays/linked lists/trees/graphs to provide necessary functionalities meeting a given set of user requirements **(Cognitive Knowledge Level: Analyse)**
CO2	Write a time/space efficient program to sort a list of records based on a given key in the record (**Cognitive Knowledge Level: Apply**)
CO3	Examine a given Data Structure to determine its space complexity and time complexities of operations on it (**Cognitive Knowledge Level: Apply**)
CO4	Design and implement an efficient data structure to represent given data (**Cognitive Knowledge Level: Apply**)
CO5	Write a time/space efficient program to convert an arithmetic expression from one notation to another (**Cognitive Knowledge Level: Apply**)
CO6	Write a program using linked lists to simulate Memory Allocation and Garbage Collection (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓		✓		✓
CO2	✓	✓	✓	✓				✓		✓		✓
CO3	✓	✓	✓	✓				✓		✓		✓
CO4	✓	✓	✓	✓				✓		✓		✓
CO5	✓	✓	✓					✓		✓		✓
CO6	✓	✓	✓					✓		✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Test (Internal Exam)*Percentage*	End Semester Examination *Percentage*
Remember	20	20
Understand	20	20
Apply	60	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**75**	**75**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Evaluation in Lab : 30 marks

Continuous Assessment Test : 15 marks

Viva-voce : 15 marks

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Operating System to Use in Lab **:** Linux

Compiler/Software to Use in Lab **:** gcc

Programming Language to Use in Lab **:** Ansi C

Fair Lab Record:

All Students attending the Data Structures Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Data Structure used and the operations performed on them, Details of Experiment including algorithm and Result of Experiment. The left hand page should contain a print out of the code used for the experiment and sample output obtained for a set of input.

SYLLABUS

1. Implementation of Polynomials and Sparse matrices using arrays**
2. Implementation of Stack , Queues, Priority Queues, DEQUEUE and Circular Queues using arrays**
3. Application problems using stacks: Conversion of expression from one notation to another notation . **
4. Implementation of various linked list operations. **
5. Implementation of stack, queue and their applications using linked list.pression
6. Implementation of trees using linked list
7. Representation of polynomials using linked list, addition and multiplication of polynomials. **
8. Implementation of binary trees using linked lists and arrays- creations, insertion, deletion and traversal. **
9. Implementation of binary search trees – creation, insertion, deletion, search
10. Any application programs using trees
11. Implementation of sorting algorithms – bubble, insertion, selection, quick, merge sort

and heap sort.**

12. Implementation of searching algorithms – linear search, binary search.**

13. Representation of graphs and computing various parameters (in degree, out degree etc.) - adjacency list, adjacency matrix.

14. Implementation of BFS and DFS for each graph representations.**

15. Implementation of hash table using your own mapping functions and observe collisions and overflow resolving schemes.**

16. Simulation of first-fit, best-fit and worst-fit allocations.

17. Simulation of a basic memory allocator and garbage collector using doubly linked list.
    ** mandatory.

DATA STRUCTURES LAB - PRACTICE QUESTIONS

1. Write a program to read two polynomials and store them in an array. Calculate the sum of the two polynomials and display the first polynomial, second polynomial and the resultant polynomial.

2. C Write a program to enter two matrices in normal form . Write a function to convert two matrices to tuple form and display it. Also find the transpose of the two matrices represented in tuple form and display it. Find the sum of the two matrices in tuple form and display the sum in tuple form.

3. Write a program to enter two matrices in normal form . Write a function to convert two matrices to tuple form and display it. Also find the transpose of the two matrices represented in tuple form and display it. Find the sum of the two matrices in tuple form and display the sum in tuple form.

4. Implement a circular queue using arrays with the operations:
   4.1. Insert an element to the queue.
   4.2. Delete an elements from the queue.
   4.3. Display the contents of the queue after each operation.

5. Implement a Queue using arrays with the operations:

5.1. Insert elements to the Queue.
5.2. Delete elements from the Queue.
5.3. Display the contents of the Queue after each operation.

6. Implement a Stack using arrays with the operations:
   6.1 Pushing elements to the Stack.
   6.2 Popping elements from the Stack
   6.3 Display the contents of the Stack after each operation.

7. Implement a Priority Queue using arrays with the operations:
   7.1 Insert elements to the Priority Queue.
   7.2 Delete elements from the Priority Queue.
   7.3 Display the contents of the Priority Queue after each operation.

8. Implement a Double-Ended Queue (DEQUEUE) with the operations:
   8.1 Insert elements to the Front of the queue.
   8.2 Insert elements to the Rear of the queue
   8.3 Delete elements from the Front of the queue.
   8.4 Delete elements from the Rear of the queue.
   8.5 Display the queue after each operation.

9. Using stack convert an infix expression to a postfix expression and evaluate the postfix expression.

10. Write a program to convert an infix expression to a prefix expression using stacks.

11. Convert an infix expression to a postfix expression without using a stack

12. Write a menu driven program for performing the following operations on a Linked List: 12.1. Display
    12.2. Insert at Beginning
    12.3. Insert at End
    12.4. Insert at a specified Position
    12.5. Delete from Beginning
    12.6. Delete from End
    12.7. Delete from a specified Position

13. Implement a stack using linked list with the operations:
    13.1. Push elements to the queue.
    13.2. Pop elements from the queue.
    13.3. Display the queue after each operation.

14. Implement a Queue using linked list with the operations:

14.1. Insert an elements to the queue.
14.2. Delete an elements from the queue.
14.3. Display the queue after each operation.

15. Write a program to reverse the content of queue using stack

16. Write a program to read two polynomials and store them using linked list. Calculate the sum of the two polynomials and display the first polynomial, second polynomial and the resultant polynomial.

17. Write a program to read two polynomials and store them using linked list. Find the product of two polynomials and store the result using linked list. Display the resultant polynomial.

18. Write a program for addition of polynomials containing two variables using linked list.

19. The details of students(number, name, total-mark) are to be stored in a linked list. Write functions for the following operations:
    19.1. Insert
    19.2. Delete
    19.3. Search
    19.4. Sort on the basis of number
    19.5. Display the resultant list after every operation

20. Create a Doubly Linked List from a string taking each character from the string. Check if the given string is palindrome in an efficient method.

21. Create a binary tree with the following operations
    21.1. Insert a new node
    21.2. Inorder traversal.
    21.3. Preorder traversal.
    21.4. Postorder traversal.
    21.5. Delete a node.

22. Write a program to create a binary search tree and find the number of leaf nodes

23. Create a binary search tree with the following operations:
    23.1. Insert a new node .
    23.2. Inorder traversal.
    23.3. Preorder traversal.
    23.4. Postorder traversal.
    23.5. Delete a node.

24. Write a program to sort a set of numbers using a binary tree.

25. Represent any given graph and
    25.1. Perform a depth first search .
    25.2. Perform a breadth first search

26. Create a text file containing the name, height, weight of the students in a class. Perform Quick sort and Merge sort on this data and store the resultant data in two separate files. Also write the time taken by the two sorting methods into the respective files.

Eg.	Sony Mathew	5.5	60
	Arun Sajeev	5.7	58
	Rajesh Kumar	6.1	70

27. Write a program to sort a set of numbers using Heap sort and find a particular number from the sorted set using Binary Search.

28. Implement a Hash table using Chaining method. Let the size of hash table be 10 so that the index varies from 0 to 9.

29. Implement a Hash table that uses Linear Probing for collision resolution

CSL 203	OBJECT ORIENTED PROGRAMMING LAB (IN JAVA)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The aim of the course is to provide hands-on experience to the learners on various object oriented concepts in Java Programming. This course helps the learners to enhance the capability to design and implement various Java applications for real world problems.

Prerequisite: Topics covered under the course Programming in C (EST 102)

Course Outcomes:

At the end of the course, the student should be able to

CO1	Implement the Object Oriented concepts - constructors, inheritance, method overloading & overriding and polymorphism in Java (Cognitive Knowledge Level: **Apply**)
CO2	Implement programs in Java which use datatypes, operators, control statements, built in packages & interfaces, Input/Output streams and Files (Cognitive Knowledge Level: **Apply**)
CO3	Implement robust application programs in Java using exception handling (Cognitive Knowledge Level: **Apply**)
CO4	Implement application programs in Java using multithreading and database connectivity (Cognitive Knowledge Level: **Apply**)
CO5	Implement Graphical User Interface based application programs by utilizing event handling features and Swing in Java (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓			✓		✓		✓
CO2	✓	✓	✓	✓	✓			✓		✓		✓
CO3	✓	✓	✓	✓	✓			✓		✓		✓
CO4	✓	✓	✓	✓	✓			✓		✓		✓
CO5	✓	✓	✓	✓	✓			✓		✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Test - Internal Exam (Percentage)	End Semester Examination (Percentage)
Remember	20	20
Understand	20	20
Apply	60	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 15 marks
Continuous Evaluation in Lab	: 30 marks
Continuous Assessment Test	: 15 marks
Viva-voce	: 15 marks

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Operating System to Use in Lab **:** Linux

Compiler/Software to Use in Lab **:** gcc, javac, jdk, jre, Eclipse, NetBeans, MySQL / PostgreSQL.

Programming Language to Use in Lab **:** Java

Fair Lab Record:
All Students attending the Object Oriented Programming Lab (in Java) should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experi- ment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Operations Performed, Details of Experiment including algo- rithm and Result of Experiment. The left hand page should contain a print out of the code used for the experiment and sample output obtained for a set of input.

SYLLABUS

The syllabus contains six sessions (A, B, C, D, E, F). Each session consists of three concrete Java exercises, out of which at least two questions are mandatory.

(A) Basic programs using datatypes, operators, and control statements in Java.

1) Write a Java program that checks whether a given string is a palindrome or not.
   Ex: MALAYALAM is palindrome.
2) Write a Java Program to find the frequency of a given character in a string. **
3) Write a Java program to multiply two given matrices. **

(B) Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism and garbage collection:

4) Write a Java program which creates a class named 'Employee' having the following members: Name, Age, Phone number, Address, Salary. It also has a method named 'print-Salary( )' which prints the salary of the Employee. Two classes 'Officer' and 'Manager' inherits the 'Employee' class. The 'Officer' and 'Manager' classes have data members 'specialization' and 'department' respectively. Now, assign name, age, phone number, address and salary to an officer and a manager by making an object of both of these classes and print the same. (Exercise to understand inheritance). **
5) Write a java program to create an abstract class named Shape that contains an empty method named numberOfSides( ). Provide three classes named Rectangle, Triangle and Hexagon such that each one of the classes extends the class Shape. Each one of the classes contains only the method numberOfSides( ) that shows the number of sides in the given geometrical structures. (Exercise to understand polymorphism). **
6) Write a Java program to demonstrate the use of garbage collector.

(C) Handling different types of files as well as input and output management methods:

7) Write a file handling program in Java with reader/writer.
8) Write a Java program that read from a file and write to file by handling all file related exceptions. **
9) Write a Java program that reads a line of integers, and then displays each integer, and the sum of all the integers (Use String Tokenizer class of java.util). **

(D) Exception handling and multi-threading applications:

10) Write a Java program that shows the usage of try, catch, throws and finally. **
11) Write a Java program that implements a multi-threaded program which has three threads. First thread generates a random integer every 1 second. If the value is even, second thread computes the square of the number and prints. If the value is odd the third thread will print the value of cube of the number.
12) Write a Java program that shows thread synchronization. **

(E) Graphics Programming:

13) Write a Java program that works as a simple calculator. Arrange Buttons for digits and the + - * % operations properly. Add a text field to display the result. Handle any possible exceptions like divide by zero. Use Java Swing. **
14) Write a Java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time. No light is on when the program starts. **
15) Write a Java program to display all records from a table using Java Database Connectivity (JDBC).

(F) Standard Searching and Sorting Algorithms using data structures and algorithms learned from course Data Structures (**CST 201**):

16) Write a Java program for the following: **
    1) Create a doubly linked list of elements.
    2) Delete a given element from the above list.
    3) Display the contents of the list after deletion.
17) Write a Java program that implements Quick sort algorithm for sorting a list of names in ascending order. **
18) Write a Java program that implements the binary search algorithm.

** Mandatory

PRACTICE QUESTIONS

1) Write a Java program to reverse an given string.
2) Write a Java program to display the transpose of a given matrix.
3) Write a Java program to find the second smallest element in an array.
4) Write a Java program to check whether a given number is prime or not.
5) Write a Java program to calculate the area of different shapes namely circle, rectangle, and triangle using the concept of method overloading.
6) Write two Java classes Employee and Engineer. Engineer should inherit from Employee class. Employee class to have two methods display() and calcSalary(). Write a program to display the engineer salary and to display from Employee class using a single object instantiation (i.e., only one object creation is allowed).
   - display() only prints the name of the class and does not return any value. Ex. “ Name of class is Employee.”
   - calcSalary() in Employee displays “Salary of employee is 10000” and calcSalary() in Engineer displays “Salary of employee is 20000.”
7) Write a Java program to illustrate Interface inheritance.
8) Write a Java program that shows how to create a user-defined exception.
9) Write a Java program to create two threads: One for displaying all odd number between 1 and 100 and second thread for displaying all even numbers between 1 and 100.
10) Write a Java program that shows thread priorities.
11) Write a Java program that reads a file and displays the file on the screen, with a line number before each line.
12) Write a Java program that displays the number of characters, lines and words in a text file.
13) Write a Java program for handling mouse events.
14) Write a Java program for handling key events using Adapter classes (general).
15) Write a Java program that allows the user to draw lines, rectangles and ovals.
16) Write a Java Swing program to print a wave form on the output screen.
17) Write a program to accept rollno, name, CGPA of “n” students and store the data to a database using JDBC connectivity. Display the list of students having CGPA greater than 7. (Use MySQL /PostgreSQL).
18) Write a Java program to implement Heap sort algorithm using array.

SEMESTER III

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET285	DYNAMIC CIRCUITS AND SYSTEMS	VAC	3	1	0	4

Preamble : This course introduces the application of circuit analysis techniques to dc and ac electric circuits. Analysis of electric circuits both in steady state and dynamic conditions are discussed. Network analysis using network parameters and transfer functions is also included .

Prerequisite : **Basics of Electrical Engineering / Introduction to Electrical Engineering**

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Apply circuit theorems to simplify and solve complex DC and AC electric networks.
CO 2	Analyse dynamic DC and AC circuits and develop the complete response to excitations.
CO 3	Solve dynamic circuits by applying transformation to s-domain.
CO 4	Solve series /parallel resonant circuits.
CO 5	Develop the representation of two-port networks using network parameters and analyse the network.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2
CO 5	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. State and explain network theorems (K1)
2. Problems on solving circuits using network theorems. (K2, K3)

Course Outcome 2 (CO 2):

1. Distinguish between the natural response and forced response. (K2, K3)
2. Problems related to steady state and transient analysis of RL, RC and RLC series circuits with DC excitation and initial conditions. (K2, K3)
3. Problems related to steady state and transient analysis of RL, RC and RLC series circuits with sinusoidal excitation. (K2, K3)

Course Outcome 3 (CO 3):

1. Problems related to mesh analysis and node analysis of transformed circuits in s-domain (K2, K3).
2. Problems related to solution of transformed circuits including mutually coupled circuits in s-domain (K2, K3).

Course Outcome 4 (CO 4):

1. Define Bandwidth, and draw the frequency dependence of impedance of an RLC network. (K1).
2. Develop the impedance/admittance Vs frequency plot for the given RLC network. (K2).
3. Evalutate the parameters such as quality factor, bandwidth,

Course Outcome 5 (CO 5):

1. Problems to find Z, Y, h and T parameters of simple two port networks. (K2).
2. Derive the expression for Z parameters in terms of T parameters. (K1).
3. Show that the overall transmission parameter matrix for cascaded 2 port network is simply the matrix product of transmission parameters for each individual 2 port network in cascade. (K1).

Model Question paper

QP CODE:

PAGES:2

Reg. No:_______________
Name:_______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH. DEGREE EXAMINATION

Course Code: EET285
Course Name: DYNAMIC CIRCUITS AND SYSTEMS

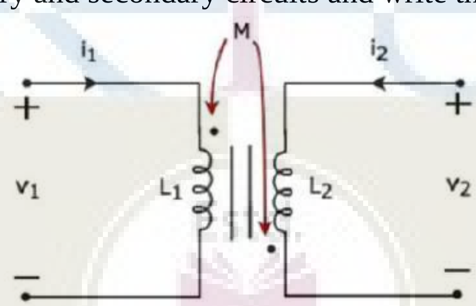
Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1. What is the condition for transferring maximum power to load in an ac network? How is it obtained?
2. State and explain the reciprocity theorem.
3. Derive an expression for calculating the steady state current when an ac is applied to a series RL circuit.
4. A voltage of $v(t) = 10\cos(1000t + 60^0)$ is applied to a series RLC circuit in which R=10Ω, L=0.02H and C=10^{-4} F. Find the steady current.
5. Apply KVL in both primary and secondary circuits and write the corresponding equations.



6. Give the transform representation in s-domain of an inductor with initial current and transform representation in s-domain of a capacitor with initial voltage.
7. Compare series and parallel resonance on the basis of resonant frequency, impedance and bandwidth.
8. How is selectivity measured in a parallel resonant circuit? How is selectivity increased?
9. What are the conditions for reciprocity of a two port network in terms of z parameters? What are the similar conditions in terms of y parameters?
10. How do we find equivalent T network of a two port network if z parameters are given?

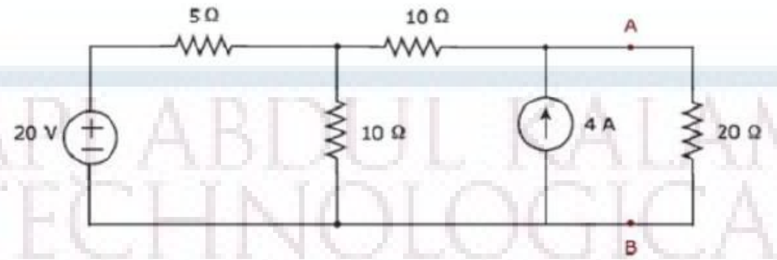
(10 x 3 = 30)

PART B

Answer any one full question, each carries14 marks.

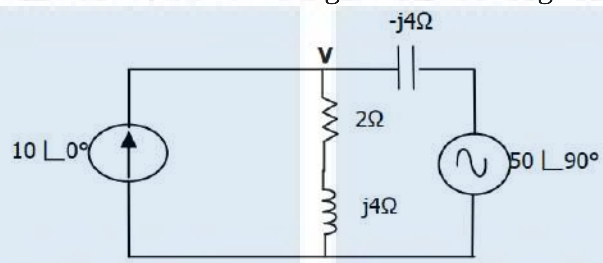
MODULE1

11. a) Find the current through the 20Ω resistor using Norton's theorem. **(6)**



b) State and prove maximum power transfer theorem. **(8)**

12. a) Use superposition theorem to find the voltage V shown in figure. **(8)**



b)State Thevenin's theorem. How is Thevenin equivalent circuit developed? **(6)**

MODULE II

13. a)Write the dynamic equations for analyzing the behavior of step response of a series RLC circuit. **(7)**

b) A sinusoidal voltage 25 sin 10t is applied at time t=0 to a series RL circuit comprising of R=5 Ω, L = 1 H. Using Laplace transformation, find an expression for instantaneous current in the circuit. **(7)**

14. a) A voltage 10 cos (1000t + 60^0) is applied to a series RLC circuit comprising of R=10 Ω, L = 0.02 H, C = 10^{-4} F. Find an expression for the steady state current in the circuit. **(7)**

b) A capacitor C having capacitance of 0.2 F is initially charged to 10 volts and it is connected to an RL series circuit comprising of R=4Ω and L = 1 H, by means of a switch at time t=0. Find the current through the circuit by means of Laplace transformation method. **(7)**

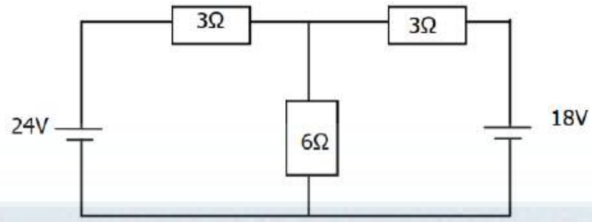
MODULE III

15. a) An LC network comprises of series inductor branches L1 and L2 each of inductance 2 H and parallel capacitor branches C1 and C2 each with capacitance 1 F. Find the transform impedance Z(s). **(6)**

b) What are reciprocal networks? What are the conditions that should be satisfied by a network to be reciprocal? **(8)**

16. a) How is transfer function representation of a network function helpful in analyzing the behavior of the network? Mention the significance of poles and zeros in network functions? **(8)**

b) Using Laplace transformation, find the current in the 6 Ω resistor. **(6)**



MODULE IV

17. a) In a series RLC circuit, for frequencies more than the resonant frequency, what nature of reactance is exhibited? Substantiate the reason for the answer. **(6)**

b) A series RLC circuit consists of R= 25 Ω, L = 0.01 H, C = 0.04 μF. Calculate the resonant frequency. If 10 V is applied to the circuit at resonant frequency, calculate the voltages across L and C. Find the frequencies at which these voltages are maximum. **(8)**

18. a) A coil of resistance 20 ohm and inductance of 200 mH is connected in parallel with a variable capacitor. This combination is connected in series with a resistance of 8000 ohm. Supply voltage is 200 V, 50Hz. Calculate the following

i) The value of C at resonance

ii) The Q of the coil

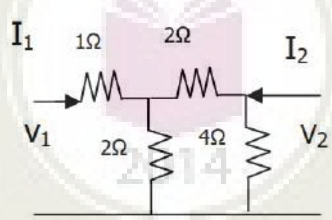
iii) Dynamic resistance of the circuit. **(7)**

b) Derive expressions for selectivity and bandwidth of a parallel tuned circuit. **(7)**

MODULE V

19. a) A two port network has the following z parameters: z_{11}=10 Ω, z_{12}=z_{21}=5 Ω, z_{22} = 12 Ω. Evaluate the y parameters for the network. **(8)**

b) Find the z parameters of the network given. **(6)**



20. a) For the given two-port network equations, draw an equivalent network. $I_1 = 5V_1 - V_2$; $I_2 = -V_2 + V_1$. **(7)**

b) A symmetrical T-network has the following open-circuit and short-circuit impedances:

Z_{oc}= 800Ω (open circuit impedance)

Z_{sc}= 600Ω(short circuit impedance)

Calculate impedance values of the network. **(7)**

Syllabus

Module 1

Circuit theorems: DC and Sinusoidal steady state analysis of circuits with dependent and independent sources applying Superposition principle, Source transformation, Thevenin's, Norton's and Maximum Power Transfer theorems - Reciprocity theorem.

Module 2

Analysis of first and second order dynamic circuits: Formulation of dynamic equations of RL, RC and RLC series and parallel networks with dc excitation and initial conditions and complete solution using Laplace Transforms - Time constant - Complete solution of RL, RC and RLC circuits with sinusoidal excitation using Laplace Transforms – Damping ratio – Over damped, under damped, critically damped and undamped RLC networks.

Module 3

Transformed circuits in s-domain: Transform impedance/admittance of R, L and C - Mesh analysis and node analysis of transformed circuits in s-domain. Transfer Function representation – Poles and zeros.

Analysis of Coupled Circuits: – Dot polarity convention – Sinusoidal steady state analysis of coupled circuits - Linear Transformer as a coupled circuit - Analysis of coupled circuits in s-domain.

Module 4

Resonance in Series and Parallel Circuits:

Resonance in Series and Parallel RLC circuits – Quality factor – Bandwidth – Impedance Vs Frequency, Admittance Vs Frequency, Phase angle Vs frequency for series resonant circuit.

Module 5

Two port networks: Driving point and transfer functions – Z, Y, h and T parameters **-** Conditions for symmetry & reciprocity – relationship between parameter sets – interconnections of two port networks (series, parallel and cascade) — T-π transformation.

Text Books

1. Joseph A. Edminister and MahmoodNahvi, "Theory and Problems in Electric circuits", McGraw Hill, 5th Edition, 2010.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References:

1. Hayt and Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, New Delhi, 8th Ed, 2013.
2. Van Valkenberg, "Network Analysis", Prentice Hall India Learning Pvt. Ltd., 3 edition, 1980.
3. K. S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
4. Chakrabarti, "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
5. R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 2010.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Network theorems - DC and AC steady state analysis (12 hours)**	
1.1	Linearity and Superposition principle - Application to the analysis of DC and AC (sinusoidal excitation) circuits. Application of source transformation in electric circuit analysis.	2
1.2	Thevenin's theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.3	Norton's theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.4	Maximum power transfer theorem - DC and AC steady state analysis with dependent and independent sources.	2
1.5	Reciprocity Theorem - Application to the analysis of DC and AC Circuits.	2
2	**First order and second order dynamic circuits. (9 hours)**	
2.1	Review of Laplace Transforms – Formulae of Laplace Transforms of common functions/signals, Initial value theorem and final value theorem, Inverse Laplace Transforms – partial fraction method. *(Questions to evaluate the Laplace/inverse transforms of any function / partial fractions method shall not be given in tests/final examination. Problems with application to circuits can be given).*	2
2.2	Formulation of dynamic equations of RL series and parallel networks and solution using Laplace Transforms – with DC excitation and initial conditions. Natural response and forced response. Time constant.	1

2.3	Formulation of dynamic equations of RC series networks and solution using Laplace Transforms – with DC excitation and initial conditions. Natural response and forced response. Time constant.	1
2.4	Formulation of dynamic equations of RLC series networks with DC excitation and initial conditions, and solution using Laplace Transforms – Natural response and forced response. Damping coefficient. Underdamped, Overdamped, critically damped and undamped cases.	1
2.5	Formulation of dynamic equations of RL, RC and RLC series networks and solution with sinusoidal excitation. Complete solution (Solution using Laplace transforms).	2
2.6	Formulation of dynamic equations of RL, RC and RLC parallel networks and solution using Laplace Transforms – with DC and Sinusoidal excitations. Damping ratio.	2
3	**Transformed Circuits in s-domain and Coupled circuits (9 Hours)**	
3.1	Transformed circuits in s-domain: Transformation of elements (R, L, and C) with and without initial conditions.	2
3.2	Mesh analysis of transformed circuits in s-domain.	1
3.3	Node analysis of transformed circuits in s-domain.	1
3.4	Transfer Function representation – Poles and zeros.	1
3.5	Analysis of coupled circuits: mutual inductance – Coupling Coefficient-Dot polarity convention — Conductively coupled equivalent circuits. Linear Transformer as a coupled circuit.	2
3.6	Analysis of coupled circuits in s-domain.	2
4	**Resonance in Series and Parallel Circuits. (6 Hours)**	
4.1	Resonance in Series and Parallel RLC circuits –Related problems	3
4.2	Quality factor – Bandwidth –	1
4.3	Impedance Vs Frequency, Admittance Vs Frequency and Phase angle Vs frequency for series resonant circuit.	2

5	**Two port networks (9 Hours)**	
5.1	Two port networks: Terminals and Ports, Driving point and transfer functions. Voltage transfer ratio, Current transfer ratio, transfer impedance, transfer admittance, poles and zeros.	2
5.2	Z –parameters. Equivalent circuit representation.	1
5.3	Y parameters. Equivalent circuit representation.	1
5.4	h parameters. Equivalent circuit representation.	1
5.5	T parameters.	1
5.6	Conditions for symmetry & reciprocity, relationship between network parameter sets.	1
5.7	Interconnections of two port networks (series, parallel and cascade).	1
5.8	T-π Transformation.	1

CODE EOT283	BASICS OF MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course will enable students to:

1) Understand the prominent methods for machine learning

2) Distinguish between, supervised, unsupervised learning

3) Apply the appropriate machine learning strategy for any given problem

Prerequisite:Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Differentiate various learning approaches, and to interpret the concepts of supervised learning
CO 2	Apply theoretical foundations of decision trees and design and implement machine learning solutions to regression and clustering problems
CO 3	Understand Instance based learning and Artificial Neural Networks concepts
CO 4	Illustrate the working of classifier models like SVM and to interpret Unsupervised learning concepts
CO 5	Understand Reinforcement learning, Ensemble learning and Deep Neural Networks concepts
CO 6	Design and analyse machine learning experiments for real-life problems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										
CO 2	3	3	3	1								
CO 3	3	1										
CO 4	3	3	2									
CO 5	3	1										
CO 6	3	3	3	2								

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Machine learning? Briefly explain the types of learning
2. Explain different perspectives and issues in machine learning.
3. Briefly describe the concept on model selection and generalization

Course Outcome 2 (CO2)

1. Give Decision Tree representations for following Boolean Functions
   - A ∨ (B ∧ C)
   - (A ∧ B) ∨ (C ∧ D)
2. Use Principle component analysis (PCA) to arrive at the transformed matrix for the given matrix A

A^T

$$\begin{bmatrix} 2 & 1 & 0 & -1 \\ 4 & 3 & 1 & 0.5 \end{bmatrix}$$

3. Discuss the issues of avoiding overfitting the data, handling continuous data and missing values in decision trees

Course Outcome 3(CO3):

1. With a suitable example explain back propagation in Neural Network ?
2. What is instance based learning? Explain k-nearest neighbour algorithm.
3. Explain locally weighted linear regression

Course Outcome 4 (CO4):

1. What is the goal of the support vector machine (SVM)? How to compute the margin
2. Explain the concept of a Kernel function in Support Vector Machines. Why are kernels so useful? What properties a kernel should possess to be used in an SVM?
3. Define VC dimension. How VC dimension is related with no of training examples used for learning.

Course Outcome 5 (CO5):

1. What you mean by Reinforcement learning? How the reinforcement problem differs from other function approximation tasks?
2. Discuss the learning tasks and Q learning in the context of reinforcement learning
3. Differentiate between bagging, boosting

Course Outcome 6 (CO6):

1. Identify the suitable learning method in each case and Explain it.

(a) Grouping people in a social network

(b)Training a robotic arm

2. With a suitable example, explain Face Recognition using Machine Learning
3. Discuss the application of Neural network which is used for learning to steer an autonomous vehicle

Model Question Paper

PAGES: 2

QP CODE:

Reg.No:____________

Name:_____________

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION

MONTH & YEAR

Course Code**: EOT283**

Course Name: **BASICS OF MACHINE LEARNING**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1 List out any five application of machine learning

2 Compare Unsupervised Learning and Reinforcement Learning with examples

3 Illustrate the idea of PCA for a two-dimensional data using suitable diagrams

4 Distinguish between inductive bias and estimation bias

5 Is regression a supervised learning technique? Justify your answer. Compare regression with classification with examples

6 What types of problems are suitable with- Neural Network?

7 Explain Kernel Trick in the context of support vector machine. List any two kernel function used in SVM.

8 Explain Kernel Trick in the context of support vector machine. List any two kernel function used in SVM

9 Describe any two techniques used for Ensemble Learning

10 What are the basic elements of reinforcement learning?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Explain the steps of developing machine learning applications (10 marks)

b) Define Machine Learning and Explain with example importance of Machine Learning (4 marks)

12 a) What is the significance of classification & explain their types? (7 marks)

b) Imagine you have two possibilities: You can fax a document, that is, send the image, or you can use an optical character reader (OCR) and send the text file. Discuss the advantage and disadvantages of the two approaches in a comparative manner. When would one be preferable over the other? (7 marks)

Module 2

13 a) at is inductive biasing? Is there any effect on classification due to bias?(10 marks)

b) Explain the derivation of k-means algorithm. (4 marks)

14 a) Describe ID3 algorithm for decision tree learning (7 marks)

b) Write and explain decision tree for the following transactions (7 marks)

Tid	Refund	Marital status	Taxable Income	Cheat
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	95K	Yes
6	No	Married	60K	No
7	Yes	Divorced	220K	No
8	No	Single	85K	Yes
9	No	Married	75K	No
10	No	Single	90K	Yes

Module 3

15 a) Discuss how k-nearest neighbour learning differ from distance weighted neighbour learning? Explain with example (10 marks)

b) Discuss locally weighted regression (4 marks)

a) Derive the backpropagation rule considering the output layer and training rule for output unit weights. (8 marks)

b) Discuss the application of neural network which is used for learning to steer an automated vehicle. (6 marks)

Module 4

17 a) Discuss the influence of model complexity on underfitting and overfitting. (7 Marks)

b) How do we measure the power of a classifier? What is the VC dimension for a linear classifier? (7 Marks)

18 a) Discuss the geometric intuition behind SVMs. Discuss soft margin and hard margin SVMs. (10 Marks)

b) When do you apply "kernel Trick"? (4 Marks)

Module 5

19 a) Explain the concept of Bagging with its uses. (6 marks)

b) You're training a neural network and notice that the validation error is significantly lower than the training error. Name two possible reasons for this to happen. (8 marks)

a) Discuss problem characteristics in the Reinforcement Learning method. (5 marks)
b) Explain boosting and ADA boosting algorithm with neat sketch. (9 Marks)

Syllabus

Module 1.
Introduction: Well-posed learning problems, examples of machine learning applications, classification, regression, supervised and unsupervised learning, reinforcement learning, perspective and issues in machine learning, noise, learning multiple classes, model selection and generalization

Module 2
Decision tree: representation, appropriate problems for decision tree learning, inductive bias in tree learning, restriction biases and preference biases, avoiding overfitting the data, regression tree.
Clustering: k means, hierarchical clustering, Feature reduction: PCA

Module 3
Instance based learning: k-nearest neighbor learning, distance weighted neighbor learning, Linear regression, Logistic Regression, locally weighted regression,
Artificial Neural Networks: Early Models, Training, Backpropagation

Module 4
Support Vector Machines: VC dimension, linear SVM, soft margin SVM, kernel functions, nonlinear SVM, Multiclass classification using SVM, support vector regression
Unsupervised Learning: Competitive learning, learning vector quantization, self organizing maps

Module 5
Fundamentals of reinforcement learning, introduction to deep neural network, Ensemble learning: Bagging, Boosting
Model Evaluation, cross validation and Evaluation Measures, The ROC Curve

Text Books

1. Ethem Alpaydin,” Introduction to Machine Learning (Adaptive Computation and Machine Learning)”, Second Edition,The MIT Press, Year: 2010
2.Tom M. Mitchell,” Machine Learning”, McGraw-Hill, 1, 1997.

Reference Books

1. Nilsson N.J,” Introduction to machine learning”,1996, Stanford university
2.Simon Rogers and Mark Girolami,” A First Course in Machine learning”, CRC Press
3. Oliver Kramer, ”Machine learning for Evolution strategies”, Springer international publishing, 2016
4. Harrigton P., “Machine learning in Action”, Manning publications,2012

5. Miroslav Kubat, 'An Introduction to Machine Learning", Springer international publishing, 2015
Online Resources
6. Mehyryar mohri, Afshin, Ameel, "Foundations of Machine Learning", MIT Press,2012

Online Resources

1.AndrewNg,"MachineLearning",StanfordUniversityhttps://www.coursera.org/learn/machine -learning/home/info
2. Sudeshna Sarkar, "Introduction to Machine Learning", IIT Kharagpur. https://nptel.ac.in/courses/106105152/1
3. Prof. BalaramanRavindran, "Introduction to Machine Learning", IIT Madras. https://nptel.ac.in/courses/106106139/1

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	**(8 hours)**
1.1	Introduction: Well-posed learning problems, examples of machine learning applications, classification	2
1.2	Regression, supervised and unsupervised learning, reinforcement learning	3
1.3	Perspective and issues in machine learning, noise, learning multiple classes, model selection and generalization	3
2	**Module 2**	**(8 hours)**
2.1	Decision tree; representation, Appropriate problems for decision tree learning,	2
2.2	Inductive bias in tree learning, restriction biases and preference biases, avoiding overfitting the data, regression tree	3
2.3	Clustering: k means, hierarchical clustering, Feature reduction: PCA	3
3	**Module 3**	**(9 hours)**
3.1	Instance based learning: k-nearest neighbor learning, distance weighted neighbor learning	3
3.2	Linear regression, Logistic Regression, locally weighted regression	3
3.3	Artificial Neural Networks: Early Models, Training, Backpropagation	3
4	**Module 4**	**(10 hours)**
4.1	Support Vector Machines: VC dimension, linear SVM, soft margin SVM, kernel functions	3
4.2	nonlinear SVM, Multiclass classification using SVM, support vector regression	3
4.3	Unsupervised Learning: Competitive learning, learning vector	4

	quantization, self organizing maps	
5	**Module 5**	**(10 hours)**
5.1	Fundamentals of reinforcement learning, introduction to deep neural network	3
5.2	Ensemble learning: Bagging, Boosting	3
5.3	Model Evaluation, cross validation and Evaluation Measures, The ROC Curve	4

EOT285	ELECTRICAL MACHINES FUNDAMENTALS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Objective of this course is to inculcate in students an awareness of Electrical machines

Prerequisite: Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Select appropriate DC motors and generators for any industrial applications
CO 2	Choose appropriate transformers for ac drives
CO 3	Choose appropriate three phase motors for ac drives
CO 4	Find suitable motors for low power applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1										1
CO 2	2	1					1					1
CO 3	3	1					1					1
CO 4	2	1										1

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1.Classify the DC machines.
2. What is Armature Reaction:
3. Problems on EMF equation

Course Outcome 2 (CO2)

1.What are the losses in transformers? .
2. What are the design constraints in transformer winding?
3. Problems in transformers

Course Outcome 3(CO3)

1.Plot the torque speed characteristics of induction motor.
2. What is slip? Why is it significant for selection of a motor drive?
3. Problems in motor

Course Outcome 4 (CO4):

1.Problems in stepper motor.
2. What is the principle of BLDC motor?
3. What are the motors required for mixer – grinder?

Model Question paper

No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION

Model Question paper

PART A

Answer all Questions. Each question carries 3 Marks

1) What is meant by critical speed of a dc shunt generator? How can it be determined?
2) What is critical resistance and why is it significant?
3) What are the applications of dc shunt, series and compound motors?
4) Explain why we are using starters for starting a dc motor.
5) What do you meant by all day efficiency of a single phase transformer
6) The maximum flux density in the core of a 240/3000V,50 Hz single phase transformer is 1.3Wb/m^2. If the EMF per turn is 8 Volt. Determine i) primary and secondary turns ii)area of the core
7) What is meant by circle diagram of an induction motor? What are the parameters we get from the circle diagram?
8) Explain with diagram auto transformer starting of a three phase induction motor.
9) Draw and explain V curves of a synchronous motor.
10) What are the methods of starting a synchronous motor?

PART B

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11 a) A 6 pole dc shunt generator with 780 wave connected armature conductors and running at 500 rpm supplies a load of 12.5 ohms resistance at a terminal voltage of 250 V. The armature resistance is 0.25 ohms and field resistance is 250 ohms. Find the following i)Armature current ii) induced EMF iii) Flux per pole (6)

b)Draw and explain load characteristics of dc shunt generator. (8)

12 a) Explain the classification of dc generators based on their field winding excitation with diagrams and equations. (7)

b) What is mean by armature reaction in dc generator.What are the effects of armature reaction in a dc generator? (7)

Module 2

13 a) Derive an expression for gross armature torque developed by a dc motor (6)

b) Draw and explain torque speed and torque armature current characteristics of dc series motor. (8)

14 a) With the help of a neat sketch explain the load test of a dc shunt motor. (7)

b) A 4 pole, 245 V wave connected shunt motor gives 11.19KW power when running at 1000 rpm and drawing armature and field currents of 50A and 0.8A respectively. It has 542 armature conductors. Its resistance is 0.15 ohms. Assuming a drop of 1 volt per brush. Find i) Total torque ii) useful torque iii) rotational losses iv) efficiency (7)

Module 3

15 a) Explain open circuit and short circuit test of a single phase transformer with circuit diagrams. (7)

b) Draw and explain phasor diagram of a transformer at capacitive load. (7)

16 a) Explain with diagram current transformer and potential transformer. (7)

b)Derive the emf equation of single phase transformer. Mention the condition to be satisified for operating the transformer at its maximum efficiency (7)

Module 4

17 a) Differentiate between slip ring and squirrel cage induction motors (7)

b) Draw and explain the torque slip characteristics of a three phase induction motor.(7)

18 a)Prove that a three phase supply will produce a rotating magnetic field of constant magnitude in a three phase induction motor. (7)

b) Explain no load and blocked rotor tests on three phase induction motor with circuit diagrams and relevant equations (7)

Module 5

19 a) Explain with diagram the working of universal motor (6)

b) How voltage regulation of an alternator is determined by EMF method. Explain (8)

20 a) Explain the working of capacitor start single phase induction motor with diagram. Also list its applications. (7)

b) Draw the schematic diagram of a permanent magnet stepper motor and explain its working. (7)

Syllabus

Module 1 DC Machines-principle of operation-emf equation-types of excitations. Separately excited, shunt and series excited DC generators, compound generators. General idea of armature reaction, OCC and load characteristics - simple numerical problems.

Module 2 Principles of dc motors-torque and speed equations-torque speed characteristics- variations of speed, torque and power with motor current. Applications of dc shunt series and compound motors. Principles of starting, losses and efficiency – load test- simple numerical problems.

Module 3 Transformers – principles of operations – emf equation- vector diagrams- losses and efficiency – OC and SC tests. Equivalent circuits- efficiency calculations- maximum efficiency – all day efficiency – simple numerical problems. Auto transformers constant voltage transformer- instrument transformers

Module 4 Three phase induction motors- slip ring and squirrel cage types- principles of operation – rotating magnetic field- torque slip characteristics- no load and blocked rotor tests. Circle diagrams- methods of starting – direct online – auto transformer starting.

Module 5 Single phase motors- principle of operation of single phase induction motor – split phase motor – capacitor start motor- stepper motor- universal motor. Synchronous machines- types – emf equation of alternator. Principles of operation of synchronous motors- methods of starting- V curves- synchronous condenser.
Principle of BLDC Motor- emf equation, ripple torque- torque equation (concept only)

Text Books

1. Kothari D. P. and I. J. Nagrath, *Electrical Machines*, Tata McGraw Hill, 2004.

Reference Books

1. Theraja B. L. and A. K. Theraja, *A Text Book of Electrical Technology*, S. Chand & Company Ltd., 2008.

2. Partab H., *Art and Science of Utilization of Electric Energy*, Dhanpat Rai & Sons, 1980.
3. Mehta V. K. and R. Mehta, *Principles of Electrical and Electronics*, S. Chand & Company Ltd., 1996.
4. Gupta B. R. and V. Singhal, *Fundamentals of Electric Machines*, New Age International Publishers Ltd, New Delhi, 2005.

5. Sivanagaraju S., M. B. Reddy and D. Srilatha, Generation and Utilization Electrical Energy, Pearson Education, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction	(10)
1.1	DC Machines-principle of operation-emf equation	1
1.2	types of excitations. Separately excited, shunt and series excited DC generators	1
1.3	shunt and series excited DC generators, compound generators	1
1.4	General idea of armature reaction,	1
1.5	OCC	2
1.6	load characteristics	2
1.7	Simple numerical problems.	2
2	DC Motors	(9)
2.1	Principles of dc motors-torque and speed equation	2
2.2	torque speed characteristics-	1
2.3	variations of speed, torque and power with motor current	2
2.4	Applications of dc shunt series and compound motors. Principles of starting	2
2.5	losses and efficiency – load test	2
3	Transformers	(8)
3.1	Transformers – principles of operations – emf equation-	1
3.2	vector diagrams- losses and efficiency	2
3.3	OC and SC tests. Equivalent circuits	2
3.4	Efficiency calculations- maximum efficiency – all day efficiency – simple numerical problems.	2
3.5	Auto transformers constant voltage transformer- instrument transformers	1
4	Three Phase AC Motors	(9)
4.1	Three phase induction motors- slip ring and squirrel cage types	2
4.2	principles of operation – rotating magnetic field- torque slip characteristics-	2
4.3	No load and blocked rotor tests.	2
4.4	Circle diagrams	2
4.5	Methods of starting – direct online – auto transformer starting.	1
5	AC and DC Motors	(9)
5.1	Single phase motors- principle of operation of single phase induction motor	1
5.2	split phase motor – capacitor start motor	1
5.3	stepper motor- universal motor	1
5.4	Synchronous machines- types – emf equation of alternator	1
5.5	Principles of operation of synchronous motors - V curves	1
5.6	Methods of starting synchronous condenser.	1

5.7	BLDC motor- Principle	1
5.8	EMF and ripple torque -Torque equation-	2

SEMESTER IV

CODE MAT204	COURSE NAME PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS	CATEGORY	L	T	P	CREDIT
		BSC	3	1	0	4

Preamble: This course introduces students to the modern theory of probability and statistics, covering important models of random variables and analysis of random processes using appropriate time and frequency domain tools. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

Prerequisite: A basic course in one-variable and multi-variable calculus**.**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the concept, properties and important models of discrete random variables and, using them, analyse suitable random phenomena.
CO 2	Understand the concept, properties and important models of continuous random variables and, using them, analyse suitable random phenomena.
CO 3	Analyse random processes using autocorrelation, power spectrum and Poisson process model as appropriate.
CO 4	Compute roots of equations, evaluate definite integrals and perform interpolation on given numerical data using standard numerical techniques
CO 5	Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	2	2					2		1
CO 2	3	2	2	2	2					2		1
CO 3	3	2	2	2	2					2		1
CO 4	3	2	2	2	2					2		1
CO 5	3	2	2	2	2					2		1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(%)		End Semester Examination(%)
	1	2	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Let X denote the number that shows up when an unfair die is tossed. Faces 1 to 5 of the die are equally likely, while face 6 is twice as likely as any other. Find the probability distribution, mean and variance of X.
2. An equipment consists of 5 components each of which may fail independently with probability 0.15. If the equipment is able to function properly when at least 3 of the components are operational, what is the probability that it functions properly?
3. X is a binomial random variable $B(n,p)$with $n = 100$and $p = 0.1$. How would you approximate it by a Poisson random variable?
4. Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of (X,Y)

Course Outcome 2 (CO2)

1. What can you say about $P(X = a)$for any real number $a$when $X$is (i) a discrete random variable? (ii) a continuous random variable?
2. A string, 1 meter long, is cut into two pieces at a random point between its ends. What is the probability that the length of one piece is at least twice the length of the other?

3. A random variable has a normal distribution with standard deviation 10. If the probability that it will take on a value less than 82.5 is 0.82, what is the probability that it will take on a value more than 58.3?

4. X and Y are independent random variables with X following an exponential distribution with parameter μ and Y following and exponential distribution with parameterλ. Find $P(X+Y \leqslant 1)$

Course Outcome 3(CO3):

1. A random process $X(t)$ is defined by $acos(\omega t+\Theta)$where a and ω are constants and Θ is uniformly distributed in$[0,2\pi]$. Show that $X(t)$ is WSS

2. How are the autocorrelation function and power spectral density of a WSS process are related to each other?

3. Find the power spectral density of the WSS random process $X(t)$, given the autocorrelation function $R_X(\tau)=9e^{-|\tau|}$

4. A conversation in a wireless ad-hoc network is severely disturbed by interference signals according to a Poisson process of rate $\lambda=0.01$ per minute. (a) What is the probability that no interference signals occur within the first two minutes of the conversation? (b) Given that the first two minutes are free of disturbing effects, what is the probability that in the next minute precisely 1 interfering signal disturbs the conversation? (c) Given that there was only 1 interfering signal in the first 3 minutes, what is the probability that there would be utmost 2 disturbances in the first 4 minutes?

Course Outcome 4(CO4):

1. Use Newton-Raphson method to find a real root of the equation $f(x)=e^{2x}-x-6$correct to 4 decimal places.

2. Compare Newton's divided difference method and Lagrange's method of interpolation.

3. Use Newton's forward interpolation formula to compute the approximate values of the function $f$at $x=0.25$from the following table of values of $x$and $f(x)$

x	0	0.5	1	1.5	2
f(x)	1.0000	1.0513	1.1052	1.1618	1.2214

4. Find a polynomial of degree 3 or less the graph of which passes through the points (-1, 3), (0,-4), (1,5) and (2,-6)

Course Outcome 5 (CO5):

1. Apply Gauss-Seidel method to solve the following system of equations
$$4x_1 - x_2 - x_3 = 3$$
$$-2x_1 + 6x_2 + x_3 = 9$$
$$-x_1 + x_2 + 7x_3 = -6$$

2. Using the method of least squares fit a straight line of the form $y = ax + b$to the following set of ordered pairs (x, y) :
(2,4), (3,5), (5,7), (7,10), (9,15)

3. Write the normal equations for fitting a curve of the form $y = a_0 + a_1x^2$to a given set of pairs of data points.

4. Use Runge-Kutta method of fourth order to compute $y(0.25)$and $y(0.5)$, given the initial value problem
$$y' = x + xy + y, y(0) = 1$$

Syllabus

Module 1 (Discrete probability distributions) 9 hours

(Text-1: *Relevant topics* from sections-3.1-3.4, 3.6, 5.1)

Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables)

Module 2 (Continuous probability distributions) 9 hours

(Text-1:*Relevant topics* from sections-4.1-4.4, 3.6, 5.1)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables), i. i. d random variables and Central limit theorem (without proof).

Module 3 (Random Processes) 9 hours

(Text-2: *Relevant topics* from sections-8.1-8.5, 8.7, 10.5)

Random processes and classification, mean and autocorrelation, wide sense stationary (WSS) processes, autocorrelation and power spectral density of WSS processes and their properties, Poisson process-distribution of inter-arrival times, combination of independent Poisson processes(merging) and subdivision (splitting) of Poisson processes (**results without proof**).

Module 4 (Numerical methods -I) 9 hours

(Text 3- *Relevant topics* from sections 19.1, 19.2, 19.3, 19.5)

Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Newton's forward and backward difference method, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (**Proof or derivation of the formulae not required for any of the methods in this module**)

Module 5 (Numerical methods -II) 9 hours

(Text 3- *Relevant topics* from sections 20.3, 20.5, 21.1)

Solution of linear systems-Gauss-Seidel and Jacobi iteration methods. Curve fitting-method of least squares, fitting straight lines and parabolas. Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams-Moulton predictor-correction method (**Proof or derivation of the formulae not required for any of the methods in this module**)

Text Books

1. (Text-1) Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, 8th edition, Cengage, 2012
2. (Text-2) Oliver C. Ibe, *Fundamentals of Applied Probability and Random Processes,* Elsevier, 2005.
3. (Text-3) Erwin Kreyszig, *Advanced Engineering Mathematics*, 10 th Edition, John Wiley & Sons, 2016.

Reference Books

1. Hossein Pishro-Nik, *Introduction to Probability, Statistics and Random Processes*, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2. V.Sundarapandian, *Probability, Statistics and Queueing theory*, PHI Learning, 2009
3. Gubner, *Probability and Random Processes for Electrical and Computer Engineers*, Cambridge University Press,2006.
4. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 36 Edition, 2010.

Assignments

Assignments should include specific problems highlighting the applications of the methods introduced in this course in physical sciences and engineering.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Discrete Probability distributions**	**9 hours**
1.1	Discrete random variables and probability distributions, expected value, mean and variance (discrete)	3
1.2	Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial	3
1.3	Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	3
2	**Continuous Probability distributions**	**9 hours**
2.1	Continuous random variables and probability distributions, expected value, mean and variance (continuous)	2
2.2	Uniform, exponential and normal distributions, mean and variance of these distributions	4
2.3	Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	3
3	**Random processes**	**9 hours**
3.1	Random process -definition and classification, mean , autocorrelation	2
3.2	WSS processes its autocorrelation function and properties	2
3.3	Power spectral density	2
3.4	Poisson process, inter-distribution of arrival time, merging and splitting	3
4	**Numerical methods-I**	**9 hours**
4.1	Roots of equations- Newton-Raphson, regulafalsi methods	2
4.2	Interpolation-finite differences, Newton's forward and backward formula,	3
4.3	Newton's divided difference method, Lagrange's method	2
4.3	Numerical integration-trapezoidal rule and Simpson's 1/3-rd rule	2
5	**Numerical methods-II**	**9 hours**
5.1	Solution of linear systems-Gauss-Siedal method, Jacobi iteration	2

	method	
5.2	Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares	2
5.3	Solution of ODE-Euler and Classical Runge-Kutta methods of second and fourth order	4
5.4	Adams-Moulton predictor-corrector method	1

Model Question Paper

(2019 Scheme)

Reg No: .... **Total Pages: 3**

Name: ....

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION

(Month & year)

Course Code: MAT 204

Course Name: PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS

(For (i) Electrical and Electronics, (ii) Electronics and Communication, (iii) Applied Electronics and Instrumentation Engineering branches)

Max Marks :100 Duration : 3 Hours

PART A

(Answer *all* questions. Each question carries 3 marks)

1. Suppose X is binomial random variable with parameters $n = 100$ and $p = 0.02$. Find $P(X < 3)$ using Poisson approximation to X. (3)

2. The diameter of circular metallic discs produced by a machine is a random variable with mean 6cm and variance 2cm. Find the mean area of the discs. (3)

3. Find the mean and variance of the continuous random variable X with probability density function $f(x) = \begin{cases} 2x - 4, & 2 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$ (3)

4. The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3 | X > t)$ where t is any positive real number. (3)

5. Give any two examples of a continuous time discrete state random processes. (3)

6. How will you calculate the mean, variance and total power of a WSS process from its autocorrelation function? (3)

7. Find all the first and second order forward and backward differences of y for the following set of (x, y) values: $(0.5, 1.13)$, $(0.6, 1.19)$, $(0.7, 1.26)$, $(0.8, 1.34)$ (3)

8. The following table gives the values of a function $f(x)$ for certain values of x. (3)

x	0	0.25	0.50	0.75	1
$f(x)$	1	0.9412	0.8	0.64	0.5

   Evaluate $\int_0^1 f(x)dx$ using trapezoidal rule.

9. Explain the principle of least squares for determining a line of best fit to a given data (3)

10. Given the initial value problem $y' = y + x, \quad y(0) = 0$, find $y(0.1)$ and $y(0.2)$ using Euler method. (3)

PART B

(Answer one question from each module)

MODULE 1

11. (a) The probability mass function of a discrete random variable is $p(x) = kx, x = 1, 2, 3$ where k is a positive constant. Find (i)the value of k (ii) $P(X \leq 2)$ (iii) $E[X]$ and (iv) $\text{var}(1 - X)$. (7)

(b) Find the mean and variance of a binomial random variable (7)

OR

12. (a) Accidents occur at an intersection at a Poisson rate of 2 per day. what is the probability that there would be no accidents on a given day? What is the probability that in January there are at least 3 days (not necessarily consecutive) without any accidents? (7)

(b) Two fair dice are rolled. Let X denote the number on the first die and $Y = 0$ or 1, according as the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y, (ii) the marginal distributions. (iii) Are X and Y independent ? (7)

MODULE 2

13. (a) The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130. (7)

(b) A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find $P(X < 0)$ (7)

OR

14. (a) The joint density function of random variables X and Y is given by (7)

$$f(x, y) = \begin{cases} e^{-(x+y)}, & x > 0, \quad y > 0 \\ 0 & \text{otherwise.} \end{cases}$$

Find $P(X + Y \leq 1)$. Are X and Y independent? Justify.

(b) The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time. (7)

MODULE 3

15. (a) A random process $X(t)$ is defined by $X(t) = Y(t)\cos(\omega t + \Theta)$ where $Y(t)$ is a WSS process, ω is a constant and Θ is uniformly distributed in $[0, 2\pi]$ and is independent of $Y(t)$. Show that $X(t)$ is WSS (7)

(b) Find the power spectral density of the random process $X(t) = a\sin(\omega_0 t + \Theta)$, ω_0 constant and Θ is uniformly distributed in $(0, 2\pi)$ (7)

OR

16. Cell-phone calls processed by a certain wireless base station arrive according to a Poisson process with an average of 12 per minute.

(a) What is the probability that more than three calls arrive in an interval of length 20 seconds? (7)

(b) What is the probability that more than 3 calls arrive in each of two consecutive intervals of length 20 seconds? (7)

MODULE 4

17. (a) Use Newton-Raphson method to find a non-zero solution of $x = 2\sin x$. Start with $x_0 = 1$ (7)

(b) Using Lagrange's interpolating polynomial estimate $f(1.5)$ for the following data (7)

x	0	1	2	3
$y = f(x)$	0	0.9826	0.6299	0.5532

OR

18. (a) Consider the data given in the following table (7)

x	0	0.5	1	1.5	2
$f(x)$	1.0000	1.0513	1.1052	1.1618	1.2214

Estimate the value of $f(1.80)$ using newton's backward interpolation formula.

(b) Evaluate $\int_0^1 e^{-x^2/2}dx$ using Simpson's one-third rule, dividing the interval $[0, 1]$ into 8 subintervals (7)

MODULE 5

19. (a) Using Gauss-Seidel method, solve the following system of equations (7)

$$20x + y - 2z = 17$$
$$3x + 20y - z = -18$$
$$2x - 3y + 20z = 25$$

(b) The table below gives the estimated population of a country (in millions) for during 1980-1995 (7)

year	1980	1985	1990	1995
population	227	237	249	262

Plot a graph of this data and fit an appropriate curve to the data using the method of least squares. Hence predict the population for the year 2010.

OR

20. (a) Use Runge-Kutta method of fourth order to find $y(0.2)$ given the initial value problem (7)

$$\frac{dy}{dx} = \frac{xy}{1 + x^2}, \quad y(0) = 1$$

Take step-size, $h = 0.1$.

(b) Solve the initial value problem (7)

$$\frac{dy}{dx} = x + y, \quad y(0) = 0,$$

in the interval $0 \leq x \leq 1$, taking step-size $h = 0.2$. Calculate $y(0.2), y(0.4)$ and $y(0.6)$ using Runge-Kutta second order method, and $y(0.8)$ and $y(1.0)$ using Adam-Moulton predictor-corrector method.

****

CST202	COMPUTER ORGANISATION AND ARCHITECTURE	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble:

The course is prepared with the view of enabling the learners capable of understanding the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learnersto understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

Prerequisite : Topics covered under the course Logic System Design (CST 203)

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Recognize and express the relevance of basic components, I/O organization and pipelining schemes in a digital computer **(Cognitive knowledge: Understand)**
CO2	Explain the types of memory systems and mapping functions used in memory systems **(Cognitive Knowledge Level: Understand**)
CO3	Demonstrate the control signals required for the execution of a given instruction **(Cognitive Knowledge Level: Apply**))
CO4	Illustrate the design of Arithmetic Logic Unit and explain the usage of registers in it (**Cognitive Knowledge Level: Apply**)
CO5	Explain the implementation aspects of arithmetic algorithms in a digital computer **(Cognitive Knowledge Level:Apply)**
CO6	Develop the control logic for a given arithmetic problem (**Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓						✓		✓
CO3	✓	✓	✓	✓						✓		✓
CO4	✓	✓	✓	✓						✓		✓
CO5	✓	✓	✓							✓		✓
CO6	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	20	20	30
Understand	40	40	30
Apply	40	40	40
Analyze			

Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations,Instructions and instruction sequencing , addressing modes.

Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization

Module 2

Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations.

Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register –design of shifter - processor unit – design of accumulator.

Module 3

Arithmetic algorithms: Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier , Booth's multiplication algorithm.

Pipelining: Basic principles**,** classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.

Module 4

Control Logic Design: Control organization – Hard_wired control-microprogram control – control of processor unit - Microprogram sequencer,micro programmed CPU organization - horizontal and vertical micro instructions.

Module 5

I/O organization: accessing of I/O devices – interrupts, interrupt hardware -Direct memory access.

Memory system: basic concepts – semiconductor RAMs. memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions.

Text Books

1. Hamacher C., Z. Vranesic and S. Zaky, Computer Organization ,5/e, McGraw Hill, 2011
2. Mano M. M., Digital Logic & Computer Design, PHI, 2004
3. KaiHwang, Faye Alye Briggs, Computer architecture and parallel processing McGraw-Hill, 1984

Reference Books

1. Mano M. M., Digital Logic & Computer Design, 3/e, Pearson Education, 2013.
2. Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013.
3. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.
4. Chaudhuri P., Computer Organization and Design, 2/e, Prentice Hall, 2008.
5. Rajaraman V. and T. Radhakrishnan, Computer Organization and Architecture, Prentice Hall, 2011

Sample Course Level Assessment Questions

Course Outcome1(CO1): Which are the registers involved in a memory access operation and how are they involved in it?

Course Outcome 2(CO2): Explain the steps taken by the system to handle a write miss condition inside the cache memory.

Course Outcome 3(CO3): Generate the sequence of control signals required for the execution of the instruction MOV [R1],R2 in a threebus organization.

Course Outcome 4(CO4): Design a 4-bit combinational logic shifter with 2 control signals H0 and H1 that perform the following operations :

H1	H0	Operation
0	0	Transfer 1's to all output line
0	1	No shift operation
1	0	Shift left
1	1	Shift right

Course Outcome 5(CO5): Explain the restoring algorithm for binary division. Also trace the algorithm to divide $(1001)_2$ by $(11)_2$

Course Outcome 6(CO6): Design a software control logic based on microprogramed control to perform the addition of 2 signed numbers represented in sign magnitude form.

Model Question Paper

QP CODE: PAGES:2

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH &

YEAR Course Code: CST202

Course Name: Computer organisation and architecture

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Give the significance of instruction cycle.
2. Distinguish between big endian and little endian notations. Also give the significance of these notations.
3. Compare I/O mapped I/O and memory mapped I/O.
4. Give the importance of interrupts in I/O interconnection.
5. Justify the significance of status register.
6. How does the arithmetic circuitry perform logical operations in an ALU.
7. Illustrate divide overflow with an example.
8. Write notes on arithmetic pipeline.
9. Briefly explain the role of micro program sequence.
10. Differentiate between horizontal and vertical micro instructions.

Part B

Answer any one Question from each module. Each question carries 14 Marks

11.

11.(a) What is the significance of addressing modes in computer architecture.

(4)

11.(b) Write the control sequence for the instruction DIV R1,[R2] in a three bus structure.

(10)

OR

12. Explain the concept of a single bus organization with help of a diagram. Write the control sequence for the instruction ADD [R1],[R2].

(14)

13. Explain various register transfer logics.

(14)

OR

14.

14.(a) Design a 4 bit combinational logic shifter with 2 control signals H1 and H2 that perform the following operations (bit values given in parenthesis are the values of control variable H1 and H2 respectively.) : Transfer of 0's to S (00), shift right (01), shift left (10), no shift (11).

(5)

14.(b) Design an ALU unit which will perform arithmetic and logic operation with a given binary adder.

(9)

15.

15.(a) Give the logic used behind Booth's multiplication algorithm.

(4)

15.(b) Identify the appropriate algorithm available inside the system to perform the multiplication between -14 and -9. Also trace the algorithm for the above input.

(10)

OR

16.

16.(a) List and explain the different pipeline hazards and their possible solutions

(10)

16.(b) Design a combinational circuit for 3x2 multiplication. (4)

17. Design a hardwared control unit used to perform addition/subtraction of 2 numbers represented in sign magnitude form. (14)

OR

18. Give the structure of the micro program sequencer and its role in sequencing the micro instructions. (14)

19.

19.(a) Explain the different ways in which interrupt priority schemes can be implemented (10)

19.(b) Give the structure of SRAM cell. (4)

OR

20.

20.(a) Explain the various mapping functions available in cache memory. (9)

20.(b) Briefly explain content addressable memory. (5)

TEACHING PLAN		
No	**Contents**	**No of Lecture Hrs**
	Module 1 : (Basic Structure of computers) (9 hours)	
1.1	Functional units,basic operational concepts,bus structures (introduction)	1
1.2	Memory locations and addresses , memory operations	1
1.3	Instructions and instruction sequencing	1
1.4	Addressing modes	1
1.5	Fundamental concepts of instruction execution, instruction cycle	1
1.6	Execution of a complete instruction - single bus organization (Lecture 1)	1
1.7	Execution of a complete instruction - single bus organization (Lecture 2)	1
1.8	Execution of a complete instruction - multiple bus organization (Lecture 1)	1
1.9	Execution of a complete instruction - multiple bus organization (Lecture 2)	1
	Module 2 :(Register transfer logic and Processor logic design) (10 hours)	
2.1	Inter register transfer – arithmetic micro operations	1
2.2	Inter register transfer – logic and shift micro operations	1
2.3	Processor organization	1
2.4	Design of arithmetic circuit	1
2.5	Design of logic circuit	1
2.6	Design of arithmetic logic unit	1
2.7	Design of status register	1
2.8	Design of shifter - processor unit	1

2.9	Design of accumulator (Lecture 1)	1
2.10	Design of accumulator (Lecture 2)	1
Module 3 : (Arithmetic algorithms and Pipelining) (9 hours)		
3.1	Algorithm for multiplication of binary numbers	1
3.2	Algorithm for division (restoring method) of binary numbers	1
3.3	Array multiplier	1
3.4	Booth's multiplication algorithm	1
3.5	Pipelining: Basic principles	1
3.6	Classification of pipeline processors (Lecture 1)	1
3.7	Classification of pipeline processors (Lecture 2)	1
3.8	Instruction and arithmetic pipelines (Design examples not required)	1
3.9	Hazard detection and resolution	1
Module 4 :(Control Logic Design) (9 hours)		
4.1	Control organization –design of hardwired control logic (Lecture 1)	1
4.2	Control organization –design of hardwired control logic (Lecture 2)	1
4.3	Control organization –design of hardwired control logic (Lecture 3)	1
4.4	Design of microprogram control logic–control of processor unit (Lecture1)	1
4.5	Design of microprogram control logic–control of processor unit (Lecture2)	1
4.6	Design of microprogram control logic–control of processor unit (Lecture3)	1
4.7	Microprogram sequencer	1
4.8	Micro programmed CPU organization	1
4.9	Microinstructions –horizontal and vertical micro instructions	1
Module 5 : (Basic processing units, I/O and memory) (8 hours)		
5.1	Accessing of I/O devices –interrupts	1
5.2	Interrupt hardware	1

5.3	Direct memory access	1
5.4	Memory system: basic concepts –semiconductor RAMs	1
5.5	Memory system considerations – ROMs	1
5.6	Content addressable memory	1
5.7	Cache memories -mapping functions (Lecture 1)	1
5.8	Cache memories -mapping functions (Lecture 2)	1

CST 206	OPERATING SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2019

Preamble: Study of operating system is an essential to understand the overall working ofcomputer system, tradeoffs between performance and functionality and the division of jobs between hardware and software. This course introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of operatingsystem to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

Prerequisite: Topics covered in the courses are **Data Structures (CST 201)** and **Programming in C (EST 102)**

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the relevance, structure and functions of Operating Systems in computing devices. (**Cognitive knowledge: Understand**)
CO2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems. (**Cognitive knowledge: Understand**)
CO3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors (**Cognitive knowledge: Understand**)
CO4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems. (**Cognitive knowledge: Understand**)
CO5	Explain the memory management algorithms in Operating Systems. (**Cognitive knowledge: Understand**)
CO6	Explain the security aspects and algorithms for file and storage management in Operating Systems. **(Cognitive knowledge: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓							✓		✓
CO2	✓	✓	✓	✓						✓		✓
CO3	✓	✓	✓	✓						✓		✓
CO4	✓	✓	✓	✓						✓		✓
CO5	✓	✓	✓	✓						✓		✓
CO6	✓	✓	✓	✓						✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (Marks in percentage)	Test 2 (Marks in percentage)	End Semester Examination (Marks in percentage)
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module I

Introduction: Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules – System boot process.

Module II

Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems.

Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job Firs, Priority scheduling, Round robin scheduling

Module III

Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.

Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.

Module IV

Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.

Module V

File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods.
Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.

Text Book

Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, ' Operating System Concepts' 9th Edition, Wiley India 2015.

Reference Books:

1. Andrew S Tanenbaum, "Modern Operating Systems" , 4th Edition, Prentice Hall, 2015.
2. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition, Pearson Education.
4. D.M.Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.
5. Sibsankar Haldar, Alex A Aravind, "Operating Systems", Pearson Education.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture?

Course Outcome 2 (CO2): Define process. With the help of a neat diagram explain different states of process.

Course Outcome 3 (CO3): What do you mean by binary semaphore and counting semaphore? With C, explain implementation of wait () and signal().

Course Outcome 4 (CO4): Describe resource allocation graph for the following. a) with a deadlock b) with a cycle but no deadlock.

Course Outcome 5 (CO5): Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4 page frames, using the following page replacement algorithms. i) LRU ii) FIFO iii) Optimal

Course Outcome 6 (CO6): Explain the different file allocation methods with advantages and disadvantages.

Model Question Paper

QP CODE: PAGES: ___

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST206

Course name : OPERATING SYSTEMS

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. How does hardware find the Operating System kernel after system switch-on?
2. What is the purpose of system call in operating system?
3. Why is context switching considered as an overhead to the system?

4. How is inter process communication implement using shared memory?
5. Describe resource allocation graph for the following.

   a) with a deadlock b)with a cycle but no deadlock.

6. What is critical section? What requirement should be satisfied by a solution to the critical section problem?
7. Consider the reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults occur while using FCFS for the following cases.

   a) frame=2 b)frame=3

8. Differentiate between internal and external fragmentations.
9. Compare sequential access and direct access methods of storage devices.
10. Define the terms (i) Disk bandwidth (ii) Seek time.

PART-B(Answer any one question from each module)

11. a) Explain the following structures of operating system (i) Monolithic systems (ii) Layered Systems (iii) Micro Kernel (iv) Modular approach. **(12)**

    b) Under what circumstances would a user be better of using a time sharing system than a PC or a single user workstation? **(2)**

OR

12. a) What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture? **(8)**

b) Describe the differences between symmetric and asymmetric multiprocessing? What are the advantages and disadvantages of multiprocessor systems? **(6)**

13. a) Define process. With the help of a neat diagram explain different states of process. **(8)**

b) Explain how a new process can be created in Unix using fork system call. **(6)**

OR

14 a) Find the average waiting time and average turnaround time for the processes given in the table below using:- i) SRT scheduling algorithm ii) Priority scheduling algorithm **(9)**

Process	Arrival Time (ms)	CPU Burst Time (ms)	Priority
P1	0	5	3
P2	2	4	1
P3	3	1	2
P4	5	2	4

b) What is a Process Control Block? Explain the fields used in a Process Control Block. **(5)**

15. Consider a system with five processes P_0 through P_4 and three resources of type A, B, C. Resource type A has 10 instances, B has 5 instances and C has 7 instances. Suppose at time t_0 following snapshot of the system has been taken:

Process	Allocation			Max			Available		
	A	B	C	A	B	C	A	B	C
P_0	0	1	0	7	5	3	3	3	2
P_1	2	0	0	3	2	2			
P_2	3	0	2	9	0	2			
P_3	2	1	1	2	2	2			
P_4	0	0	2	4	3	3			

i) What will be the content of the Need matrix? Is the system in a safe state? If Yes, then what is the safe sequence? **(8)**

iii)What will happen if process P_1 requests one additional instance of resource type A and two instances of resource type C? **(6)**

OR

16. a) State dining philosopher's problem and give a solution using semaphores. **(7)**

b) What do you mean by binary semaphore and counting semaphore? With C struct, explain implementation of wait () and signal() **(7)**

17. a) Consider the following page reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. Find out the number of page faults if there are 4 page frames, using the following page replacement algorithms i) LRU ii) FIFO iii) Optimal **(9)**

b) Explain the steps involved in handling a page fault. **(5)**

OR

18. a) With a diagram, explain how paging is done with TLB. **(5)**

b) Memory partitions of sizes 100 kb, 500 kb, 200 kb, 300 kb, 600 kb are available, how would best ,worst and first fit algorithms place processes of size 212 kb, 417 kb, 112 kb, 426 kb in order. Rank the algorithms in terms of how efficiently they uses memory. **(9)**

19. a) Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. the drive currently services a request at cylinder 143, and the previous request was at cylinder 125. the queue of pending request in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following algorithms

i) FCFS ii) SSFT iii) SCAN iv) LOOK v) C-SCAN **(10)**

b) What is the use of access matrix in protection mechanism? **(4)**

OR

20. a) Explain the different file allocation operations with advantages and disadvantages. **(8)**
b) Explain the following i) file types ii) file operation iii) file attributes **(6)**

Teaching Plan

	Module 1 - Introduction	**5 Hours**
1.1	Introduction to Operating System	1
1.2	Operating System operations, functions, service	1
1.3	System calls, Types	1
1.4	Operating System Structure: Simple, Layered, Microkernel, Modules	1
1.5	System Boot Process	1
	Module 2 – Processes and Process Scheduling	**9 Hours**
2.1	Processes, Process states	1
2.2	Process Control Block, Threads	1

2.3	Scheduling	1
2.4	Operations on processes: process creation and termination	1
2.5	Inter-process communication: Shared memory systems, Message Passing	1
2.6	Process Scheduling – Basic concepts, Scheduling Criteria	1
2.7	Scheduling algorithms - Basics	1
2.8	First come First Served, Shortest Job First	1
2.9	Priority scheduling, Round Robin Scheduling	1
	Module 3 - Process synchronization and Dead locks	**13 Hours**
3.1	Process synchronization, Race conditions	1
3.2	Critical Section problem, Peterson's solution	1
3.3	Synchronization hardware, Mutex Locks	1
3.4	Semaphores	1
3.5	Monitors	1
3.6	Synchronization problem examples (Lecture 1)	1
3.7	Synchronization problem examples (Lecture 2)	1
3.8	Deadlocks: Necessary conditions, Resource Allocation Graphs	1
3.9	Deadlock prevention	1
3.10	Deadlock avoidance	1
3.11	Banker's algorithm	1
3.12	Deadlock detection	1
3.13	Deadlock recovery	1
	Module 4 - Memory Management	**9 Hours**
4.1	Memory Management: Concept of Address spaces	1
4.2	Swapping	1
4.3	Contiguous memory allocation, fixed and variable partitions	1
4.4	Segmentation.	1
4.5	Paging (Lecture 1)	1
4.6	Paging (Lecture 2)	1
4.7	Virtual memory, Demand Paging	1

4.8	Page replacement algorithms (Lecture 1)	1
4.9	Page replacement algorithms (Lecture 2)	1
	Module 5 - File and Disk management	**9 Hours**
5.1	File concept, Attributes, Operations, types, structure	1
5.2	Access methods	1
5.3	Protection	1
5.4	File-System implementation	1
5.5	Directory implementation	1
5.6	Allocation methods	1
5.7	Magnetic disks, Solid-state disks, Disk structure	1
5.8	Disk scheduling	1
5.9	Disk formatting	1

<table>
<tr><td rowspan="3">CSL204</td><td rowspan="3">OPERATING SYSTEMS LAB</td><td rowspan="2">CATEGORY</td><td rowspan="2">L</td><td rowspan="2">T</td><td rowspan="2">P</td><td rowspan="2">CREDIT</td><td>YEAR OF</td></tr>
<tr><td>INTRODUCTION</td></tr>
<tr><td>PCC</td><td>0</td><td>0</td><td>3</td><td>2</td><td>2019</td></tr>
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Preamble: The course aims to offer students a hands-on experience on Operating System concepts using a constructivist approach and problem-oriented learning. Operating systems are the fundamental part of every computing device to run any type of software.

Prerequisite: Topics covered in the courses are **Data Structures (CST 201)** and **Programming in C (EST 102)**

Course Outcomes:

At the end of the course, the student should be able to

CO1	Illustrate the use of systems calls in Operating Systems. **(Cognitive knowledge: Understand)**
CO2	Implement Process Creation and Inter Process Communication in Operating Systems. **(Cognitive knowledge: Apply)**
CO3	Implement Fist Come First Served, Shortest Job First, Round Robin and Priority-based CPU Scheduling Algorithms. **(Cognitive knowledge: Apply)**
CO4	Illustrate the performance of First In First Out, Least Recently Used and Least Frequently Used Page Replacement Algorithms. **(Cognitive knowledge: Apply)**
CO5	Implement modules for Deadlock Detection and Deadlock Avoidance in Operating Systems. **(Cognitive knowledge: Apply)**
CO6	Implement modules for Storage Management and Disk Scheduling in Operating Systems. **(Cognitive knowledge: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓		✓		✓
CO2	✓	✓	✓					✓		✓		✓
CO3	✓	✓	✓	✓				✓		✓		✓
CO4	✓	✓	✓	✓				✓		✓		✓
CO5	✓	✓	✓	✓				✓		✓		✓
CO6	✓	✓	✓	✓				✓		✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern:

Bloom's Category	**Continuous Assessment Test (Internal Exam) Marks in percentage**	**End Semester Examination Marks in percentage**
Remember	20	20
Understand	20	20
Apply	60	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**75**	**75**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	:	15 marks
Continuous Evaluation in Lab	:	30 marks
Continuous Assessment Test	:	15 marks
Viva Voce	:	15 marks

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The percentage of marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 75 marks.

Operating System to Use in Lab : Linux

Compiler/Software to Use in Lab : gcc

Progamming Language to Use in Lab : Ansi C

Fair Lab Record:

All Students attending the Operating System Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record, the right hand page should contain Experiment Heading, Experiment Number, Date of experiment, Aim of the Experiment and the operations performed on them, Details of experiment including algorithm and result of Experiment. The left hand page should contain a print out of the code used for experiment and sample output obtained for a set of input.

SYLLABUS

OPERATING SYSTEMS LAB

* mandatory

1. Basic Linux commands
2. Shell programming

   -Command syntax

   -Write simple functions with basic tests, loops, patterns
3. System calls of Linux operating system:*

   fork, exec, getpid, exit, wait, close, stat, opendir, readdir
4. Write programs using the I/O system calls of Linux operating system (open, read, write)
5. Implement programs for Inter Process Communication using Shared Memory *
6. Implement Semaphores*
7. Implementation of CPU scheduling algorithms. a) Round Robin b) SJF c) FCFS d) Priority *
8. Implementation of the Memory Allocation Methods for fixed partition*

   a) First Fit b) Worst Fit c) Best Fit
9. Implement l page replacement algorithms a) FIFO b) LRU c) LFU*
10. Implement the banker's algorithm for deadlock avoidance. *
11. Implementation of Deadlock detection algorithm
12. Simulate file allocation strategies.

    b) Sequential b) Indexed c) Linked
13. Simulate disk scheduling algorithms. *

    c) FCFS b)SCAN c) C-SCAN

OPERATING SYSTEMS LAB - PRACTICE QUESTIONS

1. Write a program to create a process in linux.
2. Write programs using the following system calls of Linux operating system:

   fork, exec, getpid, exit, wait, close, stat, opendir, readdir
3. Write programs using the I/O system calls of Linux operating system (open, read, write)

4. Given the list of processes, their CPU burst times and arrival times, display/print the Gantt chart for FCFS and SJF. For each of the scheduling policies, compute and print the average waiting time and average turnaround time
5. Write a C program to simulate following non-preemptive CPU scheduling algorithms to find turnaround time and waiting time.

   a) FCFS b) SJF c) Round Robin (pre-emptive) d) Priority
6. Write a C program to simulate following contiguous memory allocation techniques

   a) Worst-fit b) Best-fit c) First-fit
7. Write a C program to simulate paging technique of memory management.
8. Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.
9. Write a C program to simulate disk scheduling algorithms a) FCFS b) SCAN c) C-SCAN
10. Write a C program to simulate page replacement algorithms a) FIFO b) LRU c) LFU
11. Write a C program to simulate producer-consumer problem using semaphores.
12. Write a program for file manipulation for display a file and directory in memory.
13. Write a program to simulate algorithm for deadlock prevention.
14. Write a C program to simulate following file allocation strategies.

    a)Sequential b) Indexed c) Linked

CODE EEL204	DIGITAL ELECTRONICS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Formulate digital functionsusing Boolean Algebra and verify experimentally.
CO 2	Design and implement combinational logic circuits.
CO 3	Design and implement sequential logic circuits.
CO 4	Design and fabricate a digital circuit using the knowledge acquired from the laboratory.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	1	3	3			2	3	3		1
CO 2	3	3	3	3	3			2	3	3		1
CO 3	3	3	3	3	3			2	3	3		1
CO 4	3	2	1	3	2			2	3	3	2	3

LIST OF EXPERIMENTS

Pre-lab assignment : Familiarisation of Logic Gates, Identification of typical logic ICs, Interpreting IC datasheets.

1. Verification & Realisation of De Morgan's theorem.
2. Realisation of SOP & POS functions after K-map reduction.
3. Half adder & Full adder using gates.
4. 4-bit adder/subtractor & BCD adder using IC 7483.
5. Realisation of 2-bit comparator using gates and study of four-bit comparator IC 7485.
6. BCD to decimal decoder and BCD to 7-segment decoder & display.
7. Study of multiplexer IC and realization of combinational circuits using multiplexers.
8. Realization of RS, T, D & JK flip flops using gates.
9. Study of flip flop ICs (7474 & 7476).
10. Realisation of ripple up and down counters and modulo-N counter using flip-flops.
11. Study of counter ICs (7490, 7493).
12. Design of synchronous up, down & modulo-N counters.
13. Realization of 4-bit serial IN serial OUT registers using flip flops.
14. Study of shift register IC 7495, ring counter and Johnsons counter.
15. VHDL implementation of full adder, 4 bit magnitude comparator

Course Project : Students have to do a mandatory course project (group size not more than 4 students) using digital ICs or Programmable Logic Devices (CPLD/FPGA) to realise a functional digital circuit. A maximum of 5 marks shall be awarded for this project (to be evaluated along with the final internal test).

Example of course projects :

1. Realisation of a real-time digital clock with display.
2. Digital Alarms
3. ALU (May be implemented in FPGA)
4. Digital Security Monitoring System
5. Traffic Control

Assessment Pattern :

Mark distribution :

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Regular Lab work	InternalTest	CourseProject	Total
15	30	25	5	75

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks:

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipment and troubleshooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

General instructions : Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Reference Books:

1. Floyd T.L, Digital Fundamentals, 10/e, Pearson Education, 2011.
2. C.H.Roth and L.L.Kimney Fundamentals of Logic Design, 7/e, Cengage Learning,2013.

SEMESTER IV

MINOR

EET286	PRINCIPLES OF INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course introduces principle of operation and construction of basic instrumentation components, their selection and applications.Familiarization of modern basic digital systems are also included.

Prerequisite: Basics of Electronics and Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify and analysethe factors affecting performance of instrumentation system
CO 2	Choose appropriate instrumentation system components for the measurement of different parameters
CO 3	Identify different amplifier circuits for instrumentation including selection of Op-amp for linear and Non-linear applications.
CO 4	Identification and selection of basic filters for instrumentation
CO 5	Outline the principles of operation of linear &Non-linear signal processing systems
CO 6	Understand the operating principles of basic building blocks of digital systems, recording and display units

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	1	-	-	-	-	-	-	2
CO 6	3	-	-	-	2	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. What is the loss angle of a capacitor?
2. Explain sensitivity.
3. What is the theoretical relationship between the current through a pn-diode and the voltage across it?

Course Outcome 2 (CO2):

1. What phenomenon is described by the early effect?
2. What is the loss angle of a capacitor?
3. What types of transducers are used for pressure measurements?

Course Outcome 3(CO3):

1. How to design a second order band pass filter using an OPAMP circuit?
2. Explain the working of Schmitt trigger using OPAMP circuit?
3. Show how Analog multipliers can be used for division and square rooting applications?

Course Outcome 4 (CO4):

1. Explain the different types of passive filters.
2. Differentiate between first and second order filters.

Course Outcome 5 (CO5):

1. What is an amplitude modulated signal with a suppressed carrier?
2. Explain phase locked loop (PLL).
3. How to calculate the maximum digital output error for 3-bit cascaded converter?
4. Explain why the pulse frequency is not of importance to the dual slope converter

Course Outcome 6 (CO6):

1. Block diagram of DMM, CRO, DSO
2. Explain the handshake procedure and indicate also what implications this has for data transmission speed?
3. Discuss the main aspects of “virtual instruments”.

MODEL QUESTION PAPER

QP CODE: PAGES:3

Reg No:______________

Name :______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR Course Code: EET286

Course Name: **PRINCIPLES OF INSTRUMENTATION**

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. What is transducer?
2. What you mean by DC hall effect sensors?
3. How we can find the maximum operating signal frequency of OPAMP?
4. Determine the output voltage of an op-amp for input voltages of V_{i1} = 150 μV, V_{i2} = 140 μV. If it has a differential gain of A_d = 4000 and the value of CMRR is 100
5. Explain voltage-controlled oscillator?
6. What is meant by multiplexing?
7. Draw the block diagram of Dual slope ADC.
8. Calculate the cut-off frequency of a first-order low-pass filter for R_1 =1.2 kΩ and C_1 =0.02 μF.
9. Explain Synchronization and triggering operation in CRO
10. What is use of spectrum and network analysers?

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a)To obtain the value of the series resistance $\mathbf{r_s}$ of a diode the voltage is measuredin two different currents: 0.1 mA and 10 mA. The respective results are 600 mVand 735 mV. Find $\mathbf{r_s}$. **(4)**

    b)With neat diagram explain the working of diode peak detector. **(5)**

    c)Give the approximate value of the differential resistance of a pn-diode at 1 mA,at 0.5 mA and at 1 μA. Give also the conductance values. **(5)**

12. a)Explain with neat diagram explain the operation of diode Limiter/clipper. **(7)**

    b) Explain about thermocouples and their practicaluse in instrumentation. **(7)**

Module 2

13. a)What phenomenon is described by the early effect? **(4)**
    b.Explain the working of differential amplifier. **(5)**
    c. State and explain Inverse square law and Lamberts cosine law. **(5)**
14. a) If the input signal has an rms value of 1 V, the op amp input impedance is 1 MΩ and the circuit's load resistance is 1 kΩ. What is the load current? Express the power gain in terms of the input resistance R_i and the load resistance R_L, what is its value in decibels? **(8)**
    b) Derive the expression for noise factor in OPAMP amplifiers **(6)**

Module 3

15. a)Explain the operation of Active voltage limiter and its advantages over diode voltage limiters. **(6)**

    b) With neat diagram explain the operation of Schmitt trigger. Why positive feedback is provided always in the comparator circuit using an OPAMP? Also explain the hysteresis property of Schmitt trigger circuit. **(8)**

16. a)A voltage amplifier is specified as follows: input offset voltage at 20°C is < 0.5 mV, the temperature coefficient of the offset is < 5 μV/K. Calculate the maximum input offset that might occur within a temperature range of 0 to 80 °C. **(6)**

    b) In the integrator circuit given below the component values are C = 1 mF and R = 10 kW. The specifications of the operational amplifier are: $|V_{off}|$ <0.1 mV and $|I_{bias}|$ < 10 nA. The input is supposed to be zero. At t = 0 the output voltage v_o = 0. What is the value of v_o after 10 seconds? **(8)**

Module 4

17. a) Explain why the pulse frequency is not of importance to the dual slope converter. **(4)**

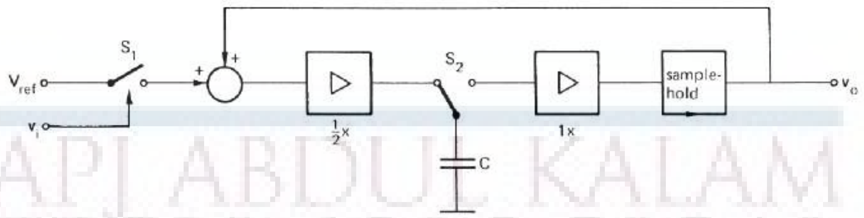
    b) The integration period of an integrating AD-converter is 100 ms ±1 μs.Determine the maximum conversion error caused by a 50 Hz interferencesignal withrms value of 1 V. **(6)**
    c)Explain R-2R ladder digital to analog converter operation. **(4)**

18. a)What is the differential non-linearity of a DA-converter? What is monotony? **(4)**

    b) The clock frequency of a 10-bit successive approximation AD-converter is 200 kHz. Find the (approximated) conversion time for this converter. **(6)**
    c) Explain the term "multiplying DAC" for a DA-converter with external reference. **(4)**

Module 5

19. a) The input signal of the DAC in Figure below is the 3-bit word 101. Make a plot of the relevant output signal versus time. The capacitor is uncharged for t < 0.**(10)**



b)The reference voltage of a 10-bit DA-converter is 10 V. Calculate the outputvoltage when the input code is 1111100000 (MSB first). **(4)**

20. a) Explain the operation of Integrating AD-converters with neat diagram. **(6)**

b)Explain the operation of parallel AD-converters with neat diagram. **(8)**

Syllabus

Module 1

Passive electronic components– Resistors- Capacitors- Inductors and transformers

Circuits with pn-diodes - Limiters - Peak detectors - Clamp circuits - DC voltages sources

Sensors– Sensor components - Resistive sensors - Inductive sensors - Capacitive sensors - Thermoelectric sensors - Piezoelectric sensors.

Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.

Module 2

Circuits with bipolar transistors & field effect transistors - Voltage-to-current converter - voltage amplifier stage with base-current bias - voltage amplifier stage with a base-voltage bias - emitter follower - source follower- differential amplifier

Operational amplifiers - Amplifier circuits with ideal operational amplifiers - Current-to-voltage converters - Inverting voltage amplifiers - Non-inverting voltage amplifiers - Differential amplifiers -Instrumentation amplifiers

Non-ideal operational amplifiers - Selection of operational amplifiers (Specifications)- Input offset voltage - Finite voltage gain

Module 3

Nonlinear signal processing with OPAMP - Voltage comparators - Schmitt-trigger - Voltage limiters - Rectifiers - Nonlinear arithmetic operations - Logarithmic converters - Exponential converters – Multipliers and other arithmetic operators

Electronic switching circuits - Electronic switches - Properties and Components as electronic switches - Circuits with electronic switches - Time multiplexers - Sample-hold circuits - Transient errors

Passive filters - First and second order RC-filters - Low-pass first-order RC-filter – High pass first-order RC-filter - Bandpass filters - Notch filters

Module 4

Modulation and Demodulation - Amplitude modulation and demodulation - Amplitude modulation methods - Demodulation methods. Systems based on synchronous detection - Phase-locked loop - Lock-in amplifiers - Chopper amplifiers

Digital-to-Analogue and Analogue-to-Digital conversion - Parallel converters - Binary signals and codes - Parallel DA-converters - Parallel AD-converters. Special converters - The serial DA-converter - The direct AD converter - Integrating AD-converters

Module 5

Measurement instruments - Stand-alone measurement instruments - Multimeters - Signal generators - Counters, frequency meters and time meters - Spectrum analyzers - Network analyzers - Impedance analyzers

Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.

Computer-based measurement instruments - Bus structures - Introduction to Virtual Instrumentation systems- Simulation softwares(description only)

Text Books

1. D. Patranabis, ‘Sensors and Transducers’, Prentice Hall of India, 2003
2. Helfrick& Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India,5th Edition,2002
3. Sawhney A.K., A course in Electrical and Electronic Measurements & instrumentation, DhanpatRai.
4. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012
5. S Tumanski, Principles of electrical measurement, Taylor & Francis.
6. David A Bell, Electronic Instrumentation and Measurements,3/e, Oxford

Reference Books

1. Cooper W.D., Modern Electronics Instrumentation, Prentice Hall of India
2. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill
3. E.O Doebelin and D.N Manik, Doebelin’s Measurements Systems, sixth edition, McGraw Hill Education (India) Pvt. Ltd.
4. P.Purkait, B.Biswas, S.Das and C. Koley, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education (India) Pvt. Ltd.,2013

Course Contents and Lecture Schedule

Module	Topic coverage	No. of Lectures
1	**Basic Instrumentation Circuit Components (9 hours)**	
1.1	Passive electronic components– Resistors- Capacitors- Inductors and transformers. Circuits with pn-diodes - Limiters - Peak detectors - Clamp circuits - DC voltages sources	3
1.2	Sensors– Sensor components - Resistive sensors - Inductive sensors - Capacitive sensors - Thermoelectric sensors - Piezoelectric sensors	3
1.3	Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.	3
2	**Transistor and amplifier circuits (9 hours)**	
2.1	Circuits with bipolar transistors - Voltage-to-current converter - voltage amplifier stage with base-current bias - voltage amplifier stage with a base-voltage bias - emitter follower - - differential amplifier.	2
2.2	Circuits with field-effect transistors - Voltage-to-current converter - voltage amplifier stage - source follower.	2
2.3	Operational amplifiers - Amplifier circuits with ideal operational amplifiers - Current-to-voltage converters - Inverting voltage amplifiers - Non-inverting voltage amplifiers - Differential amplifiers -Instrumentation amplifiers	3
2.4	Non-ideal operational amplifiers - Selection of operational amplifiers (Specifications)- Input offset voltage - Finite voltage gain	2
3	**Nonlinear signal processing with OPAMP and Filters (9 hours)**	
3.1	Nonlinear transfer functions - Voltage comparators - Schmitt-trigger - Voltage limiters - Rectifiers - Nonlinear arithmetic operations - Logarithmic converters - Exponential converters – Multipliers and other arithmetic operators	3

3.2	Electronic switching circuits - Electronic switches - Properties and Components as electronic switches - Circuits with electronic switches - Time multiplexers - Sample-hold circuits - Transient errors.	3
3.3	Passive filters - First and second order RC-filters - Low-pass first-order RC-filter – High pass first-order RC-filter - Bandpass filters - Notch filters	3
4	**Magnetic ,Lumen and Temperature Measurements (9 hours)**	
4.1	Modulation - Amplitude modulation and demodulation - Amplitude modulation Demodulation- Demodulation methods. Systems based on synchronous detection - The phase-locked loop - Lock-in amplifiers - Chopper amplifiers	4
4.2	Digital-to-Analogue and Analogue-to-Digital conversion - Parallel converters - Binary signals and codes - Parallel DA-converters - Parallel AD-converters	3
4.3	Special converters - The serial DA-converter - The direct AD converter - Integrating AD-converters	2
5	**Measuring instruments including modern recording and displaying instruments (9 hours)**	
5.1	Measurement instruments - Stand-alone measurement instruments - Multimeters - Signal generators - Counters, frequency meters and time meters - Spectrum analyzers - Network analyzers - Impedance analyzers.	4
5.2	Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.	3
5.3	Computer-based measurement instruments - Bus structures - Introduction to Virtual Instrumentation systems- Simulation software's (description only)	2

EOT 284	MATHEMATICS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course teach the solution of system linear equation through matrix method, construction of probability space and important probability distributions, various optimisation techniques, calculus, density estimation with Guassian mixture models and SVM

Prerequisite: EOT283 Basics of Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems (Cognitive Knowledge Level: **Apply**)
CO 2	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems (Cognitive Knowledge Level:**Apply**)
CO 3	Train Machine Learning Models using unconstrained and constrained optimization methods (Cognitive Knowledge Level:**Apply**)
CO 4	Perform calculus operations on functions of several variables and matrices,including partial derivatives and gradients (Cognitive Knowledge Level:**Apply**)
CO 5	Illustrate how the mathematical objects - linear algebra, probability, and calculus can be used to design machine learning algorithms using Density Estimation, Dimension Reduction and Support Vector Machines (Cognitive Knowledge Level:**Understand**)

Mapping of course outcomes with program outcomes

	PO 1		**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3		3	2	2								2
CO 2	3		3	2	2								2
CO 3	2		3	2	2		2						2
CO 4	3		2	2									2
CO 5	3		2	2	2	3	2				2		2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Determine the rank of a matrix.
2. Determine inverse of a matrix
3. Find the characteristic equation, eigen values and eigen spaces corresponding to each eigen value of a matrix.
4. Checks whether the given vector sets are linearly independent.
5. Diagonalize a given matrix.

Course Outcome 2 (CO2)

1. Let A and B be events such that P(A)=0.45 , P(B)=0.35 and P(A∪B)=0.5. Find P(A|B).
2. A biased coin (with probability of obtaining a head equal to p > 0) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.
3. A coin for which P(heads) = p is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.
4. What is an exponential family? Why are exponential families useful?
5. You roll a fair dice twice. Let the random variable X be the product of the outcomes of the two rolls. What is the probability mass function of X? What are the expected value and the standard deviation of X?
6. Explain Normal distribution, Binomial distribution and Poisson distribution in the exponential family form.

Course Outcome 3(CO3):

1. Find the extrema of f(x, y) = x subject to $g(x, y) = x^2 + 2y^2 = 3$.
2. Maximize the function f(x, y, z) = xy + yz + xz on the unit sphere $g(x, y, z) = x^2 + y^2 + z^2 = 1$.
3. Provide necessary and sufficient conditions under which a quadratic optimization problem be written as a linear least squares problem.
4. Consider the univariate function $f(x) = x^3 + 6x^2 - 3x - 5$. Find its stationary points and indicate

whether they are maximum, minimum, or saddle points.
5. Consider the update equation for stochastic gradient descent. Write down the update when we use a mini-batch size of one.

Course Outcome 4 (CO4):
1. For a scalar function f(x, y, z) = $x^2 + 3y^2 + 2z^2$, find the gradient and its magnitude at the point (1, 2, -1).
2. Find the maximum and minimum values of the function f(x, y) = $4x + 4y - x^2 - y^2$ subject to the condition $x^2 + y^2 <= 2$.
3. Suppose you were trying to minimize f(x, y) = $x^2 + 2y + 2y^2$. Along what vector should you travel from (5, 12)?
4. Find the second order Taylor series expansion for f(x, y) = $(x + y)^2$ about (0 , 0).
5. Find the critical points of f(x, y) = $x^2 – 3xy+5x-2y+6y^2+8$.

Course Outcome 5 (CO5):
1. What is a kernel? What is a dot product? Give examples of kernels that are valid dot products.
2. What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance? In what sense is the representation obtained from a projection onto the eigen directions corresponding the the largest eigen values optimal for data reconstruction.
3. Suppose that you have a linear support vector machine (SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Explain your answer in one sentence.
4. Explain linear discriminant analysis.

Model Question paper

QP Code : **Total Pages: 4**

Reg No.:________________ Name:_____________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

IV SEMESTER B.TECH (MINOR) DEGREE EXAMINATION, MONTH and YEAR

Course Code: EOT 284

Course Name: MATHEMATICS FOR MACHINE LEARNING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. Prove that any two bases of a finite dimensional vector space have same length.
2. Find all eigen values and eigenvectors of matrix

$$A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & 0 \\ -2 & 2 & 1 \end{bmatrix}$$

3. Let X be a continuous random variable with probability density function on 0 <= x <= 1 defined by f(x) = 3x2. Find the pdf of Y = X2.
4. Show that if two events A and B are independent, then A and B' are independent.
5. What are the gradient and the intercept for a straight line with the equation: 6y = 48x - 24.
6. Find the Taylor polynomials of degree two approximating the given function centered at the given point.

1) f(x)=1+x+x2 at a=1

2) f(x)=1+x+x2 at a=−1

7. Explain the principle of the gradient descent algorithm.
8. Give example for gradient descent with momentum and stochastic gradient descent.
9. Explain the concept of a Kernel function in Support Vector Machines. Why are kernels so useful? What properties a kernel should posses to be used in an SVM?
10. What is the difference between principal component analysis and linear discriminant analysis?

PART B

Answer any one Question from each module. Each question carries 14 Marks

11. a) i) Solve the systems of linear equations. **(6)**

x+y+z= 6
x+2y-3z=-4
-x-4y+9z=18

ii) Show that the set V= {(x,y,z) | x,y,z in **R** and x+y= 11 } is not a subspace of $\mathbf{R}^3$.

b) Apply Gram-Schmidt orthogonalization to the following sequence of vectors in R3: **(8)**

$$\begin{bmatrix} 1 \\ 2 \\ 0 \end{bmatrix}, \begin{bmatrix} 8 \\ 1 \\ -6 \end{bmatrix}, \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

OR

12. a) i) Verify whether the vectors (1,2,1,2), (3,1,-2,1), (4,-3,-1,3) and (2,4,2,4) are linearly independent. **(8)**

ii) Find the rank of the matrix

$$\begin{pmatrix} 0 & -1 & 5 \\ 2 & 4 & -6 \\ 1 & 1 & 5 \end{pmatrix}$$

b) i) Find the orthonormal basis of R3 consisting of eigen vectors for the following matrix **(6)**

$$\begin{pmatrix} 5 & 3 & 0 \\ 1 & 2 & -4 \\ -2 & -4 & 8 \end{pmatrix}$$

ii) Find a 3x3 orthogonal matrix **S** and a 3x3 diagonal matrix **D** such that $\mathbf{A = SDS^T}$.

13. a) i) Briefly explain about Conjugacy and exponential family. **(8)**

ii) State and explain Bayes' Theorem.

b) Express the Binomial distribution as an exponential family distribution. Also express the Beta distribution is an exponential family distribution. Show that the product of the Beta and the Binomial distribution is also a member of the exponential family. **(6)**

OR

14. a) There are two bags. The first bag contains four mangos and two apples; the second bag contains four mangos and four apples. We also have a biased coin, which shows "heads" with probability 0.6 and "tails" with probability 0.4. If the coin shows "heads". we pick a fruit at random

from bag 1; otherwise we pick a fruit at random from bag 2. Your friend flips the coin (you cannot see the result), picks a fruit at random from the corresponding bag, and presents you a mango.What is the probability that the mango was picked from bag 2? **(8)**

b) State the Sum rule and Product rule of Probabilities. **(6)**

15. a) Explain optimization using gradient Descent with an example. **(8)**

b) Differentiate linear programming and quadratic programming **(6)**

OR

16. a) Derive the gradient descent training rule assuming that the target function is represented as $\mathbf{o_d = w_0 + w_1x_1 + \ldots + w_nx_n}$. Define explicitly the cost/ error function **E**, assuming that a set of training examples **D** is provided, where each training example d D is associated with the target output $\mathbf{t_d}$. **(8)**

b) Find the maximum value of f(x,y,z) = xyz given that g(x,y,z) = x + y + z = 3 and x,y,z >= 0. **(6)**

17. a) Find the linear approximation to the function f(x,y) = 2 - sin(-x - 3y) at the point (0 , π), and then use your answer to estimate **(6)**

f(0.001 , π).

b) Find the second order Taylor series expansion for $f(x,y) = e^{-(x2+y2)} \cos(xy)$ about (0 , 0). **(8)**

OR

18. a) Explain the differences between Jacobean and Hessian matrices' partial derivatives. **(8)**

b) Explain with example how to find the gradients of vector valued functions and matrices. **(6)**

19 a) Explain in detail about Density Estimation with Gaussian Mixture Models. **(8)**

b) What are soft margin support vector machines. **(6)**

OR

20 a) How do you calculate optimal separating hyperplane? What is the equation for the maximal margin separating hyperplane? **(8)**

b) What is EM algorithm in machine learning? What is EM algorithm used for? **(6)**

Syllabus

Module 1

LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings, Norms, - Inner Products - Lengths and Distances - Angles and Orthogonality - Orthonormal Basis - Orthogonal Complement - Orthogonal Projections. Matrix Decompositions - Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization,

Module 2

Probability and Distributions: Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Important Probability distributions - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform**.**

Module 3

Optimization: Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.

Module 4

Calculus: Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Jacobean, Hessian, Higher Order Derivatives, Linearization and Multivariate Taylor Series.

Module 5

Density Estimation with Gaussian Mixture Models - Gaussian Mixture Model, Parameter Learning via Maximum Likelihood, EM Algorithm.

DIMENSIONS REDUCTION ALGORITHMS- Principal component analysis, linear discriminant analysis

Support Vector Machines –Separating Hyperplanes, SVM formulation-Primal and dual, Kernels, Soft margin SVM

Text Books

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https:// mml - book.github.io)

Reference Books

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
2. Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press
4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge University Press

5. Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published by Springer
6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, published by MIT Press
7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge University Press
8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MIT Press.
9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module-I (LINEAR ALGEBRA) – 9 hours**	
1.1	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations.	1 Hr
1.2	Vector Spaces - Linear Independence. Problems	1Hr
1.3	Vector Spaces - Basis and Rank	1 Hr
1.4	Linear Mappings	1 Hr
1.5	Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement	1 Hr
1.6	Orthogonal Projections, Matrix Decompositions, Determinant and Trace.	1 Hr
1.7	Eigenvalues and Eigenvectors Problems	2 Hr
1.8	Cholesky Decomposition, Eigen decomposition and Diagonalization	1 Hr
2	**Module-II (Probability and Distributions) – 10 hours**	
2.1	Construction of a Probability Space - Discrete and Continuous Probabilities (Lecture 1)	1 Hr
2.2	Construction of a Probability Space - Discrete and Continuous Probabilities (Lecture 2)	1 Hr
2.3	Sum Rule, Product Rule	1 Hr
2.4	Bayes' Theorem	1 Hr
2.5	Summary Statistics and Independence	1 Hr
2.6	Important probability Distributions (Lecture 1)	1 Hr
2.7	Important probability Distributions (Lecture 2)	1 Hr
2.8	Conjugacy and the Exponential Family (Lecture 1)	1 Hr
2.9	Conjugacy and the Exponential Family (Lecture 2)	1 Hr
2.10	Change of Variables/Inverse Transform	1 Hr
3	**Module-III (Optimization) – 8 hours**	
3.1	Optimization Using Gradient Descent.	2 Hr
3.2	Gradient Descent With Momentum, Stochastic Gradient Descent	1 Hr
3.3	Constrained Optimization and Lagrange Multipliers (Lecture 1)	1 Hr
3.4	Constrained Optimization and Lagrange Multipliers (Lecture 2)	1 Hr
3.5	Convex Optimization	1 Hr
3.6	Linear Programming . Problems	2 Hr

3.7	Quadratic Programming	1 Hr
4	**Module-IV (VECTOR CALCULUS) – 9hours**	
4.1	Differentiation of Univariate Functions, Partial Differentiation and Gradients	1 Hr
4.2	Gradients of Vector Valued Functions, Gradients of Matrices	2 Hr
4.3	Useful Identities for Computing Gradients	1 Hr
4.4	Jacobean and Hessian	2 Hr
4.5	Higher Order Derivatives	1 Hr
4.6	Linearization and Multivariate Taylor Series	2 Hr
5	**Module-V (CENTRAL MACHINE LEARNING PROBLEMS) – 9 hours**	
5.1	Density Estimation with Gaussian Mixture Models	1 Hr
5.2	Parameter Learning via Maximum Likelihood	1 Hr
5.3	EM Algorithm	1 Hr
5.4	Dimensionality Reduction with Principal Component Analysis	1 Hr
5.5	Dimensionality Reduction with linear discriminant analysis	1 Hr
5.6	Classification with Support Vector Machines - Separating Hyperplanes	1 Hr
5.7	Primal Support Vector Machines, Dual Support Vector Machines	1 Hr
5.8	Kernels	1 Hr
5.9	Soft margin SVM	1 Hr

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT286	DRIVES AND CONTROL	VAC	3	1	0	4

Preamble: The purpose of the course is to provide the fundamentals of dc and ac drives and deals with various speed control techniques employed in electric drives. Also the selection criteria of electric drives for various applications is discussed.

Prerequisite: Basics of electrical engineering, Fundamentals of Electrical Machines.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Select a drive for particular application.
CO 2	Determinetheperformancecharacteristicsofdcand ac drives under specified operating conditions.
CO 3	Familiarize with the various control techniques employed for controlling drives with ac and dc motors.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2											
CO 2	2											
CO 3	2											

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	30	30	70
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B.
Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the basic component of electric drives.
2. Explain the factors influencing the choice of electrical drives.
3. Explain the selection of power rating of motors.

Course Outcome 2 (CO2)

1. Describe the electrical and mechanical characteristics of dc drives.
2. List the different applications of dc and ac drives.
3. Explain the different types of braking employed in dc and ac drives.

Course Outcome 3(CO3):

1. Explain the conventional &solid state speed control of dc drives.
2. Explain the conventional &solid state speed control of ac drives.
3. Describe the drive circuits of stepper motors.

Model Question paper

QP CODE: PAGES: 2

Reg. No:______________

Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FOURTH SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EOT286

Course Name: DRIVES AND CONTROL

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1)What are the typical elements of an Electric Drive.

2) Enumerate thefactors that influence the choice of Electrical drives.

3) Why dc series motor is used to lift heavy loads.

4) Compare electrical and mechanical braking?

5) Why starters is required in a dc motor?

6) Is it possible to include/ Exclude external resistance in the rotor of a Squirrel cage induction motor? Justify.

7) Discuss the different types of armature speed control in DC shunt motor.

8) Explain the control techniques used in chopper controlled drives?

9) Explain the circuit of stator controlled induction motor using AC voltage regulators.

10) Draw and explain the torque speed characteristics of a stepper motor.

PART B

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11. a) What is electric drive? Explain it briefly with neat block diagram? (10)

b) What is ingress protection code? (4)

12.Explain about the Classes of Motor Duty with a neat diagram? (14)

Module 2

13. a)Series motor should never be started without some mechanical Load? Justify. (6)

b) Explain the types of electric braking in dc shunt motor. (8)

14. Explain types of electric braking in ac induction motor and draw its characteristics waveforms? (14)

Module 3

15. a) Explain the prime purpose of a starter for induction motors? (4)

b) What are the types of starters available for three phase induction motors? Explain (10)

16. With the help of diagram explain how dc motor is started using three point starter? (14)

Module 4

17. a) Whatare the merits and demerits of rheostat speed control method? (5)
    b) A 230 V d.c. shunt motor runs at 800 r.p.m. and takes armature current of 50 A. Find resistanceto be added to the field circuit to increase speed to 1000 r.p.m. at an armature current of 80 A. Assume flux proportional to field current. Armature resistance=0.15ohms and field winding resistance=250ohms. (9)
18. How is the speed control of the dc drive achieved using half, fully controlled rectifier?Explain. (14)

Module 5

19. a) Enumerate any five difference between D.C. and A.C. drives? (5)
    b) Describe methods available for speed control of three phase induction motor on stator side? (9)
20. Explain the methods of speed control of three phase induction motor using inverters (14)

Syllabus

Module 1

Introduction: Basic principle of Electric Drives-Block diagram-Parts of Electric Drives-types of electric drives-factors influencing electric drives-heating and cooling curves- loading conditions and classes of duty-Selection of power rating for drive motors with regard to thermal overloading and load variation factors.

Module 2

Drive motor characteristics: Mechanical characteristics- speed- torque characteristics of various types of load and drive motors - Electrical characteristics of dc motor- braking of electrical motors-dc motors: shunt, series, compound motors-single phase and three phase induction motors.

Module 3

Starting methods: Necessity of a Starter for Motors -Types of d.c motor starters -3point and 4 point starters (principle only)-typical control circuits for shunt and series motors-three phase squirrel and slip ring induction motor Starters.

Module 4

Conventional and solid state speed control of D.C Drives: Speed control of DC series and shunt motors-Armature and field control, Ward-leonard control system-using controlled rectifiers and DC choppers –applications-Numerical Problems.

Module 5

Conventional and solid state speed control of AC drives: Speed control of three phase induction motor-Voltage control, voltage/frequency control, slip power recovery scheme-using inverters and AC voltage regulators-applications.

Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper

Motor.

Text Books

1. VEDAM SUBRAMANIAM “Electric drives (concepts and applications)”, Tata McGraw-Hill.2001.
2. NAGARATH.I.J& KOTHARI .D.P,”Electrical machines”, Tata McGraw-Hill.1998.

Reference Books

1. Dubey G. K., Power *Semiconductor Controlled Drives*, Prentice Hall, Englewood Cliffs, New Jersy, 1989.
2. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
3. B. L. Theraja, Electrical Technology Vol II,S.Chand Publications.
4. M.D. SINGH, K.B.KHANCHANDANI,”Power electronics,” Tata McGraw-Hill.1998.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to electric drives	9
1.1	Basic principle of Electric Drives-Block diagram-Parts of Electric Drives- types of electric drive	3
1.2	factors influencing electric drives-heating and cooling curves	2
1.3	loading conditions and classes of duty	2
1.4	Selection of power rating for drive motors with regard to thermal overloading and load variation factors	2
2	Drive motor characteristics	8
2.1	Mechanical characteristics- speed- torque characteristics of various types of load and drive motors	2
2.2	Electrical characteristics of dc motor	1
2.3	braking of electrical motors-dc motors: shunt, series, compound motors	3
2.4	single phase and three phase induction motors	2
3	Starting methods	8
3.1	Necessity of a Starter For Motors -Types of d.c motor starters -3point starter (principle only	2
3.2	4 point starters (principle only)-typical control circuits for shunt and series motors	3
3.3	three phase squirrel and slip ring induction motor Starters.	3
4	Conventional and solid state speed control of D.C Drives	8
4.1	Speed control of DC series and shunt motors-Armature and field control, Ward-leonard control system	3
4.2	Speed control of DC series and shunt motors using controlled rectifiers and DC choppers –applications	3
4.3	Numerical Problems	2
5	Conventional and solid state speed control of AC drives	10
5.1	Speed control of three phase induction motor-Voltage control,	3

	voltage/frequency control, slip power recovery scheme	
5.2	Speed control of three phase induction motor using inverters and AC voltage regulators	3
5.3	Stepper Motor **:**Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors	2
5.4	Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor	2

SEMESTER IV

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET292	NETWORK ANALYSIS AND SYNTHESIS	VAC	3	1	0	4

Preamble : This honors course is designed with the objective of expanding the student's knowledge in network analysis beyond the basic topics. It includes advanced topics in network analysis, basics of filter design and network synthesis concepts. This course would help students to explore more advanced concepts in the analysis of complex networks.

Prerequisite : **EET201 Circuits and Networks**

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Apply network topology concepts in the formulation and solution of electric network problems.
CO 2	Apply two-port network analysis in the design and analysis of filter and attenuator networks.
CO 3	Identify the properties and characteristics of network functions, and verify the mathematical constraints for their physical realisation.
CO 4	Synthesize passive one-port networks using standard Foster and Cauer forms.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	15	15	20
Understand (K2)	20	20	50
Apply (K3)	15	15	30
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

[K1]: Questions on Network topology terminology, definitions.

[K2}: Questions on identification of graphs, paths, sub-paths, etc., Questions on incidence matrix.

[K2, K3] Understand level and application level numerical problems on application of Kirchoff's laws in matrix formulation, nodal analysis.

[K2, K3]. Numerical problems on graph theory based network analysis, cut-set, circuit matrices, nodal and loop analysis.

Course Outcome 2 (CO2): [K1, K2] Questions on definitions and properties of filters.

[K2, K3]. Numerical problems on constant-k and m-derived filter design and analysis.

Course Outcome 3 (CO3): [K1] Questions on the properties of network functions and realizability of passive impedance functions.

[K2, K3]. Numerical problems on the realizability of network functions, testing of positive real functions and Hurwitz polynomials.

Course Outcome 4 (CO4): [K1]. Questions to describe Foster and Cauer forms and the properties of immittance functions.

[K2, K3]. Numerical problems to synthesise networks in Foster and Cauer forms.

Model Question Paper

Reg. No.:
Name: **Pages: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: EET292

Course Name: Network Analysis and Synthesis

Max. Marks: 100 Time: 3 hrs

Part A
Answer *all* questions. Each question carries 3 marks.

1. Define subgraph, path and a tree, with proper examples.
2. Describe the properties of the complete incidence matrix.
3. What are dual graphs? What is the condition for a network graph to have a dual? Illustrate with an example.
4. Describe a cut-set with an example.
5. Show that the image impedances of a two-port network are given by $Z_{im1} = \sqrt{\dfrac{AB}{CD}}$ and $Z_{im2} = \sqrt{\dfrac{BD}{AC}}$.
6. Draw the frequency response curves for ideal and non-ideal low pass filter, band pass filter, band reject filter, and high pass filter respectively.
7. For the pole-zero plot shown in Fig. 1 below, for a network function, identify the function and find its impulse response.
8. List the properties of positive real functions.
9. What are the properties of LC immittance functions.
10. Draw the Foster and Cauer forms of RC networks. (10 x 3 = 30)

Part B
Answer any one full question from each module.
Each question carries 14 Marks.
Module 1

11. (a) Draw the oriented graph of the given network shown in Fig. 2, and identify one tree and its co-tree. Obtain the incidence matrix. (6)

    (b) Find all voltages and branch currents in the network shown in Fig. 3 by node analysis, and applying network graph principles. (8)

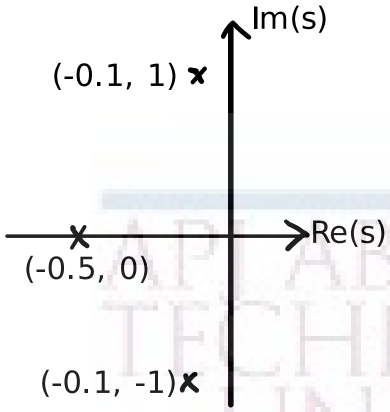


Figure 1: Pole Zero Plot

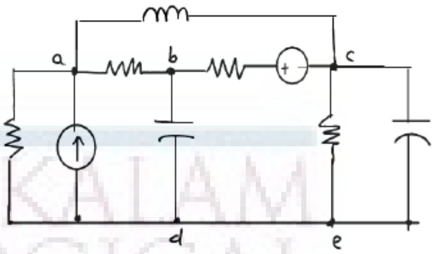


Figure 2: Figure for question 11 (a).

12. (a) The reduced incidence matrix A of an oriented graph is given below. (6)

$$A = \begin{bmatrix} -1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & -1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & -1 & 1 & 0 & -1 \\ 1 & 0 & 1 & 0 & 0 & 0 & -1 & 0 \end{bmatrix}$$

Draw the graph of an electrical network represented by this matrix. The branches constituting the outer loop of are independent current sources branches. All the current sources have their branch current variable at 1 A. Find the currents in all other branches.

(b) Find the total power dissipated in the circuit shown in Fig. 4 by node analysis (graph based). (8)

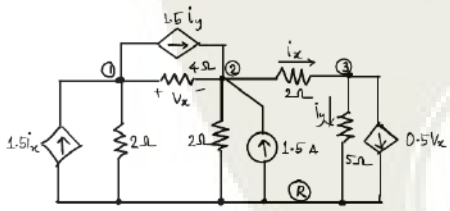


Figure 3: Figure for question 11 (b).

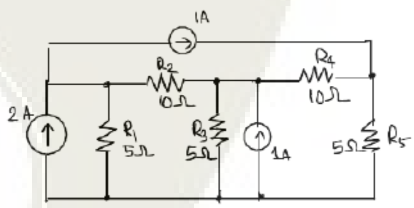


Figure 4: Figure for question 12 (b).

Module 2

13. (a) Find the power delivered by the independent voltage sources in the network shown in Fig. 5 by loop analysis (use graph theory). Prepare the network graph using the reference directions marked in the figure. (8)

(b) A connected network has the fundamental circuit matrix given as, (6)

$$B_f = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 \\ 1 & -1 & -1 & 0 & 0 & 1 \end{bmatrix}$$

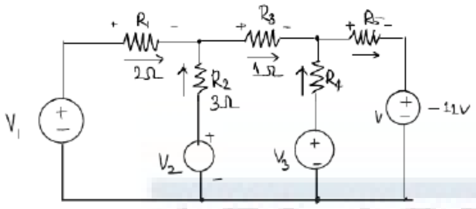


Figure 5: Figure for question 13 (a).

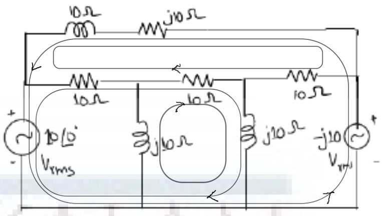


Figure 6: Figure for question 14 (a).

for some choice of tree. Obtain the f-cut-set matrix for the same tree.

14. (a) For the network shown in Fig. 6assign reference directions and draw the network graph. Obtain the connection matrix between branch currents and the loop currents in the three loops shown in the network diagram. Determine the loop impedance matrix of the network. (8)

(b) For the graph shown in Fig. 7, write the cut-set (KCL) equations for the following cut-sets: {1, 6}, {1,2,7,8}, {5, 6, 8, 9} and {2, 5, 7, 9}. Will this set of equations form an independent set of equations? If not why? (6)

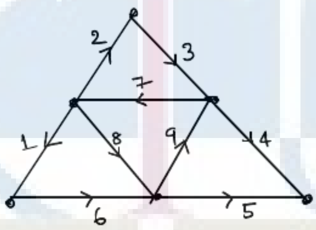


Figure 7: Figure for question 14 (b).

Module 3

15. (a) Design a prototype T-section low-pass filter to cut-off at 100 Hz with a load resistance of 75Ω. Calculate the attenuation in Np and in dB at 200 Hz and 1 kHz. Also find the phase shift suffered by the output signal for 10 Hz and 50 Hz. (7)

(b) Design an m-derived high pass filter having a design impedance of 300 Ω, cut-off frequency of 2000 Hz and infinite attenuation at 1700 Hz. (7)

16. (a) The open-circuit voltage observed across a signal source varies between $\pm 100\ mV$. The voltage across a 60Ω resistance connected across this source is found to vary between $\pm 50\ mV$. Design a T-section attenuator such that the voltage across a 600 Ω load connected across the output of the attenuator varies between $\pm 5\ mV$. (7)

(b) Design the T-section and p-section of a constant K-type BPF that has a pass band from 1500 to 5500 Hz and characteristic resistance of 200 Ω. Further, find resonant frequency of series and shunt arms. (7)

Module 4

17. (a) Test the following polynomials for the Hurwitz property: (6)
    (i). $s^3 + s^2 + 2s + 2$
    (ii). $s^7 + s^5 + s^3 + s$
    (iii). $s^7 + 2s^6 + 2s^5 + s^4 + 4s^3 + 8s^2 + 8s + 4$

    (b) Determine whether the following functions are positive real or not: (8)
    (i). $F(s) = \dfrac{2s^2 + 2s + 4}{(s+1)(s^2+2)}$
    (ii). $F(s) = \dfrac{5s^2 + s}{s^2 + 1}$

18. (a) Find the limits of K so that the polynomial $s^3 + 14s^2 + 56s + K$ may be Hurwitz. (6)

    (b) Find the driving point impedance Z(s) in the form $K\dfrac{N(s)}{D(s)}$ for the network shown in Fig. 8. Verify that Z(s) is positive real and that the polynomial D(s)+KN(s) is Hurwitz. (8)

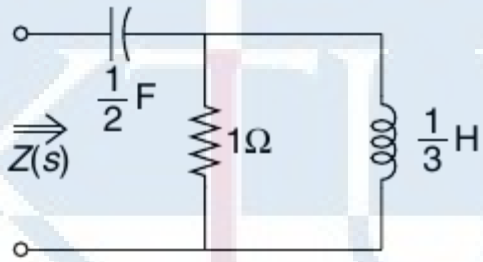


Figure 8: Figure for question 18 (b).

Module 5

19. Realise the impedance $Z(s) = \dfrac{2(s^2+1)(s^2+0)}{s(s^2+4)}$ in three different ways. (14)

20. (a) For the network function $Y(s) = \dfrac{2(s+1)(s+3)}{(s+2)(s+4)}$, synthesise a Foster form and a Cauer form realisations. (10)

    (b) Check whether the driving point impedance $Z(s) = \dfrac{s^4 + s^2 + 1}{s^3 + 2s^2 - 2s + 10}$ represents a passive network or not. (4)

Syllabus

Module 1

Network Topology (8 hours)

Linear Oriented Graphs -incidence matrix of a linear oriented graph –Kirchoff's Laws in incidence matrix formulation –nodal analysis of networks (independent and dependent sources) – Circuit matrix of linear oriented graph –Kirchoff's laws in fundamental circuit matrix formulation.

Module 2 (8 hours)

Loop analysis of electric networks (with independent and dependent sources) - Planar graphs –Mesh analysis- Duality –Cut set matrix -Fundamental cut set matrix –Relation between circuit, cut set and incidence matrices –Kirchoff's laws in fundamental cut-set formulation –Node-pair analysis – Analysis using generalized branch model (node, loop and node pair analysis) –Tellegen's theorem.

Module 3: (12 hours)

Modeling Two-port networks-application examples-amplifiers, transmission lines, passive filters.

Review of network parameter sets for two-port networks (z, y, h, g, T parameters, equivalent circuits and inter-relationship between parameters). (Review may be done using assignments/homeworks).

Image parameter description of a reciprocal two-port network -- Image impedance - Characteristic impedance - propagation constant—derivation of characteristic impedance and propagation constant for T and Pi networks under sinusoidal steady state -- Attenuation constant and phase constant.

Filter terminology: Low pass, high pass, band-pass and band-reject filters.

Constant k and m-derived filters -- low pass, high pass, band-pass and band-stop filters -- design--effect of cascading multiple sections. Resistive T, Pi and lattice attenuators.

Module 4

Network Functions (10 hours)

Review of Network functions for one port and two port networks: – pole zero location for driving point and transfer functions-Impulse response of Network functions from pole-zero plots- Sinusoidal steady-state frequency response from pole-zero plots.

Hurwitz polynomials –properties - Positive real functions –Properties of positive real functions – passivity-necessary and sufficient conditions for positive real functions-physical realizability.

Module 5

Synthesis of one port networks (8 hours)

Synthesis of reactive one-ports by Foster's and Cauer methods (forms I and II) -Synthesis of LC, RC and RL driving-point functions.

Text Books

1. K. S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References

1. Franklin Kuo, "Network Analysis and Synthesis", 2nd Ed.,Wiley India.
2. Van Valkenburg M.E., "Introduction to Modern Network Synthesis," Wiley Eastern, 1960 (reprint 1986).
3. Van Valkenburg M.E, "Network Analysis," Prentice Hall India, 2014.
4. Charles A. Desoer and Ernest S. Kuh, "Basic Circuit Theory," Tata McGraw Hill Edition.
5. Chakrabarti, A., "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
6. S. K. Bhattacharya, "Network Analysis and Synthesis," Pearson Education India.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Network Topology (8 hours)**	
1.1	Linear Oriented Graphs - Connected Graph, sub graphs, paths, The incidence matrix of a linear oriented graph – Path matrix, its relation to incidence matrix.	2
1.2	Kirchoff's Laws in incidence matrix formulation – nodal analysis of networks (independent and dependent sources) principle of v-shifting.	2
1.3	Circuit matrix of linear oriented graph – Fundamental Circuit matrix B_f. Relation between All incidence matrix and All Circuit matrix.	2
1.4	Kirchoff's laws in fundamental circuit matrix formulation -	2
2	**(8 hours)**	
2.1	Loop analysis of electric networks (with independent and dependent sources) -- Planar graphs –Mesh analysis- Duality.	2
2.2	Cut set matrix -Fundamental cut set matrix –Relation between circuit, cut set and incidence matrices – Orthogonality relation.	2
2.3	Kirchoff's laws in fundamental cut-set formulation –Node-pair analysis. i-shifting.	2
2.4	Analysis using generalized branch model (node, loop and node pair analysis) –Tellegen's theorem.	2
3	**(13 hours)**	
3.1	Modeling Two-port networks - application examples-amplifiers, transmission lines, passive filters. Review of network parameter sets for two-port networks (z, y, h, g, T parameters, equivalent circuits and inter-relationship between parameters, Standard T- and pi networks. (Review may be done using assignments/homeworks).	2
3.2	Image parameter description of a reciprocal two-port network - Image impedance.	1
3.3	Characteristic impedance - propagation constant—derivation of characteristic impedance and propagation constant for T and Pi networks under sinusoidal steady state -- Attenuation constant and phase constant.	2

3.4	Filter terminology: Low pass, high pass, band-pass and band-reject filters. Gain characteristics. Constant k-derived low pass filter -- Comparison with ideal low-pass filter -- Prototype Low pass filter design.	2
3.5	m-derived low pass filter sections, m-derived half-sections for filter termination. m-derived half-sections for input termination. Half-pi termination for pi section filters.	2
3.6	Constant k- and m-derived high pass filters --Design. Constant k- band-pass filter -- Design of prototype bandpass filter -- Constant-k band-stop filter-effect of cascading multiple sections.	2
3.7	Resistive attenuators-Symmetric T and Pi section attenuators -- Lattice-section attenuator- Symmetrical bridged T-section attenuator - Asymmetrical T-Section and Pi-section attenuator.	2
4	**Network Functions (7 hours)**	
4.1	Review of Network functions for one port and two port networks: – calculation of network functions for ladder and general networks-poles and zeros for network functions-pole zero location for driving point and transfer functions.	2
	Impulse response of Network functions from pole-zero plots- Sinusoidal steady-state frequency response from pole-zero plots.	2
	Hurwitz polynomials – properties - Positive real functions – Properties of positive real functions – passivity-necessary and sufficient conditions for positive real functions - physical realizability.	3
5	**Synthesis of one port networks (9 hours)**	
5.1	Synthesis of reactive one - ports by Foster's and Cauer methods (forms I and II): Synthesis of R–C Network -- Properties of the R–C Impedance or R–L Admittance Function -- Foster Form-I of R–C Network -- Foster Form-II of R–C Network, Cauer Forms of R–C Network.	3
5.2	Synthesis of R–L Network -- Properties of R–L Function/R–C Admittance Function -- Foster Form-I of R–L Network -- Foster Form-II of R–L Network -- Cauer Form-I of R–L Network -- Cauer Form-II R–L Network.	3
5.3	Synthesis of L–C Networks -- Properties of L–C Immittance -- Foster Form-I of L–C Network -- Foster Form-II of L–C Network -- Cauer Form-I of L–C Network -- Cauer Form-II of L–C Network.	3

SEMESTER V

ELECTRICAL AND COMPUTER ENGINEERING

EOT 301	INSTRUMENTATION SYSTEMS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

PREAMBLE

This course imparts knowledge in the area of electrical instruments with an in-depth knowledge about the construction and the working of the instruments. To expose the student about measurement of voltage, current, resistance, inductance, capacitance, power, energy and data acquisition concepts. To give an idea about modern digital measurement systems oscilloscopes and display systems

PREREQUISITE

Basic Electrical Engineering

COURSE OUTCOMES

After the completion of the course the student will be able to

CO1	Classify the different measuring instruments and errors that occur in an instrument.
CO2	Illustrate the working principle of power and energy measurement
CO3	Describe the operation of digital energy meters
CO4	Choose appropriate instruments for the measurement of resistance, inductance and capacitance in ac and dc bridges.
CO5	Outline the principles of operation of magnetic measurement systems
CO6	Understand the concept virtual instrumentation & digital instruments.

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	2	-	-	-	-	-	-	2
CO6	3	-	-	-	-	-	-	-	-	-	-	-

ASSESSMENT PATTERN

Total Marks	CIE marks	ESE MARKS	Duration
150	50	100	3Hrs

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Series Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember(K1)	15	20	30
Understand(K2)	20	20	50
Apply(K3)	15	10	20
Analyse(K4)			
Evaluate(K5)			
Create(K6)			

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Explain the classification of measuring instruments.(K2, PO1)
2. Explain static characteristics and dynamic characteristics of measuring systems. (K2, PO1)
3. Problems related to measurement errors. (K3, PO2)
4. Explain the construction and working indicating Instruments (K2,PO1)
5. Problems related to extension of range of meters.K3,PO1.PO2)

Course Outcome 2 (CO2):

1. Describe the principle of operation and construction of energy meter (K2, PO1)
2. Describe the principle of operation and construction of wattmeter (K2,PO1)
3. Explain the principle of two and three wattmeter method of power measurement. (K2,K3,PO2)
4. Describe the method of measurement of earth resistance(K2)
5. Explain the working of electronic energy meter(K2)

Course Outcome 3(CO3):

1. Explain the Measurement of un known resistance using wheat stone bridge(K2,K3,PO1,PO2)
2. Explain the measurement of inductance using maxwells inductance bridge. (K2,K3, PO1)
3. Describe the function of TOD meter. (K2, PO1,PO2)
4. Illustrate the principle of temperature measurement using RTD and Thermistor (K2, PO1)
5. Explain the working principle of sphere gap for high voltage measurement (K2)

Course Outcome 4 (CO4):

1. Explain the principle of operation of ballistic galvanometer. (K2, PO1,PO2)
2. Describe the procedure for plotting the B-H curve of a magnetic specimen. (K2)
3. Explain the method of measurement of permeability (K2, PO1,PO2)
4. Explain the measurement of iron losses in a magnetic material employing Llyod- Fisher square using wattmeter method. (K2, PO1)
5. Describe the construction and working of photo conductive transducers. (K2, PO1)

Course Outcome 5 (CO5):

1. Explain classification of Transducers (K2, PO1)
2. With the help of a neat sketch explain the working of LVDT (K2, PO1,)
3. Explain the operation of CRO, with a neat sketch (K2, PO1)

Course Outcome 6 (CO6):

1. Basic ideas on simulation software and virtual instrumentation (K1, PO1)
2. With the help of a neat sketch explain the working of LVDT (K2)
3. Explain the operation and working principle of DSO (K2, PO1)

Model Question paper

QPCODE:

Reg.No:

Name :

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH &YEAR

Course Code: EOT 301

Course Name: INSTRUMENTATION SYSTEMS

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain the different types of errors in measuring instruments
2. Describe damping and types of damping provided in measuring instruments.
3. Explain the special features incorporated in low power factor wattmeter
4. Write short notes on three phase energy meters.
5. Illustrate the working principle of hall effect sensors
6. Explain any one method to measure earth resistance
7. Describe the measurement of BH curve and Hysteresis loop in magnetic circuits
8. Explain with a neat sketch the working of photovoltaic cell
9. Realize the basic gates using ladder logic in PLC
10. Explain the working of piezoelectric transducers

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Explain the construction and working of moving coil instrument with a neat sketch Derive the equation for torque of the MC instrument also give the merits and demerits. (8)

(b) Classify the different types of instruments with example. (6)

OR

12. (a) Define measurement standards and explain the need of calibration. (6)

(b) Explain the advantage of shunts in ammeter and multipliers in voltmeter. (8)

Module 2

13. Derive the expression for transformation ratio and phase angle of a current transformer using its equivalent circuit and phasor diagram. (14)

OR

14. (a) Explain the construction and operation of dynamometer type wattmeter. (7)

(b) With a neat block diagram, explain the working of electronic energy meter also write its merits compared to induction type energy meter (7)

Module 3

15. (a) Explain with the help of neat connection diagram derive the formula to determine the value of low resistance by kelvin's double bridge method. (8)

(b) Explain the calibration of wattmeter using DC potentiometer. (6)

OR

16. (a) Draw the circuit and phasor diagram of Schering bridge for the measurement of capacitance also derive the expression for the unknown capacitance. (10)

(b) Explain the construction and working of sphere gaps. (4)

Module 4

17. (a) Explain the method of measurement of permeability. (5)

(b)Describe the principle of temperature measurement using thermistors and compare temperature measurement using RTD and thermistor. (9)

OR

18. (a) Explain the working of Ballistic Galvanometer. (5)

(b) What is a Llyod- Fisher square. Explain the measurement of iron losses in a magnetic material employing Llyod- Fisher square using wattmeter method. (10)

Module 5

19. (a) Illustrate the working of DSO with the help of a neat sketch. (6)

(b) Explain the operating principle of DMM. (8)

OR

20. (a) With the help of a neat sketch explain the working of Strain gauge. (6)

(b) Explain how CRO can be used to measure the frequency and phase angle. (8)

Syllabus

Module 1

Measurement standards–Errors-Types of Errors- Need for calibration. Classification of instruments, secondary instruments–indicating, integrating and recording operating forces - essentials of indicating instruments - deflecting, damping, controlling torques. Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles shunts and multipliers – extension of range.

Module 2

Measurement of power: Dynamometer type wattmeter –Construction and working - 3- phase power measurement-Low Power factor wattmeters. Measurement of energy: Induction type watt-hour meters-Single phase energy meter – construction and working, two element three phase energy meters, Digital Energy meters -Time of Day meter and Smart metering. Current transformers and potential transformers – principle of working -ratio and phase angle errors. Extension of range using instrument transformers, Hall effect multipliers.

Module 3

Classification, measurement of low, medium and high resistance- Ammeter voltmeter method Kelvin's double bridge Wheat stones bridge- loss of charge method, measurement of earth resistance. Measurement of self-inductance -Maxwell's Inductance bridge, Measurement of capacitance –Schering's, Measurement of frequency-Wien's bridge. Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers. High voltage and high current in DC measurements- voltmeters, Sphere gaps, DC Hall effect sensors.

Module 4

Magnetic Measurements: Ballistic galvanometer–principle- Measurement of flux and permeability - flux meter, BH curve and hysteresis measurement- determination of BH curve - hysteresis loop. measurement of iron losses- Lloyd Fisher square. Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells Temperature Sensors-Resistance temperature detectors-negative temperature coefficient -Thermistors-thermocouples

Module 5

Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge. Oscilloscopes-Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator. DSO-Characteristics-Probes and Probing techniques. Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters. Introduction to Virtual Instrumentation systems - Simulation software's.

Text Books

1. Sawhney A.K., A course in Electrical and Electronic Measurements & instrumentation, Dhanpat Rai.
2. J. B. Gupta, A course in Electrical & Electronic Measurement & Instrumentation., S K Kataria & Sons
3. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012
4. S Tumanski, Principles of electrical measurement, Taylor & Francis.
5. David A Bell, Electronic Instrumentation and Measurements,3/e, Oxford

Reference Books

1. E.O Doebelin and D.N Manik, Doebelin's Measurements Systems, sixth edition, McGraw Hill Education (India) Pvt. Ltd
2. Cooper W.D., Modern Electronics Instrumentation, Prentice Hall of India
3. Stout M.B., Basic Electrical Measurements, Prentice Hall
4. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill
5. Golding E.W., Electrical Measurements & Measuring Instruments, Wheeler Pub.
6. P.Purkait, B.Biswas, S.Das and C. Koley, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education (India) Pvt. Ltd.,2013

Course Contents and Lecture Schedule

Module	Topic Coverage	No. of Lectures	No. of Hour
1	**Measurement Standards and Classification of meters**		
1.1	Measurement standards–Errors-Types of Errors-Need for calibration.	**2**	**10**
1.2	Classification of instruments, secondary instruments–indicating, integrating and recording	**1**	
1.3	Operating forces - essentials of indicating instruments - deflecting, damping, controlling torques	**2**	
1.4	Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles	**3**	
1.5	Principles shunts and multipliers – extension of range	**2**	
2	**Measurement of Resistance, Power and Energy**		
2.1	Measurement of power: Dynamometer type wattmeter– Construction and working	**2**	**10**
2.2	3-phase power measurement Low Power factor wattmeter's	**1**	
2.3	Measurement of energy: Induction type watt-hour meters Single phase energy meter-construction and working, two element three phase energy meters,	**2**	
2.4	Digital Energy meters - Time of Day (TOD) and Smart metering.	**1**	
2.5	Current transformers and potential transformers-principle of working -ratio and phase angle errors.	**3**	
2.6	Extension of range using instrument transformers, Hall effect multipliers.	**1**	
3	**Measurement of circuit parameters using bridges, High voltage and high current measurements**		
3.1	Classification of resistance, low resistance, Ammeter voltmeter method, Kelvin's double bridge Medium resistance- Ammeter voltmeter method -Wheatstone's bridge.	**2**	**9**
3.2	High resistance- loss of charge method-measurement of earth resistance	**1**	
3.3	Measurement of self-inductance-Maxwell's Inductance bridge Measurement of capacitance–Schering's bridge Measurement of frequency-Wien's bridge	**2**	
3.4	Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers.	**2**	
3.5	High voltage and high current in DC measurements voltmeters, Sphere gaps, DC Hall effect sensors.	**2**	
4	**Magnetic, Lumen and Temperature Measurement**		

4.1	Magnetic Measurements: Ballistic galvanometer–principle- Measurement of flux and permeability - flux meter	**2**	**8**
4.2	BH curve and hysteresis measurement	**1**	
4.3	Determination of BH curve - hysteresis loop.	**2**	
4.4	Measurement of iron losses- Lloyd Fisher square.	**1**	
4.5	Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells	**1**	
4.6	Temperature Sensors-Resistance temperature detectors-negative temperature coefficient -Thermistors-thermocouples	**2**	
5	**Transducers and Digital instruments including modern recording and displaying instruments**		
5.1	Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters.	**1**	**9**
5.2	Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge	**1**	
5.3	Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc.	**2**	
5.3	DSO-Characteristics-Probes and Probing techniques. Digital voltmeters and frequency meters using electronic counters	**2**	
5.4	DMM, Clamp on meters Introduction to Virtual Instrumentation systems	**3**	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT303	MICROPROCESSORS AND EMBEDDED SYSTEMS	PCC	3	1	0	4

Preamble

This course helps the students to understand 8085 microprocessor and 8051 microcontroller architecture as well as to design hardware interfacing circuit. This also aids to thrive their programming skills to solve real world problems.

Prerequisite

Fundamentals of Digital Electronics, C Programming

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Describe the architecture and timing diagram of 8085 microprocessor.
CO 2	Develop assembly language programs in 8085 microprocessors.
CO 3	Identify the different ways of interfacing memory and I/O with 8085 microprocessors.
CO 4	Understand the architecture of 8051 microcontroller and embedded systems.
CO 5	Develop assembly level and embedded C programs in 8051 microcontroller.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3	2	3	2	1							
CO 3	3	2	2	2	2							
CO 4	3	2										
CO 5	3	2	3	2	1	1						1

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	10	10	20
Apply (K3)	30	30	60
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern : There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.
Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the register organization in 8085 microprocessor.
2. Explain the Stack and subroutine operations.
3. Explain the basic steps involved in accessing memory locations.
4. Draw the timing diagrams of different instructions of 8085 microprocessor.

Course Outcome 2 (CO2):

1. Describe the addressing modes of 8085 microprocessor.
2. Describe the various types of 8085 microprocessor instructions.
3. Explain in detail the instruction set of 8085 microprocessor.
4. Write an ALP for data transfer, arithmetic, logical and branching operations.

Course Outcome 3(CO3):

1. Explain how RAM and ROM memory are interfaced with 8085 microprocessor.
2. Describe address decoding used in I/O interfacing.
3. Explain the architecture of 8255 PPI.
4. Explain the modes of operation of 8255 PPI.

Course Outcome 4 (CO4):

1. Explain the special function registers in 8051 microcontroller.
2. Explain the operating modes of serial port of 8051 microcontroller.
3. Describe the addressing modes and modes of operation of timer of 8051microcontroller.
4. Explain the embedded C Programming.

Course Outcome 5 (CO5):

1. Explain timer programming in assembly language and embedded C.
2. Explain serial port programming in assembly language and embedded C.
3. How to interface ADC, DAC and sensors with 8051 microcontroller.
4. Explain interrupt programming in assembly language and C.

Model Question Paper

QP Code: Pages: 2

Reg No: ___________________

Name: _____________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT303

Course Name: MICROPROCESSORS AND EMBEDDED SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain the use of ALE signal in Intel 8085 microprocessor.
2. Describe the use of CLK OUT and RESET OUT signals.
3. With the help of an example explain the operation of XTHL instruction.
4. How can we check the status of flags in 8085 microprocessor?
5. Explain software and hardware interrupts.
6. Write the differences between microprocessor and microcontroller.
7. Draw the block diagram of 8051 microcontroller.
8. Explain the bit pattern of TMOD register of 8051 microcontroller.
9. How we can enable and disable interrupts in 8051 microcontroller.
10. Find the bits of TMOD registers to operate as timers in the following modes
    (i) Mode 1 Timer (ii) Mode 2 Timer 0.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Explain the functional block diagram of 8085 microprocessor. **(10)**

(b) Define machine cycle and T state. **(4)**

12. (a) Sketch and explain the timing diagram of LDA 2003H. **(10)**

(b) Describe the addressing modes of 8085 microprocessor. **(4)**

Module 2

13. (a) Write an ALP to sort an array of 10 numbers stored from memory location 2001H onwards in ascending order. **(10)**

(b) Explain stack related operations in 8085 microprocessors. **(4)**

14. (a) Write a delay program to introduce a delay of 1 second. **(8)**

(b) Explain the operation of DAA instruction in 8085 microprocessors. **(6)**

Module 3

15. (a) Explain the address decoding technique in memory interfacing. **(8)**

(b) Give the control word format for BSR and I/O Mode in 8255. **(6)**

16. (a) Explain the architecture of 8051 microcontroller. **(8)**

(b) Explain hard and soft real time systems. **(6)**

Module 4

17. (a) Explain the different methods to create a time delay in 8051 microcontroller. **(7)**

(b) Explain the different addressing modes of 8051 microcontroller? **(7)**

18. (a) Explain the various types of instructions in 8051 microcontroller? **(6)**

(b) Write a Program in 8051 for the generation of square wave having a duty ratio of 0.5 for a time period of 1ms. **(8)**

Module 5

19. (a) Explain how a DAC can be interfaced to 8051 microcontroller. **(10)**

(b) Explain the role of SBUF and SCON registers used in 8051 microcontroller. **(4)**

20. (a) Describe the generation of time delay using the timer of 8051 microcontroller. **(8)**

(b) Explain the various interrupts in 8051 microcontroller. **(6)**

Syllabus

Module 1

Internal architecture of 8085 microprocessor–Functional block

diagram Instruction set-Addressing modes - Classification of

instructions - Status flags.

Machine cycles and T states – Fetch and execute cycles- Timing diagram for instruction anddata flow.

Module 2

Introduction to assembly language programming- Data transfer operations, arithmetic operations, logic operations, branching operations, I/O and machine control operations.

Assembly language programmes (ALP) in 8085 microprocessor- Data handling/Data transfer, Arithmetic operations, Code conversion- BCD to Binary - Binary to BCD, Sorting - Ascending and descending including bubble sorting.

Stack and subroutines – Conditional CALL and Return instructions

Time delay subroutines using 8 bit register, 16 bit register pair and Nested loop control.

Module 3

Interrupt & interrupt handling - Hardware and Software interrupts.

I/O and memory interfacing – Address decoding– Interfacing I/O ports -Programmable Peripheral Interface PPI 8255 - Modes of operation- Interfacing of seven segment LED.

Introduction to embedded systems, Current trends and challenges, Applications of embedded systems- Hard and soft real time systems.

Introduction to microcontrollers- Microprocessor Vs Microcontroller- 8051 Microcontrollers – Hardware - Microcontroller architecture and programming model - I/O port structure - Register organization -General purpose RAM - Bit addressable RAM - Special FunctionRegisters (SFRs).

Module 4

Instruction set - Instruction types - Addressing modes of 8051 microcontrollers.

8051 microcontroller data types and directives - Time delay programmes and I/O port programming.

Introduction to embedded C Programming - time delay in C - I/O port programming in embedded C.

Module 5

8051 Timer/counter programming - Serial port programming - Interrupt programming in assembly language and embedded C.

Interfacing –ADC - DAC and temperature sensor

Text Books

1. Ramesh Gaonkar, "Microprocessor Architecture Programming and Applications", Penram International Publishing; Sixth edition, 2014.
2. Mohamed Ali Mazidi, Janice GillispieMazidi, "The 8051 microcontroller and embedded systems using Assembly and C", second edition, Pearson/Prentice hall of India.
3. Kenneth J. Ayala, "The 8051 microcontroller", 3rd edition, Cengage Learning, 2010
4. Lyla B Das, "Embedded Systems - An Integrated Approach", Pearson Education India

Reference Books

1. B Ram, "Fundamentals of Microprocessors and Microcontrollers", 9e, DhanpatRaiPublications, 2019.
2. Wadhwa, "Microprocessor 8085 microprocessor: Architecture, Programming andInterfacing", PHI 2010
3. Shibu K V, "Introduction to Embedded systems", TMH

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Architecture and Instruction set of 8085 microprocessor (9 hours)**	
1.1	Internal architecture of 8085 microprocessor– functional block diagram	2
1.2	Instruction set- Addressing modes, Classification of instructions - Status flags.	4
1.3	Machine cycles and T states – Fetch and execute cycles - timing diagram for instruction and data flow.	3
2	**Assembly language programming (9 hours)**	
2.1	Introduction to assembly language programming- data transfer operations, arithmetic operations, logic operations, branching operations, I/O and machine control operations.	2
2.2	Assembly language programmes (ALP) in 8085 microprocessor-Data handling/Data transfer - Arithmetic operations - Code conversion - BCD to Binary - Binary to BCD, Sorting - Ascending and descending including bubble sorting.	4
2.3	Stack and subroutines – Conditional call and return instructions – Stack operations.	2
2.4	Time delay subroutines using 8bit register, 16 bit register pair and Nested loop control.	1
3	**Interfacing circuits for 8085 microprocessor and introduction to 8051 Microcontroller (10 hours)**	
3.1	Interrupt and interrupt handling - Hardware and Software interrupts.	1
3.2	I/O and memory interfacing – Address decoding – Interfacing I/O ports-Programmable peripheral interface PPI 8255 - Modes of operation -Interfacing of seven segment LED.	4
3.3	Introduction to embedded systems - Current trends and challenges - Applications of embedded systems - Hard and Soft real time systems.	1
3.4	Introduction to microcontrollers - Microprocessor Vs Microcontroller - 8051- Microcontrollers - Hardware	1
3.5	Microcontroller Architecture and programming model: I/O Port structure - Register organization - General purpose RAM -Bit Addressable RAM - Special Function Registers (SFRs).	3

4	**Programming of 8051 Microcontroller (9 hours)**	
4.1	Instruction Set - Instruction Types - Addressing modes	3
4.2	8051- Data types and directives -Time delay programmes and I/O port programming.	3
4.3	Introduction to embedded C Programming - Time delay in C - I/O port programming in embedded C.	3
5	**Interfacing circuits of 8051 Microcontroller (9 hours)**	
5.1	Timer/counter programming in assembly language and embedded C	3
5.2	Serial port programming in assembly language and embedded C	2
5.3	Interrupt programming in assembly language and embedded C	2
5.4	Interfacing –ADC - DAC and temperature sensor	2

EOT 305	DATABASE MANAGEMENT SYSTEMS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

Preamble

This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization and Transaction Processing Concepts. The course also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite

Topics covered under the course Data Structures (CST 201), Exposure to a High Level Language like C/python.

Course Outcomes

After the completion of the course the student will be able to

CO1	Summarize and exemplify fundamental nature and characteristics of database systems (**Cognitive Knowledge Level: Understand)**
CO2	Model real word scenarios given as informal descriptions, using Entity Relationship diagrams. **(Cognitive Knowledge Level: Apply**)
CO3	Model and design solutions for efficiently representing and querying data using relational model (**Cognitive Knowledge Level: Analyze**)
CO4	Demonstrate the features of indexing and hashing in database applications **(Cognitive Knowledge Level: Apply**)
CO5	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems **(Cognitive Knowledge Level: Apply**)
CO6	Explain various types of NoSQL databases (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔									✔
CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔								✔
CO4	✔	✔								✔		✔
CO5	✔	✔								✔		✔
CO6	✔	✔								✔		✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test1 (%)	Test2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30

Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1: Introduction & Entity Relationship (ER) Model

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification.

ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

Module 2: Relational Model

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema

Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

Module 3: SQL DML (Data Manipulation Language), Physical Data Organization

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types.

Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.

Module 4: Normalization

Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.

Module 5: Transactions, Concurrency and Recovery, Recent Topics

Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions.
Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing.

Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB)

Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

Reference Books:

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018
3. Web Resource: https://www.w3resource.com/redis/
4. web Resource: https://www.w3schools.in/category/mongodb/
5. Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource : https://www.tutorialspoint.com/arangodb/index.htm

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. List out any three salient features of database systems, which distinguish it from a filesystem.
2. Give one example each for logical and physical data independence.

Course Outcome 2(CO2):

1. What facts about the relationships between entities EMPLOYEE and PROJECT are conveyed by the following ER diagram?

1. Design an ER diagram for the following scenario:
   There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team.

Course Outcome 3(CO3):

1. For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on thetable R(A, B, C, D), where A is a key, write any three equivalent relational algebra expressions.
2. Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence of *Armstrong's Axioms* needed to arrive at the following FDs: (a) P → T (b) PR → S (c) QR → SU
3. Consider a relation PLAYER (PLAYER-NO, PLAYER-NAME, PLAYER-POSN, TEAM, TEAM-COLOR, COACH-NO, COACH-NAME, TEAM-CAPTAIN). Assume that PLAYER-NO is the *only* key of the relation and that the following dependencies hold:

   TEAM→{TEAM-COLOR, COACH-NO, TEAM-CAPTAIN}

   COACH-NO→COACH-NAME.

   i. Is the relation in 2NF? If not, decompose to 2NF.
   ii. Is the relation in 3NF? If not, decompose to 3NF.

4. In the following tables foreign keys have the same name as primary keys except DIRECTED-BY, which refers to the primary key ARTIST-ID. Consider only *single- director* movies.
   MOVIES(<u>MOVIE-ID</u>, MNAME, GENRE, LENGTH, DIRECTED-BY)
   ARTIST(<u>ARTIST-ID</u>, ANAME)
   ACTING(<u>ARTIST-ID, MOVIE-ID</u>)
   Write SQL expressions for the following queries:
   (a) *Name(s) and director name(s) of movie(s) acted by 'Jenny'.*
   (b) *Names of actors who have <u>never</u> acted with 'Rony'*
   (c) *Count of movies genre-wise.*
   (d) *Name(s) of movies with maximum length.*

Course Outcome 4(CO4):

1. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key.Assuming un-spanned organization, block size of 512 bytes and block pointer size of 5 bytes. Compute the number of block accesses needed for retrieving an employee record based on employee number if (i) No index is used (ii) Multi-level primary index is used.

Course Outcome 5(CO5):

1. Determine if the following schedule is *recoverable*. Is the schedule *cascade-less*? Justify your answer. *r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2.* (*Note: ri(X)/wi(X)* means transaction *Ti* issues read/write on item X; *ci* means transaction *Ti* commits.)
2. Two-phase locking protocol ensures serializability. Justify.

Course Outcome 6(CO6):

1. List out any three salient features of NoSQL databases. Give example of a document in MongoDB.

Model Question paper

QPCODE

Reg No:__________________ **Name:_____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code:EOT305

Course Name: **Database Management Systems**

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1 List out any three salient features of a database systems.

2 When is multi-valued composite attribute used in ER modelling?

3 For the SQL query, SELECT *A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any two equivalent relational algebra expressions.

4 Outline the concept of *theta*-join.

5 How is the purpose of *where* clause is different from that of having clause?

6 What is the use of a trigger?

7 When do you say that a relation is not in 1NF?

8 Given the FDs P→Q, P→R, QR→S, Q→T, QR→U, PR→U, write the sequence ofArmstrong's Axioms needed to arrive at a. P → T b. PR → S

9 What is meant by the lost update problem?

10 What is meant by check pointing?

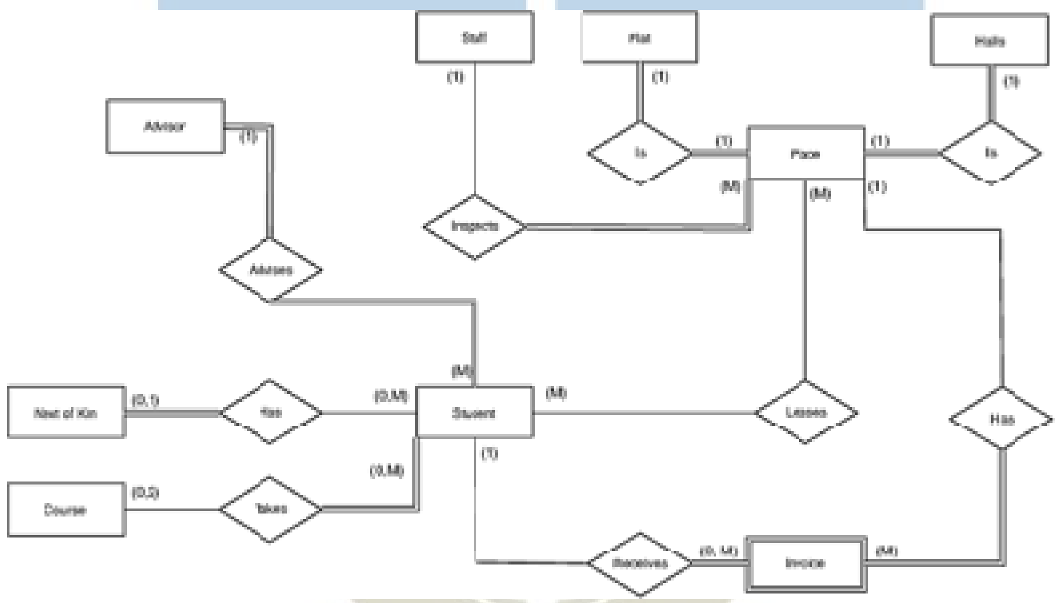
PART B

Answer any one Question from each module. Each question carries 14 Marks

11 a. Design an ER diagram for the following scenario: There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. For each match we need to keep track of the following: The date on which the game is played The final result of the match. The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card. During the match, one player may substitute another player. We want to capture this substitution and the timeat which it took place. Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One refereeis the main referee and the other two are assistant referee. (14)

OR

12 a. Interpret the the following ER diagram. (8)



b. Distinguish between physical data independence and logical data independence with suitable examples. (6)

13. *EMPLOYEE(ENO, NAME, ADDRESS, DOB, AGE, GENDER, SALARY,DNUM, SUPERENO)* (14)

DEPARTMENT(DNO, DNAME, DLOCATION, DPHONE, MGRENO)PROJECT(PNO, PNAME, PLOCATION, PCOST, CDNO)

DNUM is a foreign key that identifies the department to which an employeebelongs. MGRENO is a foreign key identifying the employee who manages the department. CDNO is a foreign key identifying the department that controls the project. SUPERENO is a foreign key identifying the supervisor of each employee.

Write relational algebra expressions for the following queries:-

(a) Names of female employees whose salary is more than 20000.
(b) Salaries of employee from 'Accounts' department
(c) Names of employees along with his/her superviser's name
(d) For each employee return name of the employee along with his departmentname and the names of projects in which he/she works
(e) Names of employees working in all the departments

OR

14 a. Write SQL DDL statements for the the following (Assume suitable domain types): (10)

i. Create the tables STUDENT(ROLLNO, NAME, CLASS, SEM, ADVISER), FACULTY(FID, NAME, SALARY, DEPT). Assume thatADVISER is a foreign key referring FACUTY table.

ii. Delete department with name 'CS' and all employees of thedepartment.

iii. Increment salary of every faculty by 10%.

b. Illustrate foreign key constraint with a typical example. (4)

15 For the relation schema below, give an expression in SQL for each of the queriesthat follows: (14)

employee(employee-name, street, city)
works(employee-name, company-name, salary)
company(company-name, city) manages(employee-name, manager-name)

a) Find the names, street address, and cities of residence for all employeeswho work for the Company 'RIL Inc.' and earn more than $10,000.
b) Find the names of all employees who live in the same cities as the companies for which they work.
c) Find the names of all employees who do not work for 'KYS Inc.'. Assume that all people work for exactly one company.
d) Find the names of all employees who earn more than every employee of'SB Corporation'. Assume that all people work for at most one company.
e) List out number of employees company-wise in the decreasing order ofnumber of employees.

OR

16 a. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), whichis the primary key. Assuming un-spanned organization and block size of 512 bytes compute the number of block accesses needed for selectingrecords based on employee number if, (9)

i. No index is used
ii. Single level primary index is used
iii. Multi-level primary index is used

Assume a block pointer size of 6 bytes.

b. Illustrate correlated and non-correlated nested queries with real examples. (5)

17 a. Illstrate3NF and BCNF with suitable real examples. (6)

b. Given a relation R(A1, A2 ,A3 ,A4, A5) with functional dependencies A1→A2A4 and A4→A5, check if the decomposition R1(A1,A2,A3), R2(A1,A4), R3(A2,A4,A5) is lossless. (8)

OR

18 a. Consider the un-normalized relation R(A, B, C, D, E, F, G) with the FDs A→B , AC→G, AD→EF, EF→G, CDE→AB. Trace the normalization process to reach 3NF relations. (7)

b. Illustrate Lossless Join Decomposition and Dependency Preserving Decomposition with typical examples. (7)

19 a. Discuss the four ACID properties and their importance. (7)

b. Determine if the following schedule is conflict serializable. Is the schedule recoverable? Is the schedule cascade-less? Justify your answers. (7)

r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2

(Note: ri(X)/wi(X) means transaction Ti issues read/write on item X; ci means transaction Ti commits.)

OR

20 a. Discuss the main characteristics of Key-value DB and Graph DB. (7)

b. Illustrate two-phase locking with a schedule containing three transactions. Argue that 2PL ensures serializability. Also argue that 2Pl can lead to deadlock. (7)

Teaching Plan

	Course Name	Hours (48)
	Module 1: Introduction & ER Model	**8**
1.1	Concept & Overview of DBMS, Characteristics of DB system, Database Users.	1
1.2	Structured, semi-structured and unstructured data. Data Models and Schema	1
1.3	Three-Schema-architecture. Database Languages	1
1.4	Database architectures and classification	1
1.5	ER model: basic concepts, entity set & attributes, notations	1
1.6	Relationships and constraints – cardinality, participation, notations	1
1.7	Weak entities, relationships of degree 3	1
1.8	ER diagram – exercises	1
	Module 2: Relational Model	**7**
2.1	Structure of relational Databases, Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema, Introduction to relational algebra.	1
2.3	Relational algebra: select, project, Cartesian product operations	1
2.4	Relational Algebra: join - Equi-join, Natural join	1
2.5	Query examples	1
2.6	Introduction to SQL, important data types	1
2.7	DDL, Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE	1
	Module 3: SQL DML, Physical Data Organization	**11**
3.1	SQL DML, SQL queries on single and multiple tables	1
3.2	Nested queries (correlated and non-correlated)	1
3.3	Aggregation and grouping	1

3.4	Views, assertions (with examples)	1
3.5	Triggers (with examples), SQL data types	1
3.6	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing	1
3.7	Singe level indices, numerical examples	1
3.8	Multi-level-indices, numerical examples	1
3.9	B-Trees and B+Trees (structure only, algorithms not required)	1
3.10	Extendible Hashing	1
3.11	Indexing on multiple keys – grid files	1
	Module 4: Normalization	**8**
4.1	Different anomalies in designing a database, The idea of normalization	1
4.2	Functional dependency, Armstrong's Axioms (proofs not required)	1
4.3	Closures and their computation, Equivalence of FDs, minimal Cover (proofs not required).	1
4.4	1NF, 2NF	1
4.5	3NF, BCNF	1
4.6	Lossless join and dependency preserving decomposition	1
4.7	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 1)	1
4.8	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 2)	1
	Module 5: Transactions, Concurrency and Recovery, Recent Topics	**14**
5.1	Transaction Processing Concepts: Transaction Model	1
5.2	Overview of concurrency control, Significance of concurrency Control & Recovery	1
5.3	Transaction States, System Log	1

5.4	Desirable Properties of transactions, Serial schedules	1
5.5	Concurrent and Serializable Schedules	1
5.6	Conflict equivalence and conflict serializability	1
5.7	Recoverable and cascade-less schedules	1
5.8	Locking, Two-phase locking, strict 2PL.	1
5.9	Log-based recovery	1
5.10	Deferred database modification (serial schedule), example	1
5.11	Deferred database modification (concurrent schedule) example, check-pointing	1
5.12	Introduction to NoSQL Databases	1
5.13	Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) [detailed study not expected]	1
5.14	Main characteristics of Column-Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB) [detailed study not expected]	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT 307	COMPUTER COMMUNICATION & NETWORK SECURITY	PCC	3	1	0	4

Preamble

The syllabus is prepared with a view to equip the Engineering Graduates to learn basic concepts in data communication and network security.

Prerequisite

Nil

Course Outcomes

After completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the basic concepts used in data communication and computer networking	Level 2: Understand
CO 2	Identify the concepts of data transmission and apply signal encoding techniques and multiplexing in data transmission.	Level 3: Apply
CO 3	Describe the design issues and protocols in data link layer	Level 2: Understand
CO 4	Familiarize with routing algorithms and transport layer protocols	Level 2: Understand
CO 5	Understand the basics of network security	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes 3/2/1: High/Medium/Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	-	-	-	-	-	-	-	-	2
CO 2	3	3	2	1	2	-	-	-	-	-	-	2
CO 3	2	3	1	2	2	-	-	-	-	-	-	2
CO 4	2	3	3	2	1	-	-	-	-	-	-	2

CO 5	2	2	2	1	1	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category Levels	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
BL 2: Understand	30	30	60
BL 3: Apply	20	20	40
BL 4: Analyse			
BL 5: Evaluate			
BL 6: Create			

Mark distribution

Total Marks	**Continuous Internal Evaluation (CIE)**	**End Semester Examination (ESE)**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be *two* parts; **Part A** and **Part B**. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer *all* questions. Part B contains 2 questions from each module of which student should answer *any one*. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. List the various layers of the OSI reference model.
2. What are the types of topologies used in a network?
3. Mention the various devices used in different layers of the TCP/IP reference model.
4. Define a Protocol Data Unit (PDU).
5. Compare the features of different guided media used in data transmission.
6. Give a comparative analysis of different kinds of satellite communication.

Course Outcome 2 (CO 2):

1. Explain the impairments in data transmission.
2. What is Nyquist criteria for channel bandwidth?
3. Differentiate between analog and digital signals used in transmission.
4. Explain the process of Delta Modulation?
5. Compare and contrast FDM and WDM.

Course Outcome 3 (CO 3):

1. Assess the suitability of various error correcting codes to deal with single-bit and burst errors in data transmission.
2. Derive a Hamming code for single bit error correction (For a data of length 7 Bit).
3. How errors are detected using parity checking? What are the limitations of parity checking?
4. What are the services offered by the Data Link Layer? Mention the protocols also.
5. With the help of a diagram, explain the format of an Ethernet frame.

Course Outcome 4 (CO 4):

1. What are the functionalities of network layer?
2. Compare distance vector routing and link state routing?
3. What is count-to-infinity problem? How can it be solved?
4. Explain how congestion control is performed in network layer
5. Explain congestion control in virtual circuit subnet
6. Explain the segment format of TCP

Course Outcome 5 (CO 5):

1. What is a firewall?
2. Compare public key cryptography and private key cryptography
3. What is a digital signature?
4. What are the features of cryptographic hash functions?
5. Explain RSA in detail

Model Question Paper

Course Code: EOT 307

Course Name: Computer Communication and Network Security

Max.Marks:100 **Duration: 3 Hours**

Part A

Answer all questions. Each question carries 3 marks. (10 * 3 = 30 Marks)

1. What are the features of WAN?
2. Explain the role of routers in Networks.
3. Explain Data rate, Noise and Bandwidth with respect to a channel.
4. If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700, and 900 Hz, what is its bandwidth? Draw the spectrum, assuming all components have a maximum amplitude of 10 V.
5. Using an example, explain two-dimensional parity checks.
6. Write a short note on CSMA/CD.
7. How choke packets help in reducing congestion?
8. Explain the importance of the age field in link state messages.
9. What are the differences between message confidentiality and message integrity?
10. In what way does a hash provide a better message integrity check than a checksum?

Part B

Answer all questions. Each question carries 14 marks. (5 * 14 = 70 Marks)

11		List and explain the main features of all the seven layers of the ISO/OSI reference model and compare it with TCP/IP Model.	14
		OR	
12	a.	Explain the features of any two guided transmission media.	9
	b.	Describe the use of satellites in communication.	5

13	a	Explain the features of NRZ, AMI, and Manchester encoding schemes. Encode the given digital data 10110010 using NRZ-L, NRZ-I, AMI, Manchester and differential Manchester encoding schemes?	10
	b	A telephone line normally has a bandwidth of 3000 Hz (300 to 3300 Hz) assigned for data communications. The signal-to-noise ratio is usually 3162. Find the channel capacity.	4
		OR	
14	a	What are the transmission impairments happening in data communication?	10
	b	Consider a channel with a 1-MHz bandwidth. The SNR for this channel is 63. What are the appropriate bit rate and signal level?	4
15	a	List and explain the sliding window protocols used in data link layer.	10
	b	Compare pure ALOHA and slotted ALOHA.	4
		OR	
16	a	Describe about CRC encoding and decoding with data word 1010 with $G(x) = x^3+x+1$.	10
	b	Explain about contention free protocols.	4
17	a	Explain distance vector routing in detail.	10
	b	Explain the header format of UDP.	4
		OR	
18	a	Explain in detail about the TCP finite state machine.	10
	b	Explain the congestion prevention policies used in network layer.	4
19	a	Explain in detail about PGP.	8
	b	Explain in detail about cipher block chaining.	6
20	a	Explain in detail about VPN.	10
	b	What is intrusion detection system?	4

Syllabus

Module 1: Overview of Computer Communication (10 Hours)
Introduction: - Types of Computer Networks, Network Software - Protocol Hierarchies, Connection oriented and Connection less hierarchies, Reference Models - ISO-OSI Reference Model, TCP/IP Reference Model – Comparison of OSI and TCP/IP reference models. Physical Layer: - Guided Transmission Media– Twisted Pair, Coaxial and Fiber Optics, Wireless Transmission- Radio and Microwave transmission, Communication Satellites – GEO, MEO, LEO. Data and signals, Analog Signals, Digital Signals - Transmission Impairments, Data Rate Limits: Channel Capacity, Nyquist Bit Rate, Shannon Capacity
Module 2: Data Transmission and Encoding Techniques (8 Hours)
Digital-To-Digital Conversion: Line Coding Schemes: Unipolar, Polar, Bipolar - Block Coding, Scrambling, Analog-To-Digital Conversion: Pulse Code Modulation, Delta Modulation - Digital-To-Analog Conversion: ASK, FSK, PSK. Transmission Modes: Parallel and Serial Transmission, Asynchronous, Synchronous, Isochronous Transmission, Multiplexing - TDM, FDM, WDM
Module 3: Data Link Layer (8 Hours)
Data Link Layer – design issues - Error Detection: Parity Check, Checksum, CRC, Error Correction: Hamming code - Flow Control: Stop-and-Wait, Go-Back-N, and Selective- Repeat. Multiple Access Protocols: ALOHA, CSMA, CSMA/CD, Collision free protocols Ethernet- Ethernet Cabling, Encoding, Frame Format, Binary Exponential Back Off Algorithm.
Module 4: Network Layer and Transport Layer (9 Hours)
Network Layer Design Issues, Routing Algorithm – Optimality principle - Flooding - Distance vector routing – Link state routing –Congestion Control Algorithms – General principles – Congestion prevention policies – Choke packets – Random Early Detection. Transport layer – transport services, elements of transport protocols, introduction to UDP, introduction to TCP – TCP service model, TCP segment header, TCP connection establishment and release, TCP finite state machine.
Module 5: Network Security (8 Hours)

Introduction to network security, principles of cryptography – symmetric key cryptography, public key cryptography, message integrity and digital signatures, securing e-mail, securing TCP connections, IPSec, VPN, Firewalls and Intusion detection systems

Text Books

1. Andrew S. Tanenbaum and David J. Wetheral, "Computer Networks", Pearson, 5th Edition, 2019
2. James F. Kurose and Keith W. Ross, "Computer Networking: A Top Down Approcah", Pearson, Sixth Edition, 2013

Reference Books

1. Behrouz A. Forouzan, Data Communications and Networking, 5/e, Tata McGraw Hill, 2017.
2. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
3. Fred Halsall, Computer Networking and the Internet, 5/e.
4. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring Internet, 6/e, Pearson Education, 2012.
5. L. L. Peterson and B. S. Davie, Computer Networks, A systems approach, 5/e, Morgan Kaufmann, 2011.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Overview of Computer Communication**	**10 Hours**
1.1	Introduction: - Types of Computer Networks, Network Software - Protocol Hierarchies, Connection oriented and Connection less hierarchies, Reference Models - ISO-OSI Reference Model, TCP/IP Reference Model – Comparison of OSI and TCP/IP reference models.	2
1.2	Physical Layer: - Guided Transmission Media– Twisted Pair, Coaxial and Fiber Optics	1
1.3	Wireless Transmission- Radio and Microwave transmission, Communication Satellites – GEO, MEO, LEO.	2
1.4	Data and signals, Analog Signals, Digital Signals	1
1.5	Transmission Impairments	2
1.6	Data Rate Limits: Channel Capacity, Nyquist Bit Rate, Shannon Capacity	2
2	**Data Transmission and Encoding Techniques**	**8 Hours**
2.1	Digital-To-Digital Conversion: Line Coding Schemes: Unipolar, Polar, Bipolar - Block Coding, Scrambling	3
2.2	Analog-To-Digital Conversion: Pulse Code Modulation, Delta Modulation	2
2.3	Digital-To-Analog Conversion: ASK, FSK, PSK.	1
2.4	Transmission Modes: Parallel and Serial Transmission, Asynchronous, Synchronous, Isochronous Transmission	1
2.5	Multiplexing - TDM, FDM, WDM	1
3	**Data Link Layer**	**8 Hours**
3.1	Data Link Layer – design issues	1
3.2	Error Detection: Parity Check, Checksum, CRC	2

3.3	Error Correction: Hamming code	1
3.4	Flow Control: Stop-and-Wait, Go-Back-N, and Selective- Repeat.	1
3.5	Multiple Access Protocols : ALOHA, CSMA, CSMA/CD, Collision free protocols	2
3.6	Ethernet- Ethernet Cabling, Encoding, Frame Format, Binary Exponential Back Off Algorithm.	1
4	**Network Layer and Transport Layer**	**9 Hours**
4.1	Network Layer Design Issues	1
4.2	Routing Algorithm – Optimality principle - Flooding	1
4.3	Distance vector routing	1
4.4	Link state routing	1
4.5	Congestion Control Algorithms – General principles – Congestion prevention policies – Choke packets – Random Early Detection.	1
4.6	Transport layer – transport services, elements of transport protocols, introduction to UDP	1
4.7	Introduction to TCP – TCP service model, TCP segment header	2
4.8	TCP connection establishment and release, TCP finite state machine.	1
5	**Network Security**	**8 Hours**
5.1	Introduction to network security	1
5.2	Principles of cryptography – symmetric key cryptography, public key cryptography	2
5.3	Message integrity and digital signatures	1
5.4	Securing e-mail, Securing TCP connections	1

5.5	IPSec, VPN	1
5.6	Firewalls and Intrusion detection systems	2

CST 309	MANAGEMENT OF SOFTWARE SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	0	0	3	2019

Preamble

This course provides fundamental knowledge in the Software Development Process.It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

Prerequisite

Basic understanding of Object-Oriented Design and Development.

Course Outcomes

After the completion of the course the student will be able to

CO1	Demonstrate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Apply)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Cognitive Knowledge Level**: **Apply**)
CO3	Justify the significance of design patterns and licensing terms in softwaredevelopment, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply**)
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with a traditional/agile framework**. (Cognitive Knowledge Level: Apply**)
CO5	Utilize SQA practices, Process Improvement techniques and Technologyadvancements in cloud-based software models and containers & microservices. **(Cognitive Knowledge Level: Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓						✓
CO2	✓	✓	✓	✓		✓				✓	✓	✓
CO3	✓	✓	✓	✓				✓		✓	✓	✓
CO4	✓	✓	✓	✓		✓			✓	✓	✓	✓
CO5	✓	✓	✓	✓		✓						✓

	Abstract POs defined by National Board of Accreditation		
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	50
Apply	30	30	20
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**
(Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.
First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

Syllabus

Module 1 : Introduction to Software Engineering (7 hours)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies: An insulin pump control system. Mentcare - a patient information system for mental health care.

Module 2: Requirement Analysis and Design (8 hours)

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component? Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per “IEEE Std1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure.

Module 3: Implementation and Testing (9 hours)

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.

Module 4: Software Project Management (6 hours)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

Module 5: Software Quality, Process Improvement and Technology trends (6 hours)

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics. Software Process Improvement (SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service (IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.

Text Books

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

References

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions
3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management: A unified framework, Pearson Education, 1998
6. Steve. Denning, the age of agile, how smart companies are transforming the way work getsdone. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/
12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the advantages of an incremental development model over a waterfallmodel?
2. Illustrate how the process differs in agile software development and traditional software development with a socially relevant case study. (Assignment question)

Course Outcome 2 (CO2):

1. How to prepare a software requirement specification?
2. Differentiate between Architectural design and Component level design.
3. How does agile approaches help software developers to capture and define the userrequirements effectively?
4. What is the relevance of the SRS specification in software development?
5. Prepare a use case diagram for a library management system.

Course Outcome 3 (CO3):

1. Differentiate between the different types of software testing strategies.
2. Justify the need for DevOps practices?
3. How do design patterns help software architects communicate the design of a complexsystem effectively?
4. What are the proactive approaches one can take to optimise efforts in the testing phase?

Course Outcome 4 (CO4):

1. Illustrate the activities involved in software project management for a socially relevantproblem?
2. How do SCRUM, Kanban and Lean methodologies help software project management?
3. Is rolling level planning in software project management beneficial? Justify your answer.
4. How would you assess the risks in your software development project? Explainhow you can manage identified risks?

Course Outcome 5 (CO5):

1. Justify the importance of Software Process improvement?
2. Explain the benefits of cloud based software development, containers and microservices.
3. Give the role of retrospectives in improving the software development process.
4. Illustrate the use of project history data as a prediction tool to plan future sociallyrelevant projects.

Model Question Paper

QP CODE:

Reg No:_______________

Name :_______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 309

Course Name: Management of Software Systems

Duration: 3 Hrs **Max. Marks :100**

PART A

Answer all Questions. Each question carries 3 marks

1. Why professional software that is developed for a customer is not simply the programs that have been developed and delivered.
2. Incremental software development could be very effectively used for customers who do not have a clear idea about the systems needed for their operations. Justify.
3. Identify any four types of requirements that may be defined for a software system
4. Describe software architecture
5. Differentiate between GPL and LGPL?
6. Compare white box testing and black box testing.
7. Specify the importance of risk management in software project management?
8. Describe COCOMO cost estimation model.
9. Discuss the software quality dilemma
10. List the levels of the CMMI model? **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Compare waterfall model and spiral model

(8)

(b) Explain Agile ceremonies and Agile manifesto (6)

12. (a) Illustrate software process activities with an example. (8)

(b) Explain Agile Development techniques and Agile Project Management (6)

13. (a) What are functional and nonfunctional requirements? Imagine that you are developing a library management software for your college, list eight functional requirements and four nonfunctional requirements. (10)

(b) List the components of a software requirement specification? (4)

OR

14. (a) Explain Personas, Scenarios, User stories and Feature identification? (8)

(b) Compare Software Architecture design and Component level design (6)

15. (a) Explain software testing strategies. (8)

(b) Describe the formal and informal review techniques. (6)

OR

16. (a) Explain Continuous Integration, Delivery, and Deployment CI/CD/CD) (8)

(b) Explain test driven development (6)

17. (a) What is a critical path and demonstrate its significance in a project schedule with the help of a sample project schedule. (8)

(b) Explain plan driven development and project scheduling. (6)

OR

18. (a) Explain elements of Software Quality Assurance and SQA Tasks. (6)

(b) What is algorithmic cost modeling? What problems does it suffer from when (8) compared with other approaches to cost estimation?

19. (a) Explain elements of Software Quality Assurance and SQA Tasks. **(8)**

(b) Illustrate SPI process with an example. **(6)**

OR

20. (a) Compare CMMI and ISO 9001:2000. **(8)**

(b) How can Software projects benefit from Container deployment and Micro service deployment? **(6)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module 1 : Introduction to Software Engineering (7 hours)		
1.1	Introduction to Software Engineering.[Book 1, Chapter 1]	1 hour
1.2	Software process models [Book 1 - Chapter 2]	1 hour
1.3	Process activities [Book 1 - Chapter 2]	1 hour
1.4	Coping with change [Book 1 - Chapter 2, Book 2 - Chapter 4]	1 hour
1.5	Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care. [Book 1 - Chapter 1]	1 hour
1.6	Agile software development [Book 1 - Chapter 3]	1 hour
1.7	Agile development techniques, Agile Project Management.[Book 1 - Chapter 3]	1 hour
Module 2 : Requirement Analysis and Design (8 hours)		
2.1	Functional and non-functional requirements, Requirements engineering processes [Book 1 - Chapter 4]	1 hour
2.2	Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix [Book 1 - Chapter 4]	1 hour
2.3	Developing use cases, Software Requirements Specification Template [Book 2 - Chapter 8]	1 hour

2.4	Personas, Scenarios, User stories, Feature identification [Book 3 - Chapter 3]	1 hour
2.5	Design concepts [Book 2 - Chapter 12]	1 hour
2.6	Architectural Design [Book 2 - Chapter 13]	1 hour
2.7	Component level design [Book 2 - Chapter 14]	1 hour
2.8	Design Document Template. Case study: The Ariane 5 launcher failure. [Ref - 2, Book 2 - Chapter 16]	1 hour
Module 3 : Implementation and Testing (9 hours)		
3.1	Object-oriented design using the UML, Design patterns [Book 1 - Chapter 7]	1 hour
3.2	Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD [Book 1 - Chapter 7]	1 hour
3.3	Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. [Book 2 - Chapter 20]	1 hour
34	Informal Review, Formal Technical Reviews, Post-mortem evaluations. [Book 2 - Chapter 20]	1 hour
3.5	Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing and Debugging (basic concepts only). [Book 2 - Chapter 22]	1 hour
3.6	White box testing, Path testing, Control Structure testing, Black box testing. Test documentation [Book 2 - Chapter 23]	1 hour
3.7	Test automation, Test-driven development, Security testing. [Book 3 - Chapter 9]	1 hour
3.8	DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. [Book 3 - Chapter 10]	1 hour
3.9	Software Evolution - Evolution processes, Software maintenance. [Book 1 - Chapter 9]	1 hour
Module 4 : Software Project Management (6 hours)		
4.1	Software Project Management - Risk management, Managing people, Teamwork [Book 1 - Chapter 22]	1 hour
4.2	Project Planning - Software pricing, Plan-driven development, Project scheduling, Agile planning [Book 1 - Chapter 23]	1 hour
4.3	Estimation techniques [Book 1 - Chapter 23]	1 hour
4.4	Configuration management [Book 1 - Chapter 25]	1 hour

4.5	Agile software management - SCRUM framework [Book 2 - Chapter 5]	1 hour
4.6	Kanban methodology and lean approaches.[Ref 9 - Chapter 2]	1 hour
Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)		
5.1	Software Quality, Software Quality Dilemma, Achieving Software Quality. [Book 2 - Chapter 19]	1 hour
5.2	Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. [Book 3 - Chapter 21]	1 hour
5.3	Software Process Improvement (SPI), SPI Process [Book 2 - Chapter 37]	1 hour
5.4	CMMI process improvement framework, ISO 9001:2000 for Software. [Book 2 - Chapter 37]	1 hour
5.5	Cloud-based Software - Virtualisation and containers, IaaS, PaaS, SaaS.[Book 3 - Chapter 5]	1 hour
5.6	Microservices Architecture - Microservices, Microservices architecture, Microservice deployment [Book 3 - Chapter 6]	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOL301	NETWORKING LAB	PCC	0	0	4	2

Preamble

The course enables the students to get hands-on experience in network programming using Linux System calls and network monitoring tools. The course aims to equip students to perform networking using IPv4 and IPv6. The lab covers static, default, and dynamic routing.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Use network related commands and configuration files in Linux Operating System	Level 2: Understand
CO 2	Develop network application programs	Level 3: Apply
CO 3	Analyze network traffic using network monitoring tools	Level 3: Apply
CO 4	Explain IPv4 addressing, IPv6 addressing, subnetting and design networks	Level 3: Apply
CO 5	Experiment with static and dynamic routing	Level 3: Apply

Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9		PO 10	PO 11	PO 12
CO 1	3	1	-	-	2	-	-	-	-		-	-	1
CO 2	3	3	3	-	-	-	-	-	-		-	-	2
CO 3	3	3	-	-	2	-	-	-	-		-	-	2
CO 4	3	3	3	-	2	-	-	-	-		-	-	2

CO 5	3	2	-	-	-	-	-	-	-		-	-	2
CO 6	3	1	2	-	3	-	-	-	-		-	-	2

3/2/1: high/medium/low

Assessment Pattern

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

a) Preliminary work : 15Marks

b) Implementing the work/Conducting the experiment : 10 Marks

c) Performance, result and inference (usage of equipment and troubleshooting) : 25 Marks

d) Viva voce : 20 Marks

e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. View the configuration, including addresses of your computers network interfaces.
   Test the network connectivity between your computer and several other computers.
   View the active TCP connections in the computer after visiting a website.
   Find the hardware/MAC address of another computer in the network using ARP.
2. Write the system calls used for creating sockets and transferring data between two nodes.

Course Outcome 2 (CO2)

1. Implement a multi-user chat server using TCP as transport layer protocol.
2. Implement a simple web proxy server that accepts HTTP requests and forwarding to remote servers and returning data to the client using TCP
3. Implement a Concurrent Time Server application using UDP to execute the program at a remote server. Client sends a time request to the server, server sends its system time back to the client. Client displays the result

Course Outcome 3(CO3):

1. Using Wireshark, Capture packets transferred while browsing a selected website. Investigate the protocols used in each packet, the values of the header fields and the size of the packet.
2. Using Wireshark, observe three way handshaking connection establishment, three way handshaking connection termination and Data transfer in client server communication using TCP.
3. Explore at least the following features of Wireshark: filters, Flow graphs (TCP), statistics, and protocol hierarchies.

Course Outcome 4 (CO4):

1. An IP address of 172.16.0.0/16 is assigned to an ISP. The ISP has to distribute it among 7 organizations. Design the subnets

2. You are given the IP Address of 193.103.20.0 /24 and need 50 Subnets. How many hosts per network, and total networks do you get once sub netted?

Course Outcome 5 (CO5):

1. An organization with 7 departments is assigned an IP address of 200.0.0.0/24. The organization should assign address to each department. Design the subnets and connect the first and third network using RIP
2. Subnet the Class B IP Address 130.13.0.0 into 500 Subnets. What is the new Subnet Mask and what is the Increment? Connect the 6^{th} and 15^{th} Subnet using static routing

LIST OF EXPERIMENTS

(All the listed experiments are mandatory)

1. Getting started with the basics of network configuration files and networking commands in Linux.
2. To familiarize and understand the use and functioning of system calls used for network programming in Linux.
3. Implement client-server communication using socket programming and TCP as transport layer protocol
4. Implement client-server communication using socket programming and UDP as transport layer protocol
5. Understanding the Wireshark tool.
6. Configure and verify IPv4 addressing and sub netting
7. Configure and verify IPv6 addressing and prefix
8. Compare IPv6 address types
9. Configure and verify IPv4 routing
    a. Static Routing
    b. Dynamic Routing – RIP, OSPF, EIGRP
10. Implement Unicast IPv6 Addresses on Routers and verify
    a. Static routing
    b. Dynamic routing – RIPng, OSPFv3

Reference Books:

1.W. Richard Stevens, Bill Fenner, Andy Rudoff, UNIX Network Programming: Volume1, The Sockets Networking API, 3rd Edition, Pearson, 2015
2. Lisa Bock, Learn Wireshark: Confidently navigate the Wireshark interface and solve real-world networking problems, Packt Publishing, 2019

3. CCNA 200-301 Official Cert Guide, Volume 1,Wendell Odom, Cisco Press

4. CCNA –Cisco Certified Network Associate. Study Guide ,Todd Lammle, CCSI, Wiley India Edition-Sixth Edition

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS	Year of Introduction
EOL 303	MEASUREMENTS AND INSTRUMENTATION LAB	PCC	0	0	4	2	2019

Preamble

This laboratory course is designed to train the students to familiarize and practice various measuring instruments and different transducers for measurement of physical parameters. Students will also be introduced to a team working environment where they develop the necessary skills for planning, preparing and implementing basic instrumentation systems.

Prerequisite

Basic Electrical Engineering

Course Outcomes

After the completion of the course the student will be able to

CO 1	Analyse voltage current relations of RLC circuits
CO 2	Measure power in a single and three phase circuits by various methods
CO 3	Determine electrical parameters using various bridges
CO 4	Calibrate various meters used in electrical systems
CO 5	Determine magnetic characteristics of different electrical devices
CO 6	Analyse the characteristics of various types of transducer systems
CO 7	**Use Simulation software to design and analyze simple systems**
CO 8	**Design and implement basic circuits using OPAMP**

Mapping of course outcomes with program outcomes

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	1	-	-				2			2
CO 2	3	3	-	-	-	-	-	-	2	-	-	2
CO 3	3	3	-	-	-	-	-	-	2	-	-	-
CO 4	3	3	2	-	-	-	-	-	2	-	-	-
CO 5	3	3	-	-	-	-	-	-	2	-	-	-
CO 6	3	3	2	-	2	-	-	-	2	-	-	2
CO 7	3	3	-	-	2	-	-	-	2	-	-	-
CO 8	3	3	3	1	-	-	-	-	2	-	-	-

ASSESSMENT PATTERN:

Mark distribution:

Total Marks	CIE marks	ESE marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation (CIE) Pattern:

Internal Test Evaluation (Immediately before the second series test)

Attendance	Regular Lab work	Internal Test	Course Project	Total
15	30	25	5	**75**

End Semester Examination (ESE) Pattern:

The following guidelines should be followed regarding award of marks

(a) Preliminary work: 15 Marks

(b) Implementing the work/Conducting the experiment : 10Marks

(c) Performance, result and inference (usage of equipments and trouble shooting) : 25 Marks

(d) Viva voce : 20 marks

(e) Record: 5 Mark

General Instruction:

Practical examination is to be conducted immediately after the second series test after conducting 12 experiments from the list of experiments given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

LIST OF EXPERIMENTS:
(12 Experiments are mandatory)

1. Determination of impedance, admittance and power factor in RLC series/ parallel circuits.
2. 3-phase power measurement using one wattmeter and two-wattmeter methods, and determination of reactive/apparent power drawn.
3. Resistance measurement using Kelvin's Double Bridge and Wheatstone's Bridge and extension of range of voltmeters and ammeters.
4. Extension of instrument range by using Instrument transformers (CT and PT)
5. Calibration of ammeter, voltmeter, wattmeter using Potentiometers
6. Calibration of 1-phase Energy meter at various power factors using phantom Loading (minimum 4 conditions)
7. Calibration of 3-phase Energy meter using standard wattmeter
8. Determination of B-H curve, μ-H curve and μ-B curve of a magnetic specimen
9. Measurement of Self- inductance, Mutual inductance and Coupling coefficient of a 1-phase transformer.
10. Experiments using PLC- Realization of Basic gates using ladder diagrams
11. Determine the characteristics of LVDT, Strain gauge and Load-cell.
12. a Determine the characteristics of thermistor, thermocouple and RTD
    b Using Virtual instrumentation characterize a thermistor, thermocouple and RTD.
13. Design an inverting, non-inverting amplifier, adder, differentiator and instrumentation amplifiers using OP amps.
14. Verification of loading effect in ammeters and voltmeters with current measurement using Clamp on meter.
15. Experiments/Simulation study:
    (a) Measurement of energy using TOD meter
    (b) Measurement of electrical variables using DSO
    (c) Harmonic analysers
    (d) Simulation of Circuits using software platform
    (e) Computer interfaced measurements of circuit parameters.

Mandatory Group Project Work:

Students have to do a mandatory micro project (group size not more than 5 students) to realise functional instrumentation system. A report also is to be submitted. Performance can be evaluated along with the internal test and a maximum of5 marks shall be awarded.

Example projects (Instrumentation system with sensors, alarm, display units etc)
1. Temperature Monitoring System.
2. Gas / Fire smoke Detection Systems.
3. Simulation using LabVIEW, PLC or Similar Software's.

Reference Books:

1. A. K. Sawhney: course in Electrical and Electronic Measurements &Instrumentation, Dhanpat Rai Publishers
2. J. B. Gupta: A course in Electrical & Electronic Measurement & Instrumentation., S. K. Kataria & Sons Publishers
3. Kalsi H. S.: Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET385	**CONTROL SYSTEMS**	**VAC**	**3**	**1**	**0**	**4**

Preamble

This course deals with the fundamental concepts of control systems theory.Modelling, time domain analysis, frequency domain analysis and stability analysis of linear systems based on transfer function approach are discussed. The state space concept is also introduced.

Prerequisite

Basics of Dynamic Circuits and Systems

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Describe the role of various control blocks and components in feedback systems
CO 2	Analyse the time domain responses of the linear systems
CO 3	Apply Root locus technique to assess the performance of linear systems
CO 4	Analyse the stability of the given LTI systems.
CO 5	Apply state variable concepts to assess the performance of linear systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	-	-	-	-	-	-	-	3
CO 2	3	3	3	-	-	-	-	-	-	-	-	3
CO 3	3	3	3	-	2	-	-	-	-	-	-	3
CO 4	3	3	3	-	-	-	-	-	-	-	-	3
CO 5	3	3	3	3	-	-	-	-	-	-	-	3

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	10	10	20
Apply (K3)	30	30	60
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern : There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Derive and explain the transfer function of field controlled dc servo motor.
2. With the help of suitable example explain the need for analogous systems.
3. Explain how does the feedback element affect the performance of the closed loopsystem?

Course Outcome 2 (CO2):

1. Obtain the different time domain specification for a given second order system withimpulse input and assess the system dynamics.
2. Determine the value of the natural frequency of oscillation ω_n for the unity feedback system with forward transfer function $G_p(s) = \frac{K}{s(s+10)}$, which results in a critically damped response.
3. Problems related to static error constant and steady state error for a given input.

Course Outcome 3 (CO3):

1. Determine the value of K such that the closed loop system with $G(s)H(s) = \frac{K}{s(s+1)(s+4)}$ is oscillatory, using Root locus.
2. Construct the Root locus for the closed loop system with $G(s)H(s) = \frac{K}{s(s^2+3s+2)}$.

   Determine the value of K to achieve a damping factor of 0.5?
3. Problem on root locus for systems with positive feedback.

Course Outcome 4 (CO4):

1. Problems related to application of Routh's stability criterion for analysing the stabilityof given system.
2. Determine the value of K such that the gain margin for the system with $G(s)H(s) = \frac{K}{s(s+2)(s+5)}$ equals to 10 dB.
3. Problem related to the analysis of given system using Polar plot.

Course Outcome 5 (CO5):

1. Determine the transfer function of the system given by:

system with state model:

$$\dot{X} = \begin{bmatrix} -2 & 1 \\ -1 & -2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u; \quad y = \begin{bmatrix} 0 & 1 \end{bmatrix} x.$$

2. Obtain the time response y(t) of the homogeneous system represented by:

$$\begin{bmatrix} \dot{x} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad [y] = [1 \quad 0][x] \text{ with } x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$$

3. Derive and analyse the state model for a field controlled dc servo motor.

Model Question Paper

PAGES: 3

QP CODE:

Reg. No:___________

Name:_____________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH & YEAR

Course Code**: EET385**

Course Name: **CONTROL SYSTEMS**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1 Give a comparison between open loop and closed loop control systems with suitable examples.

2 With relevant characteristics explain the operation of a tacho generator as a control device.

3 For a closed loop system with $G(s) = \frac{3}{s\,(s+2)}$; and H(s) = 0.1, calculate the steady state error constants.

4 Check the stability of the system given by the characteristic equation, $G(s) = s^5 + 2s^4 + 4s^3 + 8s^2 + 16s + 32;$ using Routh criterion.

5 With suitable sketches explain how addition of zeroes to the open-loop transfer function affects the root locus plots.

6 Explain Ziegler – Nichol's PID tuning rules.

7 Explain the features of Non-minimum phase systems with a suitable example.

8 How do you determine the gain margin of a system, with the help of Bode plot?

9 A system is represented by $\frac{Y(s)}{U(s)} = \frac{3}{(s+1)(s+2)}$. Derive the Canonical diagonal form of representation in state space.

10 Discuss the advantages of state space analysis.

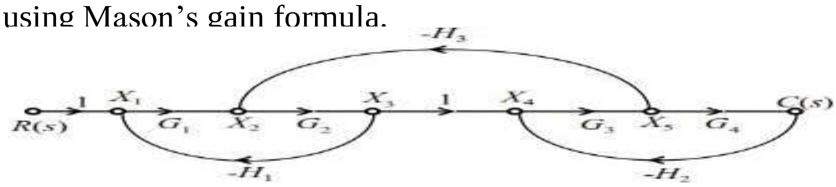
PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

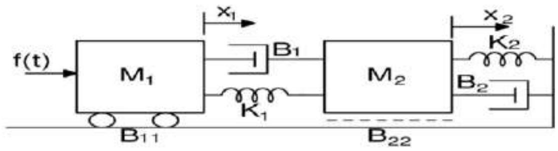
11 a) Derive the transfer function of an Armature controlled dc servo motor. Assess the effect of time constants on the system performance. **(8)**

b) Determine the transfer function of the system represented by the signal flow graph using Mason's gain formula.



(6)

12 a) Derive the transfer function $X_2(s)/F(s)$ for the mechanical system.



(9)

b) Compare the effect of H(s) on the pole-zero plot of the closed loop system with $G(s) = \dfrac{s+1}{(s^2+5s+6)}$ with: i) derivative feed back H(s)= s; ii) integral feedback H(s)=1/s. **(5)**

Module 2

13 a) Derive an expression for the step response of a critically damped second order system? Explain the dependency of maximum overshoot on damping factor. **(9)**

b) Determine the value of gain K and the natural frequency of oscillation ω_n for the unity feedback system with forward transfer function $G(s) = \dfrac{K}{s(s+6)}$, which results in a critically damped response when subjected to a unit impulse input.

Also determine the steady state error for unit velocity input. **(5)**

14 a) A unity feedback system is characterized by an open loop transfer function $G(s) = \dfrac{4}{(s^2+s+5)}$. Determine the transient response when subjected to a unit step input and sketch the response. Evaluate the rise time and peak time of the system. . **(9)**

b) Using Routh criterion determine the value of K for which the unity feedback closed loop system with $G(s) = \dfrac{K}{s(s^2+3s+1)}$ is stable. . **(5)**

Module 3

15 a) Determine the value of K such that the closed loop system with $G(s)H(s) = \dfrac{K}{s(s+2)(s+5)}$ is oscillatory, using Root locus.

Also determine the value of K to achieve a damping factor of 0.866. **(10)**

b) Compare between PI and PD controllers. **(4)**

16 a) Sketch the root locus for a system with $G(s)H(s) = \dfrac{K(s-1)}{s(s+4)}$. Hence determine the range of K for the system stability. **(9)**

b) With help of suitable sketches, explain how does Angle and Magnitude criteria of Root locus method help in control system design. **(5)**

Module 4

17 a) The open-loop transfer function of a unity feedback system is $G(s)=\dfrac{K}{s(0.5s+1)(0.04s+1)}$. Use asymptotic approach to plot the Bode diagram and determine the value of K for a gain margin of 10 dB. **(10)**

b) Derive and explain the dependence of resonant peak on damping factor. **(4)**

18 a) Draw the polar plot for the system with $G(s)H(s) = \dfrac{K}{s(s+0.5)(s+2)}$ and determine the value of K such that phase margin equals to 40°. **(9)**

b) Explain the detrimental effects of transportation lag using Bode plot. **(5)**

Module

19 a) Obtain the time response y(t) of the homogeneous system represented by:

$$\begin{bmatrix}\dot{X}\end{bmatrix} = \begin{bmatrix}-1 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} \quad [y]=[1 \quad 0][X] \text{ with } x(0)=\begin{bmatrix}1\\ 0\end{bmatrix}$$ **(6)**

b) Derive and analyse the state model for a field controlled dc servo motor **(8)**

20 a) A system is represented by $\frac{Y(s)}{U(s)} = \frac{4(s+0.5)}{(s+1)(s+2)}$. Derive the phase variable representation in state space. **(5)**

b) Derive the transfer function for the system with

$$\begin{bmatrix}\dot{X}\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 2\\ -12 & -7 & -4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 1\\ 1\end{bmatrix}u; \quad [y]=[1 \quad 0 \quad 0][X]$$

(9)

Syllabus

Module 1

System Modeling (8 hours)

Open loop and closed loop control systems
Transfer function of LTI systems- Electrical, translational and rotational systems – Force voltage and force current analogy
Block diagram representation - block diagram reduction
Signal flow graph - Mason's gain formula
Control system components: Transfer functions of DC and AC servo motors– Controlapplications of Tacho generator and Stepper motor.

Module 2

Performance Analysis of Control Systems (12 hours)

Characteristic equation of Closed loop systems- Effect of feedback-.
Time domain analysis of control systems: Time domain specifications of transient and steady state responses- Impulse and Step responses of first order and second order systems.
Error analysis: Steady state error analysis - static error coefficients of type 0,1,2 systems. Stability Analysis: Concept of stability- BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems - Routh's stability criterion-analysis - relative stability

Module 3

Root Locus Analysis and Compensators (8 hours)

Root locus technique: General rules for constructing Root loci – stability from root loci - Effect of addition of poles and zeros on Root Locus- Effect of positive feedback systemson Root Locus
Need for controllers: Types- Feedback, cascade and feed forward controllersPID controllers (basic functions only)- Zieglar Nichols PID tuning methods
Introduction to MATLAB functions and Toolbox for Root locus based analysis(Demo/Assignment only))

Module 4

Frequency Domain Analysis (9 hours)

Frequency domain specifications- correlation between time domain and frequency domain responses
Polar plot: Concepts of gain margin and phase margin- stability analysis
Bode Plot: Construction of Bode plots- Analysis based on Bode plot Effect of Transportation lag and Non-minimum phase systems
Introduction to MATLAB functions and Toolbox for various frequency domain plots and analysis (Demo/Assignment only).

Module 5

State Space Analysis of Systems (10 hours)

Introduction to state space and state model concepts- state equation of linear continuous time systems, matrix representation- features -Examples of simple electrical circuits, and dc servomotor.

Phase variable forms of state representation- controllable and observable forms- Diagonal Canonical forms - Jordan canonical form

Derivation of transfer function from state equations.

State transition matrix: Properties of state transition matrix- Computation of state transition matrix using Laplace transform- Solution of homogeneous systems

Textbooks

1. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers
2. Ogata K, Modern Control Engineering, 5/e, Prentice Hall of India.
3. Nise N. S, Control Systems Engineering, 6/e, Wiley Eastern
4. Dorf R. C. and Bishop R. H, Modern Control Systems, 12/e, Pearson Education
5. K R Varmah, Control Systems, Tata McGrawHill, 2010

Reference Books

1. Kuo B. C, Automatic Control Systems, 7/e, Prentice Hall of India
2. Desai M. D., Control System Components, Prentice Hall of India, 2008
3. Gopal M., Control Systems Principles and Design, 4/e, Tata McGraw Hill.
4. Imthias Ahamed T. P, Control Systems, Phasor Books, 2016
5. Gopal M., Modern Control System Theory, 2/e, New Age Publishers

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**System Model (8 hours)**	
1.1	Open loop and closed loop control systems	1
1.2	Transfer function of LTI systems- Electrical, translational and rotational systems – Force voltage and force current analogy	2
1.3	Block diagram representation - block diagram reduction	2
1.4	Signal flow graph - Mason's gain formula	1
1.5	Control system components: Transfer functions of DC and AC servo motors –Control applications of Tacho generator and Stepper motor.	2
2	**Performance Analysis of control systems (10 hours)**	
2.1	Characteristic equation of CL systems- Effect of feedback	1
.2	Time domain analysis of control systems Time domain specifications of transient and steady state responses, Impulse and Step responses of first order systems, Impulse and Step responses of second order systems.	
2.3	Error analysis: Steady state error analysis - static error coefficients of type 0, 1, 2 systems.	2
2.4	Stability Analysis: Concept of stability- BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems	2
2.5	Routh criterion: Routh's stability criterion- analysis - relative stability	2
3	**Root locus Analysis and Compensators (8 hours)**	
3.1	Root locus technique: General rules for constructing Root loci - stability from root loci -	3
3.2	Effect of addition of poles and zeros on Root Locus.	1
3.3	Effect of positive feedback on Root Locus	1
3.4	Need for controllers: Types- Feedback, cascade and feed forward controllers	1
3.5	PID controllers**:** PID controllers (basic functions only)- Zieglar Nichols tuning methods	2
3.6	*Introduction to MATLAB functions and Toolbox for Root locus based analysis (Demo/Assignment only)*	
4	**Frequency domain analysis (9 hours)**	
4.1	Frequency domain specifications- correlation between time domain and frequency domain responses	2
4.2	Polar plot: Concepts of gain margin and phase margin- stability analysis	2
4.3	Bode Plot: Construction of Bode plots- Analysis based on Bode plot	4
4.4	Effect of Transportation lag and Non-minimum phase systems	1
4.5	*Introduction to MATLAB functions and Toolbox for various frequency domain plots and analysis (Demo/Assignment only)*	
5	**State space Analysis of systems (10 hours)**	

5.1	Introduction to state space and state model concepts- state equation of linear continuous time systems, matrix representation- features -Examples of simple electrical circuits, and dc servomotor.	3
5.2	Phase variable forms of state representation-controllable and observable forms	2
5.3	Diagonal Canonical forms of state representation- diagonal & Jordan canonical forms	2
5.4	Derivation of transfer function from state equation.	1
5.5	State transition matrix: Properties of state transition matrix- Computation of state transition matrix using Laplace transform- Solution of homogeneous systems	2

EOT 383	MACHINE LEARNING PROGRAMMING	CATEGORY	L	T	P	CREDIT	Year of Introduction
		VAC	3	1	0	4	2022

Course Objectives

To provide learners an insight into Python programming, and develop programming skills to manage the development of software systems. This course lays the foundation to develop web applications, Machine Learning, and Artificial Intelligence-based applications and tools, Data Science and Data Visualization applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO 2	Illustrate uses of conditional (if, if-else, if-elseif-else and switch-case) and iterative (while and for) statements in Python programs **(Cognitive Knowledge level: Apply)**
CO 3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python **(Cognitive Knowledge level: Apply)**
CO 4	Implement Object Oriented programs with exception handling **(Cognitive Knowledge level: Apply)**
CO 5	Write programs in Python to process data stored in files by utilizing the modules Numpy, Matplotlib, and Pandas **(Cognitive Knowledge level: Apply)**

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2		2						2	2
CO 2	3	3	2		2					2		2
CO 3	2	3	2		2	2	1					2
CO 4	3	2	2		2		1					2
CO 5	3	2	2	2	3	2						2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination [%] (100 Marks)
	Test1 [%] (50 Marks)	Test 2 [%] (50 Marks)	
Remember	**20**	**20**	**20**
Understand	30	30	30
Apply	50	50	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE (Marks)	ESE (Marks)	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum of 2 sub-divisions and carries 14 marks.

Sample Course Level Assessment Questions

Course Outcome1(CO1): What is type conversion? How is it done in Python?

Course Outcome 2(CO2): Write a Python program which takes a positive integer n as input and finds the sum of cubes all positive even numbers less than or equal to the number.

Course Outcome 3(CO3): Given is a list of words, wordlist, and a string, name. Write a Python function which takes wordlist and name as input and returns a tuple. The first element of the output tuple is the number of words in the wordlist which have name as a substring in it. The second element of the tuple is a list showing the index at which the name occurs in each of the words of the wordlist and a 0 if it doesn't occur.

Course Outcome 4(CO4): Write a Python program to implement the addition, subtraction, and multiplication of complex numbers using classes. Use constructors to create objects. The input to the program consist of real and imaginary parts of the complex numbers.

Course Outcome 5(CO5): Given a file "auto.csv" of automobile data with the fields index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage, and price, write python code to

1) Clean and Update the CSV file

2) Print total cars of all companies

3) Find the average mileage of all companies

4) Find the highest priced car of all companies

Model Question Paper

QP CODE: **PAGES:**

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH (MINOR) DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT 383

Course name : MACHINE LEARNING PROGRAMMING

Max Marks: 100 Duration: 3 Hours

PART-A

*(*Answer All Questions. Each question carries 3 marks)

1. Explain the basic data types available in Python, with examples.
2. Write a Python program to reverse a number and also find the sum of digits of the number. Prompt the user for input.
3. Explain the concept of scope and lifetime of variables in Python programming language, with a suitable example.
4. Discuss format specifiers and escape sequences with examples.
5. Discuss the relation between tuples, lists, and dictionaries in detail.
6. Discuss the following dictionary methods with an example.
   i. *get( )* ii. *Keys( )* iii. *pop( )* iv. *update( )* v. *values( )* vi. *items( )*
7. What is polymorphism? Give an example in the context of OOP in Python.
8. How is exception handling accomplished in Python programs?
9. Write a note on the **os** and **os.path** modules in Python. Also, discuss the *walk( )* and *getcwd( )* methods of the **os** module.
10. Describe the characteristics of the CSV format.

PART-B

(Answer any one full question from each module)

11.	(a)	Compare and contrast interpreted languages and compiled languages. How does it affect the quality of program development and execution of the program?	(6)

(b) What are the possible errors in a Python program. Write a Python program to print the value of $2^{2n}+n+5$ for n provided by the user. (8)

OR

12. (a) Describe Arithmetic operators, Assignment operators, Comparison operators, Logical operators, and Bitwise operators in detail with examples. (6)

(b) Explain the software development process in detail. (8)

13. (a) Write a Python code to check whether a given year is a leap year or not [An year is a leap year if it's divisible by 4 but not divisible by 100 except for those divisible by 400]**.** (5)

(b) Input 4 integers (+ve and −ve). Write a Python code to find the sum of negative numbers, positive numbers, and print them. Also, find the averages of these two groups of numbers and print. (9)

OR

14. (a) Write a Python program to find the value for *sin(x)* up to *n* terms using the series (8)

where x is in degrees

(b) Write a Python code to determine whether the given string is a Palindrome or not using slicing. Do not use any string function. (6)

15. (a) Write a Python code to create a function called *list_of_frequency* that takes a string and prints the letters in non-increasing order of the frequency of their occurrences. Use dictionaries. (5)

(b) Write a Python program to read a list of numbers and sort the list in a non-decreasing order without using any built in functions. Separate function should be written to sort the list wherein the name of the list is passed as the parameter. (9)

OR

16. (a) Illustrate the following Set methods with an example. (6)

i. *intersection( )* ii. *Union( )* iii. *Issubset( )* iv. *Difference( )* v. *update( )* vi. *discard( )* (8)

(b) Write a Python program to check the validity of a password given by the user.

The Password should satisfy the following criteria:

1. Contains at least one letter between **a** and **z**
2. Contains at least one number between **0** and **9**
3. Contains at least one letter between **A** and **Z**
4. Contains at least one special character from **$, #, @**
5. Minimum length of password: **6**

17. (a) How can a class be instantiated in Python? Write a Python program to express the instances as return values to define a class RECTANGLE with parameters *height, width, corner_x,* and *corner_y* and member functions to find center, area, and perimeter of an instance. (10)

(b) Explain inheritance in Python. Give examples for each type of inheritance. (4)

OR

18. (a) Write a Python class named ***Circle*** constructed by a radius and two methods which will compute the area and the perimeter of a given circle (6)

(b) Write Python program to create a class called as **Complex** and implement *__add_( )* method to add two complex numbers. Display the result by overloading the + Operator. (8)

19. (a) Write a Python program to add two matrices and also find the transpose of the resultant matrix. (8)

(b) Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write Python codes using Pandas to (6)

1) Clean and Update the CSV file
2) Print total cars of all companies
3) Find the average mileage of all companies
4) Find the highest priced car of all companies.

OR

.

20. (a) Write Python program to write the data given below to a CSV file. (5)

SN	**Name Country**	**Contribution Year**	
1	Linus Torvalds Finland	Linux Kernel 1991	
2	Tim Berners-Lee	England World Wide Web	1990
3	Guido van Rossum	Netherlands Python 1991	

(b) Given the sales information of a company as CSV file with the following fields *month_number*, *facecream*, *facewash*, *toothpaste*, *bathingsoap*, *shampoo*, *moisturizer*, *total_units*, *total_profit*. Write Python codes to visualize the data as follows

1) Toothpaste sales data of each month and show it using a scatter plot
2) Face cream and face wash product sales data and show it using the bar chart
3) Calculate total sale data for last year for each product and show it using a Pie chart.

(14X5=70)

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SYLLABUS

MODULE I

Programming Environment and Python Basics:

Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter. The software development process - Case Study.

Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output. Formatting output. How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module.

MODULE II

Building Python Programs:

Control statements - Selection structure (if-else, switch-case), Iteration structure (for, while), Testing the control statements, Lazy evaluation. Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings and number systems - String function, Handling numbers in various formats.

MODULE III

Data Representation:

Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times. Dictionaries – Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup. Case Study - Data Structure Selection.

MODULE IV

Object Oriented Programming:

Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, handle multiple exceptions.

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MODULE V

Data Processing

The *os* and *sys* modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files. NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data.**Python MongoDB**

Text books:

1.Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016

2.Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017

Reference books:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016

2. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016

3. David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.

4. Charles Severance. Python for Informatics: Exploring Information,

5. http://swcarpentry.github.io/python-novice-gapminder/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE 1	
1.1	Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter The software development process: Case Study	2
1.2	Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions	3
1.3	Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output.	2
1.4	Formatting output. How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module.	2

1.5	Using built in functions and modules: Case – Using math module (Examples)	1
	MODULE II	
2.1	Control statements - Selection structure (if-else, switch-case), Iteration structure(for, while), Testing the control statements	2
2.2	Lazy evaluation. Functions - Hiding redundancy and complexity	2
2.3	Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion	2
2.4	Lambda functions. Strings and number systems - String function, Handling numbers in various formats.	2
	MODULE III	
3.1	**Data Representation**: Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting	2
3.2	Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times.	3
3.3	Dictionaries – Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup.	3
3.4	Case Study: Data Structure Selection	1
	MODULE IV	
4.1	**Object Oriented Programming:** Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism.	3

. 4.2	Abstract Classes. Exceptions - Handle a single exception, handle multiple exceptions.	3
MODULE V		
5.1	The *os* and *sys* modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files.	3
5.2	NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization	3
5.3	Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data. **Python MongoDB**	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT385	MACHINES & DRIVES-SIMULATION PRACTICES	MINOR	2	0	2	4

Preamble

This course aims to provide a strong foundation on various simulation practices for Machines& Drives. Modelling of various machines and power electronic converters will be discussed. Simulation based on MATLAB/SIMULINK will be introduced for various models.

Prerequisite

Machines& Drives

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Develop the Simulated models of controlled Rectifiers and choppers
CO 2	Develop the Simulated models of Inverters and AC voltage controllers
CO 3	Determine the characteristics of separately excited DC motor drive
CO 4	Determine the characteristics of Induction motor drives
CO 5	Determine the characteristics of BLDC drives

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	-	-	-	-	-	-	-	1
CO 2	3	3	3	-	-	-	-	-	-	-	-	2
CO 3	3	3	3	2	2	-	-	2	2	2	-	2
CO 4	3	3	3	2	-	-	-	2	2	2	-	3
CO 5	3	3	3	2	2	-	-	2	2	2	-	3

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	10	10	20
Apply (K3)	20	20	40
Analyse (K4)	10	10	20
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern

There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1) :

1. Describe the working with waveforms of three phase rectifiers for different loads. (K2)
2. Problems in finding the average output voltage of rectifier. (K2, K3)

Course Outcome 2 (CO2):

1. Problems related to step up and step down converters. (K2, K3)
2. Analyse the working of Buck, Boost & Buck Boost regulators. (K3, K4)

Course Outcome 3(CO3):

1. Simulate the no load and load tests on DC machine (K2, K3)
2. Conduct the test on the Machine and validate the results. (K3, K4)

Course Outcome 4 (CO4):

1. Simulate the no load and load tests on Induction machine (K2, K3)
2. Conduct the test on the Machine and validate the results. (K3, K4)

Course Outcome 5 (CO5):

1. Simulate the no load and load tests on BLDC machine (K2, K3)
2. Conduct the test on the Machine and validate the results. (K3, K4)

Model Question Paper

QPCODE:

Reg. No:___________

Name:_____________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH & YEAR

Course Code**: EOT385**

Course Name: **MACHINES&DRIVES-SIMULATION PRACTICES**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1 What are the advantages of a single phase controlled rectifier?

2 Explain the function of a freewheeling diode in a rectifier supplying an inductive load?

3 Differentiate between voltage source inverter and current source inverter?

4 How the source inductance affect the output voltage of an inverter?

5 What is the advantage of a closed loop system compared to an open loop system?

6 Draw the mechanical characteristics of a separately excited DC shunt motor?

7 Explain the v/f method of speed control of induction motor?

8 Explain the vector control method of speed control of induction motor?

9 What are the advantages of sensorless control of BLDC motor?

10 What are the applications of BLDC motor?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Derive the expression for output voltage, current and power of a single-phase, half-wave uncontrolled rectifier supplying a resistive load?

b) An ideal single-phase source, 240 V, 50 Hz, supplies power to a load resistor R = 100 Ω via a single ideal diode.

(a) Calculate the average and rms values of the load current and the power dissipation.

(b) Calculate the circuit power factor and the ripple factor.

12 Explain the different types of choppers?

Module 2

13 a) Design a three-phase sine PWM controlled VSI with the following data

Input DC voltage = 500V

Fundamental frequency of output voltage =50Hz

LC filter: L=50mH and C=5nF

RL load: R=100Ω and L=1mH

b) Explain the effect of source inductance on the output voltage of the inverter?

14 a) Design and set up a firing circuit suitable for triggering a triac used in a single phase ac voltage controller.

b) How does the firing angle control affect the output of a converter ?

Module 3

15 a) Explain the speed control of separately excited DC motor using field control method?

b) What are the advantages of closed loop system over open loop system ?

16 How the speed control of the DC drive is achieved using half, fully controlled rectifier? Explain. (14)

Module 4

17 Explain the scalar control method of an induction motor ? (14)

18 Compare the various speed control methods in an induction motor? (14)

Module 5

19 a) Explain the different types of sensorless control methods in a BLDC motor (7)

b) Explain the need for sensorless control in BLDC motors (7)

20 Explain one application of BLDC machine with complete circuit and control schemes. (14)

Syllabus

Module 1

Simulation of controlled Rectifiers and choppers (8 hrs)

Simulation of Single phase and three phase uncontrolled and controlled rectifiers using SIMULINK and MATLAB coding. THD analysis. Simulation of different types of choppers. Open loop and closed loop control using PI and PID control. Modeling of converter with losses-inductor winding resistance, efficiency calculation.

Module 2

Simulation of Inverters and AC voltage controllers (7 hrs)

Simulation of single phase and three phase inverters. Simulation for various PWM schemes. Simulation of single phase and three phase voltage controllers. Simulation study for analysing the effect of source inductance on the output voltage of the inverter.

Module 3

Simulation of separately excited DC motor drive (9 hrs)

Modeling of separately excited DC machine. Open loop and closed loop operation. Simulation of separately excited DC drive using MATLAB SIMULINK. Simulation of the closed loop system. OCC and Load Test of DC machine.

Module 4

Simulation of Induction motor drives (10 hrs)

Modelling of three phase induction motor. v/f control and vector control of induction motor. Simulation of scalar control and vector control of induction motor drive using MATLAB SIMULINK. No load, Blocked rotor and Load test of Induction Motor.

Module 5

Simulation of BLDC drives (11 hrs)

Speed control of BLDC motor. Sensor-less control of BLDC motor-Different types. Simulation of BLDC motor with sensor and without sensor using MATLAB SIMULINK. No Load and Load Test of BLDC machine.

Textbooks

1. Muhammad H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education.
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi.
3. G. K. Dubey, Fundamentals of Electric Drives, Narosa publishers, second edition, 2010
4. Kothari D. P. and I. J. Nagrath, *Electrical Machines*, Tata McGraw Hill, 2004.
5. https://in.mathworks.com/help/physmod/sps/powersys/ug/about-the-electric-drives-library.html
6. https://in.mathworks.com/help/physmod/sps/ug/pwm-controlled-dc-motor.html

Reference Books

1. Theraja B. L. and A. K. Theraja, *A Text Book of Electrical Technology*, S. Chand & Company Ltd., 2008.

2. Partab H., *Art and Science of Utilization of Electric Energy*, Dhanpat Rai & Sons, 1980.

3. Mehta V. K. and R. Mehta, *Principles of Electrical and Electronics*, S. Chand & Company Ltd., 1996.

4. Gupta B. R. and V. Singhal, *Fundamentals of Electric Machines*, New Age International Publishers Ltd, New Delhi, 2005.

5. Sivanagaraju S., M. B. Reddy and D. Srilatha, Generation and Utilization Electrical Energy, Pearson Education, 2010.

6. Mohan N., T. M. Undeland and W. P. Robbins., Power Electronics, Converters, Applications & Design, Wiley-India

7. Fundamentals of Power Electronics, Erickson, Robert W., and Maksimovic, Dragan.
8. Singh M. D. and K. B. Khanchandani, Power Electronics, Tata McGraw Hill, New Delhi, 2008.
9.Vedam Subramaniam "Electric drives (concepts and applications)", Tata Mc Graw Hill, 2001
10. Turan Gonen, " Electrical Machines with MATLAB", 2nd Edition, Taylor & Francis Inc.

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**Simulation of controlled Rectifiers and choppers (8 hrs)**	
1.1	Simulation of Single phase and three phase uncontrolled and controlled rectifiers using SIMULINK and MATLAB coding. THD analysis.	3
1.2	Simulation of different types of choppers.	1
1.3	Open loop and closed loop control using PI and PID control.	2
1.4	Modeling of converter with losses-inductor winding resistance, efficiency calculation.	2
2	**Simulation of Inverters and AC voltage controllers (7 hrs)**	
2.1	Simulation of single phase and three phase inverters.	3
2.2	Simulation for various PWM schemes.	2
2.3	Simulation of single phase and three phase voltage controllers.	1
2.4	Simulation study for analysing the effect of source inductance on the output voltage of the inverter.	1
3	**Simulation of separately excited DC motor drive (9 hrs)**	
3.1	Modeling of separately excited DC machine.	2
3.2	Open loop and closed loop operation.	2
3.3	Simulation of separately excited DC drive using MATLAB SIMULINK.	1
3.4	Simulation of the closed loop system.	1
3.5	OCC and Load Test of DC machine	3
4	**Simulation of Induction motor drives (10 hrs)**	
4.1	Modelling of three phase induction motor.	**2**
4.2	V/f control and vector control of induction motor.	2
4.3	Simulation of scalar control of induction motor drive using MATLAB SIMULINK.	1
4.4	Simulation of vector control of induction motor drive using MATLAB SIMULINK.	2
4.5	No load, Blocked rotor and Load test of Induction Motor	3
5	**Simulation of BLDC drives (11 hrs)**	
5.1	Speed control of BLDC motor.	**2**
5.2	Sensor-less control of BLDC motor-Different types.	1
5.3	Simulation of BLDC motor with sensor using MATLAB SIMULINK.	2
5.4	Simulation of BLDC motor without sensor using MATLAB SIMULINK.	2
5.5	No Load and Load Test of BLDC machine.	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET393	DIGITAL SIMULATION	VAC	3	1	0	4

Preamble: Numerical simulation using digital computers is an indispensable tool for electrical engineers. This honours course is designed with the objective of providing afoundation to the theory behind Numerical Simulation of electrical engineering systems andto give an overview of different styles of simulation tools and methodologies. This course would help students to explore and effectively use simulation tools with a clear understandingof their inner engines. This course also prepares students to explore and use the industry- standard tools like MATLAB and SPICE.

Prerequisites : **1. EET201 Circuits and Networks**

2. EET 205: Analog Electronics

3. MAT 204: Probability, Random Processes and Numerical Methods

Course Outcomes: After the successful completion of the course the student will be able to:

CO 1	Formulate circuit analysis matrices for computer solution.
CO 2	Apply numerical methods for transient simulation.
CO 3	Develop circuit files for SPICE simulation of circuits.
CO 4	Develop MATLAB/Simulink programs for simulation of simple dynamic systems.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3		2	3							2
CO 2	3	3		2	3							2
CO 3	3	3		2	3							2
CO 4	3	3		2	3							2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	15	15	20
Understand (K2)	20	20	50
Apply (K3)	15	15	30

Analyse (K4)			
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

Problems on Circuit Analysis Matrix Formulation for Computer Solution (MNA and Sparse Tableau Approach) - K1 and K2 Level questions to be asked.

Writing code snippets in pseudo codes/Flow - charts for simple circuit formulations - K2, K3 Level.

Course Outcome 2 (CO2):

Explain the features of different numerical algorithms with respect to the requirements of circuit simulation: Questions in K1, K2 and K3 Level.

Compare the features of numerical simulation algorithms. Numerical problems and questions in K1, K2 and K3 levels.

Explain the application-specific features of numerical methods in circuit simulation: Adaptive Step-Size, Artificial Ringing and damping - K1 and K2 level questions.

Course Outcome 3 (CO3):

Write circuit files for simple analogue passive and active circuits using standard SPICE notation. K1, K2 and K3 Level questions.

Course Outcome 4 (CO4):

Develop MATLAB scripts for solution of simple ODEs - K2, K3 level questions.

Develop Simulink signal-flow diagrams for simulation of second order, first-order passive networks. K2, K3 Level question.

Model Question paper

QP CODE: PAGES: 4

Reg. No:______________ Name:_________

APJ ABDUL KALAM TECHNOLOGICAL

UNIVERSITYFIFTH SEMESTER B.TECH DEGREE

EXAMINATION, MONTH & YEAR

Course Code: EE393

Course Name: DIGITAL SIMULATION

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Differentiate between DC simulation and Transient Simulation.
2. What is “convergence issue” in circuit simulation?
3. Differentiate between implicit and explicit numerical methods.
4. Define Local Truncation Error.
5. What is a “stiff system”? Give an example.
6. It is required to simulate a circuit with excessively oscillatory response. Out of Eulermethod and Trapezoidal method, which is suitable for this system, and why?
7. Write the SPICE circuit file to run the transient simulation of an RC circuit excited bya pulse source of amplitude 5 V and frequency 1 kHz. The RC time constant is 0.1 ms(You may choose any R, C values that satisfy this requirement). Use end time of 1 s. Assume any missing information appropriately.
8. Differentiate between ‘ .lib’ and ‘.inc' SPICE directives?
9. What is the output of the following MATLAB

code:?b = [3 8 9 4 7 5];

sum1 = 0;

for k = 1:4

sum1 =

sum1+b(k);end

sum1

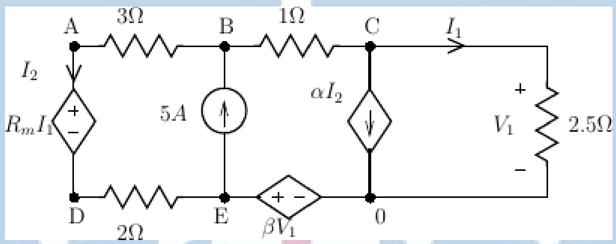
10. Write a MATLAB function to accept the coefficients of a quadratic polynomial andreturn the evaluated roots.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11. (a).Figure 1 shows a network, with α=2, β=0.4 and R_m= 1 Ω. Formulate the Modified Nodal Analysis matrix from fundamental equations. (10)



(b). Explain how ‘damping’ can be used to improve convergence in nonlinear equationsolutions using Newton-Raphson method. (4)

12. (a). For the circuit shown in Fig. 2, formulate the Sparse Tableau Analysis (STA) matrix from the fundamental equations. Take α=0.5. (10)

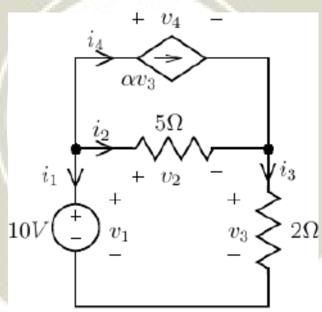


Figure 2: $\alpha = 0.5$

(b). What is Sensitivity Analysis? Explain with an example. (4)

Module 2

13. Solve

$$\frac{dx}{dt} = -\frac{1}{2}x - 6te^{-t/2}$$

, $0 < t < 20$, x_0=3, for h = 0.01 and h= 0.05 using Trapezoidalmethod and forward Euler methods. Compare with the analytical solution

$\hat{x}(t) = \left(2 - 3t^2\right) e^{-t/2}$. Find the global error at the final value. (14)

14. (a) What is 'Order' of a numerical method? Explain how order and step-size influencethe accuracy and computational efficiency of numerical methods. (8)

(b). What are the sources of error in numerical methods? (6)

Module 3

15. Write the MNA equations for the circuit shown in Fig. 3 below: Apply Trapezoidalmethod on the resulting equations to obtain the corresponding numerical equations.

(14)

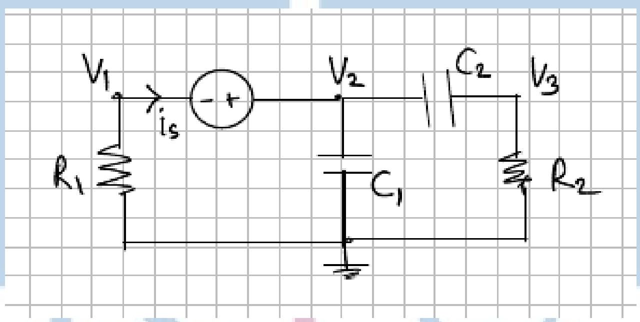


Fig. 3.

16. (a). Explain adaptive step-size in numerical simulation. What methodologies are used foradaptive step-size simulation?

(1

0)

(b). What is 'artificial damping'? Explain with an example.

(4)

Module 4

17. (a). Explain the use of .SUBCKT with an example, where the sub-circuit is an RC integrator circuit to be used in cascade with an RC differentiating circuit. The source is a pulse source of 5 V amplitude and 1 kHz frequency. Assume suitable values for the resistors and capacitors. Use an ideal pulse with no rise time, fall-time, delay time etc. Under what conditions/circumstances do you use a .MODEL instead of a

.SUBCKT in a circuit simulation? (8)

(b). Write the circuit file for an RC coupled amplifier with npn transistors. Use suitable values for the circuit parameters. The simulation is to be set up for frequency response analysis.(6).

18. (a). Shown below is a SPICE circuit file/netlist. Inspect the circuit file description and draw the circuit. What kind of simulation is being intended here? Modify this with the source replaced by a single sine wave source of 1kHz and 0.5 mA amplitude, fora transient simulation with end time of 0.1 sec, and a maximum step size of 1 us. (8)

```
L1 OUT 0 1µ
C1 OUT 0
420pL2 IN 0
1µ
C2 IN 0 420p
C3 OUT IN
{C}R1 OUT 0
300
I1 0 IN 0 AC 5m
.ac oct 200 5Meg 10Meg
.step param C 50p 150p 50p
.end
```

(b). Demonstrate the use of the SPICE directives: ".OP, .PARAM, and .IC" with suitableexamples. (6).

Module 5

19. (a)Write a MATLAB function to solve an initial value problem given by: $\dot{x} = x - t^2 + 1;\ 0 \leqslant t \leqslant 2;\ x(0) = 0.5$, using the Trapezoidal method. The function should get the initial value, final value and the step through arguments. Modify this code to solve any general function described in another file, named fx.m? (8)

(b). Develop the simulation signal-flow diagram for the simulation of a parallel RLC network excited by a current source, from the fundamental equations. Use standard blocks such as gain, sum/difference, integrators etc.(6)

20. Develop a simulation (signal-flow) diagram for a DC series motor fed from a dc voltage source and connected to a mechanical load. Take k_b as the back-emf constant and k_t as the torque constant of the motor, R_a the armature resistance, L_a the armature inductance, R_f, L_f are the field resistance and inductance respectively, J is the combined moment of inertia, and B is the viscous friction constant. The simulation diagram should show how the armature current i_a and the speed ω are derived. Show all the relevant equations from which the diagram is derived. (14)

Syllabus

Module 1 (9 Hrs)

Introduction to Simulation:

Types of simulation problems - DC Simulation - Transient Simulation - AC Simulation - Digital Circuit Simulation - Sensitivity Analysis - Noise Analysis. Examples.

Problem formulation for circuit simulation:

Nodal Analysis - General Rules/Steps to form the admittance matrix. Sample problems on formulation of the matrix.

Modified Nodal Analysis (MNA) - General Rules/Steps to form the admittance matrix. Sample problems on formulation of the matrix. (Assignments/Course projects may be assigned for writing code to formulate the Matrix using any high-level language). Formulation Examples.

Sparse Tableau Approach - Formulation of STA matrix. Features and comparison with MNA approach. Formulation Examples.

Non-linear Circuits: Application of the Newton-Raphson method - General procedure for n-thorder system of equations - Formulation of Jacobian - Examples - Resources required for simulation: Computation time.

Convergence issues -

Practical Limits due to finite precision. Damping.

(Assignments/Course projects may be given for writing code to formulate the Matrix using any high-level language/pseudo code).

Module 2 (7 hours)

Fundamental Theory behind Transient Simulation:

Introduction to transient simulation: Discretization of time, idea of time - step. - Review of backward Euler, forward Euler and trapezoidal methods.

Basic ideas of Accuracy and Stability (Qualitative description only) of methods of transient analysis using numerical techniques.

Basic ideas of Explicit and Implicit methods:

Concept of 'order' of a numerical method, Local Error (LE), Local Truncation Error (LTE) and Global Error. (No detailed derivations needed).

Module 3: (9 hours)

Application to Circuit Simulation:

Application to circuit simulation: Using BE and TRZ methods. - Second order Backward Difference Formula (BDF-2/Gear Formula, no derivation required). Equivalent Circuit

Approach- Stiff systems - Features - Simple Examples.

Basic ideas behind Adaptive/variable step-size. (Qualitative treatment only).

Practical aspects in choosing numerical methods: Artificial damping and ringing induced by numerical algorithms - Assessment of accuracy -- The issue of Singular Matrix in initial/start-up condition.

Module 4

Introduction to SPICE: (10 Hrs).

Types of simulation tools: Circuit simulation tools: SPICE, equation solvers: MATLAB®/Scilab®/Octave - Features, similarities and differences.

Circuit Simulation using SPICE.

Writing SPICE circuit files: SPICE Syntax - SPICE directives (Dot commands: .END, .FUNC, .NET .OPTIONS)

Performing different kinds of simulation and analysis - DC, DC sweep, AC, Transient andnoise analyses. (Use of .OP, .PARAM, .TRAN, .DC, .STEP, .IC .MEASURE, .FOUR,
.NOISE, .TEMP, .WAVE)

Developing circuit files for simple circuits like CE amplifiers, passive linear/non-linear circuits (Familiar Circuits with R, L, C, Diodes, Transistors).

Developing component models, subcircuits in SPICE. (Use of .MODEL, .SUBCKT, .LIB, .INC, .ENDS directives) - examples (BJTs/MOSFETs).

Simulation Demonstration with simple circuits. Setting-up simulation , and different types of simulation etc. shall be demonstrated by the course instructor.

[LTspice®, a free SPICE version, is chosen here as reference due to wide availability, however, PSpice®, LTspice®, ngSpice, eSim or any available SPICE variants may be used for assignments/demonstrations, based on availability].

Module 5

Introduction to equation solver tools (10 Hrs)

Introduction to scripting using MATLAB®: Language constructs - Basic Arithmetic Operations - Basic Operators and Special Characters Variables and Arrays - Complex numbers -Basic Handling of Arrays (Vectors and Matrices).

Control Structures (Conditional, looping - for loop, while loop, switch-case-otherwise - break -return) - functions.

Numerical Integration - ODE solvers - ode23, ode23t and ode45 - Examples - User-written functions to solve ODEs to implement the algorithms BE, FE, and TRZ only). Application examples. (Performance comparison of different solvers may be given as assignments).
Visual Modelling: Introduction to Simulink/Similar Causal modelling tools. Developing causal simulation diagrams using fundamental blocks (Gain, sum/difference, integrators, etc) for simple circuit models - first-order/second-order circuits, Separately excited DC Motor, from the ODE descriptions. Non-linear examples: DC Series Motor, Simple passive networks with switches.
Simulation Demonstration with different integration algorithms /step-sizes. [Only for practice/assignments].

(Instead of MATLAB/Simulink®, Octave and Scilab®/XCos® may be used for assignments/demonstrations).

Text Books

1. M. B. Patil, V. Ramanarayanan and V. T. Ranganathan, "Simulation of PowerElectronic Circuits", Narosa Publishing House.
2. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers", Tata-McGraw Hill, New Delhi, 2000.
3. Rudra Pratap, "Getting Started with MATLAB®: A Quick Introduction for Scientists & Engineers", 2010, Oxford University Press.

References

1. LTSpice® [Online] http://www.ltwiki.org
2. MATLAB® [Online] https://in.mathworks.com/help/matlab/
3. Won Y. Yang, Wenwu Cao, Tae-Sang Chung and John Morris, "Applied Numerical Methods Using MATLAB®"

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Introduction to Simulation and Problem Formulation. (9 Hrs).**	
1.1	Types of simulation problems - DC Simulation - Transient Simulation - AC Simulation - Digital Circuit Simulation - Sensitivity Analysis - Noise Analysis. Examples.	2
1.2	Problem formulation for circuit simulation: Nodal Analysis - General Rules/Steps to form the admittance matrix. Sample problems on formulation of the matrix. (Assignments/Course projects may be assigned for writing code to formulate the Matrix using any high-level language).	1
1.3	Modified Nodal Analysis (MNA) - General Rules/Steps to form the admittance matrix. Sample problems on formulation of the matrix. (Assignments/Course projects may be assigned for writing code to formulate the Matrix using any high-level language). Examples.	2
1.4	Sparse Tableau Approach - Formulation of STA matrix. Features and comparison with MNA approach. Examples.	1
1.5	Non-linear Circuits: Application of the Newton-Raphson method - General procedure for n-th order system of equations - Formulation of Jacobian - Examples - Resources required for simulation: Computation time.	2
1.6	Convergence issues - Limits due to finite precision. Damping.	1
2	**Fundamental Theory behind Transient Simulation: (7 Hrs).**	
2.1	Introduction to transient simulation: Discretization of time, idea of time - step. - Review of backward Euler, forward Euler and trapezoidal methods.	1
2.2	Basic ideas of Accuracy and Stability of methods of transient analysis using numerical techniques.	1
2.3	Basic ideas of Explicit and Implicit methods:	1
2.4	Concept of Order of a numerical method, Local Error (LE), Local Truncation Error (LTE) and Global Error.	4

3.	**Application to Circuit Simulation (9 Hrs)**	
3.1	Application to circuit simulation: Using Backward Euler, Trapezoidal and Second order backward differentiation formula (BDF2 - Gear's formula) methods in circuit simulation: Equivalent Circuit Approach - Equation formulation examples.	4
3.2	Stiff systems - Features - Examples.	1
3.3	Basic ideas behind Adaptive/variable step-size. (Qualitative treatment only).	1
3.4	Practical aspects in choosing numerical methods: Artificial damping and ringing induced by numerical algorithms.	1
3.5	Assessment of accuracy - The issue of Singular Matrix in initial/start-up condition.	2
4	**Introduction to SPICE: (10 Hrs)**	
4.1	Types of simulation tools: Circuit simulation tools: SPICE, equation solvers: MATLAB®/Scilab®/Octave - Features, similarities and differences.	1
4.2	Circuit Simulation using SPICE. Writing SPICE circuit files: SPICE Syntax - SPICE directives (Dot commands: .end, .FUNC, .NET .OPTIONS)	2
4.3	Performing different kinds of simulation - DC, DC sweep, AC, Transient and noise analyses. (.op, .param, .tran, .dc, .STEP, .IC .MEASURE, .FOUR, .NOISE, .TEMP, .WAVE	2
4.4	Developing simple circuit files for sample circuits like CE amplifier, passive linear/non-linear circuits (Familiar Circuits with R, L, C, Diodes).	2
4.5	Developing component models, sub-circuits in SPICE. (.model, .subckt, .lib, .inc, .ends directives) Example problems. Using datasheets to develop component models - examples (BJTs/MOSFETs) - Exercises.	2

4.6	Simulation Demonstration with simple circuits. Setting-up simulation, and different types of simulation etc., shall be demonstrated by thecourse instructor. Students shall be given SPICE circuit simulation assignments. [LTspice®, a freeware SPICE version, is chosen here as reference due to wide availability, however, PSpice®, LTspice®, ngSpice or anyavailable SPICE variants may be used for assignments/demonstrations].	1
5.	**Introduction to MATLAB®/Simulink® (10 Hrs)**	
5.1	Introduction to MATLAB® scripting. Language constructs - Basic Arithmetic Operations - Basic Operators and Special Characters - Variables and Arrays - Complex numbers - Basic Handling of Arrays (Vectors and Matrices).	2
5.2	Control Structures (Conditional, looping - for loop, while loop, switch-case-otherwise - break - return) - functions.	2
5.3	Numerical Integration - ODE solvers - ode23, ode23t and ode45 - Examples	1
5.4	User-written functions to solve ODEs to implement the algorithms BE, FE, and TRZ only). Application examples. (Performance comparison of different solvers may be given as assignments).	2
5.5	Visual Modelling: Introduction to Simulink. Developing causal simulation diagrams using fundamental blocks for simple circuit models - first-order/second-order circuits, Separately excited DC Motor, from the ODE descriptions.	2
5.6	Demonstration of simulation examples with different integration algorithms /step-sizes. [Only demonstration/practice/assignments]. (Instead of MATLAB®/Simulink®, Octave and Scilab®/XCos® may be used for assignments/demonstrations).	1

SEMESTER 6

ELECTRICAL AND COMPUTER ENGINEERING

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EOT 302	**Power Electronics and Drives**	**PCC**	**3**	**1**	**0**	**4**

Preamble

To impart knowledge about the power semiconductor devices, the operation of various power converters and its applications in electrical drives.

Prerequisite

Nil

Course Outcomes:

After the completion of the course the student will be able to:

CO1	Understand and acquire knowledge on modern power electronic devices.
CO2	Explain the working of controlled rectifiers
CO3	Demonstrate the operation of basic topologies of DC-DC converters.
CO4	Understand the basic topologies and control schemes of inverters.
CO5	Understand dynamics and speed control of electric drives.
CO6	Describe basic drive schemes for DC and AC motors

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1								
CO2	3	2	1	2								2
CO3	3	3	2	2								2
CO4	3	3										
CO5	3	3										
CO6	3	2										2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	2	
Remember (K1)	10	10	20
Understand (K2)	20	20	40
Apply (K3)	20	20	40
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A.

Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

EOT 302 POWER ELECTRONICS AND DRIVES

Module 1(8 Hours)

Introduction to Power Switching Devices: Classifications of Power semiconductor devices - Static and switching characteristics of Power diodes, SCR, IGBT, and MOSFET-–switching losses - Device selection strategy - Device specifications -. SCR turn on methods.

Gate triggering circuits – Basic triggering circuits (R, RC and UJT triggering) – Requirements of isolation and synchronization in gate drive circuits - Opto and pulse transformer based isolation.

Module 2 (9 Hours)

Phase Controlled Rectifiers: Single phase fully controlled and half controlled bridge rectifier with R, RL and RLE loads (continuous conduction only**).** Three phase fully controlled & half-controlled bridge converter with RLE load (continuous conduction, ripple free).

DC-DC converters: Step down and Step up choppers – Single-quadrant, Two-quadrant and Four quadrant chopper – Pulse width modulation & current limit control in dc-dc converters - Buck converter- Boost converter- Buck boost Converter (CCM operation only).

Module 3 (8 Hours)

Inverters: Voltage source inverters- Principle of operation of half and full bridge inverters with R and RL load- Three bridge phase inverter with R load- 180 degree and 120 degree conduction mode.

Voltage control of single phase inverters using various PWM techniques - unipolar and bipolar SPWM techniques.

Current source inverters: Working principle of current source inverter (basic circuit only) - Comparison of current source inverter and voltage source inverter.

Module 4 (10 Hours)

Electric Drives: Fundamental of electric drives- Elements of electric drives- Dynamics of a drive system – Components of load torques- Classifications of load torques - Speed torque conventions and multi-quadrant operation.

Speed control of electric drives **-** Current-limit control - closed-loop torque control - closed loop speed control - Phase-locked loop control - closed loop position control.

DC Drives: Chopper fed drives- forward motoring and braking control - Phase controlled (Single phase and three phase) rectifier fed dc drives - continuous operation - separately excited DC motor drives - Series motors drives.

Module 5 (10 Hours)

AC Drives: **Induction motor drives** - Speed control methods of induction motor, Stator Voltage control- Rotor resistance control by Chopper control- Slip energy recovery schemes-V/f control

Synchronous motor drives: Variable frequency supply- Self control- VSI & CSI fed motors- Speed control of permanent magnet synchronous motors, Brushless DC motor (BLDC motor) working principle-power and torque expression of BLDC motor, Converter for BLDC motor drive-speed control of BLDC motor

Text Books:

1. Muhammad H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education.
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi.
3. G. K. Dubey, Fundamentals of Electric Drives, Narosa publishers, second edition, 2010

References:

1. Mohan N., T. M. Undeland and W. P. Robbins., Power Electronics, Converters, Applications & Design, Wiley-India
2. Fundamentals of Power Electronics, Erickson, Robert W., and Maksimovic, Dragan.
3. Singh M. D. and K. B. Khanchandani, Power Electronics, Tata McGraw Hill, New Delhi, 2008.
4. Vedam Subramaniam "Electric drives (concepts and applications)", Tata Mc Graw Hill, 2001
5. S.K.Pillai, "A First Course on Electric Drives", New Age International.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the working and switching characteristics of SCR, MOSFET, IGBT (K1)
2. Draw and explain the switching characteristics of SCR (K1, K2)
3. Explain different types of gate triggering circuits (K1, K2)
4. Explain different types of isolation in gate drive for power converter circuits (K1, K2)

Course Outcome 2 (CO2):

1. Describe the working with waveforms of single phase half wave rectifiers for different firing angles. (K1)
2. Describe the working with waveforms of single phase fully controlled rectifiers for different firing angles and loads.(K2)
3. Describe the working with waveforms of single phase half controlled rectifiers for different firing angles and loads.(K2)
4. Describe the working with waveforms of three phase rectifiers for different loads. (K2)
5. Problems in finding the average output voltage of rectifier. (K2, K3)

Course Outcome 3 (CO3):

1. Explain the working of step up and step down converters. (K1, K2)
2. Problems related to step up and step down converters. (K2, K3)
3. Analyse the working of Buck, Boost & Buck Boost regulators. (K3, K4)

Course Outcome 4 (CO4):

1. Explain single phase inverter for R and RL loads (K1, K2)
2. Explain 3 phase 120^0 and 180^0 conduction modes. (K4)
3. Explain single phase current source inverter. (K1)
4. Explain different PWM techniques (K1, K2)

Course Outcome 5 (CO5):

1. Explain the block diagram of an electric drive (K1,K2)
2. Explain the working of single phase rectifier fed DC drive (K2, K3)

3. Explain the chopper controller DC drive (K2,K3)
4. Explain the four quadrant operation of a DC drive (K2, K3)

Course Outcome 6 (CO6):

1. Explain stator voltage control of induction motor drive (K3, K4)
2. Explain rotor resistance control of induction motor drive (K3, K4)
3. Explain the v/f control of Induction motor drive (K3,K4)
4. Explain speed control of synchronous motor drive (K3, K4)
5. Explain speed control of BLDC motor drive (K3, K4)

Model Question Paper

QP CODE: PAGES:3

Reg.No:______________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EOT 302

Course Name: POWER ELECTRONICS AND DRIVES

Max. Marks: 100. Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Explain different turn on methods of SCR.
2. Describe the reverse recovery characteristics of a power diode.
3. Draw the input and output voltage waveforms of single phase half controlled rectifier feeding RL load in continuous conduction mode.
4. Explain time ratio control method to vary the output voltage in choppers.
5. Explain the terms modulation index and frequency modulation ratio related to pulse width modulation.
6. Compare voltage source and current source inverters.
7. What are the advantages of electric drives?
8. Draw the block diagram of an closed loop speed control of an electric drive
9. Why stator voltage control is not suitable for speed control of induction motor with constant load torque?
10. When a synchronous motor is operating in true synchronous mode, frequency must be varied in steps. Why?

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Sketch the static VI characteristics of SCR and define latching current and holding current.

[7 mark]

b) With the help of neat circuit diagram and waveforms, explain the operation of RC triggering circuit for one thyristor. [7 mark]

12 a) Compare Thyristor, Power MOSFET and IGBT on the basis of following parameters:

i) Switching frequency ii) Voltage and current ratings iii) Applications (at least two)

[8 mark]

b) Explain how the firing angle of an SCR can be varied by using a UJT relaxation oscillator. [6 mark]

Module 2

13a) Explain the operation of single phase full wave controlled rectifier without freewheeling diode, when feeding RL load. [9 mark]

b) Explain time ratio control method to vary the output voltage in choppers. [5 mark]

14a) Draw the circuit of 3 phase fully controlled rectifier with RLE load and explain the working for $\alpha=60^0$ with necessary waveforms. [6 mark]

b) Explain the working of a Buck-Boost regulator, showing relevant waveforms and derive the expression for its output voltage. [8 mark]

Module 3

15a) Explain the 180^0 conduction mode of a three-phase bridge inverter with output voltage waveforms, indicating the devices conducting in each state. [10 mark]

b) Compare voltage source and current source inverters. [4 mark]

16a) Explain the working of a single phase full bridge inverter with RL load. [7 mark]

b) Explain sinusoidal PWM technique for varying the magnitude of output voltage in a single-phase inverter. [7 mark]

Module 4

17a) Explain the four quadrant operation of an electric drive [6 mark]

b) A 220 V, 900 rpm, 100 A separately excited DC motor has an armature resistance of 0.05 Ohm. It is braked by plugging from an initial speed of 1000 rpm. Calculate (i) Resistance to be placed in the armature circuit to limit braking current to 1.5 times the full load torque. (ii) Braking torque and (iii) Torque when the speed has fallen to zero.

or [8 mark]

18a) A motor when operating in quadrant I and II has the characteristic T= 400-0.4N, Nm, where N is the speed in rpm. The load which is coupled to the motor is an active load with the characteristic, $T_l = \pm 200$ Nm. Calculate the motor speeds for motoring and braking operation in the forward direction. When the drive is operating in quadrant III and IV, motor has the characteristic, T= -400-0.4N, Nm. What will be the equilibrium speed in quadrant III. [7 mark]

b) Explain the speed control of separately excited DC motor using combined armature voltage and flux control method. Draw and explain the torque and power capability curves. [7 mark]

Module 5

19 a) What is slip power recovery scheme. Explain [6 mark]

b) A 5 MW, 3 phase, 11 kV, Y connected , 6 pole, 50 Hz, 0,9 leading power factor synchronous motor has Xs = 9 Ω and Rs=0 Ω. Rated field current is 50 A. Machine is controlled by variable frequency control at constant V/f ratio upto the base speed and at constant voltage, above rated speed. Determine (i) Torque and field current for the rated armature current, 750 rpm and 0.8 leading power factor [8 mark]

20a) Explain the speed torque characteristics of induction motor under the following types of speed control. (i) Voltage control of squirrel cage induction motor (ii) V/f control of squirrel cage induction motor. [8 mark]

b) With help of neat block diagram explain the working of a BLDC drive. [6 mark]

Teaching Plan

No	Topic	No. of Lectures
1	**Introduction to Power Switching Devices (8 hours)**	
1.1	Introduction and classifications of Power semiconductor devices	1
1.2	Static and switching characteristics of Power diodes, SCR, IGBT, and MOSFET	2
1.3	switching losses - Device selection strategy	1
1.4	Device specifications - Applications	1
1.5	Basic triggering circuits (R, RC and UJT triggering)	2
1.6	Requirements of isolation and synchronization in gate drive circuits - Opto and pulse transformer based isolation	1
2	**Phase Controlled Rectifiers and DC-DC Converters (9 hours)**	
2.1	Single phase fully controlled and half controlled bridge rectifier with R, RL and RLE loads (continuous conduction only).	2
2.2	Three phase fully controlled & half-controlled bridge converter with RLE load (continuous conduction, ripple free).	2
2.3	Step down and Step up choppers	1
2.4	Single-quadrant, Two-quadrant and Four quadrant chopper	1
2.5	Pulse width modulation & current limit control in dc-dc converters	1
2.6	Buck converter- Boost converter- Buck boost Converter (CCM operation only).	2
3	**Inverters (8 hours)**	
3.1	Principle of operation of half and full bridge inverters with R and RL load	2
3.2	Three bridge phase inverter with R load- 180 degree and 120 degree conduction mode.	2
3.3	Voltage control of single phase inverters using various SPWM techniques.	2
3.4	Unipolar and bipolar SPWM techniques.	1
3.5	Working principle of current source inverter (basic circuit only) Comparison of current source inverter and voltage source inverter	1
4	**Electric Drives: (10 hours)**	
4.1	Fundamental of electric drives- Elements of electric drives- Dynamics of a drive system	1
4.2	Components of load torques- Classifications of load torques	1
4.3	Speed torque conventions and multi-quadrant operation.	1
4.4	Current-limit control - closed-loop torque control - closed loop speed control - Phase-locked loop control - closed loop position control.	2
4.5	Chopper fed drives- forward motoring and braking control	2
4.6	Phase controlled (Single phase and three phase) rectifier fed dc drives - continuous operation	2
4.7	Separately excited DC motor drives - Series motors drives	1
5	**AC Drives (10 hours)**	
5.1	Speed control methods of induction motor, Stator Voltage control	2
5.2	Rotor resistance control by Chopper control	1
5.3	Slip energy recovery schemes-V/f control	2
5.4	Synchronous motor drives -Variable frequency supply - Self control - VSI & CSI fed motors	2
5.5	Speed control of permanent magnet synchronous motors.	1

5.6	Brushless DC motor (BLDC motor) working principle-power and torque expression of BLDC motor, Converter for BLDC motor drive-speed control of BLDC motor	2

EOT 304	INTERNET OF THINGS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2022

Preamble:

This course is designed to understand the basic concepts, applications and relevance of Internet of Things (IoT) in the industry, business and digital space. The course helps learners to understand the role of sensors, actuators, networking and protocols for designing an IoT ecosystem. The course introduces programming of Arduino and Raspberry Pi for the design and development of IoT applications. IoT is an emerging technology and it can create huge impact in the daily life of humans. This course aims at moulding the learner to develop IoT applications to solve real world problems.

Prerequisite:

Topics covered under the course Microprocessors and Embedded Systems (EET303)

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the basic concepts, design principles and security of Internet of Things(IoT). **(Cognitive Knowledge Level: Understand)**
CO 2	Outline the importance of edge computing, cloud computing and fog computing in an IoT environment. **(Cognitive Knowledge Level: Understand)**
CO 3	Identify appropriate IoT ecosystem concept and architecture for an IoT application. **(Cognitive Knowledge Level: Apply)**
CO 4	Identify the significance and applications of low power wide area networking technologies in an IoT environment. **(Cognitive Knowledge Level: Apply)**
CO 5	Utilize python or Arduino programming to control embedded devices in an IoT application. **(Cognitive Knowledge Level: Apply)**
CO 6	Identify the impact of IoT in different application areas with the help of case studies. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓

CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓	✓		✓					✓
CO5	✓	✓	✓	✓	✓							✓
CO6	✓	✓	✓	✓	✓	✓	✓					✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percentage)**	
Remember	40	30	30
Understand	40	30	30
Apply	20	40	40

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the Syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B.
Suggestion: Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SYLLABUS

Module 1

Introduction to Internet of Things:

Evolution of IoT, Definition of IoT, Sensing, Actuation, Basics of Networking, Characteristics of IoT, Design Principles of IoT, IoT Architectures – SOA Based Architecture - API Oriented Architecture, Communication Protocols – Overview of Network layer protocols, Transport and Application Layer Protocols – MQTT, COAP, IoT Applications, IoT Security – Identity Management and Authentication, Privacy, Standardization and Regulatory Limitations, IoT vs M2M.

Module 2

Internet Of Things Ecosystem Concepts and Architectures:

IoT and Cloud: Introduction to CloudIoT, The Cloud of Things Architecture – Deployment Models – Applications – Essential features – Technological Pillars – Three Layers of IoT System.

IoT and Fog Computing: Introduction to Fog Computing, Fog Computing Fundamentals in the Internet-of-Things, Principles, Architectures, Management at the Fog Layer - IoT Resource Estimation Challenges and Modelling in Fog, Services of the Fog Layer - The Present and Future of Privacy-Preserving Computation in Fog Computing, Applications.

Module 3

Internet Of Things Ecosystem Concepts and Architectures:

IoT and Edge Computing: Introduction to Edge Computing – Architecture and Working, Applications and use Cases, Characteristics of Edge Computing, Challenges of Edge Computing.

LPWAN Technologies for IoT: Introduction to Low – Power Wide – Area Network, Design Considerations and Network Architectures for LPWAN, Low Power Wireless Technologies – BLE – Wi-Fi, Low Power Wide Area Technologies – NBIoT – LoRa, LoRaWAN Protocol – Architecture – Specifications – Security – Applications.

Module 4

Programming For Internet of Things:

Design and Development: Arduino – Introduction to Arduino, Board details, Arduino IDE, Basic Commands for Arduino, LCD Commands, Serial Communication Commands, Interfacing with LED and Arduino, Interfacing LCD with Arduino.

Raspberry Pi – Introduction to Raspberry Pi, Interfaces and Raspberry Pi with Python Programming – Python Fundamentals – Python Script – Variables – Data types – Arithmetic Operations – Control Statements –Basic Conditional Statements – Looping Statements, interfacing an LED and Switch with Raspberry Pi, Interfacing a Light Sensor (LDR) with Raspberry Pi.

Module 5

Internet Of Things Applications and Case Studies:

IoT/IIoT Applications in the Premises – Smart Homes, Smart Cities, Environment Monitoring and Agriculture, Smart Grid, Supply – Chain and Customer Monitoring, Connected Car and its Applications and Services.

Case Study: Smart City Street Lights Control and Monitoring, Exploiting LoRa, Edge, and Fog computing for traffic monitoring in smart cities.

Text Books

1. Adrian McEwen, Hakim Cassimally., "Designing the Internet of Things", Wiley, 2014.
2. Rajkumar Buyya, Amir Vahid Dastjerdi., "Internet of Things, Principles and Paradigms", Morgan Kaufmann., 2016.
3. Sudip Misra, Anandarup Mukherjee, Arijit Roy., "Introduction to IoT", Cambridge University Press, 2021.

Reference Books

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press., 2012.
2. Rajkumar Buyya, Satish Narayana Srirama.," Fog and Edge Computing", Wiley, 2019.
3. Deepak Gupta, Aditya Khamparia.," Fog, Edge, and Pervasive Computing in Intelligent IoT Driven Applications", Wiley, 2021.
4. Bharat S. Chaudhari, Marco Zennaro., "LPWAN Technologies for IoT and M2M Applications", Academic Press, 1st Edition, 2020.
5. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain., "Internet of Things with Raspberry Pi and Arduino", CRC Press, First Edition, 2020.
6. Arshdeep Bahga, Vijay Madisetti., "Internet of Things – A hands-on approach", Universities Press, 2015.
7. Richard Blum, Christine Bresnahan, "Sams Teach Yourself Python Programming for Raspberry Pi in 24 Hours", Pearson Education 2014.
8. Sudip Misra, Chandana Roy, Anandarup Mukherjee., "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press., 2021.
9. Raj Kamal, "Internet of Things Architecture and Design Principles", McGraw Hill Education.,2017.
10. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 2017.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Summarize the design principles of Internet of Things.
2. Illustrate between sensors and actuators.

Course Outcome 2 (CO2):

1. Explain various deployment models for cloud IoT architecture.
2. Outline the significance of fog computing in Internet of Things.

Course Outcome 3(CO3):

1. Identify the suitable IoT ecosystem concept and requirements for implementing smart energy meter which is capable of sending the meter readings to a server without human intervention.
2. Utilize appropriate ecosystem concept for pet tracking and justify the selection.

Course Outcome 4 (CO4):

1. Identify the application areas where LPWAN technologies are more suitable and cost effective when compared to other IoT technologies.
2. Identify the limitations and advantages of NBIoT and LoRa technologies in smart farming application.

Course Outcome 5 (CO5):

1. Apply Arduino programming to control embedded devices in an automatic street light application.
2. Develop a program to print temperature and humidity readings to interface DHT11 sensor with Raspberry Pi.

Course Outcome 6 (CO6):

1. Identify the significance and impact of IIoT in the business field.
2. Perform case study to explore the significance of LoRa, Edge, and Fog computing on product monitoring and customer monitoring using IoT.

Model Question paper

QP CODE: PAGES: 3

Reg No.:_______________ Name:___________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT 304

Course Name: INTERNET OF THINGS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain the major components of Internet of Things.
2. Summarize various challenges in IoT security.
3. Outline the essential features of cloud IoT architecture.
4. Explain the services provided by the fog computing layer in an IoT environment
5. Summarize the characteristics of edge computing.
6. Identify the security issues in a LoRaWAN architecture.
7. Outline various LCD commands used for Arduino.
8. Explain various python control statements used for Raspberry Pi programming.
9. Explain the various application areas of Industrial Internet of Things.
10. Illustrate the components needed in a system for connected car applications.

PART B

Answer any one full question from each module. Each question carries 14 Marks

11. a) Explain about various IoT architectures with its application areas. (10)

b) Outline the difference between IoT and M2M systems. (4)

OR

12.	a)	Explain about various application layer protocols in Internet of Things with its significance in an IoT application.	(10)
	b)	Outline the different security measures needed to secure IoT.	(4)
13.	a)	Illustrate the cloud IoT Architecture and deployment models with the help of a neat diagram.	(10)
	b)	Explain the importance of cloud and fog computing technologies in healthcare applications.	(4)
		OR	
14.	a)	Illustrate the fog computing architecture with the help of a neat diagram.	(10)
	b)	Outline the security features provided with fog computing in an IoT environment.	(4)
15.	a)	Illustrate the architecture for edge computing with the help of a neat diagram.	(10)
	b)	Identify the challenges of edge computing technology in an IoT environment.	(4)
		OR	
16.	a)	Explain LoRaWAN Architecture with the help of a neat diagram.	(7)
	b)	Identify the significance of LPWAN technologies in temperature and air quality monitoring using IoT.	(7)
17.	a)	Develop a program to turn ON LED for 2 sec after every 5 seconds to interface LED with Arduino.	(10)
	b)	Explain various serial communication commands used for Arduino.	(4)
		OR	
18.	a)	Develop a program to turn ON LED at sensor detection to interface Digital sensor (LDR) with Raspberry Pi.	(10)
	b)	Identify an embedded system development board suitable to interface temperature and humidity sensors to upload or download sensor data to cloud and mention the way it is better than other development board for the given application.	(4)
19.	a)	Design the architecture reference model for the smart grid application in an IoT environment.	(10)
	b)	Illustrate the features of Industrial IoT with suitable block diagram.	(4)

OR

20. a) Perform case study for precision agriculture in an IoT environment. (10)

b) Identify the components for Smart parking application using IoT. (4)

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Teaching Plan		
Module 1: Introduction to Internet of Things		**(8 hours)**
1.1	Evolution of IoT, Definition of IoT, Sensing, Actuation	1 hour
1.2	Basics of Networking, Characteristics of IoT	1 hour
1.3	Design Principles of IoT, IoT Architectures – SOA Based Architecture	1 hour
1.4	API Oriented Architecture, Communication Protocols – Overview of Network layer protocols	1 hour
1.5	Transport and Application Layer Protocol – MQTT	1 hour
1.6	Application Layer Protocol – COAP, IoT Applications	1 hour
1.7	IoT Security – Identity Management and Authentication, Privacy	1 hour
1.8	Standardization and Regulatory Limitations, IoT vs M2M	1 hour
Module 2: Internet Of Things Ecosystem Concepts and Architectures		**(8 hours)**
2.1	Introduction to Cloud IoT, The Cloud of Things Architecture	1 hour
2.2	Four Deployment Models, Vertical Applications	1 hour
2.3	Fifteen essential features, Four Technological Pillars, Three Layers of IoT System	1 hour
2.4	Introduction to Fog Computing, Fog Computing Fundamentals in the Internet-of-Things, Principles	1 hour
2.5	Fog Computing - Architectures	1 hour
2.6	Management at the Fog Layer - IoT Resource Estimation Challenges and Modelling in Fog	1 hour
2.7	Services of the Fog Layer - The Present and Future of Privacy-Preserving Computation in Fog Computing	1 hour
2.8	Fog Computing - Applications.	1 hour

Module 3: Internet Of Things Ecosystem Concepts and Architectures		**(8 hours)**
3.1	Introduction to Edge Computing – Architecture and Working	1 hour
3.2	Edge Computing – Applications and use Cases	1 hour
3.3	Characteristics of Edge Computing, Challenges of Edge Computing	1 hour
3.4	Introduction to Low - Power Wide - Area Network, Design Considerations and Network Architectures for LPWAN	1 hour
3.5	Low Power Wireless Technologies – BLE - Wi-Fi	1 hour
3.6	Low Power Wide Area Technologies – NBIoT – LoRa	1 hour
3.7	LoRaWAN Protocol – Architecture – Specifications	1 hour
3.8	LoRaWAN – Security - Applications	1 hour
Module 4: Programming For Internet of Things		**(12 hours)**
4.1	Arduino - Introduction to Arduino, Board details	1 hour
4.2	Arduino IDE	1 hour
4.3	Basic Commands for Arduino, LCD Commands, Serial Communication Commands	1 hour
4.4	Interfacing with LED and Arduino	1 hour
4.5	Interfacing LCD with Arduino.	1 hour
4.6	Raspberry Pi - Introduction to Raspberry Pi, Interfaces	1 hour
4.7	Raspberry Pi with Python Programming – Python Fundamentals – Python Script	1 hour
4.8	Variables - Data types – Arithmetic Operations	1 hour
4.9	Control Statements – Basic Conditional Statements	1 hour
4.10	Control Statements – Looping Statements	1 hour
4.11	Interfacing an LED and Switch with Raspberry Pi	1 hour
4.12	Interfacing a Light Sensor (LDR) with Raspberry Pi	1 hour
Module 5 : Internet Of Things Applications and Case Studies		**(9 hours)**
5.1	IoT/IIoT Applications in the Premises	1 hour
5.2	Smart Homes	1 hour

5.3	Smart Cities	1 hour
5.4	Environment Monitoring and Agriculture	1 hour
5.5	Smart Grid	1 hour
5.6	Supply-Chain and Customer Monitoring	1 hour
5.7	Connected Car and its Applications and Services.	1 hour
5.8	Case Study: Smart City Street Lights Control and Monitoring	1 hour
5.9	Case Study: Exploiting LoRa, Edge, and Fog computing for traffic monitoring in smart cities.	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT306	**ELECTRICAL MACHINES**	**PEC**	**2**	**1**	**1**	**4**

Preamble

To give exposure to the students about the concepts of DC and AC machines including the Constructional details, principle of operation and performance analysis.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Analyse various types of single-phase and three-phase transformers at various load conditions
CO 2	Analyse various types of DC generators at different load conditions
CO 3	Analyse the performance characteristics of various types of DC motors
CO 4	Analyse various types of synchronous generators and motors
CO 5	Analyse various types of three-phase induction motors
CO 6	Explain the principle of operation of various types of single-phase induction motors

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	-	-	-	-	-	-	-	-	2
CO 2	3	2	-	-	-	-	-	-	-	-	-	2
CO 3	3	2	-	-	-	-	-	-	-	-	-	2
CO 4	3	2	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	-	-	2
CO 6	3	2	-	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Describe the constructional details of core-type and shell-type single-phase transformers (PO1, PO12)
2. Derive the emf equation of 1-phase transformers. (PO1, PO12)
3. Determine the efficiency and voltage regulation of 1-phase transformer at full-load and 0.8p.f. lag and lead. (PO1, PO2, PO12)
4. Explain the constructional features of 3-phase transformer (PO1, PO12)
5. Describe the working of autotransformer and derive the expression for saving of copper (PO1, PO12)

Course Outcome 2 (CO2)

1. Describe the various classifications of DC generators. (PO1, PO12)
2. Determine the generated emf of a separately excited/shunt/series/compound generator. (PO1, PO2, PO12)
3. Differentiate between lap and wave windings. (PO1, PO12)
4. Find the critical field resistance and critical speed from OCC (PO1, PO2, PO12)

Course Outcome 3(CO3)

1. Derive the torque equation of DC motor. (PO1, PO12)
2. Explain the various performance characteristics of DC series motor. (PO1, PO2, PO12)
3. Explain the need of staring in DC motor. (PO1, PO12)
4. Determine the efficiency of DC shunt motor if the no-load data is given. (PO1, PO2, PO12)

Course Outcome 4 (CO4)

1. Describe various features of salient-pole type and cylindrical rotor type synchronous generators. (PO1, PO12)
2. Determine the voltage regulation of synchronous generator if open-circuit and short-circuit data are given. (PO1, PO2, PO12)

Course Outcome 5 (CO5)

1. Explain the principle of operation of 3-phase induction motor. (PO1, PO12)
2. Determine the efficiency of induction motor from no-load and blocked rotor data. (PO1, PO2, PO12)
3. Why starters are necessary in 3-phase induction motors. (PO1, PO12)
4. Determine the equivalent circuit of 3-phase induction motor from no-load and blocked rotor tests. (PO1, PO2, PO12)
5. Describe the various speed control techniques of 3-phase induction motors. (PO1, PO12)

Course Outcome 6 (CO6)

1. Explain why single-phase induction motors are not self-starting. (PO1, PO12)
2. Explain various types of single-phase induction motors. (PO1, PO12)

Model Question Paper

QPCODE:

Reg. No:___________

Name:_____________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EOT306**

Course Name: **ELECTRICAL MACHINES**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions.

Each question carries 3 Marks

1	List the characteristics of ideal single-phase transformer.	(3)
2	Explain the working of single-phase auto-transformer.	(3)
3	Differentiate between lap and wave windings in DC machines.	(3)
4	What are the conditions for parallel operation of DC shunt generators?	(3)
5	Draw the speed Vs armature current, torque Vs armature current and speed Vs torque characteristics of DC series motor.	(3)
6	What is the need of starters in DC motors?	(3)
7	Define voltage regulation in synchronous generators.	(3)
8	Explain any method of starting of three-phase synchronous motor.	(3)
9	Draw the equivalent circuit of a three-phase induction motor.	(3)
10	Explain the working of capacitor-start induction motor.	(3)

PART B

Answer any one full question from each module.

Each question carries 14 Marks

Module 1

11	a)	Derive the emf equation of a single-phase transformer.	(5)
	b)	A 20kVA, 250/2500V single phase transformer gave the following test results OC Test (LV side): 200V 1.4A 105W SC Test (HV side): 120V 8A 320W Draw the equivalent circuit of single-phase transformer referred to LV side.	(9)
		OR	
12	a)	Derive the condition for maximum efficiency and the load current at which maximum efficiency occurs in a single-phase transformer.	(9)
	b)	Draw the phasor diagram of a single-phase transformer.	(5)

Module 2

13 a) Draw and explain the load characteristics of DC shunt generator. (8)

b) A 400V DC shunt generator has a full load current of 190A. Its armature resistance is 0.08Ω; shunt field resistance 200Ω, iron and mechanical loss together 2000W. Find the full load efficiency. (6)

OR

14 OCC of a DC generator driven at 400rpm is as follows (14)

Field current (A)	2	3	4	5	6	7	8	9
Terminal volts	110	155	186	212	230	246	260	271

Find

i) The voltage to which the machine will excite when run as a shunt generator at 400rpm with shunt field resistance equal to 34Ω.

ii) Resistance of shunt field circuit to reduce the OC voltage to 220V

iii) Critical shunt field resistance

iv) Critical speed if the shunt field circuit resistance is 34Ω

v) Lowest possible speed at which an OC voltage of 225V can be obtained

Module 3

15 a) Derive the torque equation of a DC motor. (7)

b) A 230V DC shunt motor, takes an armature current of 3.33A at rated voltage and at a no-load speed of 1000rpm. The resistances of the armature circuit and field circuit are respectively 0.3Ω and 160Ω. The line current at full load and rated voltage is 40A. Calculate, at full load, the speed and the developed torque in case the armature reaction weakens the no-load flux by 4%. (7)

OR

16 a) Explain any two methods of speed control of DC shunt motor. (7)

b) A 230V DC series motor runs at 1000rpm when taking 155A. Its total armature circuit resistance is 0.1Ω. Calculate the speed of the motor at half the torque. Assume unsaturated magnetic field. (7)

Module 4

17 a) Explain the constructional features of salient-pole type and cylindrical rotor type synchronous generators. (9)

b) A 3 phase 8 pole 750 rpm star-connected alternator has 72 slots on the armature. Each slot has 12 conductor and winding is short chorded by 2 slots. Find the induced emf between lines, given the flux per pole is 0.06 wb. (5)

OR

18 The open circuit and short circuit test is conducted on a 3-phase, star connected, 220V, 15.25kVA alternator. The OC test results are, (14)

I_f amp	0.2	0.4	0.6	0.8	1	1.2	1.4	1.8	2.2	2.6
E_f line volts	29	58	87	116	146	172	194	232	262	284

Field current of 1.2A produces a short circuit current of 40A. R_a = 0.06Ω/phase. Calculate its full load regulation at 0.8 p.f. lag using emf method

Module 5

19	a)	Explain the principle of operation of 3-phase induction motors.	(7)
	b)	A 3-phase induction motor has a 4-pole star connected stator winding. Motor runs at 50Hz supply with 200V between lines. Rotor resistance and standstill reactance are 0.1Ω and 0.9Ω per phase respectively. Calculate a) total torque at 4% slip b) maximum torque and c) speed at maximum torque. Ratio of rotor turns to stator turns = 0.67.	(7)

OR

20		Explain the principle of operation of single-phase induction motor. Explain the various types of 1-phase induction motors.	(14)

Syllabus

Module 1 – TRANSFORMERS
Single-phase transformer – constructional details – ideal transformer – emf equation – practical transformer – - equivalent circuit and phasor diagram – voltage regulation – losses in a transformer – efficiency – condition for maximum efficiency – testing – open circuit and short circuit tests – auto-transformer – saving of copper – 3-phase transformer – constructional details – 3-phase transformer connections (Y-Δ, Y-Y, Δ-Y, Δ-Δ).

Module 2 – DC GENERATORS
Constructional details of DC machines - armature winding - simplex lap and wave – double-layer winding diagram for 12 slot, 4pole lap and 16 slot, 6-pole wave – principle of DC generator - EMF equation – separately excited and self-excited generators – basic concepts of armature reaction and commutation – open circuit characteristics of DC shunt generators – voltage build-up – load-characteristics of DC shunt generator – losses and efficiency – power flow diagram – need and conditions for parallel operation of DC shunt generators – applications of DC generators.

Module 3 – DC MOTORS
DC Motor – torque equation – types of DC motors – losses and efficiency – power flow diagram - performance characteristics (N Vs I_a, T Vs I_a, N Vs T) of DC shunt motor and series motor – starting of DC motor – necessity –speed control – armature voltage control and flux control – testing of DC motor – Swinburnes's test.

Module 4 – SYNCHRONOUS GENERATORS & MOTORS
Synchronous generator - Principle of operation – constructional details – types - armature winding - 3-phase, 12slot, 2-pole, single-layer, full-pitched winding – EMF equation – concepts of armature reaction –equivalent circuit – phasor diagram – voltage regulation - emf and mmf method - parallel operation with infinite bus bar – synchronisation – conditions for parallel operation – synchronous motor – principle – methods of starting.

Module 5 – INDUCTION MOTORS
3-phase induction motor – principle of operation – torque equation – torque-slip characteristics – phasor diagram – equivalent circuit – tests – no-load and blocked rotor tests – starting – DOL starter, auto-transformer starter, star-delta starter, rotor resistance starter (no design) – speed control – stator voltage control, V/f control, rotor resistance control – single-phase induction motor – principle – types – split-phase, capacitor start induction motor, capacitor start & run induction motor - applications of induction motors

Text Books

1. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D. P. Kothari, Theory of AC Machines, Tata McGraw Hill, 2006

Reference Books

1. Fitzgerald A. E., C. Kingsley and S. Umans, Electric Machinery, 5/e, McGraw Hill, 1990
2. Langsdorf M. N., Theory of Alternating Current Machinery, Tata McGraw Hill, 2001.
3. Say M. G., The Performance and Design of A. C. Machines, C B S Publishers, New Delhi, 2002
4. Deshpande M. V., Electrical Machines, Prentice Hall India, New Delhi, 2011

Course Contents and Lecture Schedule

Sl. No	Topic	No. of Lectures
1	**TRANSFORMERS (8 hours)**	
1.1	Single-phase transformer – constructional details – ideal transformer – emf equation	2 hours
1.2	Practical transformer –- equivalent circuit and phasor diagram – voltage regulation – losses in a transformer – efficiency – condition for maximum efficiency – numerical problems	2 hours
1.3	Testing – open circuit and short circuit tests – numerical problems	1 hours
1.4	Auto-transformer – saving of copper – numerical problems	1 hours
1.5	3-phase transformer – constructional details – 3-phase transformer connections (Y-Δ, Y-Y, Δ-Y, Δ-Δ).	2 hours
2	**DC GENERATORS (9 hours)**	
2.1	Constructional details of DC machines - armature winding - simplex lap and wave – double-layer winding diagram for 12 slot, 4pole lap and 16 slot, 6-pole wave	2 hours
2.2	Principle of DC generator - EMF equation – separately excited and self-excited generators – numerical problems	1 hour
2.3	Basic concepts of armature reaction and commutation	1 hour
2.4	Open circuit characteristics of DC shunt generators – voltage build-up – critical field resistance & critical speed - load-characteristics of DC shunt generator – numerical problems	2 hours
2.5	Losses and efficiency – power flow diagram – need and conditions for parallel operation of DC shunt generators – applications of DC generators – Numerical problems	2 hours
2.6	Need and conditions for parallel operation of DC shunt generators – applications of DC generators.	1 hours
3	**DC MOTORS (7 hours)**	
3.1	DC Motor – torque equation – types of DC motors – separately excited, shunt, series and compound - numerical problems	2 hours
3.2	Losses and efficiency – power flow diagram – numerical problems	1 hour
3.3	Performance characteristics (N Vs I_a, T Vs I_a, N Vs T) of DC shunt motor and series motor – numerical problems	1 hours
3.4	Starting of DC motor – necessity –speed control – armature voltage control and flux control – numerical problems	2 hours
3.5	Testing of DC motor – Swinburnes's test – numerical problems	1 hour
4	**SYNCHRONOUS GENERATORS & MOTORS (10 hours)**	
4.1	Synchronous generator - Principle of operation – constructional details – types - armature winding - 3-phase, 12slot, 2-pole, single-layer, full-pitched winding.	3 hours
4.2	EMF equation – concepts of armature reaction –equivalent circuit – phasor diagram – numerical problems	2 hours
4.3	Voltage regulation – open circuit and short circuit tests - emf and mmf method – numerical problems	2 hours

4.4	Parallel operation with infinite bus bar – synchronisation – conditions for parallel operation	1 hour
4.5	Synchronous motor – principle – methods of starting – starting by using external motor, using damper bars and using variable frequency method.	2 hours
5	**INDUCTION MOTORS (11 hours)**	
5.1	3-phase induction motor – principle of operation – torque equation – torque-slip characteristics – phasor diagram – equivalent circuit – numerical problems	3 hours
5.2	Tests – no-load and blocked rotor tests – numerical problems	2 hours
5.3	starting – DOL starter, auto-transformer starter, star-delta starter, rotor resistance starter (no design)	2 hours
5.4	Speed control – stator voltage control, V/f control, rotor resistance control	2 hours
5.5	single-phase induction motor – principle – types – split-phase, capacitor start induction motor, capacitor start & run induction motor - applications of induction motors	2 hours

CST 312	FOUNDATIONS OF MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble:

This course enables the learners to understand the mathematical foundations of Machine Learning concepts. This course covers Linear Algebra, Probability and Distributions. Concepts in this course help the learners to identify the inherent assumptions & limitations of the current methodologies and develop new Machine Learning solutions.

Prerequisite

A sound background in higher secondary school **Mathematics**.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Illustrate operations and applications of linear equations, matrix algebra, vector spaces, eigen values & eigenvectors **(Cognitive Knowledge Level: Apply)**
CO 2	Illustrate the concepts of orthogonality & diagonalization. **(Cognitive Knowledge Level: Apply)**
CO 3	Solve computational problems using probability and random variables. **(Cognitive Knowledge Level: Apply)**
CO 4	Identify an appropriate probability distribution for a given discrete or continuous random variable and use its properties. (**Cognitive Knowledge Level: Apply)**
CO 5	Illustrate moment generating function, law of large numbers and central limit theorems (**Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓								✓
CO 2	✓	✓	✓	✓								✓
CO 3	✓	✓	✓	✓								✓
CO 4	✓	✓	✓	✓								✓

CO 5	✓	✓	✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	30%	30%	30%
Understand	30%	30%	30%
Apply	40%	40%	40%
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment: **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module 1 (LINEAR ALGEBRA)

Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings.

Module 2 (LINEAR ALGEBRA)

Norms - Inner Products, Lengths and Distances, Angles and Orthogonality. Orthonormal Basis, Orthogonal Complement, Orthogonal Projections. Matrix Decompositions - Eigenvalues and Eigenvectors, Eigen decomposition and Diagonalization.

Module 3 (PROBABILITY AND DISTRIBUTIONS)

Probability Space - Sample Spaces, Probability Measures, Computing Probabilities, Conditional Probability, Baye's Rule, Independence. Random Variables - Discrete Random Variables (Bernoulli Random Variables, Binomial Distribution, Geometric and Poisson Distribution, Continuous Random Variables (Exponential Density, Gamma Density, Normal Distribution, Beta Density)

Module 4 (RANDOM VARIABLES)

Functions of a Random Variable. Joint Distributions - Independent Random Variables, Conditional Distributions, Functions of Jointly Distributed Random Variables.

Expected Values - Expected Value of a Random Variable, Expectations of Functions ofRandom Variables, Expectations of Linear Combinations of Random Variables, Variance and Standard Deviation, Covariance and Correlation, Conditional Expectation

Module 5 (LIMIT THEOREMS)

Moment-Generating Function. Limit Theorems(Proof not expected) - Law of Large Numbers, Convergence in Distribution and the Central Limit Theorem. Distributions derived from the Normal Distribution - Chi-square, t, and F Distributions, Sample Mean and the Sample Variance.

Text book:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (freely available at https://mml – book.github.io)
2. John A. Rice, Mathematical Statistics and Data Analysis, University of California, Berkeley, Third edition, published by Cengage.

Reference books:

1. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition,
2. Axler, Sheldon, Linear Algebra Done Right, 2015 Springer
3. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra, 2018 published by Cambridge University Press

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the set $\boldsymbol{S}$ of all solutions in $\boldsymbol{x}$ of the following inhomogeneous linear systems $\boldsymbol{Ax} = \boldsymbol{b}$, where $\boldsymbol{A}$ and $\boldsymbol{b}$ are defined as follows:

$$\boldsymbol{A} = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad \boldsymbol{b} = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

$$\boldsymbol{A} = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Are the following sets of vectors linearl independent?

$$\boldsymbol{x}_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad \boldsymbol{x}_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad \boldsymbol{x}_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

4. A set of $\boldsymbol{n}$ linearly independent vectors in $\boldsymbol{R}^n$ forms a basis. Does the set of vectors **(2, 4,−3)** **(0, 1, 1)** , **(0, 1,−1**) form a basis for $\boldsymbol{R}^3$? Explain your reasons.

Course Outcome 2 (CO2):

1. Determine which of the following sets are orthogonal sets.

$$\left\{\begin{bmatrix}3\\1\\1\end{bmatrix},\begin{bmatrix}-1\\2\\1\end{bmatrix},\begin{bmatrix}-1/2\\-2\\7/2\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}1\\-1\\1\end{bmatrix},\begin{bmatrix}2\\1\\-1\end{bmatrix},\begin{bmatrix}3\\0\\-3\end{bmatrix}\right\} \qquad \left\{\begin{bmatrix}3\\-2\\1\\3\end{bmatrix},\begin{bmatrix}-1\\3\\-3\\4\end{bmatrix},\begin{bmatrix}3\\8\\7\\0\end{bmatrix}\right\}$$

2. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue of the following matrix.

$$\begin{bmatrix}2&0&4\\0&3&0\\0&1&2\end{bmatrix}$$

3. Diagonalize the following matrix, if possible

$$\begin{bmatrix}3&0&0&0\\0&2&0&0\\0&0&2&0\\1&0&0&3\end{bmatrix}$$

Course Outcome 2 (CO3):

1. Let ***J*** and ***T*** be independent events, where ***P(J)=0.4*** and ***P(T)=0.7***.
   i. Find ***P(J∩T)***
   ii. Find ***P(J∪T)***
   iii. Find ***P(J∩T')***

2. Let ***A*** and ***B*** be events such that ***P(A)=0.45*** , ***P(B)=0.35*** and ***P(A∪B)=0.5***. Find ***P(A|B)***.

3. A random variable **R** has the probability distribution as shown in the following table:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

i. Given that $E(R)=2.85$, find a and b.
ii. Find $P(R>2)$.

4. A biased coin (with probability of obtaining a head equal to $p > 0$) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.

5. Two players A and B are competing at a quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are p and q respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A wins if
   i. A answers the first question,
   ii. B answers the first question.

6. A coin for which $P(heads) = p$ is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.

Course Outcome- 3 (CO4):

1. An urn contains **p** black balls, **q** white balls, and **r** red balls; and **n** balls are chosen without replacement.
   a. Find the joint distribution of the numbers of black, white, and red balls in thesample.
   b. Find the joint distribution of the numbers of black and white balls in thesample.
   c. Find the marginal distribution of the number of white balls in the sample.

2. Suppose that two components have independent exponentially distributed lifetimes, T_1 and T_2, with parameters α and β, respectively. Find (a) $P(T_1 > T_2)$ and (b) $P(T_1 > 2 T_2)$.

3. Let Z_1 and Z_2 be independent random variables each having the standard normal distribution. Define the random variables X and Y by $X = Z_1 + 3Z_2$ and $Y = Z_1 + Z_2$. Argue that the joint distribution of (X, Y) is a bivariate normal distribution. What are the parameters of this distribution?

4. Given a continuous random variable ***x***, with cumulative distribution function $F_x(x)$, show that the random variable $y = F_x(x)$ is uniformly distributed.
5. You roll a fair dice twice. Let the random variable ***X*** be the product of the outcomes of the two rolls. What is the probability mass function of ***X***? What are the expected values and the standard deviation of ***X***?
6. Let ***X*** be a continuous random variable with the density function $f(x) = 2x, 0 \leq x \leq 1$
    a. Find $E(X)$.
    b. Find $E(X^2)$ and $Var(X)$.

Course Outcome 5 (CO5):

1. Find the moment-generating function of a Bernoulli random variable, and use it to find the mean, variance, and third moment.
2. Use moment-generating functions to show that if **X** and **Y** are independent, then $Var(aX + bY) = a^2Var(X) + b^2Var(Y)$.
3. Suppose that you bet Rs 5 on each of a sequence of 50 independent fair games. Use the central limit theorem to approximate the probability that you will lose more than Rs 75.
4. Suppose that the number of insurance claims, ***N***, filed in a year is Poisson distributed with $E(N) = 10{,}000$. Use the normal approximation to the Poisson to approximate $P(N > 10{,}200)$.

Model Question paper

QP Code : **Total Pages: 4**

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (ELECTIVE), MONTH and YEAR

Course Code: CST 312

Course Name: FOUNDATIONS OF MACHINE LEARNING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1 Show that with the usual operation of scalar multiplication but with addition onreals given by ***x # y = 2(x + y)*** is not a vector space.

2 Are the following vectors linearly independent? Justify your answer.

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

3 Find the eigenvalues of the following matrix in terms of k. Can you find an eigenvector corresponding to each of the eigenvalues?

$$\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$$

4 Find a unit vector in $\mathbf{R}^2$ that is orthogonal to **(-1 , 2)**.

5 The first three digits of a telephone number are 452. If all the sequences of the remaining four digits are equally likely, what is the probability that a randomly selected telephone number contains seven distinct digits?

6 Show that if two events ***A*** and ***B*** are independent, then ***A*** and ***B'*** are independent.

7 Prove that ***X*** and ***Y*** are independent if and only if $f_{X|Y}(x|y) = f_X(x)$ for all ***x*** and ***y***.

8 If ***X*** is a discrete uniform random variable, i.e., $P(X = k) = 1/n$ for $k = 1, 2, \dots, n$, find $E(X)$ and $Var(X)$.

9 Compare the Poisson cdf and the normal approximation for (a) **λ = 10**, (b) **λ = 20**, and (c) **λ = 40**.

10 State law of large numbers. **10 x 3 = 30**

PART B

Answer any one Question from each module. Each question carries 14 Marks

11 a) Find all solutions to the system of linear equations **(8)**

$$\begin{aligned} -4x + 5z &= -2 \\ -3x - 3y + 5z &= 3 \\ -x + 2y + 2z &= -1 \end{aligned}$$

b) Consider the transformation $T(x, y) = (x + y, x + 2y, 2x + 3y)$. Obtain **ker T** and use this to calculate the nullity. Also find the transformation matrix for **T**. **(6)**

OR

12 a) Consider the following linear mapping **(8)**

$$\Phi : \mathbb{R}^3 \rightarrow \mathbb{R}^4$$

$$\Phi\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}\right) = \begin{bmatrix} 3x_1 + 2x_2 + x_3 \\ x_1 + x_2 + x_3 \\ x_1 - 3x_2 \\ 2x_1 + 3x_2 + x_3 \end{bmatrix}$$

i. Find the transformation matrix T.

ii. Determine rank(T).

iii. Compute the kernel and image of the mapping and find their dimension

b) Prove that all vectors orthogonal to $[2, -3, 1]^T$ forms a subspace W of R^3. What is $\dim(W)$ and why? **(6)**

13 a) Find an orthonormal basis of R^3 consisting of eigenvectors for the following matrix **(8)**

$$\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$$

b) Find a 3×3 orthogonal matrix S and a 3×3 diagonal matrix D such that $A = SDS^T$ **(6)**

OR

14 a) Find an orthogonal basis for the subspace of R^4 spanned by $\{ w_1 = (1, 1, 3, 2), w_2 = (1, -2, 0, -1), w_3 = (0, 2, 1, 2) \}$. **(8)**

b) Find the characteristic equation, eigenvalues, and eigenspaces corresponding t each eigenvalue of the following matrix **(6)**

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

15 a) Three players play 10 independent rounds of a game, and each player has probability 1/3 of winning each round. Find the joint distribution of the numbers of games won by each of the three players. **(7)**

b) An experiment consists of throwing a fair coin four times. Find the probability mass function and the cumulative distribution function of the following random variables: **(7)**

i. the number of heads before the first tail

ii. the number of heads following the first tail

iii. the number of heads minus the number of tails

iv. the number of tails times the number of heads.

OR

16 a)A factory runs three shifts. On a given day, 1% of the items produced by the firstshift are defective, 2% of the second shift's items are defective, and 5% of the third shift's items are defective. If the shifts all have the same productivity, what percentage of the items produced in a day are defective? If an item is defective, what is the probability that it was produced by the third shift? **(8)**

b)Show that if ***A*** and ***B*** are two independent events, then $P(A \cup B) = P(A) + P(B) - P(A)P(B)$ **(6)**

17 a)Find the joint density of $X + Y$ and X/Y, where X and Y are independent exponential random variables with parameter λ. Show that $X + Y$ and X/Y are independent. **(8)**

b)Let X be a discrete random variable that takes on values 0, 1, 2 with probabilities1/2 , 3/8 , 1/8 , respectively. **(6)**

i. Find **E(X)** and **Var(X)**.

ii. Let $Y = X^2$. Find the probability mass function of Y and use it to find **E(Y)**.

18 a)A random square has a side length that is a uniform [0, 1] random variable. Findthe expected area of the square. **(7)**

b)Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$. **(7)**

19 Using the fact that the mean of the chi-squared distribution is ***(n-1)***, prove that

$$E(S^2) = \sigma^2.$$ **(7)**

Random samples of size 36 are taken from an infinite population whose meanis 80 and standard deviation is 18. Find the mean and standard error of the sampling distribution.

i. Why is the Central Limit Theorem so important to statistical analysis?

OR

20 a) A six-sided die is rolled 100 times. Using the normal approximation, find the probability that the face showing a six turns up between 15 and 20 times. Find the probability that the sum of the face values of the 100 trials is less than 300. **(8)**

b) Determine an interval **(a, b)** such that ***P[a ≤ t ≤ b] = 0.80***, and that 10% of the area is on each side of ***a*** and ***b***, assuming that the sample is of size 21. **(6)**

Course content and Lecture Schedule

Teaching Plan		
No	**Topic**	**No. of Lectures (35)**
1	**Module-1 (LINEAR ALGEBRA) TB-1(Ch 2,3,4) (6 hours)**	
1.1	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations.	1 hour
1.2	Vector Spaces, sub space	1 hour
1.3	Linear Independence,	1 hour
1.4	Basis and Rank	1 hour
1.5.	Linear Mappings- Kernel, Range	1 hour
1.6.	Linear Mappings- Rank, Nullity	
2	**Module-2 (LINEAR ALGEBRA) (6 hours)**	
2.1.	Norms, Inner Products, Lengths and Distances, Angles and Orthogonality,	1 hour
2.2	Orthonormal Basis, Orthogonal Complement,	1 hour
2.3	Orthogonal Projections	1 hour
2.4.	Eigenvalues and Eigenvectors	1 hour
2.5.	Eigen decomposition	1 hour
2.6.	Eigen Diagonalization	1 hour
3.	**Module-3 (PROBABILITY AND DISTRIBUTIONS) TB-2(Ch 1,2) (9 hours)**	

3.1	Sample Spaces, Probability Measures, Computing Probabilities	1 hour
3.2	Conditional Probability,	1 hour
3.3	Baye’s Rule	1 hour
3.4	Independence of events	1 hour
3.5	Discrete Random Variables -Bernoulli Random Variables, Binomial Distribution	1 hour
3.6	Discrete Random Variables -Geometric Distribution	1 hour
3.7	Discrete Random Variables -Poisson Distribution	1 hour
3.8	Continuous Random Variables - Exponential Density, Gamma Density,	1 hour
3.9	Continuous Random Variables - Normal Distribution, Beta Density	1 hour
4.	**Module-4 (RANDOM VARIABLES) TB-2 (Ch 3, 4, 5, 6) (9 hours)**	
4.1	Functions of a Random Variable	1 hour
4.2	Joint Distributions - Independent Random Variables	1 hour
4.3	Conditional Distributions	1 hour
4.4	Functions of Jointly Distributed Random Variables	1 hour
4.5	Expected Value of a Random Variable,	1 hour
4.6	Expectations of Functions of Random Variables,	1 hour
4.7	Expectations of Linear Combinations of Random Variables	1 hour
4.6	Variance and Standard Deviation	1 hour
4.9	Covariance and Correlation	1 hour

5	**Module-5 (LIMIT THEOREMS) (6 hours)**	
5.1	Conditional Expectation,	1 hour
5.2	Moment-Generating Function	1 hour
5.3	Limit Theorem (Proof not expected) - Law of Large Numbers,	1 hour
5.4	Convergence in Distribution and the Central Limit Theorem.	1 hour
5.5	Distributions derived from the Normal Distribution - Chi-square and, and F Distributions,	1 hour
5.6	Distributions derived from the Normal Distribution - Sample Mean and the Sample Variance.	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT312	**INTRODUCTION TO SIGNAL PROCESSING**	**PEC**	**2**	**1**	**0**	**3**

Preamble

This course focuses on the analysis of deterministic signals and LTI systems, the concept of which are very extensively applied in the field of communication and control systems.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Describe various types of signals and systems.
CO 2	Analyse continuous-time systems using Laplace Transforms.
CO 3	Analyse continuous-time systems using Fourier series and transforms.
CO 4	Explain sampling process for analog to digital conversion
CO 5	Analyse discrete-time LTI systems using Z-transforms.
CO 6	Analyse discrete-time LTI systems using Fourier series and transforms.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	-	-	-	-	-	-	-	-	2
CO 2	3	2	-	-	-	-	-	-	-	-	-	2
CO 3	3	2	-	-	-	-	-	-	-	-	-	2
CO 4	3	2	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	-	-	2
CO 6	3	2	-	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	0	0	0
Understand	20	20	30
Apply	30	30	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Check whether the signals are periodic, even and energy signals (PO1, PO2, PO12)
2. Check whether the system is stable, linear, dynamic, causal and time invariant. (PO1, PO2, PO12)

Course Outcome 2 (CO2)

1. Determine the step/impulse response of the system described by the differential equation. (PO1, PO2, PO12)
2. Determine the transfer function and the impulse response of the given LTI system. (PO1, PO2, PO12)
3. Determine the impulse response and hence verify whether its is causal and stable. (PO1, PO2, PO12)
4. Find the response if the input and the impulse response is given using convolution integral and convolution theorem (PO1, PO2, PO12)

Course Outcome 3(CO3)

1. Determine the Fourier series of the periodic signals. (PO1, PO2, PO12)
2. Find the Fourier series and verify Parseval's theorem for power signals. (PO1, PO2, PO12)
3. State and prove any three properties of Fourier transform (PO1, PO2, PO12)
4. Determine the Fourier series of the aperiodic signals. (PO1, PO2, PO12)
5. Find the frequency response of the LTI system. (PO1, PO2, PO12)

Course Outcome 4 (CO4)

1. State and prove sampling theorem. (PO1, PO2, PO12)
2. Explain aliasing in analog to digital conversion. (PO1, PO2, PO12)

Course Outcome 5 (CO5)

1. State and prove sampling theorem. (PO1, PO2, PO12)
2. Find the linear convolution if the impulse response and input is given (PO1, PO2, PO12)
3. Find the impulse response if the difference equation of a LTI system is given. (PO1, PO2, PO12)
4. Find the Z-transform / inverse Z-transform. (PO1, PO2, PO12)
5. Check whether the discrete-time LTI system is stable or not if impulse response is given (PO1, PO2, PO12)

Course Outcome 6 (CO6)

1. Determine the discrete-time Fourier series of periodic signals. (PO1, PO2, PO12)
2. State and prove any three properties of DTFS (PO1, PO2, PO12)
3. Determine the discrete-time Fourier transform of aperiodic signals (PO1, PO2, PO12)
4. State and prove any three properties of DTFT (PO1, PO2, PO12)
5. State and prove Parseval's theorem for discrete-time energy signals (PO1, PO2, PO12)

Model Question Paper

PAGES: 3

QPCODE:

Reg. No:_____

Name:______

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EOT312**

Course Name: **INTRODUCTION TO SIGNAL PROCESSING**

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions.
Each question carries 3 Marks

1. Check whether the signal $x(n)=\{1,2,-1,-2\}$ is energy signal/power signal. Also find the energy/power.
2. Determine whether the system $y(t)=x(t)\times\cos\omega_o t$ is linear and time invariant.
3. Define transfer function and impulse response. What is the relation between transfer function and impulse response?
4. For the continuous-time LTI system $\frac{d^2y(t)}{dt^2}+3\frac{dy(t)}{dt}+2y(t)=x(t)$, find the transfer function.
5. State Parseval's theorem for power signals in terms of exponential Fourier series coefficients and trigonometric Fourier series coefficients.
6. Find the continuous-time Fourier transform of $e^{j\omega_o t}$.
7. A continuous-time signal is given as $x(t)=10\cos 200\pi t$. Determine Nyquist rate required to avoid aliasing.
8. List any three properties of Z-transform.
9. Determine the discrete-time Fourier series for the sequence $x(n)=\cos\frac{\pi}{2}n$.
10. State and prove time-shfting property of discrete-time Fourier transform.

PART B
Answer any one full question from each module.
Each question carries 14 Marks
Module 1

11 a) Check whether the signal $x(n)=\cos(\frac{\pi}{2}n)+\sin(\frac{\pi}{8}n)+\cos(\frac{\pi}{4}n)$ is periodic or not. If periodic find the period. (7

	b)	Determine the stability of i) $y(t)=x^2(t)$ and ii) $y(t)=tx(t)$.	(7

OR

12	a)	Explain continuous-time even and odd signals with the help of examples.	(7
	b)	Check the linearity of the following systems: i) $y(n)=anx(n)+b$ and ii) $y(n)=e^{x(n)}$	(7

Module 2

13	a)	For the following continuous-time LTI system, find the transfer function and hence find the impulse response. $\frac{dy(t)}{dt}+2y(t)=x(t)$. Also find the response y(t) if the input is $x(t)=e^{-t}u(t)$.	(7
	b)	For the continuous-time LTI system $\frac{d^2y(t)}{dt^2}+\frac{dy(t)}{dt}-6y(t)=x(t)$, find the transfer function and hence check whether the system is stable or not.	(7

OR

14	a)	Compute the convolution integral of input $x(t)=e^{-t}u(t)$ to impulse response $h(t)=u(t)$ of continuous time LTI system. Verify the result using convolution theorem.	(7
	b)	Given transfer function of a continuous-time LTI system, $H(s)=\frac{3s}{(s+2)(s^2+2s+2)}$. Find impulse response.	(7

Module 3

15	a)	Find the trigonometric Fourier series coefficients a_0, a_1, b_1, a_2, b_2 of the waveform shown in figure (1).	(7

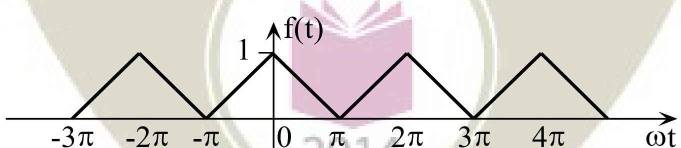


Figure (1)

	b)	For the continuous-time aperiodic signal $x(t)$ in figure (2), determine the Fourier transform. Also plot the magnitude spectrum.	(7

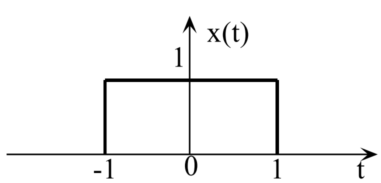


Figure (2)

OR

16 a) Find the exponential Fourier series for the waveform shown in figure (3). (7

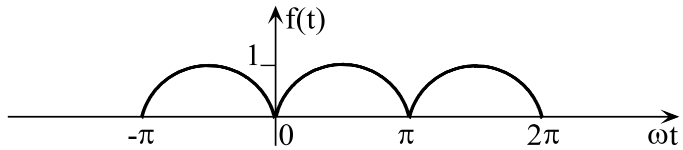


Figure (3)

b) State and prove Parseval's theorem for continuous-time energy signals. (7

Module 4

17 a) State and prove sampling theorem. What is aliasing effect? How aliasing can be avoided? (9

b) State and prove initial value theorem. Also, find the initial value x(0) if (5

$$X(z)=\frac{z^2}{(z-1)(z-0.2)}.$$

OR

18 a) Find the inverse Z-transform of $X(z)=\dfrac{z^3+z^2}{(z-1)(z-3)}$ if ROC: $|z|>3$. (7

b) Find the linear convolution $y[n]=x[n]*h[n]$ if $x[n]=\{1,\underset{\uparrow}{1},1\}$ and $h[n]=2\delta(n+1)+\delta(n)+2\delta(n-1)$. (7

Module 5

19 a) Find the discrete Fourier series of the periodic sequence $x_p[n]=\{1,1,0,0\}$ with period 4. (7

b) State and prove convolution property using discrete-time Fourier transform. (7

OR

20 a) State and prove any three properties of discrete-time Fourier series. (7

b) Find the frequency response and impulse response of a causal discrete-time LTI system which is characterized by the difference equation given as (7

$$y(n)-\frac{3}{4}y(n-1)+\frac{1}{8}y(n-2)=2x(n).$$

Syllabus

Module 1 – INTRODUCTION TO SIGNALS & SYSTEMS

Introduction to signals– classification of signals – continuous-time/discrete-time, even/odd, periodic/non-periodic, deterministic/random, energy/power signals - elementary signals –exponential, sinusoidal, step, impulse and ramp.
Introduction to systems – properties of systems – stability, memory, causality, time invariance, linearity.

Module 2 – LAPLACE TRANSFORM ANALYSIS

Representation of LTI systems – differential equation representation - Laplace transform – solution of differential equations using Laplace transform – transfer function – impulse response - causality and stability in terms of impulse response – convolution integral and convolution theorem.

Module 3 – FOURIER ANALYSIS OF CONTINUOUS-TIME SYSTEMS

Fourier representation of continuous time signals – continuous-time periodic signals - Fourier series – trigonometric and exponential Fourier series - Parseval's theorem for power signals – power spectral density.
Fourier transform – existence – properties of Fourier transform – linearity, symmetry, differentiation-in-time, differentiation in frequency, time-shift, frequency-shift, convolution property - Parseval's theorem - Energy spectral density – frequency response of LTI systems.

Module 4 – SAMPLING & Z-TRANSFORM ANALYSIS

Sampling process – sampling theorem – aliasing - difference equation representation of LTI systems – linear convolution - Z transform (two-sided only) – region of convergence – properties of Z-transform – linearity, time-reversal, time-shifting, scaling, convolution, differentiation, initial value theorem – inverse Z-transform methods - partial fraction and long series expansion – solution of difference equation of LTI systems with zero initial conditions – Z transfer function – impulse response - causality and stability in terms of impulse response.

Module 5 – FOURIER ANALYSIS OF DISCRETE-TIME SYSTEMS

Fourier representation of discrete-time signals – discrete-time Fourier series – properties – linearity, time-shifting, time-reversal, conjugation, Parseval's theorem
Fourier transform analysis of discrete-time signals – discrete-time Fourier transform – properties – linearity, time-shifting, frequency-shifting, time reversal, time scaling, convolution, conjugation, Parseval's theorem – frequency response

Text Books

1. Simon Haykin & Barry Van Veen, "Signals & Systems", Wiley-India, 2nd edition, 2008
2. S. Palani, "Signals & Systems", Ane Books Pvt Ltd, 1st edition, 2009

Reference Books

1. Alan V Oppenheim & Alan S Willsky, "Signals & Systems", Prentice-Hall of India, 2nd edition, 2003
2. P. Ramesh Babu, "Signals & Systems", Scitech Publications (India) Pvt Ltd, 2nd edition, 2003
3. D. Ganesh Rao & Satish Tunga, "Signals & Systems", Sanguine Technical Publishers, 4th edition, 2008

Course Contents and Lecture Schedule

Sl. No	Topic	No. of Lectures
1	**INTRODUCTION TO SIGNALS & SYSTEMS (8 hours)**	
1.1	Introduction to signals – classification of signals - continuous-time/discrete-time, even/odd, periodic/non-periodic, deterministic/random, energy/power signals –problems	3 hours
1.2	Elementary signals –exponential, sinusoidal, step, impulse and ramp (continuous- time and discrete-time)	1 hour
1.3	Introduction to systems – classification of systems – stable/unstable, dynamic/static, causal/non-causal, linear/non-linear, time-invariant/time variant - problems	4 hours
2	**LAPLACE TRANSFORM ANALYSIS (6 hours)**	
2.1	Representation of LTI systems – differential equation representation - Laplace transform – solution of differential equations using Laplace transform	3 hours
2.2	Transfer function – impulse response - causality and stability in terms of impulse response	2 hours
2.3	Convolution integral and convolution theorem.	1 hour
3	**FOURIER ANALYSIS OF CONTINUOUS-TIME SYSTEMS (8 hours)**	
3.1	Fourier representation of continuous time signals – continuous-time periodic signals - Fourier series – trigonometric and exponential Fourier series – problems	3 hours
3.2	Parseval’s theorem for power signals – proof - power spectral density - problems	1 hour
3.3	Fourier transform – existence – problems	2 hours
3.4	Properties of Fourier transform – linearity, symmetry, differentiation-in-time, differentiation in frequency, time-shift, frequency-shift, convolution property - Parseval’s theorem - Energy spectral density – frequency response of LTI systems.	2 hours
4	**SAMPLING & Z-TRANSFORM ANALYSIS (7 hours)**	
4.1	Sampling process – sampling theorem – derivation - aliasing	2 hours
4.2	Difference equation representation of LTI systems – linear convolution	1 hour
4.3	Z transform – region of convergence – properties of Z-transform – – linearity, time-reversal, time-shifting, scaling, convolution, differentiation, initial value theorem – inverse Z-transform methods - partial fraction and long series expansion	3 hours
4.4	Solution of difference equation of LTI systems – Z transfer function – impulse response - causality and stability in terms of impulse response.	1 hour
5	**FOURIER ANALYSIS OF DISCRETE-TIME SYSTEMS (7 hours)**	
5.1	Fourier representation of discrete-time signals – discrete-time Fourier series – properties – linearity, time-shifting, time-reversal, conjugation, Parseval’s theorem	3 hours
5.2	Fourier transform analysis of discrete-time signals – discrete-time Fourier transform – properties – linearity, time-shifting, frequency-shifting, time reversal, time scaling, convolution, conjugation, Parseval’s theorem – frequency response	4 hours

CST 332	FOUNDATIONS OF SECURITY IN COMPUTING	Category	L	T	P	Credit	Year Of Introduction
		PEC	2	1	0	3	2019

Preamble

The purpose of this course is to create awareness among learners about the fundamentals of security and number theory. This course covers Integer & Modular Arithmetic, Primes & Congruences, Discrete Logarithms & Elliptic Curve Arithmetic and an overview of computer security. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and to identify the security threats in computing.

Prerequisite

A sound knowledge in Mathematics, Discrete Computational Structures,Operating Systems and Database Systems.

Course Outcomes

After the completion of the course, the student will be able to

CO1	Illustrate the operations and properties of algebraic structures, integerarithmetic and modular arithmetic. **(Cognitive Knowledge Level: Understand)**
CO2	Use the concepts of prime numbers and factorization for ensuring security in computing systems **(Cognitive Knowledge Level: Apply)**
CO3	Illustrate the concepts of Linear Congruence, Primitive Roots, Discrete Logarithms and Elliptic Curve Arithmetic **(Cognitive Knowledge Level: Apply)**
CO4	Summarize the threats and attacks related to computer and program security **(Cognitive Knowledge Level: Understand)**
CO5	Outline the key aspects of operating system and database security **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔									✔
CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔								✔
CO4	✔	✔	✔			✔		✔				✔
CO5	✔	✔	✔			✔		✔				✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (%)	Test 2 (%)	End Semester Examination (%)
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyse			

Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Modular Arithmetic)

Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular

arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2^n).

Module-2 (Prime Numbers and Factorization)

Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Primality testing – Deterministic algorithms and Probabilistic algorithms. Factorization - Fermat's factorization, Pollard p-1 method.

Module-3 (Linear Congruence, Primitive Roots and Elliptic Curve Arithmetic)

Linear congruence - Simultaneous linear congruence, Chinese Remainder Theorem (CRT). Congruence with a prime - Power modulus, Arithmetic modulo p, Pseudoprimes and Carmichael numbers, Solving congruence modulo prime powers. Primitive roots - Existence of primitive roots for primes, Discrete logarithms. Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant.

Module-4 (Computer and Program Security)

Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, Email attack types. Introduction to program security - Non-malicious programming oversights, Malware.

Module-5 (Operating System and Database Security)

Operating system security – Security in operating system, Security in design of operating system. Database security – Security requirements of databases, Reliability and integrity, Database disclosure.

Text Books

1. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.
2. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.
3. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007

References

1. William Stallings, Cryptography and Network Security Principles and Practices, 4/e, Pearson Ed.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the n- bit word that is represented by the polynomial x^2 +1 in GF(2^5).
2. Solve the linear Diophantine equation 21x + 14y=35.

Course Outcome 2 (CO2):

1. Prove that a Carmichael number cannot be the product of two distinct primes.
2. Use the Pollard p-1 method to find a factor of 57247159 with the bound B=8.

Course Outcome 3 (CO3):

1. Find an integer that has a remainder of 3 when divided by 7 and 13, but is divisibleby 12.
2. In the elliptic curve E(1,2) over the field GF(11), find the equation of the curve andall the points on the curve.

Course Outcome 4 (CO4):

1. List three controls that could be applied to detect or prevent off-by-one errors.
2. How does fake email messages act as spam?

Course Outcome 5 (CO5):

1. Discuss the importance of auditability and access control in database security.
2. Explain the various factors which can make data sensitive.

Model Question Paper

QP CODE: **PAGES: ___**

Reg No:_______________
Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 332
Course Name: FOUNDATIONS OF SECURITY IN COMPUTING

Max Marks: 100 **Duration: 3 Hours**

PART A

(Answer All Questions. Each question carries 3 marks)

1. List the four properties of divisibility with examples.
2. Find gcd (401,700) using Euclid's algorithm.
3. Use Fermat's Little theorem to show that 91 is not a prime.
4. If m is relatively prime ton, show that $\Phi(mn) = \Phi(m)\ \Phi(n)$.
5. Solve the congruence relation 103x ≡ 57 (mod 211).
6. Find a solution for the congruence $3x \equiv 5 \bmod 7^3$
7. What are the problems created by an off-by-one error?
8. How does a clickjacking attack succeed?
9. Explain the significance of correctness and completeness in the design of operating systems.
10. How does the two-phase update technique help the database manager in handling failures?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14Marks)

11. (a) For the group G = < Z_6*, x>, prove that it is an Abelian group. Also show the result of 5 x 1 and 1 ÷ 5. **(6)**

(b) Find a particular and the general solution to the following linear Diophantine equations. **(8)**
i) 19 x+13y = 20 ii) 40 x + 16 y =88

OR

12. (a) Describe the properties of modular arithmetic and modulo operator. **(6)**

(b) Using Extended Euclidean algorithm, find the multiplicative inverse of (i) 131 in Z_{180} and (ii) 23 in Z_{100}. **(8)**

13. (a) State and prove Fermat's theorem. **(6)**

(b) Explain Fermat's factorization method and use it to factor 809009. **(8)**

OR

14. (a) Define Euler's totient function. Prove that, Ø(pq)=(p-1)(q-1) where p and q are prime numbers. **(7)**

(b) Define Fermat primes. Show that any two distinct Fermat numbers are relatively prime. **(7)**

15. (a) Using Chinese Remainder Theorem, solve the system of congruence, x ≡2(mod 3), x ≡3(mod 5), x ≡2(mod 7). **(7)**

(b) Define Carmichael number and show that a Carmichael number must be the product of at least three distinct primes. **(7)**

OR

16. (a) For the group G = <Z_{19*}, x>, find the primitive roots in the group. **(6)**

(b) Consider the elliptic curve $y^2 = x^3 + x + 1$ defined over Z_{23}. If P = (3, 10) and Q = (9,7) are two points on the elliptic curve, find 2P and P + Q. **(8)**

17. (a) Distinguish the terms vulnerability, threat and control. **(4)**

(b) With the help of suitable examples, explain the security problems created by incomplete mediation and time-of-check to time-of use. **(10)**

OR

18. (a) Differentiate between man-in-the-browser attack and page-in-the-middle attack. **(4)**

(b) Explain the four aspects of malicious code infection. **(10)**

19. (a) List any six computer security related functions addressed by operating systems. **(6)**

(b) How does a kernelized design support in enforcing security mechanisms? **(8)**

OR

20. (a) Explain any four security requirements of databases. **(4)**

(b) How can database disclosure be prevented? With the help of suitable examples, explain any six types of disclosure. **(10)**

Teaching Plan

No	Contents	No.of Lecture Hrs
Module-1 (Modular Arithmetic) (6 hrs)		
1.1	Integer arithmetic, Integer division, Divisibility, Greatest Common Divisor (GCD)	1
1.2	Euclid's algorithm for GCD, Extended Euclid's algorithm	1
1.3	Linear Diophantine Equations	1
1.4	Modular arithmetic operations, Properties of modular arithmetic	1
1.5	Groups, Rings and Fields	1
1.6	Finite fields – GF(p), GF(2^n)	1
Module-2 (Prime Numbers and Factorization) (7 hrs)		
2.1	Prime numbers and prime-power factorization	1
2.2	Fermat and Mersenne primes	1
2.3	Fermat's theorem, Applications – Exponentiation, Multiplicative inverse	1
2.4	Euler's theorem, Euler's totient function, Applications	1
2.5	Primality testing – Deterministic algorithms – Divisibility algorithm	1
2.6	Primality testing – Probabilistic algorithms-Fermat test, Square root test, Miller - Rabin test	1
2.7	Factorization - Fermat's factorization, Pollard p-1 method	1
Module-3 (Linear Congruence, Primitive Roots and Elliptic Curve Arithmetic) (7 hrs)		
3.1	Linear congruence, Simultaneous linear congruence	1
3.2	Chinese Remainder Theorem (CRT)	1
3.3	Congruence with a Prime-Power Modulus, Arithmetic modulo p	1
3.4	Pseudo-primes and Carmichael numbers	1
3.5	Solving congruence modulo prime powers	1

3.6	Primitive roots, Existence of primitive roots for primes, Discrete logarithms	1
3.7	Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant	1
Module-4 (Computer and Program Security) (7 hrs) (Text book2: Chapters 1, 3, 4)		
4.1	Threats, Vulnerabilities, Controls	1
4.2	Browser attack types	1
4.3	Web attacks targeting users	1
4.4	Email attack types	1
4.5	Non-malicious programming oversights (Lecture 1)	1
4.6	Non-malicious programming oversights (Lecture 2)	1
4.7	Malware – Four aspects of infection	1
Module-5 (Operating System and Database Security) (8 hrs)(Text book2: Chapters 5, 7)		
5.1	Security in operating system (Lecture 1)	1
5.2	Security in operating system (Lecture 2)	1
5.3	Security in design of operating system (Lecture 1)	1
5.4	Security in design of operating system (Lecture 2)	1
5.5	Security requirements of databases	1
5.6	Reliability & integrity	1
5.7	Database disclosure (Lecture 1)	1
5.8	Database disclosure (Lecture 2)	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET312	BIOMEDICAL INSTRUMENTATION	PEC	2	1	0	3

Preamble

Nil

Prerequisite

Measurements and Instrumentation

Course Outcomes

After the completion of the course, the student will be able to:

CO 1	Explain the basics of anatomy and physiology of human body.
CO 2	Explain different techniques for the measurement of various physiological parameters.
CO 3	Describe modern imaging techniques for medical diagnosis
CO 4	Identify the various therapeutic equipments used in biomedical field
CO 5	Discuss the patient safety measures and recent advancements in medical field.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	-	-	-	-	2	-	-	-	-	-	-
CO 2	2	-	2	-	-	2	-	-	-	-	-	-
CO 3	2	-	2	-	-	2	-	-	-	-	2	-
CO 4	2	2	-	-	-	2	-	-	-	-	2	-
CO 5	2	2	2	-	-	2	-	-	-	-	-	1

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	15	15	30
Understand	20	20	40
Apply	15	15	30
Analyse			
Evaluate			
Create			

End Semester Examination Pattern

There will be two parts; Part A and Part B. **Part A** contain 10 questions (each carrying 3 marks) with 2 questions from each module. Students should answer all questions.

Part B contains 2 questions from each module, out of which students should answer any one. Each question can have maximum 2 sub- divisions and carries 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the anatomy of heart and cardiac system.
2. Describe the physiology of respiratory system.
3. Discuss the generation and propagation of action potential with neat sketches.
4. Explain electrode theory and Nernst equation.
5. Draw and explain the equivalent circuit of skin electrode interface.
6. Discuss about surface electrodes.
7. What are the applications of needle electrodes?
8. What are microelectrodes?
9. What are the different bioelectrical potentials generated in human body?

Course Outcome 2 (CO2):

1. What are the problems encountered in measuring living systems?
2. Explain the direct method of blood pressure measurement.
3. Explain the indirect method of blood pressure measurement.
4. Explain the Oscillometric method of blood pressure measurement.
5. Explain the Ultrasonic method of blood pressure measurement.
6. Explain the method of blood flow measurement using electromagnetic blood flowmeter.
7. Explain the method of blood flow measurement using Ultrasonic blood flowmeter.
8. Explain the measurement of Cardiac output.
9. What is phonocardiography?
10. Explain the measurement of respiratory parameters using spirometer.

Course Outcome 3(CO3):

1. Explain ECG with a neat block diagram.
2. What is Einthoven triangle?
3. With neat sketches explain the different electrode placement schemes of ECG.
4. Explain the 10-20 system of EEG electrodes placement.
5. Draw and explain the block diagram of EEG machine.
6. Draw and explain the block diagram of EMG recorder.
7. What are the applications of EEG waveforms?
8. Draw the different EEG waveforms and state its frequency.

Course Outcome 4 (CO4):

1. Explain the generation of X-rays and also mention its applications in biomedical engineering.
2. What are the types of CAT scanning?
3. Explain the principle of MRI scanning.

4. Explain the principle of PET scanning.
5. Explain demand pacemaker with a neat block diagram.
6. Why a dual peak DC defibrillator preferred over DC defibrillator?
7. Explain artificial kidney with neat sketches.
8. Explain shortwave diathermy.
9. Explain microwave diathermy.

Course Outcome 5 (CO5):

1. Discuss the need for ventilators.
2. Draw and explain the block diagram of infant incubator.
3. Explain lithotripsy.
4. What is a heart lung machine**?**
5. What are the different methods of accident prevention in hospitals?
6. Differentiate between macro shock and micro shock.
7. Explain the physiological effects of electric current.
8. Draw the block diagram of a telemetry system.
9. What are the chemical blood tests carried out in a clinical laboratory?
10. Enumerate the application of robotics in medical field.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET312

Course Name: Biomedical Instrumentation

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)
Answer all Questions. Each question carries 3 Marks

1. What are Microelectrodes?
2. What are the different bioelectrical potentials generated in human body?
3. Explain the measurement of Cardiac output.
4. What is Phonocardiography?
5. What are the applications of EEG waveforms?
6. Explain the 10-20 system of EEG electrodes placement.
7. What are the types of CAT scanning?
8. Explain the principle of MRI scanning.
9. What are the different methods of accident prevention in hospitals?
10. Discuss the need for ventilators.

PART B (14 x 5 = 70 Marks)
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. Discuss the generation and propagation of action potential with neat sketches. **(8)**

b) Draw and explain the equivalent circuit of skin electrode interface. **(6)**

12. a) Briefly explain different Bio potential electrodes. **(10)**

b) Discuss about surface electrodes. **(4)**

Module 2

13. a) Explain the Ultrasonic method of blood pressure measurement. **(7)**

b) Explain the method of blood flow measurement using electromagnetic blood flow meter **(7)**

14. a) Explain the direct method of blood pressure measurement. **(7)**

b) Explain the measurement of respiratory parameters using Spirometer **(7)**

Module 3

15. a) Draw and explain the block diagram of EEG machine. **(8)**

b) Explain the significance of Einthoven triangle. **(6)**

16. a)Draw the different EEG waveforms and state its frequency **(7)**

b) Explain ECG with a neat block diagram **(7)**

Module 4

17. a)Explain the generation of X-rays and also mention its applications in biomedical engineering. **(14)**

18. a)Explain the principle of CAT scanning **(7)**

b) Explain the principle of MRI scanning **(7)**

Module 5

19. a) Draw the block diagram of infant incubator and explain **(10)**

b) Write a note on medical robotics **(4)**

20. a) What are the chemical blood tests carried out in a clinical laboratory **(10)**

b) Explain artificial kidney with neat sketches **(4)**

Syllabus

Module 1

Human Physiological systems:Brief discussion of Heart andCardio-vascular system-Physiology of Respiratory system - Anatomy of Nervous and Muscular systems-Problems encountered in measuring living systems

Bioelectric potential: Resting and action potential - Generation and propagation - Bioelectric potentials associated with physiology systems (ECG, EEG and EMG).

Bio potential Electrodes: Theory – Surface electrode – Microelectrode-Needle electrodes.

Transducers for biomedical applications: Transducers for the measurement of pressure, temperature and respiration rate.

Module 2

Measurement of blood pressure:Direct and indirect measurement – Oscillometric method – Ultrasonic method-Measurement of blood flow and cardiac output- Plethysmography –Photo electric and Impedance Plethysmographs-Measurement of heart sounds –Phonocardiography.

Cardiac measurements: Electro-conduction system of the heart- Electro-cardiography – Electrodes and leads – Einthoven triangle- ECG read out devices-ECG machine – block diagram

Module 3

Measurements from the nervous system:Neuronal communication-EEG waveforms and features - 10-20 electrode measurement- EEG Block diagram – Brain-Computer interfacing.

Muscle response: Electromyography- Block diagram of EMG recorders – Nerve conduction velocity measurement

Measurements of respiratory parameters: Spiro meter-Pneumograph

Module 4

Modern Imaging Systems: Basic X-ray machines - CAT scanner- Principle of operation - scanning components - Ultrasonic Imaging principle - types of Ultrasound Imaging - MRI and PET scanning(Principle only).

Therapeutic equipment: Cardiac Pacemakers - De-fibrillators - Hemodialysis machines - Artificial kidney – Lithotripsy - Short wave and Micro wave Diathermy machines

Module 5

Ventilators - Heart Lung machine - Infant Incubators

Instruments for clinical laboratory: Test on blood cells – Chemical tests

Electrical safety: Physiological effects of electric current – Shock hazards from electrical equipment – Method of accident prevention.

Introduction to Tele- medicine - Introduction to medical robotics

Text Books

L. Cromwell, F. J. Weibell and L. A. Pfeiffer, "Biomedical Instrumentation Measurements", Pearson education, Delhi, 1990.

J. G. Webster, "Medical Instrumentation, Application and Design", John Wiley and Sons

Reference Books

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill
2. J. J. Carr and J. M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education
3. AchimSchweikard, "Medical Robotics", Springer

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Human Physiology Systems and Transducers (8 hours)**	
1.1	Problems encountered in measuring living systems - Cardio-vascular – Respiratory- nervous and muscular systems of the body.	2
1.2	Electrode theory-Bioelectric potential - Resting and action potential - Generation and propagation.	1
1.3	Bioelectric potentials associated with physiology systems (ECG, EEG and EMG).	1
1.4	Electrodes Theory - Surface electrode - Needle electrode - Microelectrode	2
1.5	Transducers for the measurement of Pressure, temperature and respiration rate.	2
2	**Cardio Vascular System Measurements (8 hours)**	
2.1	Measurement of blood pressure – direct and indirect measurement – Oscillometric measurement –Ultrasonic method	2
2.2	Measurement of blood flow and cardiac output -Plethysmography – Photo electric and Impedance Plethysmographs	3
2.3	Measurement of heart sounds –Phonocardiography.	1
2.4	Electro-conduction system of the heart - Electro Cardiography – Electrodes and leads – Einthoven triangle.	1
2.5	ECG read out devices - ECG machine – Block diagram	1
3	**Nervous System and its Measurements (7 hours)**	
3.1	Neuronal communication - Measurements from the nervous system.	1
3.2	Electroencephalography- Lead system -10-20 Electrode system,	1
3.3	EEG Block diagram - EEG waveforms and features – Brain-Computer interfacing.	2
3.4	Electromyography- Block diagram of EMG recorders - Nerve conduction velocity	2
3.5	Respiratory parameters measurements – Spiro meter - Pneumography.	1
4	**Modern Imaging Systems and Therapeutic Equipment (7 hours)**	
4.1	Basic X-ray machines	1

4.2	CAT Scanner- Principle of operation - Scanning components	1
4.3	Ultrasonic imaging principle - Types of Ultrasound imaging - MRI and PET scanning(Principle only).	2
4.4	Cardiac pace makers - De-fibrillators	1
4.5	Hemo-dialysis machines -Artificial kidney -Lithotripsy	1
4.6	Short wave and Micro wave diathermy machines	1
5	**Instrumentation for Patient Support and Safety (6 hours)**	
5.1	Ventilators - Heart lung machine - Infant incubators	1
5.2	Instruments for clinical laboratory – Test on blood cells – Chemical tests	1
5.3	Electrical safety– Physiological effects of electric current	1
5.4	Shock hazards from electrical equipment - Method of accident prevention	1
5.5	Introduction to tele- medicine	1
5.6	Introduction to medical robotics	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET322	RENEWABLE ENERGY SYSTEMS	PEC	2	1	0	3

Preamble

This course introduces about different new and renewable sources ofenergy. Design of some of the systems are also discussed

Prerequisite

Power Systems I

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Describe the environmental aspects of renewable energy resources.
CO 2	Explain the operation of various renewable energy systems.
CO 3	Design solar PV systems.
CO 4	Explain different emerging energy conversion technologies and storage.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the environmental impacts of wind energy systems. (K1)
2. Explain the limitations of renewable energy systems (K2)

Course Outcome 2 (CO2):

1. With the help of a block diagram, explain the working of a wind energy conversion system. (K2)
2. Explain the working of a small hydro power plant with the help of a diagram. (K2)

Course Outcome 3 (CO3):

1. Design a grid connected solar photovoltaic system. (K3).
2. Design a solar photovoltaic system for a water pumping system. (K3).

Course Outcome 4 (CO4):

1. Explain how energy can be generated from alcohol. (K2)
2. Explain the need for energy storage systems. Discuss how energy can be stored inbatteries. (K2).

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: EET322

Course Name: RENEWABLE ENERGY SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. What do you mean by global warming? Explain its adverse effects.
2. Write notes on Indian energy scenario.
3. Determine the local apparent time corresponding to 11.30 IST on July 1, at Delhi (28035' N,770 12'E). The equation of time correction on July 1 is -4 minutes.
4. Draw and explain the V- I characteristics of a solar cell.
5. Define tip speed ratio, cut in speed and cut out speed of a wind turbine.
6. Explain the factors to be considered for the selection of small hydro plants.
7. Discuss the advantages and disadvantages of tidal power plants.
8. Explain the principle of operation of an OTEC plant. What are its advantages?
9. Explain how power can be derived from satellite stations.
10. Explain how energy can be stored using flywheels.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a. Illustrate the relation between energy and sustainable development. **(4)**
    b. Compare the advantages and disadvantages of different conventional sources of energy. **(10)**
12. a. Write notes on Kyoto protocol. **(4)**
    b. List out the advantages and disadvantages of different non-conventional sourcesof energy. **(10)**

Module 2

13. a. With the help of a diagram, explain the working of a pyrheliometer. **(7)**
    b. Explain how a standalone solar PV system can be designed. **(7)**
14. a. With the help of a diagram, explain the working of a flat plate collector. **(7)**
    b. Explain how Maximum Power Point Tracking can be done using a buckboost converter. **(7)**

Module 3

15. a. Derive an expression for power derived from wind. Explain the characteristic of awind turbine. **(7)**

b. A propeller wind machine has rotor diameter of 40 m. It is operating at location having wind speed of 35kmph and rotating at 20 rpm. Calculate theoretically the power which the machine can extract from the wind considering both wake rotation and effect of drag. Assume ξ=.012. **(7)**

16. a. With the help of a diagram, explain a wind energy conversion system with variablespeed drive scheme. **(8)**

b. Explain the different types of turbines used in small hydro plants. **(6)**

Module 4

17. With the help of a diagram, explain the working of different types of tidal powerplants. **(14)**

18. a. With the help of a diagram, explain the working of an OTEC system using hybridcycle. **(10)**

b. Write notes on the factors to be considered for site selection of OTEC plants. **(4)**

Module 5

19. a. With the help of a diagram, explain biomass gasification based electric power generation. **(8)**

b. Explain the working of a fuel cell with the help of a diagram **(6)**

20. a. With the help of a diagram, explain the working of KVIC model biogas plant. **(10)**

b. Write notes on pumped storage plants **(4)**

Syllabus

Module 1

Introduction, Environmental Aspects Of Energy-Ecology-Greenhouse Effect-GlobalWarming-Pollution-Various Pollutants and their Harmful Effects-Green Power-The United Nations Framework Convention On Climate Change (UNFCC)- Environment-Economy- Energy and Sustainable development-Kyoto Protocol -Classification of Energy Resources; Conventional Energy Resources -Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.

Module 2

SOLAR THERMAL SYSTEMS: Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data (Numerical Problems)–Pyranometer and Pyrheliometer -Solar Thermal Collectors –General description and characteristics –Flat plate collectors – Heat transfer processes –Solar concentrators (Parabolic trough, Parabolic dish, Central Tower Collector)

SOLAR ELECTRIC SYSTEMS: Introduction- Solar Photovoltaic –Solar Cell fundamentals, characteristics, classification, construction of Module, Panel and Array-Effect of shadowing-.Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems – stand-alone and grid connected-Design steps for a Stand-Alone system; Applications –Street lighting, Domestic lighting and Solar Water pumping systems.

Module 3

Wind Energy–Introduction–Wind Turbine Types (HAWT and VAWT) and their construction-Wind power curve-Betz's Law-Power from a wind turbine(NumericalProblems)-Wind energy conversion system(WECS) – Fixed–speed drive scheme-Variable speed drive scheme.-Effect of wind speed and grid condition(system integration).

Small hydro power: Classification as micro, mini and small hydro projects -Basic concepts and types of turbines - Classification, Characteristics and Selection

Module 4

ENERGY FROM OCEAN: Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Advantages and Limitations of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation –Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.

Module 5

BIOMASS ENERGY: Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, factors affecting biogas generation, types of biogas plants –KVIC and Janata model;.

EMERGING TECHNOLOGIES: Fuel Cell, Hydrogen Energy, alcohol energy and power from satellite stations.

ENERGY STORAGE: Necessity Of Energy Storage-Pumped storage-Compressed airstorage-Flywheel storage-Batteries storage-Hydrogen storage.

References:

1. A.A.M. Saigh(Ed): Solar Energy Engineering, Academic Press, 1977
2. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their EnvironmentalImpact, Prentice Hall of India, 2001.
3. Thomas E. Kissell, David M. Buchla, Thomas L. Floyd, Renewable energy systems,Pearson 2017
4. Boyle G. (ed.), Renewable Energy -Power for Sustainable Future, Oxford UniversityPress, 1996
5. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHILearning, 2011.
6. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
7. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications,Narosa Publishers, 2002
8. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994
9. Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, Renewable Energy –Sources for Fuel and Electricity, Earth scan Publications, London, 1993.
10. Khan B. H., Non-Conventional Energy Resources, Tata McGraw Hill, 2009.
11. D.P.Kothari, K.C.Singal, RakeshRanjan, *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India, New Delhi, 2009
12. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 1999.
13. Sab S. L., Renewable and Novel Energy Sources, MI. Publications, 1995.
14. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
15. Tiwari G. N., Solar Energy-Fundamentals, Design, Modelling and Applications, CRCPress, 2002.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Environmental impacts of various energy resources. (7 hours)**	
1.1	Introduction, Environmental Aspects Of Energy-Ecology-Greenhouse Effect-Global Warming	1
1.2	Pollution-Various Pollutants and their Harmful Effects-Green Power - The United Nations Framework Convention On Climate Change (UNFCC)	2
1.3	Environment-Economy-Energy and Sustainable development-Kyoto Protocol -Classification of Energy Resources	1
1.4	Conventional Energy Resources -Availability and their limitations	1
1.5	Non-Conventional Energy Resources –Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.	2
2	**Solar radiation data, solar thermal and electric systems. (7 hours)**	
2.1	Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data(Numerical Problems)–Pyranometer and Pyrheliometer	2
2.2	Solar Thermal Collectors –General description and characteristics –Flat plate collectors –Heat transfer processes	1
2.3	Solar concentrators(Parabolic trough, Parabolic dish, Central Tower Collector)	1
2.4	Solar Photovoltaic –Solar Cell fundamentals, characteristics, classification, construction of Module, Panel and Array-Effect of shadowing	1
2.5	Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems –stand-alone and grid connected-Design steps for a Stand-Alone system	1
2.6	Applications –Street lighting, Domestic lighting and Solar Water pumping systems.	1
3	**Wind energy and small hydro plant (6 Hours)**	
3.1	Wind Energy–Introduction–Wind Turbine Types (HAWT and VAWT) and their construction	1
3.2	-Wind power curve-Betz's Law-Power from a wind turbine(Numerical Problems)	1
3.3	Wind energy conversion system(WECS) – Fixed–speed drive scheme-	1

3.4	Variable speed drive scheme.-Effect of wind speed and grid condition(system integration)	1
3.5	Small hydro power: Classification as micro, mini and small hydro projects -Basic concepts and types of turbines - Classification, Characteristics and Selection	2
4	**Energy from ocean (7 Hours)**	
4.1	Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP)	2
4.2	Classification of Tidal Power Plants, Advantages and Limitations of TPP.	1
4.3	Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation	1
4. 4	Open Cycle (Claude cycle), Closed Cycle (Anderson cycle)	1
4. 5	Hybrid cycle (block diagram description of OTEC)	1
4. 6	Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.	1
5	**Emerging technologies (9 Hours)**	
5.1	Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies	2
5.2	Urban waste to Energy Conversion, factors affecting biogas generation, types of biogas plants –KVIC and Janata model	2
5.3	Types of biogas plants –KVIC and Janata model	1
5.4	Fuel Cell, Hydrogen Energy	1
5.5	Alcohol energy and power from satellite stations.	1
5.6	Necessity Of Energy Storage-Pumped storage-Compressed air storage	1
5.7	Flywheel storage-Batteries storage-Hydrogen storage.	1

CST 362	PROGRAMMING IN PYTHON	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2019

Preamble

The objective of the course is to equip the learners to develop multi-module software solutions for real world computational problems using Python. It encompasses the Python programming environment, syntax, data representations, intermediate level features, GUI programming, Object Oriented Programming and data processing. This course lays the foundation to develop modular software solutions including complex interactive applications, network applications, and data-driven intelligent applications.

Prerequisite

Basic knowledge in Computational Problem Solving, A course in anyprogramming language.

Course Outcomes

After the completion of the course the student will be able to

CO1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO2	Illustrate uses of conditional (if, if-else and if-elif-else) and iterative (while and for) statements in Python programs. **(Cognitive Knowledge level: Apply)**
CO3	Develop programs by utilizing the Python programming constructs such as Lists, Tuples, Sets and Dictionaries. **(Cognitive Knowledge level: Apply)**
CO4	Develop graphical user interface for solutions using Python libraries. (**Cognitive Knowledge level: Apply)**
CO5	Implement Object Oriented programs with exception handling. **(Cognitive Knowledge level: Apply)**
CO6	Write programs in Python to process data stored in files by utilizing Numpy, Matplotlib, and Pandas. **(Cognitive Knowledge level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔		✔							✔
CO2	✔	✔	✔									✔
CO3	✔	✔	✔	✔	✔							✔
CO4	✔	✔	✔	✔	✔							✔
CO5	✔	✔	✔	✔	✔							✔
CO6	✔	✔	✔	✔	✔	✔						✔

Abstract POs defined by National Board of Accreditation

#PO	Broad PO	#PO	Broad PO
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Test 1 (*Marks in percentage*)	Test 2 (*Marks in percentage*)	End Semester Examination Marks
Remember	20	20	20

Understand	35	35	35
Apply	45	45	45
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B ins 2 questions from each module of which a student should answer any one. Each questioncan have a maximum of 2 sub-divisions and carries 14 marks.

SYLLABUS

Module -1 (Programming Environment and Python Basics) (6 hours)

Getting started with Python programming – Interactive shell, IDLE, iPython Notebooks, Detecting and correcting syntax errors, How Python works. The software development process – A case study. Basic coding skills – strings, assignment, and comments, Numeric data types and character sets, Expressions, Using inbuilt functions and modules. Control statements – Iteration with for/while loop, Formatting text for output, A case study, Selection structure (if-else, switch- case), Conditional iteration with while, A case study, Testing control statements, Lazy evaluation.

Module -2 (Building Python Programs) (8 hours)

Strings and text files – Accessing characters, substrings, Data encryption, Strings and number system, String methods, Text files, A case study on text analysis. Design with Functions – Functions as Abstraction Mechanisms, Problem solving with top-down design, Design with recursive functions, Managing a program's namespace, Higher-Order Functions. Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times, A case study with lists. Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup. Case Study – Data Structure Selection.

Module -3 (Graphics) (7 hours)

Graphics – Terminal-based programs, Simple Graphics using Turtle, Operations, 2D Shapes, Colors and RGB Systems, A case study. Image Processing – Basic image processing with inbuilt functions. Graphical User Interfaces – Event-driven programming, Coding simple GUI-based programs : Windows, Labels, Displaying images, Input text entry, Popup dialog boxes, Command buttons, A case study.

Module -4 (Object Oriented Programming) (7 hours)

Design with classes - Objects and Classes, Methods, Instance variables, Constructor, Accessor and Mutator, Data-Modeling Examples, Structuring classes with inheritance and polymorphism. Abstract classes, Interfaces, Exceptions - Handle a single exception, handle multiple exceptions.

Module -5 (Data Processing) (9 hours)

The os and sys modules, NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data. Introduction to Micro services using Flask.

Text Books:

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
3. Flask: Building Python web services, Jack Stouffer, Shalabh Aggarwal, Gareth Dwyer,PACKT Publishing Limited, 2018

Reference Books:

1. Zed A Shaw, Learn Python 3 The Hard Way, Addison-Wesley, 2017
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
3. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
4. Charles Severance. Python for Informatics: Exploring Information,

Sample Course Level Assessment Questions

Course Outcome1(CO1):

1. What is type conversion? How is it done in Python?
2. Write a note on the Python editors.

Course Outcome 2(CO2):

1. Write a Python program which takes a positive integer **n** as input and finds the sum of cubesall positive even numbers less than or equal to the number.
2. What is printed when the below code is executed?

```
mysum = 0
   for i in range(5, 11, 2):
               mysum += i
               if mysum == 5:
                           break
                     mysum += 1
   print(mysum)
```

What would be the output if 'break' is replaced with 'continue' in the above code fragment?

Course Outcome 3(CO3):

1. Given is a list of of words, *wordlist*, and a string, *name.* Write a Python function which takes *wordlist* and *name* as input and returns a tuple. The first element of the output tuple is the

number of words in the *wordlist* which have *name* as a substring in it. The second element of the tuple is a list showing the index at which the *name* occurs in each of the words of the *wordlist* and a 0 if it doesn't occur.

2. What is the value of L after you run the code below?

```
L = ["life", "answer", 42, 0]
for thing in L:
        if thing == 0:
          L[thing] = "universe"
        elif thing == 42:
            L[1] = "everything"
```

Course Outcome 4(CO4):

1. A bouncy program is defined as follows – The program computes and displays the total distance traveled by a ball, given three inputs—the initial height from which it is dropped, its bounciness index, and the number of bounces. Given the inputs write a GUI-based program to compute the total distance traveled.
2. Write a Python program to find the quadrant of a point, say (x,y).

Course Outcome 5(CO5):

1. Write a Python program to implement the addition, subtraction, and multiplication of complex numbers using classes. Use constructors to create objects. The input to the program consist of real and imaginary parts of the complex numbers.
2. Explain inheritance in Python using suitable examples.

Course Outcome 6(CO6):

1. Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price***,** write python code to
    1. Clean and Update the CSV file
    2. Print total cars of all companies
    3. Find the average mileage of all companies
    4. Find the highest priced car of all companies.
2. Given two matrices A and B, write a program to find the product of A and B^T.

Model Question Paper

QP CODE: PAGES:

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY SIXTH SEMESTER B.TECHDEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 362

Course name : PROGRAMMING IN PYTHON

Max Marks: 100 **Duration: 3 Hours**

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Write a Python program to reverse a number and also find the sum of digits of the number. Prompt the user for input.
2. Explain the concept of scope and lifetime of variables in Python programming language, with a suitable example.
3. Illustrate format specifiers and escape sequences with examples.
4. Compare tuples, lists, and dictionaries with examples.
5. Describe the following dictionary methods with an example.
   i. *get( )* ii. *Keys( )* iii. *pop( )* iv. *update( )* v. *values( )* vi. *items( )*
6. Differentiate the terminal-based and GUI-based programming in Python.
7. What is polymorphism? Give an example in the context of OOP in Python.
8. How is exception handling accomplished in Python programs?
9. Explain the **os** and **os.path** modules in Python with examples. Also, discuss the *walk( )* and *getcwd( )* methods of the **os** module.
10. What are the important characteristics of CSV file format.

PART-B

(Answer any one full question from each module)

11. (a) Write a Python code to check whether a given year is a leap year or not [An year is a leap year if it's divisible by 4 but not divisible by 100 except for those divisible by 400]. (6)

(b) What are the possible errors in a Python program. Write a Python program to print the value of $2^{2n}+n+5$ for n provided by the user. (8)

OR

12. (a) Write a Python program to find the value for *sin(x)* up to *n* terms using the series (6)

$$\sin(x) = \frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$

where x is in degrees

(b) Write a Python code to determine whether the given string is a Palindrome or not using slicing. Do not use any string function. (8)

13. (a) Write a Python code to create a function called *list_of_frequency* that takes a string and prints the letters in non-increasing order of the frequency of their occurrences. Use dictionaries. (5)

(b) Write a Python program to read a list of numbers and sort the list in a non-decreasing order without using any built in functions. Separate function should be written to sort the list wherein the name of the list is passed as the parameter. (9)

OR

14. (a) Illustrate the following Set methods with an example. (6)

i. *intersection( )* ii. *Union( )* iii. *Issubset( )* iv. *Difference( )* v. *update( )* vi. *discard( )*

(b) Write a Python program to check the validity of a password given by the user. (8)

The Password should satisfy the following criteria:

1. Contains at least one letter between **a** and **z**

2. Contains at least one number between **0** and **9**

3. Contains at least one letter between **A** and **Z**

4. Contains at least one special character from **$, #, @**

5. Minimum length of password: **6**

15. (a) Write a program to draw a hexagon using turtle. (5)

(b) Write a note on the image processing function in Python. (9)

OR

16. (a) Describe the features of event driven programming. (4)

(b) Write a GUI-based program that allows the user to convert temperature values between degrees Fahrenheit and degrees Celsius. The interface should have labeled entry fields for these two values. These components should be arranged in a grid where the labels occupy the first row and the corresponding fields occupy the second row. At start-up, the Fahrenheit fieldshould contain 32.0, and the Celsius field should contain 0.0. The third row in the window contains two command buttons, labeled >>>> and <<<<. When the user presses the first button, the program should use the data inthe Fahrenheit field to compute the Celsius value, which should then be output to the Celsius field. The second button should perform the inverse function. (10)

17. (a) How can a class be instantiated in Python? Write a Python program to express the instances as return values to define a class RECTANGLE with parameters *height, width, corner_x,* and *corner_y* and member functions to find center, area, and perimeter of an instance. (10)

(b) Explain inheritance in Python. Give examples for each type of inheritance. (4)

OR

18. (a) Write a Python class named ***Circle*** constructed by a radius and two methods which will compute the area and the perimeter of a given circle (6)

(b) Write Python program to create a class called as **Complex** and implement *__add_( )* method to add two complex numbers. Display the result by overloading the **+** Operator. (8)

19. (a) Write a Python program to add two matrices and also find the transpose of the resultant matrix. (8)

(b) Given a file "auto.csv" of automobile data with the fields *index, company, body-style, wheel-base, length, engine-type, num-of-cylinders, horsepower, average-mileage,* and *price*, write Python codes using Pandas to (6)

1) Clean and Update the CSV file
2) Print total cars of all companies

3) Find the average mileage of all companies

4) Find the highest priced car of all companies.

OR

20. (a) Write Python program to write the data given below to a CSV file. (5)

SN	Name	Country	Contribution	Year
1	Linus Torvalds	Finland	Linux Kernel	1991
2	Tim Berners-Lee	England	World Wide Web	1990
3	Guido van Rossum	Netherlands	Python	1991

(b) Given the sales information of a company as CSV file with the following fields *month_number, facecream, facewash, toothpaste, bathingsoap, shampoo, moisturizer, total_units, total_profit*. Write Python codes to visualize the data as follows (9)

1) Toothpaste sales data of each month and show it using a scatter plot

2) Face cream and face wash product sales data and show it using thebar chart

Calculate total sale data for last year for each product and show it using aPie chart.

(14X5=70)

Teaching Plan

Module 1: Programming Environment and Python Basics		**(6 hours)**
1.1	Getting started with Python programming – Interactive shell, IDLE, iPython Notebooks, Detecting and correcting syntax errors, How Python works.	**1 hour**
1.2	The software development process – A case study.	**1 hour**
1.3	Basic coding skills – strings, assignment, and comments, Numeric data types and character sets	**1 hour**
1.4	Expressions, Using inbuilt functions and modules.	**1 hour**
1.5	Control statements – Definite Iteration with for loop, Formatting text for output, Selection structure (if-else, switch-case), Conditional iteration with	**1 hour**
	while loop, A case study	
1.6	Testing the control statements, Lazy evaluation.	**1 hour**
Module 2: Building Python Programs		**(8 hours)**
2.1	Strings – Accessing characters, substrings, Data encryption, Strings and number system, String methods,	**1 hour**
2.2	Text files, A case study on text analysis.	**1 hour**
2.3	Design with Functions – Functions as Abstraction Mechanisms, Problem solving with top-down design,	**1 hour**
2.4	Design with recursive functions, Managing a program's namespace, Higher-Order Functions.	**1 hour**
2.5	Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension.	**1 hour**
2.6	Work with tuples. Sets. Work with dates and times, A case study with lists.	**1 hour**
2.7	Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup.	**1 hour**
2.8	Case Study - Data Structure Selection.	**1 hour**
Module 3: Graphics		**(7 hours)**
3.1	Graphics – Simple Graphics using Turtle, Operations, 2D Shapes,	**1 hour**
3.2	Colors and RGB Systems, A case study.	**1 hour**
3.3	Image Processing – Basic image processing with inbuilt functions.	**1 hour**

3.4	Graphical User Interfaces – Event-driven programming	**1 hour**
3.5	Coding simple GUI-based programs : Windows, Labels, Displaying images,	**1 hour**
3.6	Coding simple GUI-based programs : Input text entry, Popup dialog boxes, Command buttons	**1 hour**
3.7	A case study - GUI	**1 hour**
Module 4: Object Oriented Programming		**(7 hours)**
4.1	Design with classes : Objects and Classes, Methods, Instance Variables	**1 hour**
4.2	Constructor, Accessors, and Mutators	**1 hour**
4.3	Structuring classes with Inheritance	**1 hour**
4.4	Polymorphism	**1 hour**
4.5	Abstract Classes	**1 hour**
4.6	Interfaces	**1 hour**
4.7	Exceptions : Handle a single exception, handle multiple exceptions	**1 hour**
Module 5: Data Processing		**(9 hours)**
5.1	The *os* and *sys* modules, NumPy : Basics, Creating arrays, Arithmetic, Slicing	**1 hour**
5.2	Matrix Operations, Random numbers.	**1 hour**
5.3	Matplotlib : Basic plot, Ticks, Labels, and Legends	**1 hour**
5.4	Working with CSV files	**1 hour**
5.5	Pandas : Reading, Manipulating	**1 hour**
5.6	Pandas : Processing Data and Visualize.	**1 hour**
5.7	Introduction to Microservices using Flask	**1 hour**
5.8	Introduction to Microservices using Flask	**1 hour**
5.9	Introduction to Microservices using Flask	**1 hour**

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET372	SOFT COMPUTING	PEC	2	1	0	3

Preamble

This course gives an introduction to some new fields in soft computing. It combines the fundamentals of neural network, fuzzy logic, and genetic algorithm which in turn offers the superiority of humanlike problem solving capabilities. This course provides a broad introduction to machine learning, data clustering algorithms and support vector machines.

Prerequisite: Digital Electronics

Course Outcomes: After the completion of the course, the student will be able to:

CO 1	Explain various constituents of soft computing and artificial neural networks.
CO 2	Explain the different learning methods for training of ANNs.
CO 3	Apply fuzzy logic techniques to control a system.
CO 4	Utilize genetic algorithm techniques to find the optimal solution of a given problem.
CO 5	Explain the basics of machine learning, data clustering algorithms and support vector machines.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	-	-	-	-	-	-	2
CO 2	3	1	1	1	-	-	-	-	-	-	-	2
CO 3	3	1	1	1	2	-	-	-	-	-	-	2
CO 4	3	1	1	1	-	-	-	-	-	-	-	2
CO 5	3	1	2	1	2	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

End Semester Examination Pattern

There will be two parts; Part A and Part B. PartA contains 10 questions (each carrying 3 marks) with 2 questions from each module. Students should answer all questions. Part B contains 2 questions from each module, out of which students should answer any one. Each question can have maximum 2 sub-divisions andcarries14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare Soft and Hard computing.
2. Define ANN. What are the characteristics of ANN?
3. Realize using McCulloch Pitts neuron model (i) a 2-input AND logic and (ii) a 2-input NOR logic considering +1 as the bias value of the neuron.
4. Draw the non-linear model of a neuron and explain the basic elements of the neuronalmodel.
5. Explain any five types of activation functions used in neural network models.
6. Explain how a biological neuron transmits signals in the human brain with the help of neatdiagrams.

Course Outcome 2 (CO2):

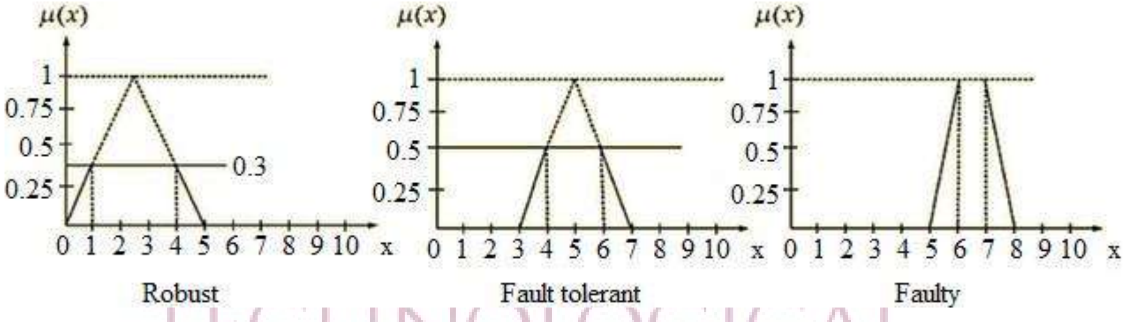
1. Describe learning. What are the different learning methods in ANN?
2. Explain the different architectures of neural networks.
3. Explain error correction learning algorithm.
4. What is meant by feed forward network? Compare SLFFN and MLFFN.
5. Compare supervised learning and unsupervised learning methods.
6. Derive the expression for local gradient of an output neuron, in back propagation algorithm.

Course Outcome 3(CO3):

1. Define membership function. Also give any three features of a membership function.
2. Define (i) core (ii) support (iii) boundary and crossover points of membership function.
3. Given two fuzzy sets:
   $\tilde{A}$: Mary is efficient, T ($\tilde{A}$) = 0.8
   $\tilde{B}$: Ram is efficient, T ($\tilde{B}$) = 0.65
   Find (i) Mary is not efficient (ii) Mary is efficient and so is Ram (iii) Either Mary or Ram is efficient (iv) If Mary is efficient.
4. P represents a set of four varieties of paddy plants, D represents the four diseases affecting the plants, and S represents the common symptoms of the diseases. $P = \{P_1, P_2, P_3, P_4\}, D = \{D_1, D_2, D_3, D_4\}, S = \{S_1, S_2, S_3, S_4\}$. R is a relation on $P \times D$ representing which plant is susceptible to which diseases and T is another relation on $D \times S$ and is stated as

$$R = \begin{array}{c c} & \begin{array}{cccc} D_1 & D_2 & D_3 & D_4 \end{array} \\ \begin{array}{c} P_1 \\ P_2 \\ P_3 \\ P_4 \end{array} & \begin{bmatrix} 0.6 & 0.6 & 0.9 & 0.8 \\ 0.1 & 0.2 & 0.9 & 0.8 \\ 0.9 & 0.3 & 0.4 & 0.8 \\ 0.9 & 0.8 & 0.4 & 0.2 \end{bmatrix} \end{array}, \qquad T = \begin{array}{c c} & \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{array}{c} D_1 \\ D_2 \\ D_3 \\ D_4 \end{array} & \begin{bmatrix} 0.1 & 0.2 & 0.7 & 0.9 \\ 1 & 1 & 1 & 0.6 \\ 0 & 0 & 0.5 & 0.9 \\ 0.9 & 1 & 0.8 & 0.2 \end{bmatrix} \end{array}$$

6. List out the various operations on Fuzzy sets.
7. Explain simple fuzzy logic controllers.
8. The faulty measure of a circuit is defined fuzzily by three fuzzy sets namely Robust (*R*), Fault tolerant (*FT*) and Faulty (*F*), defined by three membership functions with number of faults occur, as universe of discourse as



Reliability is measured as $r = R \cup FT \cup F$. Determine the crisp value of r using centroid method, COS method and weighted average methods of defuzzification.

Course Outcome 4 (CO4):

1. Draw a neat architecture of Adaptive Neuro Fuzzy Inference System (ANFIS).
2. Explain any two types of encoding used in GA.
3. Discuss selection operation in GA. Explain briefly Roulette wheel selection.
4. What is Genetic Algorithm? What are the various methods of selecting chromosomes ofparents to crossover?
5. What is crossover? Explain any three types of crossover operators in GA.
6. Define (i) Population (ii) Fitness (iii) Selection (iv) Mutation.

Course Outcome 5 (CO5):

1. What is “Machine Learning”? Give examples of learning machines.
2. Explain different types of machine learning models.
3. Explain different types of Machine Learning Architecture.
4. Explain, K-Means Clustering algorithm. What are its applications?
5. Compare SVM and SVR.
6. ExplainHierarchical clustering technique. What are its limitations?

Model Question paper

QP CODE: PAGES:2

Reg. No:______________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code: EET 372

Course Name: SOFT COMPUTING

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks.

1. Compare the structure of a biological neuron with an artificial neuron.
2. What is a perceptron? Explain the training process in perceptron.
3. Describe learning. What are the different learning methods in ANN?
4. Explain the architecture of a Hopfield network.
5. The two fuzzy sets representing an *apple* and an *orange* are:

$$Apple = \left\{ \frac{0.4}{orange} + \frac{0.5}{chair} + \frac{0.8}{table} + \frac{0.9}{apple} + \frac{0.3}{plate} \right\}$$

$$Orange = \left\{ \frac{0.6}{orange} + \frac{0.3}{chair} + \frac{0.4}{table} + \frac{0.5}{apple} + \frac{0.4}{plate} \right\}$$

Find the following:

$i)\ Apple \cup Orange \quad ii)\ Apple \cap Orange \quad iii)\ \overline{Apple \cap Orange}$

$iv)\ Apple \cup \overline{Apple}$

6. With a neat block diagram, explain the fuzzy inference system.
7. Write short notes on any two methods used for selection process in GA.
8. Explain two different types of crossover used in a genetic algorithm.
9. What is a linear learning machine?
10. List out any 4 applications of support vector machines.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks.

Module I

11	a	Realize using McCulloch Pitts neuron model (i) a 2-input AND logic and (ii) a 2-input NOR logic considering +1 as the bias value of the neuron.	**(9)**
	b	Explain any five types of activation functions used in neural network models.	**(5)**
12	a	Explain the architecture of ADALINE and MADALINE networks.	**(9)**
	b	Draw the non-linear model of a neuron and explain the basic elements of the neuronal model.	**(5)**

Module II

13	a	Explain back propagation algorithm with the help of a block diagram and a suitable example.	**(9)**
	b	Explain radial basis function network.	**(5)**
14	a	Explain reinforcement learning with the help of a block diagram.	**(7)**
	b	Explain Kohonen Self organizing map.	**(7)**

Module III

15 a P represents a set of four varieties of paddy plants, D represents the four diseases affecting the plants, and S represents the common symptoms of the diseases. $P = \{P_1, P_2, P_3, P_4\}$, $D = \{D_1, D_2, D_3, D_4\}$, $S = \{S_1, S_2, S_3, S_4\}$. R is a relation on $P \times D$ representing which plant is susceptible to which diseases and T is another relation on $D \times S$ and is stated as **(9)**

$$R = \begin{array}{c} \\ P_1 \\ P_2 \\ P_3 \\ P_4 \end{array} \begin{array}{c} \begin{array}{cccc} D_1 & D_2 & D_3 & D_4 \end{array} \\ \begin{bmatrix} 0.6 & 0.6 & 0.9 & 0.8 \\ 0.1 & 0.2 & 0.9 & 0.8 \\ 0.9 & 0.3 & 0.4 & 0.8 \\ 0.9 & 0.8 & 0.4 & 0.2 \end{bmatrix} \end{array}, \quad T = \begin{array}{c} \\ D_1 \\ D_2 \\ D_3 \\ D_4 \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{bmatrix} 0.1 & 0.2 & 0.7 & 0.9 \\ 1 & 1 & 1 & 0.6 \\ 0 & 0 & 0.5 & 0.9 \\ 0.9 & 1 & 0.8 & 0.2 \end{bmatrix} \end{array}$$

Obtain the association of plants with the different symptoms of the disease using max-min composition.

	b	Discuss any two common membership functions used in fuzzy logic.	**(5)**
16		With the help of an example, explain the working of a fuzzy logic controller.	**(14)**

Module IV

17	a	Describe the steps involved in solving an optimization problem using Genetic Algorithm. Illustrate the steps with a suitable example	**(14)**
18	a	Explain Adaptive Neuro-Fuzzy Inference System (ANFIS) with the help of a block diagram.	**(9)**
	b	What is the role of 'mutation' in GA based optimizationprocess? What is the usual range of probability value given for mutation process**?**	**(5)**

Module V

19	a	Describe Machine Learning. Write any three applications	**(9)**
	b	Briefly explain any one clustering algorithm with example.	**(5)**
20	a	Explain support vector regression. List any 2 applications.	**(9)**
	b	What are the common distance measures used in clustering algorithms?	**(5)**

Syllabus

Module 1

Introduction: Soft and Hard Computing, Evolution of soft computing, Soft computing constituents.

Artificial Neural Networks: Biological foundations –ANN models - Characteristics of ANN- Types of activation function - McCulloch-Pitts neuron model, Realization of logic gates using McCulloch-Pitts neuron model - simple perceptron, Adaline and Madaline.

Module 2

Neural network architectures - single layer, multilayer, recurrent networks.

Knowledge representation - Learning process - Supervised and unsupervised learning, Learning algorithms–Errorcorrection learning - Hebbian learning – Boltzmann learning - competitive learning- Backpropagation algorithm- Case study-Radial basis function networks - Hopfield network- Kohonen Self organizing maps

Module 3

Fuzzy Logic: Introduction to crisp sets and fuzzy sets, examples, Properties, Basic fuzzy set operations, examples. Fuzzy relations - Cardinality of Fuzzy relations - Operations on Fuzzy relations - Properties of Fuzzy relations. Membership functions - triangular, trapezoidal, bell shaped, Gaussian, sigmoidal.

Fuzzy logic controller (Block Diagram), Fuzzification, rule base, inference engine and defuzzification - Max-membership principle, Centroid method, Weighted Average Method, Mean-Max membership, Center of Sums, and Center of Largest area, First and Last of Maxima.

Simple fuzzy logic controllers with examples.

Module 4

Genetic Algorithm: Introduction - basic concepts of Genetic Algorithm, encoding, fitness function, reproduction, cross over, mutation operator, bit-wise operators, generational cycle.

Hybrid Systems: Adaptive Neuro Fuzzy Inference System (ANFIS), Genetic algorithm based back propagation networks, fuzzy back propagation networks.

Module 5

Machine Learning- Machine learning model-Approaches to machine learning- Machine learning architecture- Data Clustering Algorithms -Hierarchical clustering, K-Means Clustering

Support Vector Machines for Learning – Linear Learning Machines – Support Vector Classification – Support Vector Regression - Applications.

Reference Books

1. S.Rajasekharan, G.A.Vijayalakshmi Pai, *Neural Network, Fuzzy Logic and GeneticAlgorithms Synthesis and Applications*, Prentice Hall India, 2003.
2. S.N.Sivanandam, S.N.Deepa, *Principles of Soft Computing*, Wiley India, 2007.
3. Simon Haykin, *Neural Networks a Comprehensive foundation*, Pearson Education, 1999.
4. Bart Kosko, *Neural Network and Fuzzy Systems*, Prentice Hall of India, 2002
5. Zurada J.M., *Introduction to Artificial Neural Systems*, Jaico Publishers, 2003.
6. Hassoun Mohammed H, *Fundamentals of Artificial Neural Networks*, Prentice Hall of India, 2002.J.-S.R.Jang, C.-T.Sun,E.Mizutani, *Neuro-Fuzzy and Soft Computing*, Prentice Hall, 1997.
7. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill, New York.
8. Driankov D., Hellendoorn H., Reinfrank M, *An Introduction to Fuzzy Control*, Narosa Publications, 1993.
9. Ronald R Yager and Dimitar P Filev, *Essentials of Fuzzy Modelling & Control*, JohnWiley & Sons, Inc, 2002.
10. SuranGoonatilake& Sukhdev Khebbal (Eds.), *Intelligent Hybrid Systems*, John Wiley,1995.
11. D.E.Goldberg, *Genetic Algorithms in Search Optimisation and Machine Learning*,Pearson Education, 1989.
12. Tom Mitchell,*Machine Learning*, McGraw Hill, 1997
13. Margaret H. Dunham, *Data Mining- Introductory & Advanced Topics*, Pearson Publication

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	***Introduction to Artificial Neural Networks***	**5 hrs**
1.1	Introduction to soft computing, soft and hard Computing, Soft computing constituents	1
1.2	ANN- Biological foundations - ANN models - Characteristics of ANN - Types of activation function.	1
1.3	McCulloch-Pitts neuron model, Realization of logic gates using McCulloch-Pitts neuron model.	2
1.4	Simple perceptron, Adaline and Madaline.	1
2	***Neural network architectures and Learning***	**7 hrs**
2.1	Neural network architectures - single layer, multilayer, recurrent networks, Knowledge representation.	1
2.2	Learning process: Supervised and unsupervised learning. Learning algorithms- Errorcorrection learning.	1
2.3	Hebbian learning – Boltzmann learning - competitive learning.	1
2.4	Back propagation networks	1
2.5	Radial basis function networks - Hopfield network.	2
2.6	Kohonen Self organizing maps	1
3	***Introduction to Fuzzy Logic***	**11 hrs**
3.1	Introduction to crisp sets and fuzzy sets, examples, Properties.	1
3.2	Basic fuzzy set operations, examples.	1
3.3	Fuzzy relations- Cardinality of Fuzzy relations - Operations on Fuzzy relations - Properties of Fuzzy relations.	2
3.4	Membership functions - triangular, trapezoidal, bell shaped, Gaussian, sigmoidal.	1
3.5	Fuzzy logic controller (Block Diagram), Fuzzification, rule base, inference engine	2

3.6	Defuzzification - Max-membership principle, Centroid method, Weighted Average Method, Mean-Max membership, Center of Sums, and Center of Largest area, First and Last of Maxima, Example problems.	2
3.7	Simple fuzzy logic controllers with examples	2
4	***Introduction to Genetic Algorithms and Hybrid Systems***	**7 hrs**
4.1	Basic concepts of Genetic Algorithm – encoding - fitness function – reproduction - cross over - mutation operator - bit-wise operators, generational cycle.	3
4.2	Hybrid Systems: Adaptive Neuro fuzzy Inference System (ANF1S)	2
4.3	Genetic algorithm based back propagation networks	1
4.4	Fuzzy back propagation networks	1
5	***Introduction to Machine Learning***	**6 hrs**
5.1	Machine Learning- Machine learning model- Approaches to machine learning- Machine learning architecture	**2**
5.2	Data Clustering Algorithms - Hierarchical clustering, K-Means Clustering	**2**
5.3	Support Vector Machines for Learning Support Vector Classification – Support Vector Regression - Applications	**2**

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT308	COMPREHENSIVE COURSE WORK	PCC	1	0	0	1

Preamble:

The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental Program core courses in the curriculum. Six core courses credited from Semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course helps the learner to become competent in cracking GATE, placement tests and other competitive examinations. This course has an End Semester Objective Test conducted by the University for 50 marks. One hour is assigned per week for this course for conducting mock tests of objective nature in all the listed five courses.

Prerequisite:

1. Circuits and Networks
2. Discrete Mathematical Structures
3. Data Structures
4. Operating Systems
5. Computer Organization and Architecture
6. Digital Electronics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply the knowledge of circuit theorems to solve the problems in electrical networks
CO 2	Comprehend the concepts of discrete mathematical structures
CO 3	Comprehend the concepts and applications of data structures
CO 4	Comprehend the concepts, functions and algorithms in Operating System
CO 5	Comprehend the organization and architecture of computer systems
CO 6	Identify appropriate digital components to realise any combinational or sequential logic.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	2										2
CO 3	3	3										2
CO 4	3	3										2
CO 5	3	2										2
CO 6	3	3	1		1							2

Assessment Pattern

Bloom's Category	**End Semester Examination**
Remember	10
Understand	20
Apply	20
Analyse	
Evaluate	

Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice (Four). Question paper include Fifty Questions of One mark each covering the six identified courses.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. A circuit with resistor, inductor and capacitor in series is resonant at f_0 Hz. If all the component values are now doubled, the new resonant frequency is

a) 2 f_0
b) Still f_0
c) f_0 /2
d) f_0 /4

2. The line A to neutral voltage is $10<15^0$ V for a balance three phase star connected load with phase sequence ABC. The voltage of line B with respect to line C is given by

a) $10\sqrt{3}<105^0$ V
b) $10<105^0$ V
c) $10\sqrt{3}<75^0$ V
d) $-10\sqrt{3}<90^0$ V

3. The average power delivered to an impedance (4-j3)Ω by a current $5\cos(100\pi t+100)$A is

a) 44.2 W
b) 50 W
c) 62.5 W
d) 125 W

Course Outcome 2 (CO2)

1. The set {1,2,4,7,8,11,13,14} is a group under multiplication modulo 15. Find the inverse ofelement 13

a) 7
b) 13
c) 1
d) 8

2. What is the maximum possible number of relations from a set with 5 elements to another setwith 4 elements?

a) 2^10
b)2^16
c)2^20
d)2^25

3. Which among the following is not a subgroup of the set of Complex numbers under addition?

a)R, the set of all Real numbers.
b)Q^+, the set of positive rational numbers.
c), the set of all integers.
d) The set iiR of purely imaginary numbers including 0

Course Outcome 3 CO3):

1. Construct a binary search tree by inserting 8, 6, 12, 3, 10, 9 one after another. To make the resulting tree as AVL tree which of the following is required?

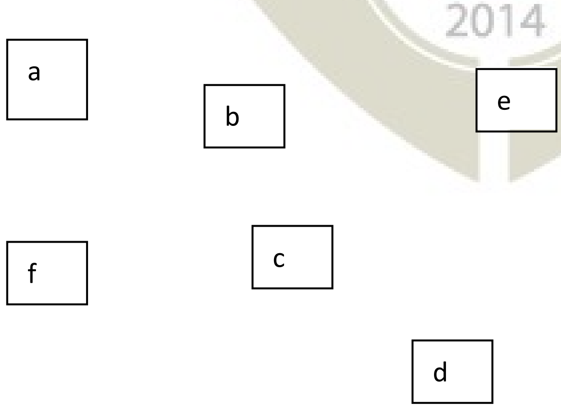
a) One right rotation only
b) One left rotation followed by two right rotations
c) One left rotation and one right rotation
d) The resulting tree itself is AVL

2. In a complete 4-ary tree, every internal node has exactly 4 children or no child. The numberof leaves in such a tree with 6 internal nodes is:

a)20
b) 18
c) 19
d) 17

3. Consider the following graph with the following sequences

I. a b c f d e
II. a b e d f c
III. a b f c d e
IV. a f c b e d



Which are Depth First Traversals of the above graph?

a) I, II and IV only
b) I and IV only
c) II, III and IV only
d) I, III and IV only

Course Outcome 4 (CO4):

1. In a system using single processor, a new process arrives at the rate of 12 processes per minute and each such process requires 5 seconds of service time. What is the percentage ofCPU utilization?
a) 41.66
b) 100.00
c) 240.00
d) 60.00

2. Calculate the internal fragmentation if page size is 4KB and process size is 103KB.
a)3KB
b) 4KB
c) 1KB
d)2KB

3. Which of the following scheduling policy is likely to improve interactiveness?
a)FCFS
b) Round Robin
C) Shortest Process Next
d) Priority Based Scheduling

Course Outcome 5 (CO5):

1. A 64-bit processor can support a maximum memory of 8 GB, where the memory is word-addressable (one word is of 64 bits). The size of the address bus of the processor is atleast__ bits.
a) 30
b) 31
c) 32
d) None

2. The stage delays in a 4-stage pipeline are 900, 450, 400 and 350 picoseconds. The first stage (with delay 900 picoseconds) is replaced with a functionally equivalent design involving twostages with respective delays 600 and 550 picoseconds. The throughput increase of the pipeline is__percent.
a)38
b)30
c)58
d) 50

3. Consider a direct mapped cache of size 256 Kilo words with block size 512 words. There are6 bits in the tag. The number of bits in block (index) and word (offset) fields of physical address are is:

a)block (index) field = 6 bits, word (offset) field = 9 bits
b)block (index) field = 7 bits, word (offset) field = 8 bits
c)block (index) field = 9 bits, word (offset) field = 9 bits
d)block (index) field = 8 bits, word (offset) field = 8 bits

Course Outcome 6 (CO6):

1. The SOP (sum of products) form of a Boolean function is ∑(0, 1, 3, 7, 11), where inputs are A, B, C, D (A is MSB and D is LSB). The equivalent minimized expression of the function is

a) (B’+C)(A’+C)(A’+B’)(C’+D)
b) (B’+C)(A’+C)(A’+C’)(C’+D)
c) (B’+C)(A’+C)(A’+C’)(C’+D’)
d) (B’+C)(A+B’)(A’+B’)(C’+D)

2. A cascade of three identical modulo-5 counters has an overall modulus of

a) 5
b) 25
c) 125
d) 625

3. The octal equivalent of the HEX number AB.CD is

a) 253.314
b) 253.632
c) 526.314
d) 526.632

SYLLABUS

Full Syllabus of all Six selected Courses.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Circuits and Networks**	
1.1	Mock Test on Module 1 and Module 2	1
1.2	Mock Test on Module 3, Module 4 and Module 5	1
2	**Discrete Mathematical Structures**	
2.1	Mock Test on Module 1 and Module 2	1
2.2	Mock Test on Module 3, Module 4 and Module 5	1
3	**Data Structures**	
3.1	Mock Test on Module 1 and Module 2	1
3.2	Mock Test on Module 3, Module 4 and Module 5	1
4	**Operating Systems**	
4.1	Mock Test on Module 1 and Module 2	1
4.2	Mock Test on Module 3, Module 4 and Module 5	1
5	**Computer Organization and Architecture**	
5.1	Mock Test on Module 1 and Module 2	1
5.2	Mock Test on Module 3, Module 4 and Module 5	1
6	**Digital Electronics**	
6.1	Mock Test on Module 1 and Module 2	1
6.2	Mock Test on Module 3, Module 4 and Module 5	1

EOL302	EMBEDDED SYSTEMS AND IoT LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2022

Preamble

The course aims to give a hands-on experience for learners on interfacing various sensors with Arduino/Raspberry Pi for implementing various applications. The Arduino and Raspberry Pi boards are used to control embedded devices. This course helps learners to implement IoT communication protocols, database connectivity and cloud connectivity with the help of Arduino/Raspberry Pi.

Prerequisite

Topics covered under the course Microprocessors and Embedded Systems (EET303) and Programming in C (EST 102)

Course Outcomes

After the completion of the course the student will be able to

CO 1	Develop and execute assembly language programs for solving arithmetic and logical problems using microprocessor/microcontroller.
CO 2	Design and Implement systems with interfacing circuits for various applications.
CO 3	Perform installation and software setup of Arduino/Raspberry Pi and interface with various sensors. **(Cognitive Knowledge Level: Apply)**
CO 4	Utilize Python or Arduino program to control embedded devices using Arduino/Raspberry Pi. **(Cognitive Knowledge Level: Apply)**
CO 5	Perform MySQL database installation and basic SQL operation on Raspberry Pi. **(Cognitive Knowledge Level: Apply)**
CO 6	Simulate MQTT protocol and upload/download data to thingspeak cloud using Arduino/Raspberry Pi. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓			✓	✓	✓		✓
CO2	✓	✓	✓	✓	✓			✓	✓	✓		✓
CO3	✓	✓	✓	✓	✓			✓		✓		✓

CO4	✓	✓	✓	✓				✓		✓		✓
CO5	✓	✓	✓	✓				✓		✓		✓
CO6	✓	✓	✓	✓	✓			✓		✓		✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Test (Internal Exam) Percentage	End Semester Examination Percentage
Remember	20	20
Understand	20	20
Apply	60	60
Analyze		
Evaluate		
Create		

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Evaluation in Lab : 30 marks

Continuous Assessment Test : 15 marks

Viva-voce : 15 marks

Internal Examination Pattern:

The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern:

The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Operating System to Use in Lab : Linux

Compiler/Software to Use in Lab : gcc

Programming Language to Use in Lab : Ansi C

Fair Lab Record:

All Students attending the Data Structures Lab should have a Fair Record. The fair record should be produced in the University Lab Examination. Every experiment conducted in the lab should be noted in the fair record. For every experiment in the fair record the right hand page should contain Experiment Heading, Experiment Number, Date of Experiment, Aim of Experiment, Data Structure used and the operations performed on them, Details of Experiment including algorithm and Result of Experiment. The left hand page should contain a print out of the code used for the experiment and sample output obtained for a set of input.

SYLLABUS

1. Data transfer using different modes and block of data in 8085.
2. Basic arithmetic operations- Addition, Subtraction, Multiplication of 8 bit numbers and division of 16-bit number by 8-bit number using 8085.
3. Sorting of numbers – Ascending and descending order using 8085.
4. C program to generate time delay using timers in 8051.
5. C program to generate square and rectangular wave from parallel ports in 8051.
6. C program to run stepper motor using 8051.
7. C program to interface 16x2 LCD display to 8051.
8. C program to control speed and direction of DC motor using 8051.
9. C program to interface electromagnetic relay to 8051.
10. Familiarization with Arduino/Raspberry Pi and perform necessary software installation. **
11. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
12. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
13. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
14. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed. **
15. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smart phone using Bluetooth.
16. Write a program on Arduino/Raspberry Pi to upload/download temperature and humidity data to thingspeak cloud. **
17. To install MySQL database on Raspberry Pi and perform basic SQL queries. **
18. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker. **

** mandatory.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOL304	ELECTRICAL MACHINES LAB		0	0	3	2

Preamble

The purpose of this lab is to provide practical experience in operation and testing of AC and DC machines.

Prerequisite

Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Determine the no-load and load characteristics of DC generators
CO 2	Determine the performance characteristics of DC motors at different load conditions
CO 3	Analyse the performance of transformers at different load conditions
CO 4	Analyse the performance of synchronous machines in various operating conditions
CO 5	Determine the performance characteristics of three-phase induction motors
CO 6	Determine the performance characteristics of single-phase induction motors on load conditions

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2		2					2			3
CO 2	3	2		2					2			3
CO 3	3	2		2					2			3
CO 4	3	2		2					2			3
CO 5	3	2		2					2			3
CO 6	3	2		2					2			3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

Course Level Assessment Questions

Course Outcome 1

1. Determine the critical field resistance, critical speed and maximum voltage build up by conducting no-load test on DC shunt generator (PO1, PO2, PO4, PO9, PO12)
2. Determine the internal and external characteristics of DC shunt generator (PO1, PO2, PO4, PO9, PO12)

Course Outcome 2

1. Determine the electrical and mechanical characteristics of DC shunt motor (PO1, PO2, PO4, PO9, PO12)
2. Determine the performance characteristics of DC series motor (PO1, PO2, PO4, PO9, PO12)

Course Outcome 3

1. Determine the equivalent circuit parameters of single-phase transformer (PO1, PO2, PO4, PO9, PO12)
2. Determine/predetermine the efficiency and voltage regulation of single-phase transformer (PO1, PO2, PO4, PO9, PO12)

Course Outcome 4

1. Predetermine the voltage regulation of 3-phase synchronous generator by emf and mmf method (PO1, PO2, PO4, PO9, PO12)
2. Obtain the V curves and inverted V-curves of synchronous motor (PO1, PO2, PO4, PO9, PO12)

Course Outcome 5

1. Determine the equivalent circuit of given 3-phase induction motor (PO1, PO2, PO4, PO9, PO12)
2. Determine the performance characteristics of 3-phase slip-ring induction motor (PO1, PO2, PO4, PO9, PO12)

Course Outcome 6

1. Determine the efficiency of given 1-phase induction motor at various load conditions (PO1, PO2, PO4, PO9, PO12)

General instructions:

Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

PART A – DC MACHINES		
1	Open circuit characteristics of DC shunt generator Objectives: a) Predetermine the OCC at different speeds b) Determine the critical field resistance c) Obtain maximum voltage built up with given shunt field resistance d) Obtain critical speed for a given shunt field resistance	
2	Load test on DC shunt generator Objectives: Determine the external and internal characteristics of the given DC shunt generator	
3	Brake test on DC shunt motor Objectives: Plot the following characteristics a) Performance characteristics b) Electrical characteristics c) Mechanical characteristics	
4	Brake test on DC series motor Objectives: Plot the following characteristics a) Performance characteristics b) Electrical characteristics c) Mechanical characteristics	
5	Swinburne’s test on a DC shunt machine Objectives : a) To predetermine the efficiency of a D.C. shunt machine when the machine operates as a motor and as a generator for various load conditions b) To plot the efficiency curves of the given DC machine.	
PART B - TRANSFORMERS		
6	OC and SC tests on 1-phase transformer Objectives: Predetermination of the following a) To pre-determine the regulation and efficiency of the given single phase transformer at different loads and power factors b) To obtain the equivalent circuit of the given transformer c) To plot regulation vs power factor curves d) To determine the power factor at which regulation is zero	
7	Direct Load test on the single phase transformer Objectives: a) To determine the efficiency of the given transformer at unity power factor at different loads b) To determine the regulation of the given transformer at unity power factor at different loads c) To plot the efficiency vs output and regulation vs output curves	
8	Parallel operation of two dissimilar single phase transformers Objectives: a) To determine the load sharing of each transformer by their equivalent impedances b) Verify the load sharing by actual measurement	
PART C – SYNCHRONOUS & INDUCTION MACHINES		
9	**Load test on a three phase Slip Ring Induction Motor** *Objectives:* a) Start the motor using auto transformer or rotor resistance starter b) Plot the performance characteristics	
10	**No load and block rotor tests on a three phase Squirrel Cage Induction Motor**	

	Objectives: a) Predetermination of efficiency b) Determination of equivalent circuit parameters	
11	**Load Test on a single phase Induction Motor** *Objectives:* a) Perform load test on the motor b) Plot the performance characteristics of the motor	
12	**Regulation of a three phase Alternator by emf and mmf methods** Objectives: Predetermine the regulation of alternator by emf and mmf methods on full-load and at different power factors	
13	**Regulation of a three phase Alternator by direct loading** Objectives: a) Determine the regulation of three phase alternator **b)** Plot the regulation versus load curve	
14	**V and inverted V curves of a Synchronous Motor** *Objectives:* a) Plot the V and inverted V curves of the Synchronous Motor at no load and full load.	
Out of the above experiments, twelve experiments are mandatory to do in lab		

Reference Books

1. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
2. Theraja B. L., A Textbook of Electrical Technology, S. Chand & Company, New Delhi, 2008.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET386	**DIGITAL CONTROL**	**VAC**	**3**	**1**	**0**	**4**

Preamble: This course aims to provide a strong foundation in digital control systems. Modelling, time domain analysis, frequency domain analysis and stability analysis of sampled data control systems based on Pulse Transfer function (conventional) approach and State variable concept are discussed. The design of digital control is also introduced.

Prerequisite: Basics of Circuits, Networks and Control Systems

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Describe the role of various control blocks and components in digital control systems.
CO 2	Analyse the time domain responses of the sampled data systems using Z Transform.
CO 3	Analyse the stability of the given discrete time system.
CO 4	Apply state variable concepts to assess the performance of linear systems
CO 5	Apply Liapunov methods to assess the stability of linear systems
CO 6	Explain control system design strategies in discrete time domain.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3		-	-	-	-	-	-	-	-	-	1
CO 2	3	2	-	-	2	-	-	-	-	-	-	1
CO 3	3	2	-	-	-	-	-	-	-	-	-	1
CO 4	3	2	-	-	2	-	-	-	-	-	-	1
CO 5	3	2	-	-	-	-	-	-	-	-	-	1
CO 6	3	2	-	-	-	-	-	-	-	-	-	1

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	15	15	40
Apply (K3)	25	25	40
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern: There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Derive the transfer function and obtain the frequency response characteristics of zeroorder hold circuit.
2. Explain how reconstruction of original signal is achieved from discrete time signals.
3. Explain any three factors to be considered for the choice of sampling frequency for asystem.

Course Outcome 2 (CO2):

1. Derive the transfer function and obtain the frequency response characteristics of firstorder hold.
2. Problems related to steady state error.
3. Problems related to ZTF from difference equation form.

Course Outcome 3(CO3):

1. Problems related to the stability analysis using Jury's test
2. Problems related to the stability analysis using Bilinear Transformation
3. Problems to determine range of K or other TF parameter for stability/ oscillation.

Course Outcome 4 (CO4):

1. Problems related to canonical form representations
2. Problems based on state transition matrix
3. Problems to determine the solution of state equations.

Course Outcome 5 (CO5):

1. Check the stability of the given LTI system using Liapunov method.
2. Explain the physical relevance of Liapunov function.
3. Test the stability of the given nonlinear state model.

Course Outcome 6 (CO6):

1. Design a digital controller using root locus approach to meet the required specifications.
2. Problems on PID tuning and selection.
3. Pole placement problems for LTI systems.

Model Question Paper

PAGES: 3

QP CODE:

Reg.No:____________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EET386**

Course Name: **DIGITAL CONTROL**

Max. Marks: 100 **Duration: 3 Hours**

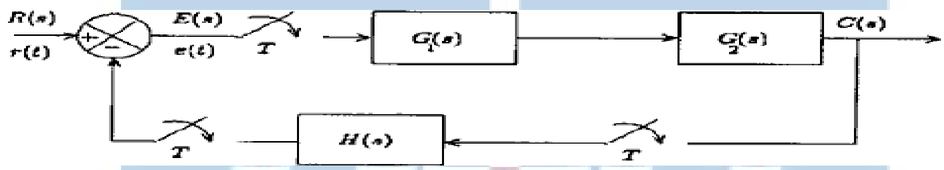
PART A

Answer all Questions. Each question carries 3 Marks

1 Explain any four advantages of sampled data control systems.

2 Determine the z-transform of $x(n)=(1/2)^n u(-n)$.

3 Obtain the pulse transfer function for the given system.



4 Obtain the poles and zeroes of the system governed by the difference equation: $y(n)+\frac{5}{4}y(n-1)+\frac{3}{8}y(n-2)=2x(n)-x(n-1)$

5 Draw and explain the mapping between s- plane to z-plane for the constant frequency loci.

6 Explain how does the P- controller affect the performance of a DT system.

7 Obtain the diagonal canonical form of the system with $G(z)=\frac{z+0.5}{(z^2+1.4z+0.4)}$

8 Determine the state transition matrix for the DT system with state matrix $A=\begin{bmatrix}0 & 1\\ -0.15 & -1\end{bmatrix}$

9 State and explain the Liapunov stability theorem for LTI discrete time systems.

10 Determine the observability of the system with: $A=\begin{bmatrix}-5 & 0\\ -2 & -3\end{bmatrix}; C=\begin{bmatrix}1 & -1\end{bmatrix}$

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Derive the transfer function of a ZoH circuit. **(5)**

b) Determine the inverse z-transform of the following functions: $i) X(z)=\frac{2z^{-1}}{(1-0.25z^{-1})^2}; ROC: |z|>\frac{1}{4}, and, ii) F(z)=\frac{3z^{-1}}{(1-z^{-1})(1-2z^{-1})}; ROC: |z|>2$ **(9)**

12 a) Determine the Z transform of $H(s)=\frac{122_3}{s(s+2)^2}$ **(4)**

b) Write short notes on:

i) Aliasing effect

ii) Importance of First order hold circuit

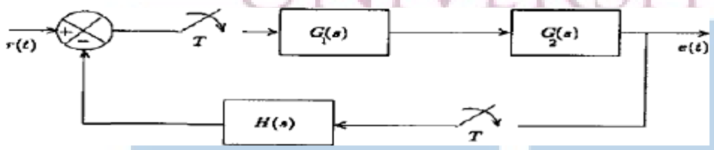
iii) Region of convergence for ZT **(10)**

Module 2

13 a) i) Obtain the direct form realization for the system described by the difference equation: $y(n) - \frac{5}{6} y(n-1) + \frac{1}{6} y(n-2) = 2x(n)$

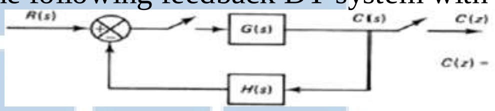
ii) Also determine the impulse response h(n) for the above system. **(3+5)**

b) Obtain the pulse transfer function for the unity feedback system with $G_1(s) = \frac{1}{s}$, $G_2(s) = \frac{1}{(s+2)}$ and assume T=1 second



(6)

14 a) Obtain the unit impulse response C(n) of the following feedback DT system with $G(s) = \frac{1}{(s+3)}$, , . $H(s) = \frac{1}{s}$,



Assume ideal sampling and T=1 ms. **(9)**

b) Explain the factors on which the steady state error constants depend on? **(5)**

Module 3

15 a) Check stability of the system described by the following characteristic equation, using Bilinear transformation: $z^3 - 0.2z^2 - 0.25z + 0.05 = 0$ **(7)**

b) With suitable characteristics compare between PI and PD controllers. **(7)**

16 a) For a unity feedback system with $G(z) = \frac{K}{z(z^2 - 0.2z - 0.25)}$ determine the range for K for ensuring stability, using Jury's test. **(5)**

b) With help of suitable sketches, explain how can you use root locus technique to design a digital controller. **(9)**

Module 4

17 a) Obtain the phase variable representation for the system with $G(z) = \frac{z+0.5}{(z^3 + 1.4z^2 + 0.5z + 0.2)}$ **(5)**

b) Determine the solution for the homogeneous system x(k+1)= G x(k), where: $G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$ and $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$ **(9)**

18 a) Determine the pulse transfer function Y(z)/U(z) for the system with:

x(k+1)= G x(k)+ Hu(k) and y(k)= Cx(k)+Du(k),

where $G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$, $H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ $C = [1 \quad 0]$ and D=0 **(9)**

b) Show that for a given pulse transfer function, the states space representation is not unique. **(5)**

a) Determine the stability of the LTI system with state model using Liapunov method: **(9)**

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -5 \end{bmatrix} X$$

b) Determine the controllability of the state model: $\dot{x} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 2 \\ 0 & -1 & -7 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$ **(5)**

19 a) Test stability of the nonlinear system given below, using Liapunov method.

$$\dot{X} = \begin{bmatrix} -4 & 0 \\ 3x_2^2 & -2 \end{bmatrix} X$$

(4)

b) Design a state feedback controller for the following system such that the closed loop poles are placed at: -1 ± j2 and -10. $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 2 \\ 0 & -1 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix} u$ **(10)**

Syllabus

Module 1

Digital control system (10 hours)

Basic block diagram of digital control system- Typical examples- Advantages of digital control systems.

Mathematical modelling of sampling process- sampling theorem- Aliasing effect- Impulse train sampling- Zero order and First order hold circuits- Signal reconstruction.

Discrete form of special functions- Discrete convolution and its properties.

Z Transform: Region of convergence- Properties of Z transform –- Inverse ZT- methods.

Module 2

Analysis of LTI Discrete time systems (8 hours)

Difference equation representations of LTI systems- Block diagram representation in Direct form

Z-Transfer function- Analysis of difference equation of LTI systems using Z transfer function.

Pulse transfer function: Pulse transfer function of closed loop systems.

Time responses of discrete data systems-Steady state performance-

Static error constants

Module 3

Stability analysis and Digital controllers (9 hours)

Stability analysis: Stability analysis of closed loop systems in the z-plane, Jury's stability test- Use of bilinear transformation for stability analysis.

Digital Controllers: Introduction to Digital Controllers- Root locus based design of digital Controllers.

PID controllers: Digital PID controller and design of PID controllers.

Module 4

State space analysis (8 hours)

State variable model of discrete data systems -Various canonical form representations- controllable, observable forms, Diagonal canonical and Jordan canonical forms

State transition matrix: Properties- Computation of state transition matrix using z-transform method -Solution of homogeneous systems

Determination of transfer function from state space model.

Module 5

Pole placement design and Liapunov stability analysis (10 hours)

Controllability and observability for continuous time systems

Pole placement design using state feedback for continuous time systems

Controllability and observability for discrete time systems- Digital control design using state feedback discrete time systems

Liapunov stability Analysis: Liapunov function- Liapunov methods to stability of linear and nonlinear systems- Liapunov methods to LTI continuous time systems

Liapunov methods to LTI Discrete time systems (Theorem only).

Text Books:

1. Ogata K., Discrete Time Control Systems, 2/e, Pearson Education.
2. Kuo B. C, Digital Control Systems, 2/e, Saunders College Publishing, Philadelphia, 1992.
3. Gopal M**,** Digital Control and State Variable Methods, 2/e, Tata McGraw Hill
4. Philips C. L., Nagle H. T. and Chakraborthy A,, Digital Control Systems, 4/e, Pearson

References:

1. Constantine H. Houpis and Lamont G. B., Digital Control Systems Theory, Hardware Software, 2/e, McGraw Hill.
2. Isermann R., Digital Control Systems, Fundamentals, Deterministic Control, 2/e, Springer Verlag, 1989.
3. Liegh J. R, Applied Digital Control, 2/e, Dover Publishers.
4. Gopal M, Modern Control System Theory, 2/e, New Age Publishers

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**Digital control system (10 hours)**	
1.1	Basic block diagram of digital control system- Typical examples- Advantages of digital control systems.	1
1.2	Mathematical modelling of sampling process -sampling theorem- Aliasing effect- Impulse train sampling	2
1.3	Zero order and First order hold circuits- Signal reconstruction	2
1.4	Discrete form of special functions- Discrete convolution and its properties	1
1.5	Z Transform: Region of convergence- Properties of the Z transform –	2
1.6	Inverse ZT- methods	2
2	**Analysis of LTI Discrete time systems (8 hours)**	
2.1	Difference equation representations of LTI systems- Delay operator and block diagram representation in Direct form	1
2.2	Z-Transfer function- Analysis of difference equation of LTI systems using ZTF	2
2.3	Pulse transfer function: Pulse transfer function of closed loop systems	2
2.4	Time responses of discrete data systems-Steady state performance- static error constants	3
3	**Stability analysis and Digital controllers (9 hours)**	
3.1	Stability analysis: Stability analysis of closed loop systems in the z-plane, Jury's stability test.	2
3.2	Use of bilinear transformation and extension of Routh-Hurwitz criterion for stability.	2
3.3	Digital Controllers: Introduction to Digital controllers- Root locus based design of Digital controllers.	3
3.4	PID controllers: Digital PID controller and design of PID controllers.	2
4	**State space analysis (8 hours)**	
4.1	State variable model of discrete data systems -Various canonical form representations-controllable and observable forms	2
4.2	Diagonal canonical and Jordan forms	2
4.3	State transition matrix- properties- Computation of state transition matrix using z-transform method	2
4.4	Solution of homogeneous systems	1
4.5	Determination of pulse transfer function from state space model	1
5	**Pole placement design and Liapunov Stability Analysis (10 hours)**	
5.1	Controllability and observability for continuous time systems	2
5.2	Pole placement design using state feedback for continuous time systems	2

5.3	Controllability and observability for discrete time systems- Digital control design using state feedback discrete time systems	3
5.4	Liapunov stability Analysis: Liapunov function- Liapunov methods to stability of linear and nonlinear systems- Liapunov methods to LTI continuous time systems	2
5.5	Liapunov methods to LTI Discrete Time systems (Theorem only).	1

EOT 384	DEEP LEARNING	Category	L	T	p	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a sub-field of machine learning and a sub-field of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

Prerequisite:

Sound knowledge in Basics of linear algebra and probability theory

CO1	Demonstrate the concepts in machine learning. **(Cognitive Knowledge Level: Understand)**
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.**(Cognitive Knowledge Level: Understand)**
CO3	Demonstrate the concept of the feed forward neural network and its training process. **(Cognitive Knowledge Level: Apply)**
CO4	Build CNN and Recurrent Neural Network (RNN)models for different use cases. **(Cognitive Knowledge Level: Apply)**
CO5	Use different neural network/deep learning models for practical applications. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	POl	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	POlO	POll	PO12
CO1	3	3	2	2								2
CO2	3	3	2	2								2
CO3	3	3	2	2								2
CO4	3	3	2	2	2	2						2
CO5	3	3	2	2								2

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
POl	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3hours**

Continuous Internal Evaluation Pattern:

Attendance :**10marks**

Continuous Assessment Tests :25marks

Continuous Assessment Assignment :**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding upto15marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2sub-divisions and carry 14 marks.

Syllabus

DEEP LEARNING

(***General Instructions***: *Instructors are to introduce students to anyone software platform (preferably Python learnt in EOT 383) and demonstrate the working of the algorithms in the syllabus using suitable use cases and public data sets to give a better understanding of the concepts discussed. Tutorial hour may be used for this purpose*)

Module-1 (Introduction)

Machine Learning basics (Revision) - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance, Bias-variance Trade-off. Challenges in machine learning. Simple Linear Regression, Multiple Linear regression,Logistic Regression, Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve(ROC), Area Under Curve(AUC).

Module- 2 (Optimization and Neural Networks) Introduction to neural networks

Motivation from Biological neuron,McCulloch Pitts Neuron, -Single layer perceptrons, Multi LayerPerceptrons (MLPs), Linearly Separable Boolean functions, Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.

Module-3 (Convolutional Neural Network)

Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

Module-4 (Recurrent Neural Network) (Convolutional Neural Network)

Convolution operation, Motivation, Pooling, CNN architecture, MLP verses CNN- Popular CNN architecture – LeNet, AlexNet- Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST

Module-5 (Application Areas) (Recurrent Neural Network)

Sequence learning problems, Back Propagation Through Time, The problem of vanishing and exploding gradients, Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, attention Mechanism and Transformers.

Text Books

1. Ian Goodfellow,Yoshua Bengio, Aaron Courville, DeepLearning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Aggarwal, Charu C.,Neural Networks and Deep Learning, Springer International Publishing A G, part of Springer Nature 2018.
4. Nikhil Buduma and Nicholas Locascio, “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed).” , 2017. O'Reilly Media, Inc

Reference Books

1. Russell Reed, Robert J Marks II, Neural Smithing: Supervised Learning in Feed forward Artificial Neural Networks, A Bradford Book, 2014
2. Mohit Sewak,Md.Rezaul Karim, Pradeep Pujari, PracticalConvolutional Neural Networks, Packt Publishing2018
3. Sudharsan Ravichandran, Hands-On Deep Learning Algorithms with Python by Packt Publishing 2019
4. Francois Chollet, Deep Learning with Python, Manning Publications Co.,2018
5. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
6. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
7. Michael Nielsen, Neural Networks and Deep Learning, 2018

Sample Course Level Assessment Questions

Course Outcome1(COl):

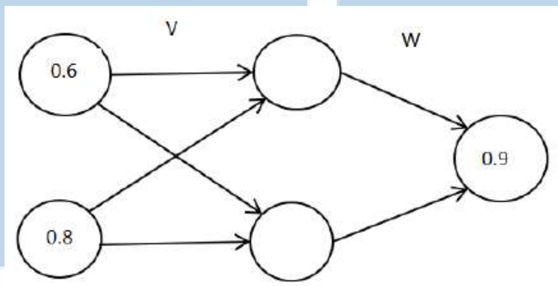
1. Compare regression and classification.
2. Define supervised learning? Distinguish between regression and classification.
3. Discuss the different learning approaches used in machine learning.

Course Outcome 2(CO2):

1. What are hyper parameters? Why are they needed?
2. What issues are to be considered whiles electing a model for applying machine learning in a given problem?

Course Outcome 3(CO3):

1. Update the parameters V11 in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V11= 0.2, V12=0.l ,V21=0.l, V22=0.3,V11=0.2,W11=0.5, W21=0.2



2. Draw the architecture of a multi-layer perceptron.
3. Derive update rules for parameters in the multi-layer neural network through the gradient descent.

Course Outcome 4(CO4):

1. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks.
2. Suppose that a CNN was trained to classify images in to different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?
3. Explain how the cell state is updated in the LSTM model from Ct-1 to Ct
4. Show the steps involved in an LSTM to predict stock prices.

Course Outcome 5(CO5):

1. Show the steps involved in an LSTM to predict stock prices.
2. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.
3. Development a deep learning solution for problems in the domain i) natural language processing or ii Computer vision with appropriate software platform such as Python or R or Matlab etc. (Assignment/ Course project)

Model Question Paper

QPCODE: **PAGES:4**

RegNo: ……………………

Name:……………………

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (MINOR), MONTH & YEAR

Course Code: EOT 384

Course Name: DEEP LEARNING

Max.Marks:100 **Duration: 3 Hours**

PART A

(Answer all Questions. Each question carries 3 Marks)

1. Distinguish between supervised learning and Reinforcement learning. Illustrate with an example.
2. Differentiate classification and regression.
3. Compare over fitting and under fitting. How it can affect model generalization.
4. Why does a single perceptron cannot simulate simple XOR function? Explain how this limitation is overcome?
5. Illustrate the strengths and weaknesses of convolutional neural networks.
6. Illustrate convolution and pooling operation with an example
7. How many parameters are there in AlexNet? Why the data set size (1.2million) is important for the success of AlexNet?
8. Explain your understanding of unfolding a recursive or recurrent computation into a computational graph.
9. Illustrate the use of deep learning concepts in Speech Recognition.
10. What is an autoencoder? Give one application of an autoencoder

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11.(a) "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E". What is your understanding of the term stask, performance and experience. Explain with two examples (10)

(b) "How does bias and variance trade-off affect machine learning algorithms? (4)

OR

12.(a)Illustrate the concepts of Websearch, Page Ranking, Recommender systems with suitable examples. (10)

(b)List and discuss the different hyper parameters used in fine tuning the traditional machine learning models (4)

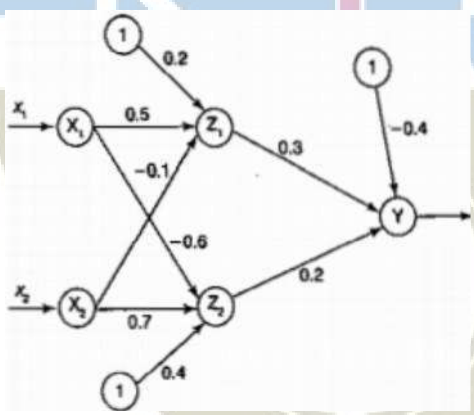
13.(a)How multilayer neural networks learn and encode higher level features from input features. (7)

(b)Explain gradient decent and delta rule? Why stochastic approximation to gradient descent is needed? (7)

OR

14.(a) Find the new weights for the network using back propogation algorithm, the network is given with a input pattern [-1,1] and target output as +1, Use

learning rate of alpha=0.3 and bipolar sigmoid function. (7)



(b)Write an algorithm for back propagation which uses stochastic gradient descent (7)

method. Comment on the effect of adding momentum to the network.

15.(a) Input to CNN architecture is a color image of size 112x112x3. The first convolution layer comprises of 64 kernels of size 5x5 applied with a stride of 2 and padding 0. What will be the number of parameters? (5)

(a) Let X=[-1, 0,3,5] W=[.3,.5.2,.1] be the the input of ith layer of a neuralnetwork and to apply softmax function. What should be the output of it? (4)

(c) Draw and explain the architecture of convolutional network. (5)

OR

16.(a) Explain the concept behind i)Early stopping ii)drop out iii)weight decay (9)

(b)How back propagation is used to learn higher-order features in a convolutional Network? (5)

17.(a)Explain the working of RNN and discuss how back propagation through time is used in recurrent networks. (8)

(b)Describe the working of a long short term memory in RNNs. (6)

OR

18. (a) What is the vanishing gradient problem and exploding gradient problem? (8)

(b)Why do RNNs have a tendency to suffer from exploding/vanishing gradient? (6)

How to overcome this challenge?

19.(a) Explain any two word embedding techniques(8)

(b)Explain the merits and demerits of using Auto encoders in Computer Vision. (6)

OR

20.(a) Illustrate the use of representation learning in object classification. (8)

(b)Compare Boltzmann Machine with Deep Belief Network. (6)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT386	**ELECTRIC VEHICLES**	**VAC**	**2**	**2**	**0**	**4**

Preamble

This course aims to provide a strong foundation on electric vehicles. Various drivetrain topologies, control of drives, energy storage systems, charging technologies and energy management strategy in electric vehicles will be discussed.

Prerequisite

Electrical machines

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Describe the various electric drivetrain topologies
CO 2	Describe the configuration and control of DC motor drives and Induction motor drives
CO 3	Analyse the battery-based energy storage system in electric vehicles
CO 4	Describe the various levels of charging in electric vehicles
CO 5	Describe the energy management strategy in electric vehicles

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	-	-	-	-	-	-	-	1
CO 2	3	3	3	-	-	-	-	-	-	-	-	2
CO 3	3	3	3	-	2	-	-	-	-	-	-	2
CO 4	3	3	3	-	-	-	-	-	-	-	-	3
CO 5	3	3	3	-	2	-	-	-	-	-	-	3

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	10	10	20
Apply (K3)	20	20	40
Analyse (K4)	10	10	20
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern **:** There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Describe the various electric drivetrain topologies.
2. List the characteristics of the transmission system in a vehicle.
3. Explain how the power flow is controlled in electric vehicles.

Course Outcome 2 (CO2):

1. How thermal management is done in electric vehicles? Explain.
2. List major components in the drivetrain of an electric vehicle.
3. Explain the control strategies for DC drives in electric vehicles.

Course Outcome 3(CO3):

1. What are the various levels of charging? Explain.
2. List any three motors that can be used in the drivetrain of electric and hybrid electric vehicles.
3. Explain about Lithium ion batteries with the help of necessary diagram. Write the chemical reactions involved in it.

Course Outcome 4 (CO4):

1. Explain the C-rating of a battery
2. Write short notes on battery management systems.
3. Explain the various AC chargers used for electric vehicles.

Course Outcome 5 (CO5):

1. What are the different energy management strategies in electric vehicles?
2. What is meant by CAN transfer protocol
3. Compare various energy management strategies in electric vehicles.

Model Question Paper

QPCODE:

Reg. No:____________
Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EOT386**
Course Name: **ELECTRIC VEHICLES**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Describe the various electric drivetrain topologies.
2. List the characteristics of the transmission system in a vehicle.
3. How thermal management is done in electric vehicles? Explain.
4. List major components in the drivetrain of an electric vehicle.
5. What are the various levels of charging? Explain.
6. List any three motors that can be used in the drivetrain of electric and hybrid electric vehicles.
7. Explain the C-rating of a battery
8. Write short notes on battery management systems.
9. What are the different energy management strategies in electric vehicles?
10. What is meant by CAN transfer protocol

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. Explain the social and environmental importance of electric vehicles.

12. Explain how the power flow is controlled in electric vehicles.

Module 2

13. a. Highlight various factors that influence the component sizing in the power trains of lectric vehicles.

 b. Explain the control strategies for DC drives in electric vehicles.

14. a. Explain the thermal modelling in electric vehicles.

 b. Demonstrate the Field Oriented Control of Induction Motors in the powertrain of electric vehicles.

Module 3

15. a. Explain about Lithium ion batteries with the help of necessary diagram. Write the chemical reactions involved in it.

    b. What are the various battery parameters? Briefly explain.

16. a. Explain the block diagram of electric drive system used in electric vehicles.

    b. Suggest various methods to minimize the battery size and maximize battery life during the power flow control in electric drive-train topologies.

Module 4

17. Explain the various AC chargers used for electric vehicles.

18. Explain the various wireless charging schemes used for electric vehicles.

Module 5

19. Compare various energy management strategies in electric vehicles.

20. Discuss about a typical CAN layout in a electric vehicle with the help of block diagram.

Syllabus

Module 1

Introduction to Electric Vehicles (9 hrs)

History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module 2

Electric Propulsion unit (9 hrs)

Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor and synchronous motor drives. 3 phase to 2 phase conversion. Heating and Cooling of motors. Thermal management in electric vehicles. Thermal efficiency, Steady state and dynamic analysis.

Module 3

Energy Storage (9 hrs)

Introduction to Energy Storage Requirements in Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis. Hybridization of different energy storage devices. Chemistry of Li-Fe iron battery. Battery management systems.

Module 4

Sizing the drive system (9 hrs)

Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology. Charging: Various levels of charging. AC chargers and DC chargers. Wireless charging. Renewable energy-based charging.

Module 5

Communications, supporting subsystems (9 hrs)

In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in electric vehicles, classification of different energy management strategies, comparison of different energy management strategies. Various control systems in electric vehicle, sensors, resolvers etc, Smart grid.

Textbooks

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Bimal K. Bose "Modern power electronics and AC drives" Pearson Education, Asia 2003
   Dubey G. K. "Power semiconductor control drives" Prentice Hall, Englewood Cliffs, New Jersey, 1989.

Reference Books

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. N. K. De, P. K. Sen "Electric drives" Prentice Hall of India 2002

4. Pillai S. K. “A first course on electric drives”, Wieley Eastern Ltd, New Delhi
5. Vedam Subrahmanyam, “Electric Drives”, MC Graw Hill Education, New Delhi

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**Introduction to Electric Vehicles (9 hrs)**	
1.1	History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies.	2
1.2	Electric Drive-trains: Basic concept of electric traction	2
1.3	introduction to various electric drive-train topologies	3
1.4	Power flow control in electric drive-train topologies, fuel efficiency analysis, fuel efficiency analysis.	2
2	**Electric Propulsion unit (9 hours)**	
2.1	Introduction to electric components used in electric vehicles	2
2.2	Configuration and control of DC Motor drives, Configuration and control of Induction Motor and synchronous motor drives.	3
2.3	3 phase to 2 phase conversion for the analysis of induction and synchronous motor drives.	2
2.4	Heating and Cooling of motors. Thermal management in electric vehicles. Thermal efficiency, Steady state and dynamic analysis.	2
3	**Energy Storage (9 hours)**	
3.1	Introduction to Energy Storage Requirements in Electric Vehicles.	1
3.2	Battery based energy storage and its analysis.	2
3.3	Fuel Cell based energy storage and its analysis.	1
3.4	Hybridization of different energy storage devices.	2
3.5	Chemistry of Li-Fe iron battery.	1
3.6	Battery management systems.	2
4	**Sizing the drive system (9 hours)**	
4.1	Sizing the propulsion motor, sizing the power electronics	2
4.2	Selecting the energy storage technology.	1
4.3	Charging: Various levels of charging.	2
4.4	AC chargers and DC chargers. Wireless charging.	2

4.5	Wireless charging. Renewable energy-based charging.	2
5	**Communications, supporting subsystems (9 hours)**	
5.1	In vehicle networks- CAN	1
5.2	Energy Management Strategies: Introduction to energy management strategies used in electric vehicles	1
5.3	Classification of different energy management strategies	2
5.4	Comparison of different energy management strategies.	2
5.5	Various control systems in electric vehicle, sensors, resolvers etc,	2
5.6	Smart grid	1

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
	MODULE 1	
1.1	Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement,	1 hour
1.2	Overfitting, Underfitting, Hyperparameters	1 hour
1.3	Validation sets, Estimators -Bias and Variance Trade off. Challenges in machine learning.	1 hour
1.4	Simple and multiple Linear Regression	1 hour
1.5	Illustration of Simple and multiple Linear Regression	1 hour
1.6	Logistic Regression	1 hour
1.7	Illustration of Logistic regression	1 hour
1.8	Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, ROC, AUC.	1 hour
1.9	Illustrative Examples for performance measures	1 hour
	MODULE II	
2.1	Motivation from Biological neuron, McCulloch Pitts Neuron	1 hour
2.2	Single layer perceptrons, Multi LayerPerceptrons (MLPs)	1 hour
2.3	Linearly Separable Boolean functions	1 hour
2.4	Representation Power of MLPs	1 hour
2.5	Activation functions - Sigmoid, Tanh, ReLU, Softmax, Loss function	1 hour
2.6	Training MLPs with backpropagation	1 hour
2.7	Illustration of back propagation algorithm	1 hour

2.8	Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems	1 hour
2.9	Local and spurious Optima, Computational Challenges.	1 hour
2.10	Applications of neural networks.	1 hour
MODULE III		
3.1	Introduction to deep learning, Deep feed forward network	1 hour
3.2	Training deep models - Introduction, setup and initialization issues	1 hour
3.3	Solving vanishing and exploding gradient problems	1 hour
3.4	Concepts of optimization, Gradient Descent (GD), GD with momentum.	1 hour
3.5	Nesterov accelerated GD, Stochastic GD.	1 hour
3.6	AdaGrad, RMSProp, Adam.	1 hour
3.7	Concepts of Regularization, L1 and L2 regularization.	1 hour
3.8	Early stopping, Dataset augmentation, Parameter sharing and tying	1 hour
3.9	Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.	1 hour
MODULE IV		
4.1	Convolutional Neural Networks – Convolution operation	1 hour
4.2	Motivation, Pooling	1 hour
4.3	CNN architecture, MLP verses CNN	1 hour
4.4	Popular CNN architecture – LeNet, AlexNet	1 hour
4.5	Convolution and Pooling as an infinitely strong prior	1 hour
4.6	Variants of convolution functions, Structured outputs, Data types	1 hour
4.7	Efficient convolution algorithms	1 hour

4.8	Practical use cases for CNNs	1 hour
	MODULEV	
5.1	Recurrent neural networks – Sequence learning problems	1 hour
5.2	Back Propagation Through Time	1 hour
5.3	The problem of vanishing and exploding gradient	1 hour
5.4	Computational graphs, RNN design	1 hour
5.5	Encoder – decoder sequence to sequence architectures,	1 hour
5.6	Deep recurrent networks, recursive neural networks	1 hour
5.7	Modern RNNs LSTM and GRU	1 hour
5.8	Modern RNNs LSTM and GRU	1 hour
5.9	Practical use cases for RNN	1 hour

CST 394	NETWORK SECURITY	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms.

Course Outcomes: After the completion of the course the student will be able to

CO#	Course Outcomes
CO1	Identify the key aspects of security, intrusion detection systems and digital signature schemes **(Cognitive Knowledge Level: Apply)**
CO2	Explain the security standards used in network communication **(Cognitive Knowledge Level:Understand)**
CO3	Identify the mechanisms in email security services **(Cognitive Knowledge Level: Apply)**
CO4	Summarize the protocols used to provide web security **(Cognitive Knowledge Level: Understand)**
CO5	Explain the fundamental concepts of wireless network security and firewalls **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔								✔
CO2	✔	✔	✔	✔								✔
CO3	✔	✔	✔	✔		✔						✔
CO4	✔	✔	✔	✔	✔	✔						✔
CO5	✔	✔	✔	✔								✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (%)
	Test 1 (%)	Test 2 (%)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			

Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1 (Network Security Basics)

Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).

Module – 2 (Network Security Standards)

Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security)

Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.

Module – 4 (Web Security)

Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol.

Module – 5 (Wireless Network Security and Firewalls)

IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.

Text Books

1. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", 2/e, PHI.
2. William Stallings, "Cryptography and Network Security Principles and Practice", 5/e, Pearson Education Asia.

References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3/e, Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill.
3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Using the Schnorr digital signature scheme, let q = 83, p = 997 and d = 23. Find values for e_1 and e_2.
2. The Digital Signature Algorithm (DSA) specifies that if the signature generation process results in a value of zero, a new value of k should be generated and the signature should berecalculated. Give reason.

Course Outcome 2 (CO2):

1. In Kerberos v4, the authenticator field is not of security benefit when asking the Key Distribution Center (KDC) for a ticket for Bob, but useful when logging in as Bob. Give reasons for your answer.
2. How does the stateless cookie protocol provide clogging protection?

Course Outcome 3 (CO3):

1. If Alice is sending an ENCRYPTED message, she first signs the message digest with her private key and then encrypts the message digest with the pre-message secret key. Why this last encryption was considered necessary for encrypted messages and not for MIC-

CLEAR or MIC-ONLY?

2. Which security services are considered desirable in the following cases? (i) Sending a purchase order (ii) Sending a ransom note. (iii) Sending a mission description to security officials.
3. Explain the security mechanism used in Gmail communication.

Course Outcome 4 (CO4):

1. Is it possible in SSL for the receiver to reorder SSL record blocks that arrive out of order? If so, how it can be done? If not, why?
2. Describe any five web security threats, their consequences and countermeasures.

Course Outcome 5 (CO5):

1. Explain the security areas addressed by IEEE 802.11i.
2. Describe the advantages and disadvantages of application layer firewalls.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE (HONORS) EXAMINATION, MONTH &YEAR

Course Code: CST 394

Course Name: Network Security

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Distinguish between signature-based and anomaly-based intrusion detection techniques.

2. A trusted third party is considered as a main component in a network security model. Why?

3. How is endpoint identifier hiding achieved in real-time communication?

4. Show how encryption is used to provide privacy and integrity in Kerberos v5.

5. End-to-end privacy is essential for e-mail security. How is this achieved?

6. List the four steps for preparing an EnvelopedData MIME entity.

7. Show the operation of a Secure Sockets Layer (SSL) Record protocol.

8. For Secure Shell (SSH) packets, what is the advantage of not including the MAC in the scope of packet encryption?

9. List the three security services provided by IEEE 802.11i.

10. Define the terms Access Point, Basic Service Set, Extended Service Set.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Using the ElGamal scheme, let p = 881 and d = 700, find values for e1 and e2. Choose r = 17. Find the value of S1 and S2 if M = 400. **(8)**

    (b) Explain the requirements and challenges of network security. **(6)**

OR

12. (a) In ElGamal, Schnorr and DSS, what happens if an attacker can find the value of random secret key used by the signer? Also, what happens if a user uses the same value of random secret key to sign two messages? Explain your answer for each scheme separately. **(8)**

    (b) Explain the network security model with the help of a neat diagram. **(6)**

13. (a) Alice wishes to log into Bob's workstation remotely. List the steps involved in this communication if Kerberos v4 is used. **(7)**

    (b) How does Diffie-Hellman technique provide perfect forward secrecy using signature keys? **(7)**

OR

14. (a) Explain the algorithm for Message Authentication Code (MAC) calculation and verification in Kerberos v5 rsa-md5-des. **(8)**

    (b) Compare the aggressive mode and main mode of Phase 1 Internet Key Exchange (IKE). **(6)**

15. (a) Describe the different methods by which authentication of source is performed in email communication. **(7)**

    (b) Explain the Signed data and Clear-signed data functions provided by S/MIME. **(7)**

OR

16\. (a) Explain the advantages of Pretty Good Privacy (PGP) over Privacy Enhanced Mail (PEM). **(7)**

(b) Define non-repudiation. Describe the different ways by which it is implemented in email communication. **(7)**

17\. (a) Describe the significance of pseudo-random function of Transport Layer Security. **(7)**

(b) Explain the four different phases of Secure Sockets Layer (SSL) HandshakeProtocol. **(7)**

OR

18\. (a) Describe how connection initiation and connection closure is done in Hyper Text Transfer Protocol Secure (HTTPS). **(7)**

(b) Illustrate the sequence of events in Secure Shell (SSH) transport layer protocol packet exchanges. **(7)**

19\. (a) Explain the Discovery phase and Authentication phase of IEEE 802.11i operation. **(7)**

(b) Why are firewalls needed? Compare the features of packet filters and circuit level firewalls. **(7)**

OR

20\. (a) Explain the two authentication methods used in Wired Equivalent Privacy (WEP). **(7)**

(b) Describe the three transaction classes provided by Wireless Transaction Protocol. **(7)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Network Security Basics) (7 hrs)		
1.1	Security requirements, Challenges of security	1
1.2	Network security model	1
1.3	Worms, Viruses, Trojans, Spyware, Adware	1
1.4	Intrusion Detection Systems (IDS) uses, Techniques	1
1.5	ElGamal digital signature	1
1.6	Schnorr digital signature	1
1.7	Digital Signature Standard (DSS)	1
Module - 2 (Network Security Standards) (12 hrs)		
2.1	Kerberos v4 configuration, Authentication	1
2.2	Kerberos v4 encryption	1
2.3	Kerberos v4 message formats	1
2.4	Kerberos v5 cryptographic algorithms – rsa-md5-des, des-mac, des-mac-k	1
2.5	Kerberos v5 cryptographic algorithms - rsa-md4-des, rsa-md4-des-k, Encryption for privacy and integrity	1
2.6	Kerberos v5 message formats	1
2.7	Public Key Infrastructure (PKI) trust models	1
2.8	PKI revocation	1
2.9	Perfect Forward Secrecy (PFS), Denial-of-Service protection	1
2.10	Endpoint identifier hiding, Live partner reassurance	1
2.11	Internet Protocol Security (IPSec) Authentication Header (AH), Encapsulating Security Payload (ESP)	1

2.12	Internet Key Exchange (IKE) phases	1
	Module - 3 (Email Security) (9 hrs)	
3.1	Security services for email, Establishing keys, Privacy	1
3.2	Authentication, Message integrity, Non-repudiation	1
3.3	Privacy Enhanced Mail (PEM) encryption, Source authentication	1
3.4	PEM integrity protection, Message formats (Lecture 1)	1
3.5	PEM message formats (Lecture 2)	1
3.6	Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM	1
3.7	Pretty Good Privacy (PGP) encoding, Certificate and key revocation, Anomalies	1
3.8	PGP Object formats (Lecture 1)	1
3.9	PGP Object formats (Lecture 2)	1
	Module – 4 (Web Security)(9 hrs)	
4.1	Web security considerations, Threats, Secure Sockets Layer (SSL) architecture	1
4.2	SSL protocols (Lecture 1)	1
4.3	SSL protocols (Lecture 2)	1
4.4	Transport Layer Security (TLS) differences from SSL (Lecture 1)	1
4.5	TLS differences from SSL (Lecture 2)	1
4.6	Hypertext Transfer Protocol Secure (HTTPS) connection initiation, Closure	1
4.7	Secure Shell (SSH) transport layer protocol	1
4.8	SSH user authentication protocol	1
4.9	SSH connection protocol	1

Module - 5 (Wireless Security and Firewalls) (8 hrs)		
5.1	IEEE 802.11 Wireless LAN network components, Architectural model, Services	1
5.2	IEEE 802.11i wireless LAN security services, Phases of operation (Lecture 1)	1
5.3	IEEE 802.11i phases of operation (Lecture 2)	1
5.4	Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2	1
5.5	Wireless Application Protocol (WAP) services, Protocol architecture (Lecture 1)	1
5.6	WAP protocol architecture (Lecture 2)	1
5.7	Need for firewalls, Packet filters	1
5.8	Circuit-level firewalls, Application layer firewalls	1

CODE CST 294	COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in ***Machine Learning***. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

Prerequisite: A sound background in higher secondary school Mathematics.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems (Cognitive Knowledge Level: **Apply**)
CO 2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients (Cognitive Knowledge Level: **Apply**)
CO 3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems (Cognitive Knowledge Level: **Apply**)
CO 4	Train Machine Learning Models using unconstrained and constrained optimization methods (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	√	√	√	√								√
CO 2	√	√	√									√
CO 3	√	√	√	√								√
CO 4	√	√	√	√		√						√

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20%	20%	20%
Understand	40%	40%	40%
Apply	40%	40%	40%
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests : 25 marks
Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.

Module 2

ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS: Norms, Inner Products,

Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization.

Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.

Module 3

VECTOR CALCULUS : Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation.Higher Order Derivatives- Linearization and Multivariate TaylorSeries.

Module 4

Probability and Distributions : Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Changeof Variables/Inverse Transform.

Module 5

Optimization : Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.

Text book:

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https:// mml - book.github.io)

Reference books:

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang

2. Linear Algebra Done Right by Axler, Sheldon, 2015 published bySpringer

3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge UniversityPress

4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge UniversityPress

5. Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published bySpringer

6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, published by MIT Press

7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge UniversityPress

8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MITPress.

9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer

Sample Course Level Assessment Questions.Course

Outcome 1 (CO1):

1. Findtheset***S***ofallsolutionsin***x***ofthefollowinginhomogeneouslinearsystems***Ax*** = ***b***, where ***A*** and ***b*** are defined as follows:

$$A = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad b = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix ifpossible

$$A = \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

3. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to eacheigenvalue of the following matrix

$$\begin{bmatrix} 2 & 0 & 4 \\ 0 & 3 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

4. Diagonalize the following matrix, if possible

$$\begin{bmatrix} 3 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 1 & 0 & 0 & 3 \end{bmatrix}$$

5. Find the singular value decomposition (SVD) of the following matrix

$$\begin{bmatrix} 0 & 1 & 1 \\ \sqrt{2} & 2 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

Course Outcome 2 (CO2):

1. For a scalar function ***$f(x, y, z) = x^2 + 3y^2 + 2z^2$***, find the gradient and its magnitude at the point **(1, 2, -1)**.
2. Find the maximum and minimum values of the function f***$(x,y)=4x+4y-x^2-y^2$*** subject to the condition ***$x^2 + y^2 <= 2$***.
3. Suppose you were trying to minimize ***$f(x, y) = x^2 + 2y + 2y^2$***. Along what vector should you travel from (5,12)?
4. Find the second order Taylor series expansion for ***$f(x, y) = (x + y)^2$***about **(0 ,0)**.
5. Find the critical points of ***$f(x, y) = x^2 - 3xy+5x-2y+6y^2+8$***.
6. Compute the gradient of the Rectified Linear Unit (ReLU) function ***ReLU(z) = max(0 , z)***.
7. Let ***$L = ||Ax - b||^2_2$***, where ***A*** is a matrix and ***x*** and ***b*** are vectors. Derive ***dL*** in terms of ***dx***.

Course Outcome 3 (CO3):

1. Let ***J*** and ***T*** be independent events, where ***P(J)=0.4*** and***P(T)=0.7***.
   - ***i.*** Find ***$P(J \cap T)$***
   - ***ii.*** Find ***$P(J \cup T)$***
   - ***iii.*** Find ***$P(J \cap T')$***
2. Let ***A*** and ***B*** be events such that ***P(A)=0.45*** , ***P(B)=0.35*** and ***P(A*** U ***B)=0.5***. Find ***P(A|B)***.
3. A random variable **R** has the probability distribution as shown in the following table:

r	1	2	3	4	5
P(R=r)	0.2	a	b	0.25	0.15

   i. Given that ***E(R)=2.85***, find ***a*** and***b***.

ii. Find ***P(R>2)***.

4. A biased coin (with probability of obtaining a head equal to ***p> 0***) is tossed repeatedly and independently until the first head is observed. Compute the probability that the first head appears at an even numbered toss.

5. Two players A and B are competing at a trivia quiz game involving a series of questions. On any individual question, the probabilities that A and B give the correct answer are ***p*** and ***q*** respectively, for all questions, with outcomes for different questions being independent. The game finishes when a player wins by answering a question correctly. Compute the probability that A winsif

   i. A answers the firstquestion,

   ii. B answers the first question.

6. A coin for which ***P(heads) = p*** is tossed until two successive tails are obtained. Find the probability that the experiment is completed on the n^{th} toss.

Course Outcome 4(CO4):

1. Find the extrema of ***f(x, y) = x*** subject to ***g(x, y) =*** $x^2 + 2y^2 = 3$.
2. Maximize the function ***f(x, y, z) = xy + yz + xz*** on the unit sphere ***g(x, y, z) =*** $x^2 + y^2 + z^2 = 1$.
3. Provide necessary and sufficient conditions under which a quadratic optimizationproblem be written as a linear least squaresproblem.
4. Consider the univariate function $f(x) = x^3 + 6x^2 - 3x - 5$. Find its stationary points and indicate whether they are maximum, minimum, or saddlepoints.
5. Consider the update equation for stochastic gradient descent. Write down the updatewhen we use a mini-batch size ofone.
6. Consider the function

$$f(x) = (x_1 - x_2)^2 + \frac{1}{1 + x_1^2 + x_2^2}.$$

   i. Is ***f(x)*** a convex function? Justify youranswer.

   ii. Is (1 , -1) a local/global minimum? Justify youranswer.

7. Is the function $f(x, y) = 2x^2 + y^2 + 6xy - x + 3y - 7$ convex, concave, or neither? Justify youranswer.
8. Consider the following convex optimization problem

$$\text{minimize } \frac{x^2}{2} + x + 4y^2 - 2y$$

Subject to the constraint ***x + y >= 4, x, y >= 1***.

Derive an explicit form of the Lagrangian dual problem.

9. Solve the following LP problem with the simplexmethod.

$$max\ 5x_1 + 6x_2 + 9x_3 + 8x_4$$

subject to the

$$\begin{array}{ccccccccc} x_1 & + & 2x_2 & + & 3x_3 & + & x_4 & \leq & 5 \\ x_1 & + & x_2 & + & 2x_3 & + & 3x_4 & \leq & 3 \end{array}$$

$$x_1, x_2, x_3, x_4 \geq 0$$

MODEL QUESTION PAPER

	QP Code :		**Total Pages : 5**

Reg No.:________________		Name:____________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

IV SEMESTER B.TECH (HONOURS) DEGREE EXAMINATION, MONTH and YEAR

Course Code: CST 294

Course Name: COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING

Max. Marks: 100		Duration: 3 Hours

PART A

		Answer all questions, each carries3 marks.	Marks
1		Show that with the usual operation of scalar multiplication but with addition on reals given by $x \# y = 2(x + y)$ is not a vector space.	
2		Are the following sets of vectors linearly independent? Explain your answer. $x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$	
3		Find the angle between the vectors $x = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$	
4		Find the eigen values of the following matrix in terms of k. Can you find an eigen vector corresponding to each of the eigen values? $\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$	
5		Let $f(x, y, z) = xye^r$, where $r = x^2+z^2-5$. Calculate the gradient of f at the point **(1, 3, -2).**	
6		Compute the Taylor polynomials $T_n, n = 0, \dots, 5$ of $f(x) = \sin(x) + \cos(x)$ at $x_0 = 0$.	
7		Let X be a continuous random variable with probability density function on $0 <= x <= 1$ defined by $f(x) = 3x^2$. Find the pdf of $Y = X^2$.	
8		Show that if two events A and B are independent, then A and B' are independent.	
9		Explain the principle of the gradient descent algorithm.	
10		Briefly explain the difference between (batch) gradient descent and stochastic gradient descent. Give an example of when you might prefer one	

		over the other.	
		PART B	
		Answer any one Question from each module. Each question carries 14 Marks	
11	a)	i.Find all solutions to the system of linearequations $-4x + 5z = -2$ $-3x - 3y + 5z = 3$ $-x + 2y + 2z = -1$	(4)
		ii. Prove that all vectors orthogonal to **[2,−3,1]^{T}** forms a subspace **W** of $\boldsymbol{R^3}$. What is ***dim (W)*** and why?	(4)
	b)	A set of $\boldsymbol{n}$ linearly independent vectors in $\boldsymbol{R^n}$ forms a basis. Does the set of vectors **(2, 4,−3),(0, 1, 1),(0, 1,−1)** form a basis for $\boldsymbol{R^3}$? Explain yourreasons.	(6)
		OR	
12	a)	Find all solutions in $x = \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} \in R^3$ of the equation system $Ax = 12x$, where $A = \begin{bmatrix} 6 & 4 & 3 \\ 6 & 0 & 9 \\ 0 & 8 & 0 \end{bmatrix}$ and $\sum_{ii=1}^{3} x_i = 1$.	(7)
	b)	Consider the transformation ***T (x, y) = (x + y, x + 2y, 2x + 3y)***. Obtain ***ker T*** and use this to calculate the nullity. Also find the transformation matrix for***T***.	(7)
13	a)	Use the Gramm-Schmidt process to find an orthogonal basis for the column space of the following matrix. $\begin{bmatrix} 2 & 1 & 0 \\ 1 & -1 & 1 \\ 0 & 3 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	(7)
	b)	Find the SVD of the matrix. $\begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}$	(7)

		OR	
14	a)	i. Let $\boldsymbol{L}$ be the line through the origin in $\boldsymbol{R^2}$ that is parallel to the vector **[3, 4]^T**. Find the standard matrix of the orthogonal projection onto L. Also find the point on $\boldsymbol{L}$ which is closest to the point **(7, 1)** and find the point on $\boldsymbol{L}$ which is closest to the point ***(-3 , 5)***.	(6)
		ii. Find the rank-1 approximation of $\begin{bmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{bmatrix}$	
	b)	i. Find an orthonormal basis of $\boldsymbol{R^3}$ consisting of eigenvectors for the following matrix. $\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$	(8)
		ii. Finda3×3orthogonalmatrix***S***anda3×3diagonalmatrix***D*** such that $\boldsymbol{A = SDS^T}$	
15	a)	Askierisonamountainwiththeequation$\boldsymbol{z=100-0.4x^2-0.3y^2}$,wherez denotes height. i. The skier is located at the point with xy-coordinates **(1, 1),** and wants to ski downhill along the steepest possible path. In which direction (indicated by a vector **(a, b**) in the xy-plane) should the skier beginskiing. **ii.** The skier begins skiing in the direction given by the xy-vector (**a, b)** you found in part (i), so the skier heads in a direction in space given by the vector **(a, b, c**). Find the value of **c**.	(8)
	b)	Find the linear approximation to the function ***f(x,y) = 2 - sin(-x - 3y)*** at the point **(0 , π)**, and then use your answer to estimate ***f(0.001 , π)***.	(6)
		OR	
16	a)	Let ***g*** be the function given by $g(x,y) = \begin{cases} \dfrac{x^2y}{x^2+y^2} & \text{if } (x,y) \neq (0,0); \\ 0 & \text{if } (x,y) = (0,0). \end{cases}$	(8)

		i. Calculate the partial derivatives of ***g*** at **(0,0)**. ii. Show that ***g*** is not differentiable at **(0,0)**.	
	b)	Find the second order Taylor series expansion for $f(x,y) = e^{-(x^2+y^2)} \cos(xy)$ about **(0 , 0)**.	(6)
17	a)	There are two bags. The first bag contains four mangos and two apples; the second bag contains four mangos and four apples. We also have a biased coin, which shows "heads" with probability 0.6 and "tails" with probability 0.4. If the coin shows "heads". we pick a fruitat random from bag 1;otherwise we pick a fruit at random from bag 2. Your friend flips the coin (you cannot see the result), picks a fruit at random from the corresponding bag, and presents you a mango. What is the probability that the mango was picked from bag 2?	(6)
	b)	Suppose that one has written a computer program that sometimes compiles and sometimes not (code does not change). You decide to model the apparent stochasticity (success vs. no success) x of the compiler using a Bernoulli distribution with parameter μ: $p(x \mid \mu) = \mu^{x}(1-\mu)^{1-x}, \quad x \in \{0,1\}$ Choose a conjugate prior for the Bernoulli likelihood and compute the posterior distribution $p(\mu \mid x_1, \ldots, x_N)$.	(8)
		OR	
18	a)	Two dice are rolled. A = 'sum of two dice equals 3' B = 'sum of two dice equals 7' C = 'at least one of the dice shows a 1' i. What is P(A|C)? ii. What is P(B|C)? iii. Are A and C independent? What about B and C?	(6)
	b)	Consider the following bivariate distribution p(x,y) of two discrete random	(8)

variables X and Y .

			x_1	x_2	x_3	x_4	x_5
Y	y_1		0.01	0.02	0.03	0.1	0.1
	y_2		0.05	0.1	0.05	0.07	0.2
	y_3		0.1	0.05	0.03	0.05	0.04

X

Compute:

i. The marginal distributions p(x) and p(y).

ii. The conditional distributions $p(x|Y = y_1)$ and $p(y|X = x_3)$.

19 a) Find the extrema of $\boldsymbol{f(x,y,z) = x - y + z}$ subject to $\boldsymbol{g(x,y,z) = x^2 + y^2 + z^2 = 2}$. **(8)**

b) Let

$$P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}, \quad q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}, \quad \text{and } r = 1.$$

Show that $\boldsymbol{x^* = (1, 1/2, -1)}$ is optimal for the optimization problem

$$\begin{array}{ll} \text{min} & \frac{1}{2}x^{\mathsf{T}}Px + q^{\mathsf{T}}x + r \\ \text{s.t.} & -1 \leq x_i \leq 1, \; i = 1, 2, 3. \end{array}$$

(6)

OR

20 a) Derive the gradient descent training rule assuming that the target function is represented as $\boldsymbol{o_d = w_0 + w_1x_1 + \ldots + w_nx_n}$. Define explicitly the cost/ error function $\boldsymbol{E}$, assuming that a set of training examples $\boldsymbol{D}$ is provided, where each training example $\boldsymbol{d}$ $\boldsymbol{D}$ is associated with the target output $\boldsymbol{t_d}$. **(8)**

b) Find the maximum value of $\boldsymbol{f(x,y,z) = xyz}$ given that $\boldsymbol{g(x,y,z) = x + y + z = 3}$ and $\boldsymbol{x,y,z>=0}$. **(6)**

***

Teaching Plan		
No	**Topic**	**No. of Lectures (49)**
	Module-I (LINEAR ALGEBRA)	**8**
1.1	Matrices, Solving Systems of Linear Equations	1
1.2	Vector Spaces	1
1.3	Linear Independence	1
1.4	Basis and Rank (Lecture – 1)	1
1.5	Basis and Rank (Lecture – 2)	1
1.6	Linear Mappings	1
1.7	Matrix Representation of Linear Mappings	1
1.8	Images and Kernel	1
	Module-II (ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS)	**11**
2.1	Norms, Inner Products	1
2.2	Lengths and Distances, Angles and Orthogonality	1
2.3	Orthonormal Basis, Orthogonal Complement	1
2.4	Orthogonal Projections – Projection into One Dimensional Subspaces	1
2.5	Projection onto General Subspaces.	1
2.6	Gram-Schmidt Orthogonalization	1
2.7	Determinant and Trace, Eigen values and Eigenvectors.	1
2.8	Cholesky Decomposition	1
2.9	Eigen decomposition and Diagonalization	1
2.10	Singular Value Decomposition	1
2.11	Matrix Approximation	1

	Module-III (VECTOR CALCULUS)	**9**
3.1	Differentiation of Univariate Functions, Partial Differentiation and Gradients	1
3.2	Gradients of Vector Valued Functions (Lecture 1)	1
3.3	Gradients of Vector Valued Functions (Lecture 2)	1
3.4	Gradients of Matrices	1
3.5	Useful Identities for Computing Gradients	1
3.6	Backpropagation and Automatic Differentiation – Gradients in deep Netwok	1
3.7	Automatic Differentiation	1
3.8	Higher Order Derivatives	1
3.9	Linearization and Multivariate Taylor Series	1
	Module-IV (PROBABILITY AND DISTRIBUTIONS)	**10**
4.1	Construction of a Probability Space	1
4.2	Discrete and Continuous Probabilities (Probability Density Function, Cumulative Distribution Function)	1
4.3	Sum Rule, Product Rule	1
4.4	Bayes' Theorem	1
4.5	Summary Statistics and Independence (Lecture 1)	1
4.6	Summary Statistics and Independence (Lecture 2)	1
4.7	Bernoulli, Binomial, Uniform (Discrete) Distributions	1
4.8	Uniform (Continuous), Poisson Distributions	1
4.9	Gaussian Distribution	1
4.10	Conjugacy and the Exponential Family (Beta – Bernoulli, Beta – Binomial Conjugacies)	1
	Module-V (OPTIMIZATION)	7
5.1	Optimization Using Gradient Descent.	1
5.2	Gradient Descent With Momentum, Stochastic Gradient Descent	1
5.3	Constrained Optimization and Lagrange Multipliers (Lecture 1)	1

5.4	Constrained Optimization and Lagrange Multipliers (Lecture 2)	1
5.5	Convex Optimization	1
5.6	Linear Programming	1
5.7	Quadratic Programming	1

COURSE CODE	COURSE NAME	L-T-P-CREDITS	YEAR OF INTRODUCTION
EOT398	DISTRIBUTED GENERATION AND SMART GRIDS	3-1-0-4	2019

Preamble:

This course introduces various advancements in the area of smart grid. It also introduces distributed energy resources and micro-grid. In addition, cloud computing, cyber security and power quality issues in smart grids are also introduced.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basic concept of distributed energy resources, micro-grid and smart grid **(Cognitive Knowledge Level: Understand)**
CO 2	Choose appropriate Information and Communication Technology (ICT) in smart grid **(Cognitive Knowledge Level: Understand)**
CO 3	Select infrastructure and technologies for consumer domain of smart grid **(Cognitive Knowledge Level: Apply)**
CO 4	Select infrastructure and technologies for smart substation and distribution automation **(Cognitive Knowledge Level: Apply)**
CO 5	Formulate cloud computing infrastructure for smart grid considering cyber security **(Cognitive Knowledge Level: Apply)**
CO 6	Categorize power quality issues and appraise it in smart grid context **(Cognitive Knowledge Level: Apply)**

	POl	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12
CO1	3	2										
CO2	3	3	3	3	2							
CO3	3	3	3	3	2							
CO4	3	3	3	3								
CO5	3	3	3	3	3							
CO6	3	3	3	3	3							

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
POl	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Explain the Technical and economic advantages of Microgrid
2. Key differences between conventional grid and smart grid
3. What are the drivers for smart grids?

Course Outcome 2 (CO 2):

1. What is the role of IoT in smart grids?

2. Which communication technology is suitable for HAN and NAN?
3. What are the communication requirements in AMI ?

Course Outcome 3 (CO 3):

1. Explain demand side management.
2. What are the benefits of demand response in smart grids?
3. What are the pricing schemes available in smart grids ?

Course Outcome 4 (CO 4):

1. What are the different stages of outage management?
2. What are the data typically stored in CIS ?
3. Explain the IEC61850 protocol.

Course Outcome 5 (CO 5):

1. What are the application for Cloud computing in smart grid.
2. What are the cyber security concerns in smart grid.
3. Explain the cloud architecture of smart grids.

Course Outcome 6 (CO 6):

1. What are the different harmonic indices?
2. What are some of the common harmonic sources in households?
3. Classify power quality disturbances.

Model Question Paper

Course Code: EOT398

Course Name: DISTRIBUTED GENERATION AND SMART GRIDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carry 3 marks.

Marks

1. What are the opportunities of Smart Grid **(3)**
2. What is an active distribution network? Explain its relevancy in microgrid system. **(3)**
3. Explain the operation of a lead acid battery and mention its merits and demerits **(3)**
4. Explain the control functions of micro-resource controller (MC). **(3)**
5. List the advantages of cloud computing.
6. Differentiate between Critical peal pricing and Real Time Pricing **(3)**
7. What is PMU? Explain **(3)**
8. Write short notes on Advanced Metering Infrastructure (AMI) **(3)**
9. Write down the transmission protocol of IEC 61850. **(3)**
10. Write short notes on Distortion Index (DIN). **(3)**

PART B

Answer any one full question, each carry 14 marks.

11. a) Draw and explain the typical configuration of an AC microgrid. **(10)**

    b) Discuss the factors which necessitate the development of smart grid technology. **(4)**

12. a) Explain the role of central controller in stand-alone and grid connected mode of operation of microgrids. **(7)**

    b) Why conventional over current relays may slowly respond or fail to operate in stand-alone Microgrid with significant number of micro sources and power electronic interfaces? Justify**.** **(7)**

13. a) Explain the working flywheel energy storage (FES) system **(7)**

    b) Explain the components of an Ultra capacitor. Mention its advantages and disadvantages. **(7)**

14. a) Explain the working and operation of different Wind Energy Conversion Systems. Also mention the advantages and disadvantages. **(10)**

    b) Explain the control functions of micro-resource controller (MC). **(4)**

15. a) Explain different scenarios related to the islanding of microgrid? **(10)**

b) What is a smart meter used in smart grid? List the features. **(4)**

16. a) Draw and explain the National Institute of Standards and Technology (NIST) Smart grid reference architecture. Explain its various domains. **(8)**

b) Write a short note on the Plug in Hybrid Electric Vehicle Technology describing the architectures. **(6)**

17. a) A power station has a maximum demand of 35MW, a plant capacity factor of 50%, a plant use factor of 70% and load factor of 60%. Determine (i) Reserve capacity (ii) Daily energy produced (iii) Maximum energy that can be produced daily if the plant runs as per the schedule. **(10)**

b) Explain the application of SANET in Smart Grid **(4)**

18. a) Draw the block diagram and explain the working of Phasor Measurement Unit (PMU). **(7)**

b) What is a smart sensor? Using block diagram, explain the different components **(7)**

19. a) List and explain the various harmonic sources in grid. **(10)**

b) Enumerate various advantages of smart substation. **(4)**

20. a) What are the different advantages of smart substations over conventional substations? **(8)**

b) Explain with diagram, about IEC 61850 substation architecture. **(6)**

SYLLABUS

Module 1: Distributed generation (8 Hours)
Introduction - Integration of distributed generation to Grid – Concepts of Micro Grid - Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economic advantages of Microgrid - Challenges and disadvantages of Microgrid development. Smart Grid: Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid –Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Technology Drivers, Smart Grid in Power-Technology Trends
Module 2: Distributed energy resources (9 Hours)
Introduction - Combined heat and power (CHP) systems - Solar photovoltaic (PV) systems – Wind energy conversion systems (WECS) - Small-scale hydroelectric power generation - Storage devices: Batteries: Lead acid, nickel metal hydrate and lithium ion batteries, ultra-capacitors, flywheels, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage, Virtual Power sources, Virtual Inertia. Control of Microgrids: Introduction to Central Controller (CC) and Microsource Controllers (MCs) - Control functions for micro source controller, Active and reactive power control, Voltage control, Storage requirement for fast load tracking, Load sharing through power-frequency control
Module 3: Protection issues for Microgrids (11 Hours)
Introduction, Islanding, Different islanding schemes, Major protection issues of stand- alone Microgrid - Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols, Block chain as a Microgrid enabler. Smart Grid: Components – NIST Smart Grid Reference ,Architecture, Role of IoT in Smart Grid Technology and Applications, Cloud computing in smart grid: Private, public and Hybrid cloud. Cloud architecture of smart grid. Cyber security in Smart Grid, Applications of smart grid to power systems and case study Introduction to Smart Meters, Electricity tariff – one part tariff, two tariff and maximum demand tariff - Dynamic pricing: time- of-use (TOU) pricing, critical-peak pricing (CPP) and Real Time Pricing- Automatic Meter Reading (AMR), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation- Elements of communication, networking and interfacing – architectures, standards, PLC, Zigbee, GSM, BPL.
Module 4: Smart energy efficient end use devices (8 Hours)
Smart distributed energy resources- Load Curves-Load Shaping Objectives-Methodologies- Peak load shaving - Energy management-Role of technology in demand response- Demand Side Management and demand response programs, Potential benefits of demand response in smart grid, enabling smart technologies for demand response - Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing - Advanced Metering Infrastructure (AMI), WAN, MAN, LAN, Neighbourhood-Area Networks (NANs), Home Area Network (HAN), Sensor and Actuator Networks (SANETs)- Numerical Problems.

Intelligent Electronic Devices (IED) and their application for monitoring & protection, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).
Module 5: Smart substation and Power quality (9 Hours)
Smart Substations, Substation Automation, IEC 61850 Substation Architecture, Advanced Distribution Automation, Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Customer Information System, Geographical Information System **Power quality:** Introduction - Types of power quality disturbances - Voltage sag (or dip), transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker - Harmonic sources: SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights), Ancillary Services within Smart Grid framework – Reactive Power, Frequency Support, Power quality aspects with smart grids, Smart Grid Economic and market operations- Energy and Reserve Markets, Locational Marginal Prices, Concepts of block chain technologies in energy trading and power purchase agreements (PPA)

TEXT BOOKS/REFERENCES:

1. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 978-0-470-62761-7, Wiley
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, ISBN: 978-0-470-88939-8, Wiley
3. R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, “Electrical Power System Quality”, McGraw-Hill
4. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, ISBN: 978-0-470-05751-3, Wiley
5. S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, ISBN 978-1-84919-014-5, IET, 2009

Course Contents and Lecture Schedule		
Sl. No.	**Topic**	**No. of Lectures**
1	**Distributed generation**	**8 Hours**
1.1	Introduction - Integration of distributed generation to Grid – Concepts of Micro Grid	1
1.2	Typical Microgrid configurations - AC and DC micro grids	1
1.3	Interconnection of Microgrids - Technical and economic advantages of Microgrid, Challenges and disadvantages of Microgrid development	2
1.4	Smart Grid: Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid –Functions	2
1.5	Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Technology Drivers, Smart Grid in Power-Technology Trends	2
2	**Distributed energy resources**	**9 Hours**
2.1	Introduction - Combined heat and power (CHP) systems - Solar photovoltaic (PV) systems – Wind energy conversion systems (WECS) - Small-scale hydroelectric power generation	2
2.2	Storage devices: Batteries: Lead acid, nickel metal hydrate and lithium ion batteries, ultra-capacitors, flywheels, Smart integration of energy resources	2
2.3	Renewable, intermittent power sources – Energy Storage, Virtual Power sources, Virtual Inertia.	1
2.4	Control of Microgrids: Introduction to Central Controller (CC) and Microsource Controllers (MCs) -	2
2.5	Control functions for micro source controller, Active and reactive power control, Voltage control, Storage requirement for fast load tracking, Load sharing through power-frequency control	2
3	**Protection issues for Microgrids**	**11 Hours**
3.1	Introduction, Islanding, Different islanding schemes, Major protection issues of stand- alone Microgrid	1
3.2	Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols, Block chain as a Microgrid enabler.	2
3.3	Smart Grid: Components – NIST Smart Grid Reference Architecture, Role of IoT in Smart Grid Technology and Applications, Cloud computing in smart grid: Private, public and Hybrid cloud	2
3.4	Cloud architecture of smart grid. Cyber security in Smart Grid, Applications of smart grid to power systems and case study	1
3.5	Introduction to Smart Meters, Electricity tariff – one part tariff, two tariff and maximum demand tariff	1

3.6	Dynamic pricing: time- of-use (TOU) pricing, critical-peak pricing (CPP) and Real Time Pricing	1
3.7	Automatic Meter Reading (AMR), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors,	1
3.8	Home & Building Automation- Elements of communication, networking and interfacing – architectures, standards, PLC, Zigbee, GSM, BPL.	2
4	**Smart energy efficient end use devices**	**8 HOURS**
4.1	Smart distributed energy resources- Load Curves-Load Shaping Objectives-Methodologies- Peak load shaving	1
4.2	Energy management-Role of technology in demand response- Demand Side Management and demand response programs, Potential benefits of demand response in smart grid, enabling smart technologies for demand response	2
4.3	Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing	1
4.4	Advanced Metering Infrastructure (AMI), WAN, MAN, LAN, Neighbourhood-Area Networks (NANs), Home Area Network (HAN), Sensor and Actuator Networks (SANETs)- Numerical Problems	2
4.5	Intelligent Electronic Devices (IED) and their application for monitoring & protection, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).	2
5	**Smart substation and Power quality**	**9 HOURS**
5.1	Substation Automation, IEC 61850 Substation Architecture, Advanced Distribution Automation, Volt / VAR control	1
5.2	Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Customer Information System, Geographical Information System	2
5.3	Power quality: Introduction - Types of power quality disturbances - Voltage sag (or dip), transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker- Harmonic sources	2
5.4	SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights), Ancillary Services within Smart Grid framework – Reactive Power, Frequency Support	2
5.5	Power quality aspects with smart grids, Smart Grid Economic and market operations- Energy and Reserve Markets, Locational Marginal Prices, Concepts of block chain technologies in energy trading and power purchase agreements (PPA)	2

SEMESTER VII

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT401	**CONTROL SYSTEMS**	PCC	**2**	**1**	**0**	**3**

Preamble **:** This course aims to provide a strong foundation on classical control theory. Modelling, time domain analysis, frequency domain analysis and stability analysis of linear systems based on transfer function and state space approach.

Prerequisite **: Basics of Circuits and Networks, Signals and Systems**

Course Outcomes **:** After the completion of the course the student will be able to:

CO 1	Develop models for various systems using Transfer functions
CO 2	Analyse the time domain responses of the linear systems.
CO 3	Apply Root locus technique to assess the performance of linear systems.
CO 4	Analyse the stability of the given LTI systems.
CO 5	Analyse the frequency domain response of the given LTI systems.
CO 6	Analyze various types of systems using state space models

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	-	-	-	-	-	-	-	1
CO 2	3	3	3	-	-	-	-	-	-	-	-	2
CO 3	3	3	3	-	2	-	-	-	-	-	-	2
CO 4	3	3	3	-	-	-	-	-	-	-	-	3
CO 5	3	3	3	-	2	-	-	-	-	-	-	3
CO 6	3	3	3	2	-	-	-	-	-	-	-	3

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	10	10	20
Apply (K3)	20	20	40
Analyse (K4)	10	10	20
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern : There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Derive transfer function models for various systems.
2. Derive and explain the transfer function of the AC servo motor.
3. Explain how the feedback element affects the performance of the closed loop system.

Course Outcome 2 (CO2):

1. Obtain the different time domain specifications for a given second order system with impulse input.
2. Determine the value of the natural frequency of oscillation $\omega_n \omega_n$ for the unity feedback system with forward transfer function $G_p(s) = \frac{K}{s(s+10)} G_p(s) = \frac{K}{s(s+10)}$, which results in a critically damped response. Also analyse the effect of K on the damping factor.
3. Problems related to static error constant and steady state error for a given input.

Course Outcome 3(CO3):

1. Determine the value of K such that the closed loop system with $G(s)H(s) = \frac{K}{s\,(s+1)\,(s+4)}$ is oscillatory, using Root locus.
2. Construct the Root locus for the closed loop system with ? Determine the value of K to achieve a damping factor of 0.5? $G(s)H(s) = \frac{K}{s\,(s^2 + 2s + 2)}$
3. Problems on root locus for systems with positive feedback.

Course Outcome 4 (CO4):

1. Problems related to application of Routh's stability criterion for analysing the stability of a given system.
2. Problems related to assess the stability of the given system using Bode plot.
3. Problem related to the analysis of given system using Nyquist stability criterion.

Course Outcome 5 (CO5):

1. Determine the value of K such that the gain margin for the system with $G(s)H(s) = \frac{K}{s\,(s+1)\,(s+5)}$ equals to 2.
2. Determine the phase margin to assess the stability of the system with $G(s)H(s) = \frac{2}{s\,(s+1)\,(s+4)}$
3. Problems related to the stability analysis using Polar plot.

Course Outcome 6 (CO6):

1. Determine state models for various systems.
2. Obtain a solution for state equations using various methods.
3. Obtain transfer function models from state equations.

Model Question Paper PAGES: 2
QPCODE:
Reg. No:____________
Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION
MONTH & YEAR
Course Code**: EOT401**
Course Name: **CONTROL SYSTEMS**

Max. Marks: 100 **Duration: 3 Hours**

	PART A **Answer all Questions. Each question carries 3 Marks**
1	Give a comparison between open loop and closed loop control systems with suitable examples.
2	What is Mason's gain formula? Explain.
3	For a closed loop system with $G(s) = \frac{1}{s\,(s+5)}$; and H(s) = 0.05, calculate the steady state error constants.
4	Check the stability of the system given by the characteristic equation, $G(s) = s^5 + 2s^4 + 4s^3 + 8s^2 + 16s + 32$; $P(s) = s^5 + 2s^4 + 4s^3 + 8s^2 + 16s + 32$ using Routh criterion.
5	With suitable sketches explain how the addition of poles to the open-loop transfer function affect the root locus plots.
6	Explain Ziegler – Nichols PID tuning rules.
7	Explain the features of non-minimum phase systems with a suitable example.
8	How do you determine the gain margin of a system, with the help of Bode plot?
9	Obtain the state space representation of the differential equation d2y/dt2 + 2 dy/dt + 5y = u
10	Explain any five properties of state transition matrix.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Derive the transfer function of an Armature controlled dc servo motor. Assess the effect of time constants on the system performance. **(9)**

b) Compare the effect of H(s) on the pole-zero plot of the closed loop system with $G(s) = \frac{s+3}{(s^2 + 3s + 2)}$ with: i) derivative feedback H(s)=s; ii) integral feedback H(s)=1/s. **(5)**

12 a) Why is compensation necessary in the feedback control system? What are the factors to be considered for choosing the feedback compensation? **(6)**

b) With relevant characteristics explain the operation of the following control devices. i) Synchro error detector ii) Tachogenerator. **(8)**

Module 2

13 a) Derive an expression for the step response of a critically damped second order system?

Explain the dependency of Mp on damping factor. **(9)**

b) Determine the value of K and the natural frequency of oscillation $\omega_n \omega_n$ for the unity feedback system with forward transfer function $G(s) = \frac{K}{s(s+10)}$ $G_p(s) = \frac{K}{s(s+10)}$, which results in a critically damped response when subjected to a unit step input. Also determine the steady state error for unit velocity input. **(5)**

14 a) A unity feedback system is characterized by an open loop transfer function $G(s) = \frac{20}{(s^2+5s+5)}$ · $G_p(s) = \frac{20}{s^2+5s+5}$ Determine the transient response when subjected to a unit step input and sketch the response. Evaluate the maximum overshoot and the corresponding peak time of the system. **(9)**

b) Using Routh criterion determine the value of K for which the unity feedback closed loop system with $G(s) = \frac{K}{s(s^2+20s+8)}$ is stable. **(5)**

Module 3

15 a) Explain the Ziegler- Nichols tuning of PID controllers (10) .

b) Compare between PI and PD controllers. (4)

16 a) Sketch root locus for a system with $G(s)H(s) = \frac{K(s+1)}{s(s+4)}$. $G(s)H(s) = \frac{K}{s(s+2)(s^2+2s+2)}$ Hence determine the range of K for the system stability. . (9)

b) With help of suitable sketches, explain how does Angle and Magnitude criteria of Root locus method help in control system design. (5)

Module 4

17 a) The open-loop transfer function of a unity feedback system is G(s)= $\frac{K \qquad K}{s(0.5s+1)(0.04s+1)s(0.5s+1)(0.04s+1)}$.Use asymptotic approach to plot the Bode diagram and determine the value of K for a gain margin of 10 dB. (8)

b) Compare between the polar plots for $G(s)H(s) = \frac{K}{(s+4)}$ and $G(s)H(s) = \frac{K(s-4)}{(s+4)}$. (6)

18 a) Draw the polar plot of an open loop transfer function G(s)= $\frac{6 \qquad 6}{(s+1)(s+2)(s+1)(s+2)}$ and comment on the phase margin and gain margin. (8)

b) Explain the detrimental effects of transportation lag, using Bode plot. (6)

Module 5

19 a) Obtain the state space representation of armature controlled DC motor (9)

b) Explain the concepts of (i) state (ii) state variables (iii) state vector (iv) state space (v) state trajectory. (5)

20 a) The transfer function of a control system is given by
$Y(S)/U(S) = (S+2)/(S^3+9S^2+26S+24)$
Check for Controllability and Observability (10)

b) Obtain the state space representation of 1/ (s+2)(s+3)(s+4) (4)

Syllabus

Module 1

Feedback Control Systems (7 hours)

Open loop-and closed loop control systems: Transfer function of LTI systems-Mechanical and Electromechanical systems – Force voltage and force current analogy - block diagram representation - block diagram reduction - signal flow graph - Mason's gain formula - characteristic equation.

Control system components – Control applications of DC and AC servo motors, Tacho generator, Synchro, Gyroscope and Stepper motor.

Module 2

Performance Analysis of Control Systems (7 hours)

Time domain analysis of control systems: Time domain specifications of transient and steady state responses- Impulse and Step responses of first and second order systems.

Error analysis: Steady state error analysis and error constants -Dynamic error coefficients.

Stability Analysis: Concept of BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems - Routh's stability criterion- Relative stability.

Module 3

Root Locus Analysis and controllers (8 hours)

Root locus technique: Construction of Root locus- stability analysis- effect of addition of poles and zeroes- Effect of positive feedback systems on Root locus.

PID controllers: PID tuning using Ziegler-Nichols methods.

Module 4

Frequency domain analysis (7 hours)

Frequency domain specifications- correlation between time domain and frequency domain responses

Bode Plot: Construction- Concepts of gain margin and phase margin- stability analysis.

Effect of Transportation lag and non-minimum phase systems.

Polar plot: Concepts of gain margin and phase margin.

Nyquist criterion: Nyquist plot- Stability criterion- Analysis.

Module 5

Introduction to State space analysis (7 hours)

Introduction to state space and state model concepts- State equation of linear continuous time systems, matrix representation- Examples of electrical circuits and dc servomotors.

Phase variable forms of state representation- Diagonal Canonical forms.

Solution of state equations- state transition matrix- properties.

Derivation of transfer functions from state equations.

Controllability and Observability.

Textbooks

1. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers

2. Ogata K, Modern Control Engineering, 5/e, Prentice Hall of India.
3. Nise N. S, Control Systems Engineering, 6/e, Wiley Eastern
4. Dorf R. C. and Bishop R. H, Modern Control Systems, 12/e, Pearson Education

Reference Books

1. Kuo B. C, Automatic Control Systems, 7/e, Prentice Hall of India
2. Desai M. D., Control System Components, Prentice Hall of India, 2008
3. Gopal M., Control Systems Principles and Design, 4/e, Tata McGraw Hill.
4. Imthias Ahamed T. P, Control Systems, Phasor Books, 2016

Course Contents and Lecture Schedule:

Module	**Topic coverage**	**No. of Lectures**
1	**Feedback Control Systems (7 hours)**	
1.1	Terminology and basic structure of Open loop and Closed loop control systems- Transfer function of LTI systems-Mechanical and Electromechanical systems.	2
1.2	Force-Voltage and Force-Current analogy	1
1.3	Block diagram reduction	2
1.4	Mason’s gain formula	1
1.5	Control system components: Transfer functions of DC and AC servo motors –Control applications of Tacho generator, Synchro, Gyroscope and Stepper motor	1
2	**Performance Analysis of Control Systems (7 hours)**	
2.1	Time domain analysis of control systems: Time domain specifications of transient and steady state responses- Impulse and Step responses of First order systems- Impulse and Step responses of Second order systems- Pole dominance for higher order systems	2
2.2	Error analysis: Steady state error analysis - static error coefficient of Type 0, 1, 2 systems. Dynamic error coefficients	2
2.3	Stability Analysis: Concept of stability-BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems	1
2.4	Application of Routh's stability criterion to control system analysis- Relative stability	2
3	**Root Locus Analysis and Controllers (8 hours)**	
3.1	Root locus technique: General rules for constructing Root loci – stability from root loci -	3
3.2	Effect of addition of poles and zeros on Root locus	1
3.3	Effect of positive feedback systems on Root locus	1
3.4	PID Controllers: Need for P, PI and PID controllers	1
3.5	Design of P, PI and PID controller using Ziegler-Nichols tuning method.	2

4	**Frequency domain analysis (7 hours)**	
4.1	Frequency domain specifications- correlation between time domain and frequency domain responses	1
4.2	Polar plot: Concepts of gain margin and phase margin- stability analysis	2
4.3	Bode Plot: Construction of Bode plots- gain margin and phase margin- Stability analysis based on Bode plot	2
4.4	Effect of Transportation lag and Non-minimum phase systems	1
4.5	Nyquist stability criterion: Nyquist plot- Stability criterion- Analysis	1
5	**Nyquist stability criterion and Compensator Design using Bode Plot (7 hours)**	
5.1	Introduction to state space and state model concepts- State equation of linear continuous time systems, matrix representation- Examples of electrical circuits and dc servomotors.	2
5.2	Phase variable forms of state representation- Diagonal Canonical forms.	1
5.3	Solution of state equations- state transition matrix- properties.	1
5.4	Derivation of transfer functions from state equations.	1
5.5	Controllability and Observability	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOL401	**ELECTRICAL CAD**	PCC	0	0	3	2

Preamble: This course is expected to give the Computer Aided Drawing Skill required for Electrical Engineers while carrying out real life electrical installations and MEP works.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply CAD Tools to draw different views and projections of 3 Dimensional objects
CO 2	Identify the terminologies and symbols of Electrical wiring circuits
CO 3	Apply CAD Tools to draw sectional view of any electrical equipment
CO 4	Design and draw the electrical wiring for a residential building
CO 5	Design and draw the electrical wiring for a commercial building
CO 6	Design and draw the single line diagram of a simple 11/33kV substation

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2				2	2		2		2		2
CO 2	3							3				3
CO 3	3	1			3			3				3
CO 4	3	1			3	3		3		3		3
CO 5	3	2	1		3	3		3	3	3		3
CO 6	3	1			3	3		3		3		3

Course Level Assessment Questions

CO 1: Draw the elevation of the given 3D image (Apply)
CO 2: Draw the symbols and Notations used in Electrical wiring (Assignment 1) (Understand)
CO 3: Draw the cross sectional view of the given DC/AC motor (Apply)
CO 4: Design the Wiring diagram showing the position of Main Supply Board, distribution Board and sub-circuits suitable for the plan given of a residential building. (Create)
CO 5: Prepare the Wiring diagram showing the position of Main Supply Board, distribution Board and sub-circuits suitable for the plan given of a commercial building. (Assignment 2) (Evaluate)
CO 6: Prepare the wiring diagram of a substation with two incoming 11kV feeders and 3 outgoing 33kV feeders.

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work (Explaining the commands to be used) : 15 Marks
(b) Implementing the work (usage of tools and trouble shooting) : 35 Marks
(d) Viva voce : 10 marks
(e) Record of drawings and Assignments : 15 Marks

General instructions:

Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Reference Books

1.Eddy Krygiel, Phil Read and James Vandezande, “Autodesk Official Training Guide”, Mastering Autodesk Revit Architecture 2011
2. Autocad Electrical Quick Reference Guide

List of Exercises/Experiments: (Lab experiments may be given considering 12 sessions of 3 hours each.)

Part A

1. Review of AutoCAD commands - Relative and polar coordinate systems for drawing, Direct Entry Method and Ortho Mode, Circle, Offset, Trim and Fillet,
2. Draw the plan, elevation and side view of objects by third angle projection, Arrays to draw symmetrical and unsymmetrical objects using Layers
   Assignment 1 : Terminologies, Symbols and Notations in Electrical Wiring
3. Draw the cross Sectional view of an Armature
4. Draw the cross Sectional view of a Core Type and Shell Type Transformer
5. Draw the plan, elevation and side view of DC motor by third angle projection
6. Draw the plan, elevation and side view of Induction motors (Slip Ring and Squirrel Cage) by third angle projection
7. Draw the plan, elevation and side view of Alternators (salient Pole and Turbo-alternators) by third angle projection
8. Draw the plan of a residential building (1BHK)

Part B

9. Draw the electrical wiring diagram of a residential building
10. Draw the electrical wiring diagram of a multi-storeyed residential building
11. Draw the electrical wiring line diagram of a commercial building (Supermarkets)
    Assignment 2: Prepare the single line diagram of a School/ College/ Hospital/ Theatre/ Office Building/ Computer Centre (Team Assignment)
12. Draw the Single Line Diagram of an 11kV/33kV Sub-Station.

EOQ413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Course Objectives:

- To do literature survey in a selected area ofstudy.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		2	1					3
CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

EOD415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7^{th} and 8^{th} semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7^{th} semester and two third in 8^{th} semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
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PROJECT PHASE I

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/design/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation include some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well-planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

SEMESTER VII

PROGRAM ELECTIVE II

CST413	MACHINE LEARNING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the Naive Bayes algorithm, basic clustering algorithms and classifier performance measures. This course helps the students to provide machine learning based solutions to real world problems.

Prerequisite: Basic understanding of probability theory, linear algebra and Python Programming

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate Machine Learning concepts and basic parameter estimation methods. (Cognitive Knowledge Level: **Apply)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(**Cognitive Knowledge Level: **Apply**)
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine **(**Cognitive Knowledge Level: **Apply**)
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (Cognitive Knowledge Level: **Apply**)
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests(Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Overview of machine learning)

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.

Module-2 (Supervised Learning)

Regression - Linear regression with one variable, Linear regression with multiple variables,solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Naive Bayes, Decision tree algorithm ID3.

Module-3 (Neural Networks (NN) and Support Vector Machines (SVM))

Perceptron, Neural Network - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm.

SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).

Module-4 (Unsupervised Learning)

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis.

Module-5 (Classification Assessment)

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve(AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

Text Book

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

1. Christopher Bishop. Neural Networks for Pattern Recognition,Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali.Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. A coin is tossed 100 times and lands heads 62 times. What is the maximum likelihood estimate for $\boldsymbol{\theta}$, the probability of heads.
2. Suppose data $x_1, ..., x_n$ are independent and identically distributed drawn from an exponential distribution $exp(\lambda)$. Find the maximum likelihood for λ.
3. Suppose $x_1, ..., x_n$ are independent and identically distributed(iid) samples from a distribution with density

$$f_X(x \mid \theta) = \begin{cases} \dfrac{\theta x^{\theta-1}}{3^{\theta}}, & 0 \le x \le 3 \\ 0, & \text{otherwise} \end{cases}$$

   Find the maximum likelihood estimate(MLE) for $\boldsymbol{\theta}$.
4. Find the maximum likelihood estimator (MLE) and maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have N samples, $x_1,..., x_N$ independently drawn from a normal distribution with known variance σ^2 and unknown mean μ and the prior distribution for the mean is itself a normal distribution with mean ν and variance β^2. What happens to the MLE and MAP estimators as the number of samples goes to infinity.

Course Outcome 2(CO2):

1. Suppose that you are asked to perform linear regression to learn the function that outputs y, given the D-dimensional input x. You are given N independent data points, and that all the D attributes are linearly independent. Assuming that D is around 100, would you prefer the closed form solution or gradient descent to estimate the regressor?
2. Suppose you have a three class problem where class label $y \in$ **0, 1, 2** and each training example X has 3 binary attributes $X_1, X_2, X_3 \in$ **0, 1**. How many parameters (probability distribution) do you need to know to classify an example using the Naive Bayes classifier?

Course Outcome 3(CO3):

1. What are support vectors and list any three properties of the support vector classifier solution?
2. Why do you use kernels to model a projection from attributes into a feature space, instead of simply projecting the dataset directly?

3. Describe how Support Vector Machines can be extended to make use of kernels. Illustrate with reference to the Gaussian kernel $K(x, y) = e^{-z}$, where $z = (x-y)^2$.
4. Briefly explain one way in which using tanh instead of logistic activations makes optimization easier.
5. ReLU activation functions are most used in neural networks instead of the tanh activation function. Draw both activation functions and give a) an advantage of the ReLU function compared to the tanh function. b) a disadvantage of the ReLU function compared to the tanh function.

Course Outcome 4(CO4): .

1. Which similarity measure could be used to compare feature vectors of two images? Justify your answer.
2. Illustrate the strength and weakness of k-means algorithm.
3. Suppose you want to cluster the eight points shown below using **k**-means

	A_1	A_2
x_1	2	10
x_2	2	5
x_3	8	4
x_4	5	8
x_5	7	5
x_6	6	4
x_7	1	2
x_8	4	9

Assume that **k = 3** and that initially the points are assigned to clusters as follows: $C_1 = \{x_1, x_2, x_3\}$, $C_2 = \{x_4, x_5, x_6\}$, $C_3 = \{x_7, x_8\}$. Apply the **k**-means algorithm until convergence, using the Manhattan distance.

4. Cluster the following eight points representing locations into three clusters: $A_1(2, 10)$, $A_2(2, 5)$, $A_3(8, 4)$, $A_4(5, 8)$, $A_5(7, 5)$, $A_6(6, 4)$, $A_7(1, 2)$, $A_8(4, 9)$.

Initial cluster centers are: $A_1(2, 10)$, $A_4(5, 8)$ and $A_7(1, 2)$.

The distance function between two points $a = (x_1, y_1)$ and $b = (x_2, y_2)$ is defined as $D(a, b) = |x_2 - x_1| + |y_2 - y_1|$

Use **k**-Means Algorithm to find the three cluster centers after the second iteration.

Course Outcome 5(CO5):

1. What is ensemble learning? Can ensemble learning using linear classifiers learn classification of linearly non-separable sets?
2. Describe boosting. What is the relation between boosting and ensemble learning?
3. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.
4. What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why?
5. Suppose there are three classifiers A,B and C. The (FPR, TPR) measures of the three classifiers are as follows – A (0, 1), B (1, 1) , C (1,0.5). Which can be considered as a perfect classifier? Justify your answer.

Model Question Paper

QP CODE:

Reg No: _______________

Name:_________________ PAGES : 4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY SEVENTH SEMESTER

B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST413

Course Name: Machine Learning

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Define supervised learning? Name special cases of supervised learning depending on whether the inputs/outputs are categorical, or continuous.

2. Differentiate between Maximum Likelihood estimation (MLE) and Maximum a Posteriori (MAP) estimation?

3. What is overfitting and why is it a problem?

4. Specify the basic principle of gradient descent algorithm.

5. Suppose that you have a linear support vector machine(SVM) binary classifier. Consider a point that is currently classified correctly, and is far away from the decision boundary. If you remove the point from the training set, and re-train the classifier, will the decision boundary change or stay the same? Justify your answer.

6. Mention the primary motivation for using the kernel trick in machine learning algorithms?

7. Expectation maximization (EM) is designed to find a maximum likelihood setting of the parameters of a model when some of the data is missing. Does the algorithm converge? If so, do you obtain a locally or globally optimal set of parameters?

8. Illustrate the strength and weakness of k-means algorithm.

9. Classifier A attains 100% accuracy on the training set and 70% accuracy on the test set. Classifier B attains 70% accuracy on the training set and 75% accuracy on the test set. Which one is a better classifier. Justify your answer.

10. How does bias and variance trade-off affect machine learning algorithms?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Suppose that X is a discrete random variable with the following probability mass function: where $0 \le \theta \le 1$ is a parameter. The following 10 independent observations **(7)**

X	0	1	2	3
$P(X)$	$2\theta/3$	$\theta/3$	$2(1-\theta)/3$	$(1-\theta)/3$

were taken from such a distribution: (3, 0, 2, 1, 3, 2, 1, 0, 2, 1). What is the maximum likelihood estimate of θ.

(b) Suppose you have a three class problem where class label $\boldsymbol{y} \in \mathbf{0, 1, 2}$ and each training example $\boldsymbol{X}$ has 3 binary attributes $\boldsymbol{X_1, X_2, X_3} \in \mathbf{0, 1}$. How many parameters (probability distribution) do you need to know (7) to classify an example using the Naive Bayes classifier?

OR

12. (a) Consider the geometric distribution, which has p.m.f $P(X = k) = (1 - \theta)^{k-1}\theta$. Assume that n i.i.d data are drawn from that distribution. **(7)**

i. Write an expression for the log-likelihood of the data as a function of the parameter θ.

ii. Find the maximum likelihood estimate for θ?

ii. Let θ has a beta prior distribution. What is the posterior distribution of θ?

(b) Find the maximum a posteriori (MAP) estimator for the mean of a univariate normal distribution. Assume that we have ***N*** samples, $\boldsymbol{x_1,\ldots, x_N}$ independently drawn from a normal distribution with known variance $\boldsymbol{\sigma^2}$ and unknown mean $\boldsymbol{\mu}$ and the prior distribution for the mean is itself a normal distribution with mean $\boldsymbol{\nu}$ and variance $\boldsymbol{\beta^2}$. **(7)**

13. (a) Consider the hypothesis for the linear regression $h_\theta(x) = \theta_0 + \theta_1 x$, and the cost function $J(\theta_0, \theta_1) = 1/2m \, \Sigma_1^m (h_\theta(x^{(i)}) - y^{(i)})^2$ where m is the number of training examples. Given the following set of training examples. **(7)**

x	y
3	2
1	2
0	1
4	3

Answer the following questions :

1) Find the value of h_θ (2) if $\theta_0 = 0$ and $\theta_1 = 1.5$

2) Find the value of J(0,1)

3) Suppose the value of $J(\theta_0, \theta_1) = 0$. What can be inferred from this.

(b) Assume we have a classification problem involving 3 classes: professors, students, and staff members. There are 750 students, 150 staff members and 100 professors. All professors have blond hair, 50 staff members have blond hair, and 250 students have blond hair. Compute the information gain of the test ”hair color = blond” that returns true or false. **(3)**

(c) Explain the significance of regularization. How do Ridge differs from Lasso regularization? **(4)**

OR

14. (a) The following dataset can be used to train a classifier that determines whether a given person is likely to own a car or not. There are three features: education level (primary, secondary, or university); residence (city or country); gender (female, male). (7)

education	residence	gender	has car?
sec	country	female	yes
univ	country	female	yes
prim	city	male	no
univ	city	male	no
sec	city	female	no
sec	country	male	yes
prim	country	female	yes
univ	country	male	yes
sec	city	male	yes
prim	city	female	no
univ	city	female	no
prim	country	male	yes

Use ID3 Algorithm and find the best attribute at the root level of the tree

(b) Consider a linear regression problem y = w1x + w0, with a training set having m examples $(x_1, y_1), \ldots (x_m, y_m)$. Suppose that we wish to minimize the mean 5^{th} degree error (loss function) given by $1/m\ \Sigma_1^m(y_i - w_1x_i - w_0)^5$. **(7)**

1. Calculate the gradient with respect to the parameter w_1.

2. Write down pseudo-code for on-line gradient descent on w_1.

3. Give one reason in favor of on-line gradient descent compared to batch-gradient descent, and one reason in favor of batch over on-line.

15. (a) Consider a support vector machine whose input space is 2-D, and the inner products are computed by means of the kernel ***K(x, y) = (x.y + 1)²-1***, where ***x.y*** denotes the ordinary inner product. Show that the mapping to feature space that is implicitly defined by this kernel is the mapping to 5-D given by **(8)**

$$\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \rightarrow \phi(\mathbf{x}) = \begin{bmatrix} x_1^2 \\ x_2^2 \\ \sqrt{2}\, x_1 x_2 \\ \sqrt{2}\, x_1 \\ \sqrt{2}\, x_2 \end{bmatrix}.$$

(b) Consider a neuron with four inputs, and weight of edge connecting the inputs are 1, 2, 3 and 4. Let the bias of the node is zero and inputs are 2, 3, 1, 4. If the activation function is linear f(x)=2x, compute the output of the neuron. **(3)**

(c) Compare ReLU with Sigmoid function **(3)**

OR

16. (a) State the mathematical formulation to express Soft Margin as a constraint optimization problem. (10)

(b) What is the basic idea of back propagation algorithm **(4)**

17. (a) Suppose that we have the following data (one variable). Use single linkage Agglomerative clustering to identify the clusters. **(8)**

Data: (2, 5, 9, 15, 16, 18, 25, 33, 33, 45).

(b) Given two objects represented by the tuples (22, 1, 42, 10) and (20, 0, 36, 8):
(i) Compute the Euclidean distance between the two objects.
(ii) Compute the Manhattan distance between the two objects. (6)
(iii) Compute the Minkowski distance between the two objects, using p = 3

OR

18. (a) Suppose that we have the following data: **(8)**

(2, 0), (1, 2), (2, 2), (3, 2), (2, 3), (3, 3), (2, 4), (3, 4), (4, 4), (3, 5)

Identify the cluster by applying the k-means algorithm, with k = 2. Try using initial cluster centers as far apart as possible

(b) Describe EM algorithm for Gaussian Mixtures **(8)**

19. (a) Suppose the dataset had 9700 cancer-free images from 10000 images from cancer patients. Find precision, recall and accuracy ? Is it a good classifier? Justify. **(7)**

Actual Class\Predicted class	cancer = yes	cancer = no	Total
cancer = yes	**90**	**210**	300
cancer = no	**140**	**9560**	9700
Total	230	9770	10000

(b) What is Principal Component Analysis (PCA)? Which eigen value indicates the direction of largest variance? (7)

OR

20. (a) Assume you have a model with a high bias and a low variance. What are the characteristics of such a model? **(6)**

(b) What are ROC space and ROC curve in machine learning? In ROC space, which points correspond to perfect prediction, always positive prediction and always negative prediction? Why? **(8)**

Teaching Plan

No	Contents	No. of Lecture Hours (37 hrs)
	Module -1 (Overview of machine learning) (7 hours)	
1.1	Supervised, semi-supervised, unsupervised learning, reinforcement learning (Text Book (TB) 1: Chapter 1)	1 hour
1.2	Maximum likelihood estimation(MLE) (TB 1: Section 4.2)	1 hour
1.3	Maximum likelihood estimation (MLE)- example (TB 1: Section 4.2)	1 hour
1.4	Maximum a posteriori estimation(MAP) (TB 4: Section 6.2)	1 hour
1.5	Maximum a posteriori estimation(MAP)-example (TB 4: Section 6.2)	1 hour
1.6	Bayesian formulation (TB 1: Section 14.1, 14.2)	1 hour
1.7	Bayesian formulation -example (TB 1: Section 14.1, 14.2)	1 hour
	Module-2 (Supervised Learning) (7 hours)	
2.1	Linear regression with one variable (TB 1: Section 2.6)	1 hour
2.2	Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required) (TB 1: Section 5.8)	1 hour
2.3	Overfitting in regression, Lasso and Ridge regularization	1 hour
2.4	Logistic regression	1 hour
2.5	Naive Bayes (TB 2: Section 18.2)	1 hour
2.6	Decision trees (TB 2: Chapter 19)	1 hour
2.7	Decision trees- ID3 algorithm (TB 2: Chapter 19)	1 hour
	Module-3 (Neural Networks and Support Vector Machines) (9 hours)	
3.1	Perceptron, Perceptron Learning	1 hour
3.2	Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU, Tanh)	1 hour
3.3	Back Propagation Algorithm	1 hour
3.4	Illustrative Example for Back Propagation	1 hour
3.5	Introduction, Maximum Margin Hyperplane,	1 hour
3.6	Mathematics behind Maximum Margin Classification	1 hour
3.7	Formulation of maximum margin hyperplane and solution	1 hour

3.8	Soft margin SVM, Solution of Soft margin SVM	1 hour
3.9	Non-linear SVM , Kernels for learning non-linear functions, Examples - Linear, RBF, Polynomial	1 hour
Module-4 (Unsupervised Learning) (7 hours)		
4.1	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity	1 hour
4.2	Clustering - Hierarchical Clustering (TB 2: Chapter 14)	1 hour
4.3	K-means partitional clustering (TB 2: Chapter 13)	1 hour
4.4	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1 hour
4.5	Expectation maximization (EM) for soft clustering (TB 2: Chapter 13)	1 hour
4.6	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1 hour
4.7	Dimensionality reduction – Principal Component Analysis (TB 1: Section 6.3)	1 hour
Module-5 (Classification Assessment) (7 hours)		
5.1	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC. (TB 2: Chapter 22.1)	1 hour
5.2	Boot strapping, Cross validation	1 hour
5.3	Ensemble methods- bagging, boosting	1 hour
5.4	Bias-Variance decomposition (TB 2: Chapter 22.3)	1 hour
5.5	Bias-Variance decomposition (TB 2: Chapter 22.3)	1 hour
5.6	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1 hour
5.7	Face detection (TB 3: Chapter 5 Section Application: A Face Detection Pipeline)	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET423	**DIGITAL CONTROL SYSTEMS**	**PEC**	**2**	**1**	**0**	**3**

Preamble: This course aims to provide a strong foundation in discrete domain modelling, analysis and design of digital controllers to meet performance requirements.

Prerequisite: EET201 Circuits and Networks, EET305 Signals and Systems, and EET302 Linear Control Systems

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Describe the various control blocks and components of digital control systems.
CO 2	Analyse sampled data systems in z-domain.
CO 3	Design a digital controller/ compensator in frequency domain.
CO 4	Design a digital controller/ compensator in time domain.
CO 5	Apply state variable concepts to design controller for linear discrete time system.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	-	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	-	-	-	-	-	2
CO 3	3	3	3	3	2	-	-	-	-	-	-	3
CO 4	3	3	3	3	2	-	-	-	-	-	-	3
CO 5	3	3	3	3	-	-	-	-	-	-	-	3

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	15	15	30
Apply (K3)	25	25	50
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern : There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Selection of sampling period and elements of discrete time systems (K2) (PO1, PO2).
2. Derivation of the transfer functions of discrete time systems (K3)(PO1, PO2, PO3, PO12).
3. Relations between continuous system poles and that in discrete domain (K2) (PO1, PO2).

Course Outcome 2 (CO2):

1. Derivation of pulse transfer function or response function of various system configurations (K3) (PO1, PO2, PO3, PO4, PO12).
2. Determination of time response of systems, error constant and steady state error (K2) (PO1, PO2).
3. Problems to analyse the response of systems (K3) (PO1, PO2, PO3, PO4, PO12).

Course Outcome 3(CO3):

1. Obtain the frequency response and design controller (K3) (PO1, PO2, PO3, PO4, PO5, PO12).
2. Design suitable compensator in frequency domain (K3) (PO1, PO2, PO3, PO4, PO5, PO12).
3. Problems related to compensator and controller design in frequency domain (K3) (PO1, PO2, PO3, PO4, PO5, PO12).

Course Outcome 4 (CO4):

1. Problems related to design controller from time response (K3) (PO1, PO2, PO3, PO4, PO5, PO12).
2. Design suitable compensator in time domain (K3) (PO1, PO2, PO3, PO4, PO5, PO12).
3. Problems related compensator and controller design in time domain (K3) (PO1, PO2, PO3, PO4, PO5, PO12).

Course Outcome 5 (CO5):

1. Problems related to modelling and analysis (stability, controllability and observability) of system in state space (K2) (PO1, PO2, PO3, PO4).
2. Design a state feedback controller and observer (K3) (PO1, PO2, PO3, PO4).
3. Problems to identify the response and solution of state equation (K2) (PO1, PO2, PO3, PO4).

Model Question Paper PAGES: 2

QP CODE:

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH & YEAR

Course Code**: EET423**

Course Name: **DIGITAL CONTROL SYSTEMS**

Max. Marks: 100 **Duration: 3 Hours**

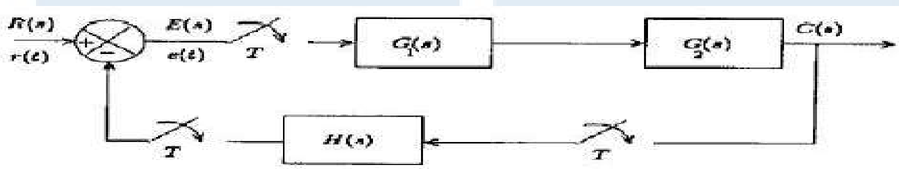
PART A

Answer all Questions. Each question carries 3 Marks

1 Explain any four advantages of sampled data control systems.

2 Identify and justify a suitable sampling frequency for the continuous time system with transfer function $G(s) = \frac{100}{(s+1)(s+10)(s+100)}$

3 Obtain the pulse transfer function for the given system.



4 Distinguish between type and order of a system.

5 Explain the frequency domain specifications.

6 Realize the digital compensator with transfer function $D(z) = \frac{2.3798z-1.9387}{z-0.5589}$

7 Draw and explain the mapping between s- plane to z-plane for the constant frequency loci.

8 What is dead beat response?

9 Identify the discrete equivalent of the continuous time system $\dot{x} = Ax$ when the sampling period is Ts

10 Define controllability and observability.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Derive the transfer function of a FoH circuit. **(6)**

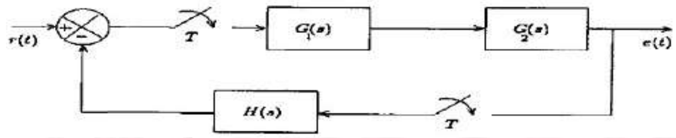
b) Determine the pulse transfer function of the system with transfer function $H(s) = \frac{3}{s(s+2)^2}$ if the sampling period is 0.1s. **(8)**

12 a) Derive the transfer function of a ZoH circuit. **(5)**

b) Realize the digital filter $D(z) = \frac{2z-0.6}{z+0.5}$ by the three methods of direct, standard and ladder programming. **(9)**

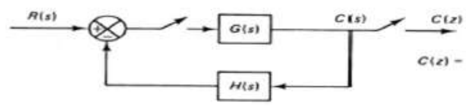
Module 2

13 Obtain the pulse transfer function for the unity feedback system with $G_1(s)=\frac{1}{s}$, $G_2(s)=\frac{1}{(s+2)}$ and assume T=0.1s and hence determine the step response of the system.



(14)

14 a) Obtain the unit impulse response C(n) of the following feedback DT system with $G(s)=\frac{1}{(s+3)}$, $.H(s)=\frac{1}{s}$,



Assume ideal sampling and T=1 ms. **(9)**

b) Explain the factors on which the steady state error constants depend on? **(5)**

Module 3

15 Design a suitable compensator for the unity feedback system with forward transfer function $G(z)=\frac{0.01758\,(z+0.8753)}{(z-1)\,(z-0.6703)}$, $T=0.1s$, such that the phase margin of the system be atleast 45° at approximately 2 rad/sec and velocity error constant atleast 100s^{-1}.**(14)**

16 Consider the unity feedback system with forward transfer function $G(z)=\frac{K(0..01873z+0.01752)}{z^2-1.8187z+0.8187}$. Design a controller for the system such that the *w*-plane phase margin is 50°, gain margin is 10dB, and the static velocity error constant is 2 sec^{-1}. Assume a sampling period of 0.2sec.

(14)

Module 4

17 Design a suitable digital compensator for the unity feedback system with open loop transfer function $G(s)=\frac{1}{s(s+4)}$ to meet the following specifications. Velocity error constant $K_v \geq 40$ sec^{-1}, Damping factor $\zeta=0.5$, Natural frequency ω_n=4 rad/sec. Assume a sampling period of 0.1s **(14)**

18 Design a controller, by the method of Ragazzini, for the unity feedback system with open loop transfer function $G(z)=\frac{0.018201\,(z+0.905)}{(z-1.105)\,(z-0.6703)}$, $T=0.1s$ to meet the following specifications. Damping factor $\zeta=0.5$, Natural frequency ω_n=2 rad/sec and zero steady state error for unit step input. **(14)**

Module 5

19 Design a suitable controller for the system by selecting suitable poles. $x(k+1)=\begin{bmatrix}0.9128 & -0.008826 & 0.1574\\ 0.09194 & 1.114 & -0.1662\\ 0.07429 & -0.08753 & 0.6855\end{bmatrix}x(k)+\begin{bmatrix}0.104\\ -0.00411\\ 0.08707\end{bmatrix}u(k),$ $y(k)=[0 \quad 1 \quad 0]x(k)$ Formulate the control law that can perfectly track a step command. Since the output is directly available for measurement, design a reduced

order observer to realise the controller. **(14)**

20 Compute the unit step response of the system represented by $x(k+1) = \begin{bmatrix} 0.9048 & 0 \\ 0.08611 & 0.8187 \end{bmatrix} x(k) + \begin{bmatrix} 0.09516 \\ 0.09516 \end{bmatrix} u(k),\ y(k) = [1\ \ 1]x(k)$ assume the initial state $x(0) = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$.
(14)

Syllabus

Module 1

Basics of Digital Control **(6 hours)**

Basic digital control system- Mathematical modelling - sampling and reconstruction - Zero order and First order hold circuits - realisation of digital filters. Relation between transfer function and pulse transfer function - Mapping between s-domain and z-domain.

Module 2

Response Computation **(7 hours)**

Pulse transfer function of different configurations of systems- Modified z-transform- Time Response of discrete time system. Order and Type of a system Steady state error and Static error constants.

Module 3

Design of controller/Compensator in frequency domain **(7 hours)**

Bilinear transformation and sketching of frequency response - Digital P/PI/PID controller design based on frequency response - Digital compensator based on frequency response. Introduction to design and simulation using MATLAB (for demo/ assignment only and not to be included for examination).

Module 4

Design of controller/Compensator based on time response **(7 hours)**

Design of lag, lead and lag-lead compensator using root locus - Design of controllers and compensators by the method of Ragazzini- Dead beat response and deadbeat controller design.

Module 5

Modern control approach to digital control **(10 hours)**

Introduction to state space - state space modelling of discrete time SISO system - Computation of solution of state equation and state transition matrix.

Controllability, observability and stabilizability of discrete time systems- Loss of controllability and observability due to sampling. Digital controller and observer design - state feedback – pole placement - full order observer - reduced order observer.

Text Book:

1. C. L. Philips, H. T. Nagle, Digital Control Systems, Prentice-Hall, Englewood Cliffs, New Jersey, 1995.
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill, 1997
3. Ogata K., Discrete-Time Control Systems, Pearson Education, Asia.

References:

1. Benjamin C. Kuo, Digital Control Systems, 2/e, Saunders College Publishing, Philadelphia, 1992.
2. Constantine H. Houpis and Gary B. Lamont, Digital Control Systems Theory, Hardware Software, McGraw Hill Book Company, 1985.
3. Isermann R., Digital Control Systems, Fundamentals, Deterministic Control, V. I, 2/e, Springer Verlag, 1989.
4. Liegh J. R., Applied Digital Control, Rinchart & Winston Inc., New Delhi.
5. Åström, Karl J., and Björn Wittenmark,. Computer-controlled systems: theory and design. Courier Corporation, 2013.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of Digital Control**	**(6 hours)**
1.1	Basic digital control system- Examples - mathematical model - choice of sampling and reconstruction-ZOH and FOH	2
1.2	Realisation of digital filters.	2
1.3	Relation between s and z - Mapping between s-domain and z-domain	2
2	**Response Computation**	**(7 hours)**
2.1	Pulse transfer function- Different configurations for the design	2
2.2	Time Response of discrete time system.	2
2.3	Steady state performance and error constants.	3
3	**Design of controller/Compensator in frequency domain**	**(7 hours)**
3.1	Digital P/PD/PI controller design	2
3.2	Digital PID controller design	1
3.3	Design of lag and lead compensator,	2
3.4	Design of lag-lead compensator.	1
3.5	Demo with MATLAB	1
4	**Design of controller/Compensator based on time response**	**(7 hours)**
4.1	Design of lag and lead compensator.	2
4.2	Design of lag-lead compensator.	1
4.3	Design based on method of Ragazzini.	2
4.4	Dead beat response design and deadbeat controller design.	2
5	**Modern control approach to digital control**	**(10 hours)**
5.1	Introduction to state space-	1
5.2	Computation of solution of state equation and state transition matrix. (examination questions can be limited to second order systems)	2
5.3	Controllability, Observability, and stabilizability of systems	2
5.4	Loss of controllability and observability due to sampling.	1
5.5	State feedback controller based on pole placement.	2
5.6	Observer design based on pole placement.	2

CODE	COURSE NAME	CATEGORY	L	T	P	Credits
EOT423	Energy Management	PEC	2	1	0	3

Preamble: This course introduces basic knowledge about energy management and audit. Energy management opportunities in electrical and mechanical systems are discussed. Demand side management and ancillary services are explained. Economic analysis of energy conservation measures are also described.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	**Analyse the significance of energy management and auditing.**
CO 2	**Discuss the energy efficiency and management of electrical loads.**
CO 3	**Apply demand side management techniques.**
CO 4	**Explain the energy management opportunities in industries.**
CO 5	**Compute the economic feasibility of the energy conservation measures.**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1	1		1			
CO 2	2		1	1		1	1					
CO 3	2		1	1		1	1					
CO 4	2		1	1		1	1					
CO 5	2										2	

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	15	15	30
Understand (K2)	20	20	40
Apply (K3)	15	15	30
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define energy management. (K1, PO1, PO6, PO7)

2. List the different phases involved in energy management planning. (K1, PO1, PO6, PO7)

3. State the need for energy audit. (K2, PO1, PO6, PO7, PO9)

Course Outcome 2 (CO2)

1. State the different methods which can be adopted to reduce energy consumption in lighting. (K2, PO1, PO3, PO4)

2. Describe how energy consumption can be reduced by energy efficient motors. (K2, PO1, PO3, PO4, PO6, PO7)

3. Discuss the maximum efficiency standards for distribution transformers. (K1, PO1, PO3, PO4, PO6, PO7)

Course Outcome 3 (CO3):

1. Discuss the different techniques of DSM. (K2, PO1, PO3, PO4)

2. Illustrate the different techniques used for peak load management. (K2, PO1, PO3, PO4, PO6, PO7)

3. Explain the different types of ancillary services. (K2, PO1, PO3, PO4)

Course Outcome 4 (CO4):

1. Define Coefficient of performance. (K1, PO1)

2. Demonstrate how waste heat recovery can be done. (K2, PO1, PO3, PO4, PO6, PO7)

3. Describe how energy consumption can be reduced by cogeneration. (K3, PO1, PO3, PO4, PO6, PO7)

Course Outcome 5 (CO5):

1. State the need for economic analysis of energy projects. (K2, PO1, PO11)

2. Define pay back period. (K2, PO1, PO11)

3. Demonstrate how life cycle costing approach can be used for comparing energy projects. (K3, PO1, PO11)

Model Question paper

QP CODE:

PAGES: 3

Reg. No:______________
Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT423

Course Name: ENERGY MANAGEMENT

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all questions. Each question carries 3 Marks

1. Explain what you mean by power quality audit.
2. Write notes on building management systems.
3. Compare the efficacy of different light sources.
4. Write notes on design measures for increasing efficiency in transformers.
5. Discuss the benefits of demand side management.
6. Explain the benefits of power factor improvement.
7. Discuss any two opportunities for energy savings in steam distribution.
8. Explain the working of a waste heat recovery system.

9. What are the advantages and disadvantages of the payback period method?

10. Write notes on computer aided energy management systems.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 marks

Module 1

11. a.	With the help of case studies, explain any four energy management principles.	8
b.	Explain the different phases of energy management planning.	6
12. a.	Explain the different steps involved in a detailed energy audit.	7
b.	Discuss the different instruments used for energy audit.	7

Module 2

13. a.	With the help of case studies, explain any four methods to reduce energy consumption in lighting.	8
b.	Explain how energy efficient motors help in reducing energy consumption.	6
14. a.	With the help of case studies, explain any four methods to reduce energy consumption in motors.	8
b.	Define cascade efficiency of an electrical system. How it can be calculated?	6

Module 3

15. a.	Explain the different techniques of demand side management.	6
b.	The load on an installation is 800 kW, 0·8 lagging p.f. which works for 3000hours per annum. The tariff is Rs 100 per kVA plus 20 paise per kWh. If the power factor is improved to 0·9 lagging by means of loss-free capacitors	8

costing Rs 60 per kVAR, calculate the annual saving effected. Allow 10% per annum for interest and depreciation on capacitors.

16. a. Discuss the importance of peak demand control. Explain the different methods used for that. 8

b. Explain the different types of ancillary services. 6

Module 4

17. a. Explain any four energy conservation opportunities in furnaces 7

b. Explain the working of different types of cogeneration systems. 7

18. a. Discuss the different energy conservation opportunities in boiler. 7

b. Explain any five energy saving opportunities in heating, ventilating and air conditioning systems. 7

Module 5

19. a. Calculate the energy saving and payback period which can be achieved by replacing a 11 kW, existing motor with an EEM. The capital investment required for EEM is Rs. 40,000/-. Cost of energy/kWh is Rs. 5. The loading is 70% of the rated value for both motors. Efficiency of the existing motor is 81% and that of EEM is 84.7%. 8

b. Compare internal rate of return method with present value method for the selection of energy projects. 6

20. a. Explain how the life cycle costing approach can be used for the selection of energy projects. 6

b. The cash flow of an energy saving project with a capital investment cost of Rs. 20,000/- is given in the table below. Find the NPV of the project at a discount rate of 10%. Also find the Internal Rate of Return of the project. 8

Year	Cash flow
1	7000
2	7000

3	7000
4	7000
5	7000
6	7000

Syllabus

Module 1 (7 hours)

Energy Management - General Principles and Planning:
General principles of energy management and energy management planning

Energy Audit: Definition, need, types and methodologies. Instruments for energy audit, Energy audit report - Power quality audit

Energy conservation in buildings: ECBC code (basic aspects), Building Management System (BMS).

Module 2 (9 hours)

Energy Efficiency in Electricity Utilization:
Electricity transmission and distribution system, cascade efficiency.

Lighting: Modern energy efficient light sources, life and efficacy comparison with older light sources, energy conservation in lighting, use of sensors and lighting automation.

Motors: Development of energy efficient motors and the present status, techniques for improving energy efficiency, necessity for load matching and selection of motors for constant and variable loads.

Transformers: Present maximum efficiency standards for power and distribution transformers, design measures for increasing efficiency in electrical system components.

Module 3 (8 hours)

Demand side Management: Introduction to DSM, benefits of DSM, different techniques of DSM –time of day pricing, multi-utility power exchange model, time of day models for planning.

Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.

Power factor improvement, numerical examples.

DSM and Environment.

Ancillary services: Introduction of ancillary services – Types of Ancillary services

Module 4 (6 hours)

Energy Management in Industries and Commercial Establishments:
Boilers: working principle - blow down, energy conservation opportunities in boiler.

Steam: properties of steam, distribution losses, steam trapping. Identifying opportunities for energy savings in steam distribution.
Furnace: General fuel economy measures, energy conservation opportunities in furnaces.
HVAC system: Performance and saving opportunities in Refrigeration and Air conditioning systems.

Heat Recovery Systems:

Waste heat recovery system - Energy saving opportunities.
Cogeneration: Types and schemes, optimal operation of cogeneration plants, combined cycle electricity generation.

Module 5 (6 hours)

Energy Economics:

Economic analysis: methods, cash flow model, time value of money, evaluation of proposals, pay-back period, average rate of return method, internal rate of return method, present value method, life cycle costing approach. Computer aided Energy Management Systems (EMS).

Reference Books

1. Energy Conservation Act – 2001 and Related Rules and Standards.
2. Publications of Bureau of Energy Efficiency (BEE).
3. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003.
4. IEEE recommended practice for energy management in industrial and commercial facilities
5. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2007
6. Operation of restructured power systems Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, Kluwer Academic Pub., 2001.
7. Wayne C. Turner, Energy management Hand Book - the Fairmount Press, Inc., 1997
8. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons, 1996.

No	Topic	No. of Lectures
1	**Energy Management - General Principles and Planning; Energy audit (7 hours)**	
1.1	Energy management; General principles of energy management	2
1.2	Energy management planning	1
1.3	**Energy audit:** Definition, need, types and methodologies.	2
1.4	Instruments for energy audit, Energy audit report. Power quality audit	1
1.5	ECBC code (basic aspects), Building Management System (BMS).	1
2	**Energy management in Electricity Utilization (8 hours)**	
2.1	Electricity transmission and distribution system, cascade efficiency.	1
2.2	Energy management opportunities in Lighting: Modern energy efficient light sources, life and efficacy comparison with older light sources, energy conservation in lighting, use of sensors and lighting automation.	2
2.3	Energy management opportunities in Motors: Development of energy efficient motors and the present status, techniques for	2

	improving energy efficiency, necessity for load matching and selection of motors for constant and variable loads.	
2.4	Transformers: Present maximum efficiency standards for power and distribution transformers, design measures for increasing efficiency in electrical system components.	3
3	**Demand side Management and Ancillary service management:(8 hours)**	
3.1	Introduction to DSM, benefits of DSM, different techniques of DSM, DSM and Environment.	2
3.2	Time of day pricing, multi-utility power exchange model, time of day models for planning.	2
3.3	Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.	2
3.4	Power factor improvement, simple problems.	1
3.5	Introduction of ancillary services – Types of Ancillary services	1
4	**Energy Management in Industries and Commercial Establishments (6 hours):**	
4.1	Boilers: working principle - blow down, energy conservation opportunities in boiler.	1
4.2	Steam: properties of steam, distribution losses, steam trapping. identifying opportunities for energy savings in steam distribution.	1
4.3	Furnace: General fuel economy measures, energy conservation opportunities in furnaces.	1
4.4	Performance and saving opportunities in Refrigeration and Air conditioning systems.	2
4.5	Waste heat recovery system - Energy saving opportunities. Cogeneration: types and schemes, optimal operation of cogeneration plants, combined cycle electricity generation.	1
5	**Energy Economics (6 hours)**	
5.1	Economic analysis methods	1
5.2	Cash flow model, time value of money, evaluation of proposals	1
5.3	Pay-back method, average rate of return method, internal rate of return method	2
5. 4	Present value method, life cycle costing approach.	1
5.4	Computer aided Energy Management Systems (EMS).	1

EOT 413	REAL TIME OPERATING SYSTEM	CATEGORY	L	T	P	CREDIT
		PE	2	1	0	3

Preamble: At the end of the course the students will be familiar with operating systems. They will have an in- depth knowledge about the Real Time Operating systems and its applications

Prerequisite: Operating System

Course Outcomes: After the completion of the course the student will be able to

CO 1	*Summarise the aspects of general operating systems.*
CO 2	*Describe the key concepts of Real-Time Operating Systems.*
CO 3	*Demonstrate the basic structure, building blocks of real-time operating systems and various operations.*
CO 4	*Evaluate the different scheduling algorithms used in RTOS.*
CO 5	*Explain the different applications of real-time operating systems.*

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	1									1
CO 2	3	3	2	1	2							1
CO 3	3	3	2									2
CO 4	3	3	3									2
CO 5	3	3	3	3	2							3

Assessment Pattern

Blooms Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the significances of process control blocks

2. Explain the shared data problem and solutions to it.

Course Outcome 2 (CO2)

1. Explain the structure of a real time systems.

2. Compare the different types of semaphores.

Course Outcome 3(CO3):

1. . What is the sufficient condition for EDF schedulability of a set of periodic task whose Period and deadline are different?

2. What do you understand by scheduling point of a task scheduling algorithm?

Course Outcome 4 (CO4):

1. Illustrate the structure of a real time kernel

2. Write short notes on real time garbage collection

Course Outcome 5 (CO5):

1. Compare and contrast various open source real time operating system

2. Describe applications of real time operating system

Model Question paper

QP Code: Pages: 2

Reg No:

Name**:**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FOURTH SEMESTER

B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EOT 413

Course Name: Real Time Operating Systems

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. Discuss the importance of kernel in an operating system.
2. Compare process and thread.
3. Describe interrupt latency
4. Discuss about the different task classes.
5. List the features of mutex semaphore.
6. Compare rate monotonic and deadline monotonic scheduling algorithms.
7. Explain the role of events in inter task communication.
8. Draw the structure of a real time kernel and explain.
9. List the features of UNIX real time operating system.
10. Give the reasons for the message delay in real time communication.

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a) Give a detailed description about the process components and states. (10)

b) Discuss about the creation and termination of a process. (10)

OR

12. a) What do you mean by shared data problem? How the system handles it? (5)

b) Compare the performance of FCFS and Round Robin algorithms with examples.(10)

c) Discuss about dynamic linking and loading (5)

Module II

13. a) Describe the structure of a Real Time Operating System in detail.(10)

b) What do you mean by re-entrancy? What are the conditions to be satisfied for a function to be re-entrant. (6)

c)Discuss about the steps used by the processor for handling an exception. (4)

OR

14. a) Explain the different constraints handled by real time systems. (10)

b) Give a detailed description about the synchronization tools used RTOS. (10)

Module III

15. a) Describe about the message queues used RTOS (10)

b) Given seven tasks, A, B, C, D, E, F, and G, construct the precedence graph from the following precedence relations:

A → C

B →C B→ D

C →E C→ F

D →F D→ G

Then, assuming that all tasks arrive at time t = 0, have deadline D = 25, and computation times 2, 3, 3, 5, 1, 2, 5, respectively, modify their arrival times and deadlines and schedule them by EDF. (10)

OR

16. a) Verify the schedulability under EDF of the task set given, and then construct the corresponding schedule. (10)

	Ci	Ti
T1	1	4
T2	2	6
T3	3	8

b) Discuss the role of mail boxes and pipes in inter task communication (6)

c) Compare EDD and EDF algorithm for aperiodic task scheduling (4)

Module IV

17. a) Draw the detailed process state transition diagram of a periodic task and explain. (10)

b) What do you mean by system overhead? How it is handled by the operating system? (4)

c) Discuss about the CAB implementation of a real time kernel (6)

OR

18. a) Explain the data structure of a real time kernel. (10)

b) Discuss about the task scheduling in MicroC/OS II (Module v) (10)

c) Explain Core RT Linux API. [8]

d) Write short notes on the following

a) Free RTOS

b)RTLInux

c)RTAI

Syllabus

Module 1

Operating system : Introduction. Kernel, Process- states, Process control block, Creation and termination Scheduling, Thread. Memory management, Interrupts: interrupt sources and handlers- saving and restoring the content, disabling interrupt, interrupt latency.

The shared data problem- atomic and critical section.

Module 2

Real Time Operating Systems: Structure of real time systems: task, task classes, typical task operations - Performance measures. Re-entrancy, re-entrancy rules.

RTOS semaphores: types, typical operations, applications. Memory management, Exceptions and Interrupts, Handling exceptions and interrupts.

Module 3

Inter task communication: message queues, mailboxes and pipes, events

Task scheduling: Task constraints. Aperiodic task scheduling: EDD, EDF, LDF, EDF with precedence constraints. Periodic task scheduling: rate monotonic, EDF, deadline monotonic.

Module 4

Structure of a real-time kernel, Process states, Data Structures, Kernel primitives, Inter-task communication mechanisms, System overhead. Process stack management, run-time buffer size, swapping, overlays, block/page management, replacement algorithms, real-time garbage collection.

Module 5

Real Time Operating Systems: Open Source Real Time Operating System – FreeRTOS/ RTLinux / RTAI, MicroC/OS-II - Commercial Real-time operating systems: General concepts -Unix and

Windows as RTOS. Applications of RTOS: Real Time Communication Architecture.

Embedded systems – Block diagram.

Reference Books

1. Abraham Silberschatz, *Operating System Concepts*, 7e. John Wiley,2004.
2. Giorgio C. Buttazzo, *Hard Real-Time Computing Systems Predictable Scheduling*
3. *Algorithms and Applications*, Kluwer Academic Publishers, 2000
4. Jean J Labrosse, *Micro C/OS-II, The Real-Time Kernel*, CMP Books, 1998.
5. Robert Krten, *Getting started with QNX Neutrino*, Parse Software Devices, 1999.
6. Krishna C.M., Kang Singh G, *Real time systems*, Tata McGraw Hill, 2003.
7. Liu J. W. S., *Real-Time Systems*, Prentice Hall, 2000.
8. Rajib Mall, *Real-Time Systems: Theory and Practice*, Pearson, 2008.
9. Qing Li, *Real-Time Concepts for Embedded Systems*, CMP Books, 2003
10. David E. Simon, *An Embedded Software Primer*, Pearson, 2012.
11. Sriram V. Iyer and, Pankaj Gupta, *Embedded Real Time Systems Programming*, Tata McGraw Hill, 2003
12. Raj Kamal, *Embedded Systems Architecture, Programming and Design*, Tata McGraw Hill,2003

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Operating system : Introduction. Kernel, Process- states, Process control block,	2
	Creation and termination Scheduling, Thread.	1
1.2	Memory management	1
1.3	Interrupts: interrupt sources and handlers- saving and restoring the content, disabling interrupt, interrupt latency.	2
1.4	The shared data problem- atomic and critical section.	2
2	**Module 2**	
2.1	Real Time Operating Systems: Structure of real time systems: task, task classes, typical task	2
2.2	operations Performance measures. Re-entrancy, re-entrancy rules.	1
2.3	RTOS semaphores: types, typical operations, applications.	1
2.4	Memory management,	1
	Exceptions and Interrupts, Handling exceptions and interrupts.	2
3	**Module 3**	
3.1	Inter task communication: message queues, mailboxes and pipes, events	2
3.2	Task scheduling: Task constraints. Aperiodic task scheduling: EDD. EDF, LDF, EDF with precedence constraints.	2

3.3	Periodic task scheduling: rate monotonic, EDF, deadline monotonic	2
4	**Module 4**	
4.1	Structure of a real-time kernel, Process states	1
	Data Structures, Kernel primitives,	1
4.2	Inter-task communication mechanisms, System overhead.	2
4.3	Real Time Operating Systems: MicroC/OS-II Overview only.	2
5	**Module 5**	
5.1	Commercial Real-time operating systems: General concepts -Unix and Windows as RTOS	3
5.2	Applications of RTOS: Real Time Communication Architecture. Embedded systems Block diagram.	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET453	**DIGITAL SIGNAL PROCESSING**	**PEC**	**2**	**1**	**0**	**3**

Preamble: This course introduces the discrete Fourier transform (DFT) and its computation using direct method and fast Fourier transform (FFT). Techniques for designing infinite impulse response (IIR) and finite impulse response (FIR) filters from given specifications are also introduced. Various structures for realization of IIR and FIR filters are discussed. Detailed analysis of finite word-length effects in fixed point DSP systems is included. Architecture of a digital signal processor is also discussed.

Prerequisite : EET305 - Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute Discrete Fourier transform and Fast Fourier transform .
CO 2	Discuss the various structures for realization of IIR and FIR discrete-time systems.
CO 3	Design IIR (Butterworth and Chebyshev) digital filters using impulse invariant and bilinear transformation methods.
CO 4	Design FIR filters using frequency sampling method and window function method.
CO 5	Compare fixed point and floating point arithmetic used in digital signal processors and discuss the finite word length effects.
CO 6	Explain the architecture of digital signal processors and the applications of DSP.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	2	2	-	-	-	-	-	-	2
CO 2	3	2	-	2	2	-	-	-	-	-	-	2
CO 3	3	2	-	2	2	-	-	-	-	-	-	2
CO 4	3	2	-	2	2	-	-	-	-	-	-	2
CO 5	3	2	-	-	2	-	-	-	-	-	-	2
CO 6	3	-	2	-	2	2	-	-	-	-	-	3

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	10	10	10
Understand (K2)	10	10	30
Apply (K3)	30	30	60
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. State and prove various properties of DFT - (K1, PO1,PO2,PO12)
2. Determine the linear convolution using DFT – (K2,PO1,PO2,PO4,PO5,PO12)
3. Determine the linear convolution using overlap-add and overlap-save method – (K3,PO1,PO2,PO4,PO5)
4. Compute DFT using DIT FFT and DIF FFT – (K2,PO1,PO2,PO4,PO5)

Course Outcome 2 (CO2)

1. Determine the structures for direct form, cascade, parallel, transposed and lattice-ladder realisations of IIR systems –(K2,PO1,PO2,PO4,PO5,PO12)
2. Determine the structures for direct form, cascade, lattice ,and linear phase realizations of FIR systems – (K2,PO1,PO2,PO4,PO5)

Course Outcome 3(CO3)

1. Design IIR digital LP/HP/BP/BS filter using Butterworth and Chebyshev methods – (K3,PO1,PO2,PO4,PO5)
2. Transform H(s) to H(z) using impulse invariant technique and bilinear transformation – (K2,PO1,PO2,PO4,PO5,PO12)

Course Outcome 4 (CO4)

1. Design FIR digital LP/HP/BP/BS filter using frequency sampling method – (K3,PO1,PO2,PO4,PO5,PO12)
2. Design FIR digital LP/HP/BP/BS filter using window function – (K3,PO1,PO2,PO4,PO5)

Course Outcome 5 (CO5)

1. Differentiate between fixed-point arithmetic and floating point arithmetic - (K2,PO1,PO2,PO12)
2. Explain various finite word length effects in fixed point DSP processors.- (K2,PO1,PO2)
3. Problems to determine steady state output noise power and round-off noise power – (K3,PO1,PO2)
4. Explain limit cycle oscillations and methods for its elimination - (K2,PO1,PO2)

Course Outcome 6 (CO6)

1. Explain Harvard architecture –(K1,PO1,PO5,PO12)
2. Describe the architecture of a fixed-point DSP processor – (K1,PO1,PO5)
3. List various applications of digital signal processor – (K3,PO1,PO3,PO6)

Model Question Paper PAGES: 3

QPCODE:

Reg. No:____________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code: **EET453**
Course Name: **DIGITAL SIGNAL PROCESSING**

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions.
Each question carries 3 Marks

1	List any 3 properties of DFT.
2	The first 5 points of the 8-point DFT of a real valued sequence are $X(k)=\{0.25, 0.125-j0.3, 0, 0.125-j0.05, 0\}$. Determine the remaining 3 points.
3	Obtain direct form 1 realization for a digital IIR system described by the system function, $H(z)=\dfrac{z+0.2}{z^2+0.5z+1}$.
4	Obtain realization with minimum number of multipliers for the system function $H(z)=\dfrac{1}{2}+z^{-1}+\dfrac{1}{2}z^{-2}$.

5 Explain warping effect in bilinear transformation.

6 Determine the order of a Chebyshev analog lowpass filter with a maximum passband attenuation of 2.5dB at Ω_p = 20 rad/sec and the stopband attenuation of 30dB at Ω_s = 50 rad/sec.

7 What are the desirable characteristics of a window function used for truncating the infinite impulse response?

8 Represent the numbers i) +4.5 and ii) -4.5 in IEEE 754 single-precision floating point format.

9 List any 3 finite-word length effects in a fixed point digital signal processor.

10 Draw the block diagram of a basic Harvard architecture in digital signal processor.

PART B

Answer any one full question from each module.
Each question carries 14 Marks

Module 1

11 a) Find the 4-point DFT of the sequence, $x(n)=\{1,-1,1,-1\}$. Also, using time shift property, find the DFT of the sequence, $y(n)=x((n-2))_4$. (7)

b) Two finite duration sequences are $h(n)=\{1,0,1\}$ and $x(n)=\{-1,2,-1,0,1,3,-2,1,-3,-2,-1,0,-2\}$. Use overlap-save method, to find $y(n)=x(n)*h(n)$. (7)

OR

12 Compute IDFT of the sequence $X(k)=\{7,-0.707-j0.707,-j,0.707-j0.707,1,0.707+j0.707,j,-0.707+j.707\}$ using DIT FFT. (14)

Module 2

13 a) Realize the system function in cascade form $H(z)=\dfrac{1+\frac{1}{3}z^{-1}}{1-\frac{3}{4}z^{-1}+\frac{1}{8}z^{-2}}$. (6)

b) Determine the direct form 2 and transposed direct form structure for the given system $y(n)=\dfrac{1}{2}y(n-1)-\dfrac{1}{4}y(n-2)+x(n)+x(n-1)$. (8)

OR

14 a) Obtain the direct form realization of linear phase FIR system given by (7)

$H(z)=1+\dfrac{3}{4}z^{-1}+\dfrac{17}{8}z^{-2}+\dfrac{3}{4}z^{-3}+z^{-4}$

b) Determine the coefficients k_m of the lattice filter corresponding to FIR filter described by the system function $H(z)=1+2z^{-1}+\frac{1}{3}z^{-2}$. Also, draw the corresponding second order lattice structure (7)

Module 3

15 a) Find H(z) using impulse invariant transformation. (7)

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}; \quad T = 1\sec.$$

b) A Butterworth lowpass filter has to meet the following specifications. (7)

i) Passband gain = -3dB at f_p = 500Hz

ii) Stopband attenuation greater than or equal to 40dB at f_s = 1000Hz

Determine the order of the Butterworth filter to meet the above specifications. Also, find the cut off frequency.

OR

16 Design a Chebyshev digital lowpass filter with a maximum passband attenuation of 2dB at 100Hz and minimum stopband attenuation of 20dB at 500Hz. Sampling rate is 4000 samples/sec. Use bilinear transformation. (14)

Module 4

17 a) Design a linear phase lowpass FIR filter with N = 7 and a cut-off frequency 0.3π radian using the frequency sampling method. (7)

b) A linear phase FIR filter has frequency response $H(\omega) = \cos\frac{\omega}{2} + \frac{1}{2}\cos\frac{3\omega}{2}$ (7)

Determine the impulse response h(n).

OR

18 A band stop filter is to be designed with the following desired frequency response (14)

$$H_d(e^{j\omega}) = \begin{cases} e^{-j\omega\alpha} & -\omega_{c1} \le \omega \le \omega_{c1} \quad \omega_{c2} \le |\omega| \le \pi \\ 0 & \text{otherwise} \end{cases}$$

Design with N = 7, ω_{c1} = π/4 rad/sec, ω_{c2} = 3π/4 rad/sec using rectangular window.

Module 5

19 a) Compare between fixed point and floating point digital signal processors. (6)

b) The output of an ADC is applied to a digital filter with system function $H(z) = \frac{0.5z}{(z-0.5)}$. Find the output noise power from digital filter when input signal is quantized to have 8 bits. (8)

OR

20 a) Draw and explain the architecture of any fixed-point DSP processor. (8)

b) Explain the techniques used to prevent overflow in fixed-point DSP operations. (6)

Syllabus

Module 1 - DISCRETE-FOURIER TRANSFORM
Review of signals and systems - Frequency domain sampling - Discrete Fourier transform (DFT) – inverse DFT (IDFT) - properties of DFT – linearity, periodicity, symmetry, time reversal, circular time shift, circular frequency shift, circular convolution, complex conjugate property – Filtering of long data sequences – over-lap save method, over-lap add method – Fast Fourier transform (FFT) – advantages over direct computation of DFT - radix -2 decimation-in-time FFT (DITFFT) algorithm, Radix-2 decimation-in-frequency FFT (DIFFFT) algorithm.

Module 2 - REALIZATION OF IIR AND FIR SYSTEMS
Introduction to FIR and IIR systems - Realization of IIR systems – direct form 1, direct form 2, cascade form, parallel form, lattice structure for all-pole system, lattice-ladder structure – conversion of lattice to direct form and vice-versa - signal flow graphs and transposed structures – Realization of FIR systems – direct form, cascade form, lattice structure, linear phase realization.

Module 3 - IIR FILTER DESIGN
Conversion of analog transfer function to digital transfer function – impulse invarient transformation and bilinear transformation – warping effect
Design of IIR filters – low-pass, high-pass, band-pass, band-stop filters – Butterworth and Chebyshev filter – frequency transformation in analog domain - design of LP, HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation.

Module 4 - FIR FILTER DESIGN AND REPRESENTATION OF NUMBERS
Impulse response of ideal low pass filter – linear phase FIR filter – frequency response of linear phase FIR filter – Design of FIR filter using window functions (LP, HP, BP, BS filters) – Rectangular, Bartlett, Hanning, Hamming and Blackmann only – FIR filter design based on frequency sampling approach (LP, HP, BP, BS filters)
Representation of numbers – fixed point representation – sign-magnitude, one's complement, two's complement – floating point representation – IEEE 754 32-bit single precision floating point representation

Module 5 - FINITE WORD LENGTH EFFECTS AND DIGITAL SIGNAL PROCESSORS
Finite word length effects in digital Filters – input quantization – quantisation noise power – steady-state output noise power – coefficient quantisation – overflow – techniques to prevent overflow - product quantization error – rounding and truncation – round-off noise power – limit cycle oscillations – zero input limit cycle oscillations – overflow limit cycle oscillations – signal scaling.
Digital signal processor architecture based on Harvard architecture (block diagram) – Harvard architecture, pipelining, dedicated hardware multiplier/accumulator, special instructions dedicated to DSP, replication, on-chip memory cache, extended parallelism

(Reference [2]) - comparison of fixed-point and floating-point processor – applications of DSP

Text Books

1. John G. Proakis & Dimitris G.Manolakis, "Digital Signal Processing Principles, Algorithms & Applications", Pearson

Reference Books

1. Emmanuel Ifeachor & Barrie W Jervis, "Digital Signal Processing", Pearson, 13th edition, 2013
2. P. Ramesh Babu, "Digital Signal Processing", Scitech Publications (India) Pvt Ltd, 2nd edition, 2003
3. Li Tan, "Digital Signal Processing, Fundamentals & Applications", Academic Press, Ist edition, 2008
4. D. Ganesh Rao & Vineeta P Gejji, "Digital Signal Processing, A Simplified Approach", Sanguine Technical Publishers, 2nd edition, 2008

Course Contents and Lecture Schedule

Sl. No	Topic	No. of Lectures
1	**DISCRETE-FOURIER TRANSFORM (7 hours)**	
1.1	Review of signals, systems and discrete-time Fourier transform (DTFT), Frequency domain sampling, discrete-Fourier transform (DFT), twiddle factor, inverse DFT, properties of DFT - linearity, periodicity, symmetry, time reversal, circular time shift, circular frequency shift, circular convolution, complex conjugate property	3 hours
1.2	Linear filtering using DFT, linear filtering of long data sequences, overlap-save method, overlap-add method	1 hour
1.3	Fast Fourier transform (FFT) – comparison with direct computation of DFT - radix -2 decimation-in-time FFT (DITFFT) algorithm – bit reversal - Radix-2 decimation-in-frequency FFT (DIFFFT) algorithm	3 hours
2	**REALIZATION OF IIR AND FIR SYSTEMS (7 hours)**	
2.1	Introduction to FIR and IIR systems - comparison - Realization of IIR systems – direct form 1, direct form 2, cascade form, parallel form	3 hours
2.2	Lattice structure for all-pole system - lattice-ladder structure – conversion of lattice to direct form and vice-versa signal flow graphs and transposed structures	2 hours
2.3	Realization of FIR systems – direct form, cascade form, lattice structure, linear phase realization.	2 hours
3	**IIR FILTER DESIGN (7 hours)**	
3.1	Conversion of analog transfer function to digital transfer function – impulse invarient transformation and bilinear transformation – warping effect	2 hours
3.2	Design of IIR filters – characteristics of ideal and practical low-pass, high-pass, band-pass, band-stop filters – design of Butterworth filter –	3 hours

	normalised analog filter - frequency transformation in analog domain - design of LP, HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation.	
3.3	Design of Chebyshev filter – design of LP, HP, BP, BS IIR digital filters using impulse invariance and bilinear transformation	2 hours
4	**FIR FILTER DESIGN AND REPRESENTATION OF NUMBERS (7 hours)**	
4.1	Impulse response of ideal low pass filter – linear phase FIR filter – frequency response of linear phase FIR filter – Design of FIR filter using window function (LP, HP, BP, BS filters) – Rectangular, Bartlett, Hanning, Hamming and Blackmann only	3 hours
4.2	FIR filter design based on frequency sampling approach (LP, HP, BP, BS filters)	2 hours
4.3	Representation of numbers – fixed point representation – sign-magnitude, one's complement, two's complement – floating point representation – IEEE 754 32-bit single precision floating point representation	2 hours
5	**FINITE WORD LENGTH EFFECTS AND DIGITAL SIGNAL PROCESSORS (7 hours)**	
5.1	Finite word length effects in digital Filters – input quantization – quantisation noise power – steady-state output noise power	2 hours
5.2	Coefficient quantisation – overflow – techniques to prevent overflow - product quantization error – rounding and truncation – round-off noise power	1 hour
5.3	Limit cycle oscillations – zero input limit cycle oscillations – overflow limit cycle oscillations – signal scaling.	1 hour
5.4	Digital signal processor architecture based on Harvard architecture (block diagram) – Harvard architecture, pipelining, dedicated hardware multiplier/accumulator, special instructions dedicated to DSP, replication, on-chip memory cache, extended parallelism (Reference [1])	2 hours
5.5	Comparison of fixed-point and floating-point processor – applications of digital signal processor	1 hour

Note: Preferable list of computer based assignments

Assignments using signal processing tool of MATLAB/SCILAB etc	
1	Determine 4-point/8-point DFT/IDFT of any sequence by direct computation
2	Compute 4-point/8-point DFT/IDFT using DIT FFT and DIF FFT algorithms.
3	Find the linear convolution and circular convolution of two sequences.
4	Find the linear convolution using overlap-add and overlap-save methods.
5	Determine 2 stage/3 stage lattice ladder coefficients if the system function of IIR direct form is given.
6	Obtain coefficients of IIR direct form from lattice ladder form.
7	Transform an analog filter into digital filter using impulse invariant technique/bilinear transformation.
8	Calculate the order and cut-off frequency of a low pass Butterworth filter
9	Obtain the frequency response and filter coefficients of a LP/HP/BP/BS IIR

	Butterworth filter
10	Obtain the frequency response and filter coefficients of a LP/HP/BP/BS IIR Chebyshev filter
11	Compute LP/HP/BP/BS FIR filter coefficients using rectangular/Bartlett/Hamming/Hanning/Blackmann window

CST463	WEB PROGRAMMING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course helps the learners to understand the web programming concepts. It includes the essential frontend and backend technologies needed for the development of web applications. The learners will have an opportunity to gain necessary web development skills such as HTML, CSS, JavaScript, PHP, MySQL integration, JSON and Laravel framework.

Prerequisite: Knowledge of Programming is required.

Course Outcomes: After the completion of the course the student will be able to

CO1	Use HyperText Markup Language (HTML) for authoring web pages and understand the fundamentals of WWW. **(Cognitive Knowledge Level: Understand)**
CO2	Construct and visually format responsive, interactive web pages using CSS and JavaScript (JS) **(Cognitive Knowledge Level: Apply)**
CO3	Construct websites using advanced sever side programming tool PHP **(Cognitive Knowledge Level: Apply)**
CO4	Develop dynamic web applications using PHP and perform MySQL database operations. **(Cognitive Knowledge Level: Apply)**
CO5	Explain the importance of object exchange formats using JSON and the MVC based web application development frameworks (Laravel) **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔				✔							✔
CO2	✔	✔	✔		✔							✔
CO3	✔	✔	✔	✔	✔							✔
CO4	✔	✔	✔	✔	✔							✔

CO5	✔	✔			✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**20**	**20**	**20**
Understand	**40**	**40**	**40**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks.

First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have a maximum of 2 subdivisions and carries 14 marks.

Syllabus

Module – 1 (WWW, HTML)

Introduction to the Internet & WWW: Evolution of Internet & World Wide Web- Web Basics, URI's & URL-MIME.

Introduction to HTML5: Structuring & editing an HTML5 document, Fundamentals of HTML - Headings-Hyper Links- Images - Special Characters & Horizontal Rules-Lists- Tables -Forms - Internal Linking- Meta Elements-HTML5 Form input types -Input and Data List Elements and autocomplete attribute- Page Structure Elements -Multimedia-HTML5 Audio & video elements..

Module -2 (CSS, JavaScript)

Introduction to Stylesheets : Introduction to CSS-Basic syntax and structure-Inline Styles, Embedded Style Sheets, Conflict Resolution, Linking External Style Sheets-Exploring CSS Selectors-Properties, values, Positioning Elements: Absolute Positioning, Relative Positioning -

Backgrounds-List Styles-Element Dimensions- Table Layouts-Box Model and Text Flow-div and span -Basics of Responsive CSS, Media port & Media Queries.

Introduction to JavaScript : Introduction to Scripting- Programming fundamentals of JavaScript -Obtaining User Input with prompt Dialogs-Arithmetic-Decision Making -Control Statements - Functions -Arrays -Objects -Document Object Model (DOM) -Form processing

Module- 3 (PHP Basics)

PHP Language Structure: Introduction- **B**uilding blocks of PHP-Variables, Data Types -simple PHP program-Converting between Data Types- Operators and Expressions -Flow Control functions - Control statements- Working with Functions- Initialising and Manipulating Arrays-- Objects- String Comparisons-String processing with Regular Expression

Module -4 (PHP- MySQL, JSON)

Advanced PHP: Form processing and Business Logic-Cookies- Sessions & MySQL Integration- Connecting to MySQL with PHP- Performing CREATE, DELETE, INSERT, SELECT and UPDATE operations on MySQL table -Working with MySQL data-Reading from Database- Dynamic Content.

Module- 5 (JSON, Laravel)

JSON Data Interchange Format: Syntax, Data Types, Object, JSON Schema, Manipulating JSON data with PHP

Web Development Frameworks: Laravel Overview-Features of Laravel-Setting up a Laravel Development Environment-Application structure of Laravel-Routing -Middleware-Controllers- Route Model Binding-Views-Redirections-Request and Responses.

Text Books

1 Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, Internet & World Wide Web How to Program 5th Edition **[Module 1,2,3,4]**
2. Lindsay Bassett, Introduction to JavaScript Object Notation: A To-the-Point Guide to JSON 1st Edition, O'Reilly **[Module 5]**
3. Julie C. Meloni, Pearson -PHP, MySQL & JavaScript All in One, Sams Teach Yourself,5th Ed [**Module 4]**
4. Matt Stauffer," LARAVEL up and Running, A framework for building modern PHP apps"1st Edition, O'REILLY **[Module 5]**

Reference Books

1. Robert W Sebesta, Programming the World Wide Web, 7/e, Pearson Education Inc,8th Edition
2. Larry Ullman, Pearson- PHP 6 and MySQL 5 for Dynamic Web Sites: Visual QuickPro Guide
3. Eric van der Vlist, Danny Ayers, Erik Bruchez, Joe Fawcett, Alessandro Vernet",Wrox-Professional Web 2.0 Programming, Wiley-India edition
4. Web Technologies Black Book 2018(As per Mumbai University Syllabus) HTML, CSS3, JavaScript, iQuery, AJAX,PHP,XML,MVC and Laravel DT Editorial Services (ISBN: 9789386052490)

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Construct a valid HTML document for your personal Profile registration page for a Job Site www.123Jobs.com. Add relevant HTML elements in a table, to accept a minimum of 10 different fields which includes your name, address, phone, email address, your picture, your college; your branch, fields for your personal history (Minimum 3 fields), favourite theory and practical subjects (Checkbox), Username, Password(password)

2. What is MIME? Give the expansion of MIME. List four examples for MIME types. State the reason why MIME type specification is necessary in a request-response transaction between a browser and server.

3. What is codec? Recognize the role of controls attribute in <video> & <audio> tag in HTML. Use the COVID vaccination promotional video 'MySafety.mp4' in a web page with suitable HTML code, 'autoplay' option enabled and displayed in a standard dimension 750 X500.

Course Outcome 2 (CO2):

1. Organize a sample web page for the event 'Raagam2021' at your campus and use embedded Style sheets to apply a minimum 5 styles. State the Style Specification format of embedded style sheets.

2. Write CSS style rules to implement the following in a web page:

a. to display the content of hyperlinks with yellow background color and in italics

b. to display the contents of unordered lists in bold and in Arial font

c. to display a background image titled "birds.jpg" with no tiling.

3. Write the code for an HTML document with embedded JavaScript scripts, which initially displays a paragraph with text "Welcome" and a button titled "Click". When the button is clicked, the message "Hello from JavaScript" in bold should replace the paragraph text

Course Outcome 3 (CO3):

1. Write a PHP program to store the name and roll no of 10 students in an Associative Array and Use foreach loop to process the array and Perform asort, rsort and ksort in the array. Illustrate with suitable output data
2. Design an HTML page which enters a given number, write a PHP program to display a message indicating, whether the number is odd or even, when clicking on the submit button.
3. Write a PHP program to compute the sum of the positive integers up to 100 using do while.

Course Outcome 4 (CO4):

1. Write a PHP form handling program to verify the user authentication credentials of a web page using MySQL connection and store the userid value as a Session variable if the userid is valid.
2. Create a valid HTML document for yourself, including your name, address, and email address. Also add your college; your major and the course. Perform form handling in PHP and process the output using POST method.
3. Write an embedded PHP script which displays the factorial of all numbers from 1 to 10 in a table in the web page. The factorial should be calculated and returned from a function. The table headings should be "Number" and "Factorial"

Course Outcome 5 (CO5):

1. What is Route Model Binding in Laravel? Which types of route model binding are supported in Laravel?
2. Explain how laravel performs route handling using routes calling controller methods?
3. List the data types used in JSON? Explain the use of parse () and stringify() functions in JSON with examples.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST463

Course Name: Web Programming

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Define WWW. List any two examples of web server & web browser. Differentiate between URL and a domain?

2. Write the syntax of the URL? Rewrite the default URL of your university website by adding a subdomain named ‘Research’ and a web page named ‘FAQ.html’. Also link this URL through the logo of ‘kturesearch.png’ placed in a web page. The FAQ page should be opened in a new window.

3. Illustrate the implementation of a JavaScript function greeting () using external .js file, to display a welcome message, when you click on a Button in an HTML page.

4. What are different ways of adjusting spacing in a text with suitable example.

5. Discuss the various CSS style sheet levels with suitable examples. How are conflicts resolved when multiple style rules apply to a single web page element?

6. Describe how input from an HTML form is retrieved in a PHP program, with an example

7. Write a PHP program to check whether a number is prime number or not.

8. Discuss the various steps for establishing PHP-MySQL connection with a MySQL

database ?

9. Describe the schema of a document implemented in JSON with suitable examples

10. Explain the role of Resource controllers in Laravel.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Design a webpage that displays the following table. **(6)**

Food Item	Recommended Intake			
	age<15		age>15	
	gm	Kcal	gm	Kcal
Cerials	1000	2000	750	1760
NonCerials	450	800	350	600

(b) What is the difference between radio buttons and checkboxes when implemented using HTML? Write HTML code to implement a form which has the following elements: **(8)**

i. A textbox which can accept a maximum of 25 characters
ii. Three radio buttons with valid Label, Names and values
iii. Three check boxes buttons with valid Label, Names and values
iv. A selection list containing four items, two which are always visible
v. A submit button clicking on which will prompt the browser to send the form data to the server "http://www..mysite.com/reg.php" using "POST" method and reset button to clear its contents. You can use any text of your choice to label the form elements.

OR

12. (a) Write the equivalent HTML code to implement the following in a web page: (i) An image titled "birds.jpg" with a height of 100 pixels and width of 200 pixels. If the image cannot be accessed, a message "No image available" should be displayed (ii) A hyperlink to the URL "www.mysite.com/birds.jpg". The hyperlink should have the label "Click Here". **(6)**

(b) Create a static HTML document for your portfolio, which includes the following contents: your name, address, Mobile Number and email address. Also add the details about your college, university, your major and the batch **(8)** of study. Include a picture of yourself and at least one other image (friend/pet/role model) to the document with a short description about that. Add three paragraphs about your personal history, with links to your social media profile. Also create an ordered list for describing your Skill Set & an unordered list showing your Strengths & Weaknesses.

13. (a) Illustrate the usage of JavaScript DOM in event handling and explain any three methods with example. **(8)**

(b) Write CSS and the corresponding HTML code for the following: **(6)**

i. Set the background color for the hover and active link states to "green"
ii. Set the list style for unordered lists to "square".
iii. Set "Flower.png" as the background image of the page and set 3% margin for the pages
iv. Set dashed border for left and right and double border for top & bottom of a table with 2 rows.

OR

14. (a) List the order of precedence of style levels. Organize a sample web page for providing 'KTU BTech Honours Regulation 19' for KTU and use embedded Style sheet to apply minimum 5 styles for list, tables and pages. **(6)**

(b) Illustrate the different ways of Array declaration in JavaScript. Describe the function of the following JavaScript Array object methods with examples. **(8)**
(i) join (ii) slice

15. (a) Explain any six string handling functions used in PHP with example. **(6)**

(b) How does a PHP array differ from an array in C? List the different ways to create an array in PHP with an example. Explain any 4 functions that deals with PHP array. **(8)**

OR

16. (a) During the process of fetching a web page from a web server to a client browser, at what point does an embedded PHP script get executed. What are the two modes that the PHP processor operates in? Explain **(6)**

(b) Why is PHP considered to be dynamically typed? Distinguish between **(8)** implode and explode function in PHP with suitable examples.

17. (a) Write equivalent PHP statements corresponding to the following: **(8)**

i. Declare an associative array named "ages" to store the key-value pairs ("Alice", 30), ("Bob", 30), ("Harry", 35), ("Mary", 32).

ii. Modify the value associated with the key "Mary" to 28.

iii. Sort the array according to values maintaining the key-value relationships and print the sorted key-value pairs.

iv. The entry identified by the key "Bob"

(b) What are the uses of cookies in web pages? Describe syntax for setting cookies in PHP. How can you access and delete the cookie using setcookie() function? **(6)**

OR

18. (a) Write a PHP form handling program to perform the user registration of any website with a minimum of 5 different fields and insert the data into a MySQL table after establishing necessary connections with the DB, **(8)**

(b) Design the HTML page which enters a given number and embed the PHP code to display a message indicating, whether the number is odd or even, when clicking on the 'CHECK NUMBER' button. **(6)**

19. (a) With a neat diagram, explain about Laravel MVC Framework. **(6)**

(b) Discuss in detail about Laravel's Routing mechanisms. **(8)**

OR

20. (a) Enumerate the data types in JSON. Illustrate the document definition of a 'Student document 'using JSON Schema. **(8)**

(b) Discuss the following in Laravel Views **(6)**

i. Creating & Rendering Views

ii. Passing Data to Views

iii. Sharing Data with All Views

Teaching Plan

No	Contents	No of Lecture Hrs (35 hrs)
	Module 1 (7 hours)	
	Introduction to Internet and WWW	
1.1	Evolution of Internet &World Wide Web- Web Basics URI's & URL -MIME [Book 1 - Chapter 1]	1
	Introduction to HTML5	
1.2	Structuring & editing an HTML5 document- Fundamentals of HTML, Headings-Images [Book 1 - Chapter 2]	1
1.3	Hyper Links, Internal Linking- Lists [Book 1 - Chapter 2]	1
1.4	Special Characters & Horizontal Rules- meta Elements- div and span [Book 1 - Chapter 2]	1
1.5	Tables- Forms [Book 1 - Chapter 2]	1
1.6	HTML5 Form input types, input and data list Elements and autocomplete attributes-Page Structure Elements [Book 1 - Chapter 3]	1
1.7	Multimedia-HTML5 Audio & video elements [Book 1 - Chapter 9]	1
	Module 2 (10 hours)	
	Introduction to Cascading Style Sheets(CSS)	
2.1	Introduction to CSS3-Basic syntax and structure-Inline Styles [Book 1 - Chapter 4]	1
2.2	Embedded Style Sheets-Linking External Style Sheets [Book 1 - Chapter 4]	1
2.3	Exploring CSS Selectors-Properties-values [Book 1 - Chapter 4]	1
2.4	Positioning Elements: Absolute Positioning- Relative Positioning -Backgrounds-List Styles- Table Layouts [Book 1 - Chapter 4]	1

2.5	Box Model and Text Flow, Basics of Responsive CSS-Media port & Media Queries [Book 1 - Chapter 4]	1
Introduction to JavaScript		
2.6	Introduction to Scripting- Programming fundamentals of JavaScript -Obtaining User Input with prompt Dialogs [Book 1 - Chapter 6]	1
2.7	Arithmetic-Decision Making [Book 1 - Chapter 6]	1
2.8	Control Statements [Book 1 - Chapter 7]- Functions [Book 1 - Chapter 9]	1
2.9	Arrays [Book 1 - Chapter 10] - Objects [Book 1 - Chapter 11]	1
2.10	Document Object Model (DOM)- Form processing [Book 1 - Chapter 12,13]	1
Module 3 (6 hours)		
Introduction to PHP		
3.1	Building blocks of PHP-Variables, Data Types simple PHP program [Book 3- Chapters 4]	1
3.2	Converting between Data Types, Operators and Expressions -Flow Control functions [Book 1- Chapters 19]	1
3.3	Control Statements -Working with Functions [Book 3- Chapters 6]	1
3.4	Initialising and Manipulating Arrays- Objects [Book 1- Chapters 19]	1
3.5	Working with Strings-String processing with Regular expression, Pattern Matching [Book 1- Chapters 19]	1
3.6	Form processing and Business Logic [Book 1- Chapters 19]	1
Module 4 (6 hours)		
PHP -MYSQL		
4.1	Cookies- Sessions [Book 1- Chapters 19]	1
4.2	PHP& MySQL Integration-Connecting to MySQL with PHP . [Book 4- Chapters 18]	1

4.3	Working with MySQL data [Book 4- Chapters 18]	1
4.4	Performing CREATE, DELETE, INSERT operations on MySQL table from PHP Program. [Book 4- Chapters 16]	1
4.5	Performing SELECT and UPDATE operations on MySQL table from PHP Program. [Book 4- Chapters 16]	1
4.6	Building Dynamic Content in PHP application [Book1- Chapter19]	1
	Module 5 (6 hours)	
	JSON	
5.1	JSON Data Interchange Format -Syntax, Data Types, Object [Book 2 - Chapters 1-2]	1
5.2	JSON Schema, Manipulating JSON data with PHP [Book 2 - Chapter 3,4]	1
	LARAVEL	
5.3	Laravel Overview**-** Design Pattern- Laravel Features [Book 4- Chapters 1] Setting up a Laravel Development Environment-Application structure of Laravel [Book 4- Chapters 2]	1
5.4	**Laravel Basics** Routing -middleware - Controllers [Book 4- Chapters 3]	1
5.5	Route Model Binding-Views-Redirections [Book 4- Chapters 3]	1
5.6	**Blade Templating-**echoing data, control structures [Book 4- Chapters 4]	1

EET413	ELECTRIC DRIVES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: To impart knowledge about the DC and AC motor drives and its applications

Prerequisite: EET306 Power Electronics, EET202 DC Machines and Transformers and EET307 Synchronous and Induction Machines.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the transient and steady state aspects electric drives
CO 2	Apply the appropriate configuration of controlled rectifiers for the speed control of DC motors
CO 3	Analyse the operation of chopper-fed DC motor drive in various quadrants
CO 4	Illustrate the various speed control techniques of induction motors
CO 5	Examine the vector control of induction motor drives
CO 6	Distinguish different speed control methods of synchronous motor drives

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	2		-	-	-	-	-	-	1
CO 3	3	2	-	2		-	-	-	-	-	-	1
CO 4	3	2	-	2		-	-	-	-	-	-	1
CO 5	3	1	-	2		-	-	-	-	-	-	1
CO 6	3	2	-	2		-	-	-	-	-	-	1

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	10	10	20
Understand (K2)	20	20	40
Apply (K3)	20	20	40
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Derive the condition for steady state stability (K3,K4, PO1, PO4).

2. Draw the speed torque characteristics of traction drive (K1, PO1).

3. Problems based on fundamental torque equations and equivalent values of drive parameters (K3, K4 , PO2, PO4).

Course Outcome 2 (CO2)

1. Numerical problems based on rectifier controlled separately excited dc motor. (K3, K4, PO2, PO4).

2. Describe the function of a three phase inverter driving a dc motor (K2, PO1).

3. Draw the circuit diagram of dual converter and explain the operation (K1, PO1).

Course Outcome 3(CO3):

1. Explain Motoring and braking operation of chopper controlled DC motor (K2,PO1).

2. Numerical problems based on chopper controlled separately excited dc motor. (K3, K4, PO2, PO4).

3. With the block diagram illustrate the closed loop control of SEDC motor (K2, PO4).

Course Outcome 4 (CO4):

1. List different speed control methods for three phase induction motors (K1, PO1)

2. Discuss sine triangle PWM control of three phase induction motor drive (K2, PO4).

3. Numerical problems based on speed control of induction motor drives (K3,K4, PO2, PO4).

Course Outcome 5 (CO5):

1. Draw the block diagram of direct vector control of induction motor drives (K2, PO1).

2. Figure out the differences of scalar and vector control methods of three phase induction motor (K3, PO1).

3. Draw the decoupled diagram and phasor diagram of three phase induction motor (K2, PO1) .

Course Outcome 6 (CO6):

1. Explain v/f control of three phase synchronous motor drive (K2, PO1).

2. Enumerate different speed control methods of synchronous motor drives (K1, PO1).

3. With the diagram of load commutated CSI synchronous motor drive discuss the operation (K2, PO1).

Model Question Paper

PAGES: 3

QPCODE:

Reg. No:____________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EET413**

Course Name: **ELECTRIC DRIVES**

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions.
Each question carries 3 Marks

1	Draw the block diagram of an electric drive.
2	List 3 classifications of load torque with one example for each.
3	For a single phase fully-controlled rectifier fed separately excited DC motor, the armature current is assumed to be continuous and ripple free ($i_a = I_a$). Draw the source current waveform for a firing angle of 45˚.

4 Can a half-controlled rectifier fed separately excited DC drive operated in quadrant IV? Justify your answer.

5 Draw the circuit diagram of a two-quadrant (class C) chopper showing the two quadrants of operation.

6 With the help of the torque – speed characteristics of a DC series motor, explain why it is used for high-starting torque applications?

7 Constant torque loads are not suitable for AC voltage controller fed induction motor drive. Why?

8 Why V/f ratio is kept constant upto base speed and V constant above base speed in variable frequency control of an induction motor?

9 Differentiate between true synchronous mode and self-control mode of operation of a synchronous motor.

10 List any two advantages of vector control of 3-phase induction motors.

PART B

Answer any one full question from each module.
Each question carries 14 Marks

Module 1

11	a)	What are the advantages of electric drives?	(7)
	b)	Explain the multi-quadrant operation of a motor driving a hoist load.	(7)
12	a)	Explain about steady state stability of equilibrium point in electric drive.	(7)
	b)	A drive has following parameters: - $J=10kg\text{-}m^2$, $T=100-0.1N$ and $T_l=0.05N$ where N is the speed in rpm. Initially the drive is operating in steady state. Now it is to be reversed. For this motor characteristics is changed to $T = -100-0.1N$. Calculate the time of reversal.	(7)

Module 2

13	a)	Explain the working of 3-phase fully-controlled separately excited DC drive with necessary waveforms.	(7)
	b)	A 220V, 1500rpm, 10A separately excited DC motor is fed from a single phase fully controlled rectifier with an ac source voltage of 230V, 50Hz. $R_a=2\Omega$. Conduction can be assumed to be continuous. Calculate the firing angles for rated motor torque and -1000rpm.	(7)
14	a)	Explain the discontinuous conduction mode of operation of a fully controlled rectifier fed separately excited DC motor with necessary waveforms.	(7)
	b)	Explain the working of a dual converter (circulating current type) fed separately excited DC motor.	(7)

Module 3

15	a)	Explain the operation of four quadrant chopper fed DC drives.	(7)
	b)	A chopper used to control the speed of a separately excited DC motor has supply voltage of 230V, T_{on} = 15ms, T_{off} = 5ms. Assuming continuous conduction of motor current, calculate the average load current when the motor speed is 3000rpm. Assume voltage constant K_v = 0.5V/rad/sec and R_a = 4Ω.	(7)

16	a)	Explain the chopper control of DC series motor.	(7)
	b)	Using a neat block diagram, explain the closed loop speed control for a separately excited DC motor.	(7)

Module 4

17	a)	Explain V/f control of 3-phase induction motor using necessary speed – torque characteristics.	(7)
	b)	A 440V, 3-phase, 50Hz, 6-pole, 945rpm, delta connected induction motor has following parameters referred to the stator: $R_s = 2\Omega$, $R_r' = 2\Omega$, $X_s = 3\Omega$, $X_r' = 4\Omega$. When driving a fan load at rated voltage it runs at rated speed. The motor speed is controlled by stator voltage control. Determine motor terminal voltage, current and torque at 800rpm.	(7)
18	a)	Explain the working of static rotor resistance control of 3-phase induction motor. Also derive the expression for the total rotor circuit resistance per phase.	(7)
	b)	Explain the static slip power recovery scheme using one uncontrolled bridge rectifier and one controlled bridge rectifier in the rotor circuit.	(7)

Module 5

19	a)	Describe the principle of operation of vector control.	(7)
	b)	Explain the variable frequency control of multiple synchronous motor.	(7)
20	a)	Explain Clerke and Park transformation with necessary equations.	(5)
	b)	Describe the working of a self-controlled synchronous motor drive employing load commutated thyristor inverter.	(9)

Syllabus (36 hours)

Module 1 (6 hours)

Introduction to electric drives – block diagram – advantages of electric drives – dynamics of motor load system, fundamental torque equations, types of load – classification of load torque, four quadrant operation of drives, Equivalent values of drive parameters- effect of gearing - steady state stability.

Module 2 (7 hours)

Rectifier control of DC drives- separately excited DC motor drives using controlled rectifiers- single-phase fully controlled rectifier fed drives (discontinuous and continuous mode of operation), critical speed - single-phase semi converter fed drives (continuous mode of operation) - three-phase semi converter and fully controlled converter fed drives (continuous mode of operation) - dual converter control of DC motor - circulating current mode.

Module 3 (6 hours)

Chopper control of DC drives - two quadrant and four quadrant chopper drives - motoring and regenerative braking - chopper fed DC series motor drive - closed loop speed control for separately excited dc motor.

Module 4 (10 hours)

Three phase induction motor drives: Stator voltage control - Stator frequency control – v/f control - below and above base speed – Voltage Source Inverter (VSI) fed v/f control using sine-triangle PWM - static rotor resistance speed control employing chopper – static slip power recovery speed control scheme for speed control below synchronous speed.

Module 5 (7 hours)

Concept of space vector – Clarke and Park transformation – field orientation principle – Introduction to direct vector control of induction motor drives – decoupling of flux and torque components - space vector diagram and block diagram [Ref.1].

Synchronous motor drives – v/f control – open loop control – self-controlled mode – load commutated CSI fed synchronous motor.

Note: Simulation assignments can be given using modern simulation tools like MATLAB, PSIM, PSpice, LTspice etc. from all modules of 2, 3, 4 and 5.

Text Books

1.G. K. Dubey, "Fundamentals of Electric Drives", Narosa publishers, second edition, 2001

Reference Books.

1. Bimal K.Bose, "Power Electronics and and Motor Drives", Academic press, An Imprint of Elsevier, 2006.
2. Vedam Subrahmanyam, "Electric Drives Concepts and Applications", MC Graw Hill Education, second edition, 2011,New Delhi.
3. Dr. P. S. Bimbhra, "Power Electronics", Khanna publishers, fifth edition, 2012.
4. Ned Mohan, Tore M Undeland, William P Robbins, "Power electronics converters applications and design", John Wiley and Sons Inc.,3rd edition
5. Muhammad H.Rashid, "Power Electronics, Devices, Circuits and Applications", Pearson, 3rd edition, 2014
6. R Krishnan, "Electric Motor Drives: Modeling, Analysis, and Control", Prentice Hall, 2001.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Fundamentals of Electric drives (6 hours)**	
1.1	Introduction to electric drives- block diagram – advantages of electric drives	1
1.2	Dynamics of motor load system, fundamental torque equations,	1
1.3	four quadrant operation of drives	1
1.4	Types of load – classification of load torque	1
1.5	Equivalent values of drive parameters- effect of gearing -	1
1.6	Steady state stability	1
2	**Rectifier Control of DC drives (7 hours)**	
2.1	Rectifier controlled DC drives- separately excited DC motor drives using controlled rectifiers- single-phase fully controlled rectifier fed drives discontinuous mode of operation,	2
2.2	continuous mode of operation - critical speed	1
2.3	single-phase semi converter fed drives (continuous mode of operation)	1
2.4	three-phase semi converter controlled converter fed drives (continuous mode of operation)	1
2.5	Three phase fully controlled converter fed drives (continuous mode of operation)	1
2.6	Dual converter control of DC motor - circulating current mode	1
3	**Chopper control of DC drives (6 hours)**	
3.1	Two quadrant chopper DC drives - motoring and regenerative braking	2
3.2	Four quadrant chopper DC drives	1
3.3	Chopper fed DC series motor drive	2
3.4	Closed loop speed control for separately excited dc motor.	1
4	**Three phase induction motor drives (10 hours)**	
4.1	Stator voltage control - Stator frequency control	1
4.2	v/f control - below and above base speed	2
4.3	Voltage Source Inverter (VSI) fed v/f control using sine-triangle PWM	2
4.4	Static rotor resistance speed control employing chopper	1
4.5	Static slip power recovery speed control scheme for speed control below synchronous speed.	1
4.6	Auto Sequential Commutated Current source Inverter (CSI) fed induction motor drives	1
4.7	Current regulated VSI using power semiconductor devices, operation and control scheme - comparison of CSI and VSI fed	2

	drives.	
5	**Concept of space vector , Synchronous motor drives (7 hours)**	
5.1	Concept of space vector – Clarke and Park transformation – field orientation principle – Introduction to direct vector control of induction motor drives – decoupling of flux and torque components - space vector diagram and block diagram.	4
5.2	Synchronous motor drives – v/f control – open loop control	1
5.3	Self-controlled mode – load commutated CSI fed synchronous motor.	2

SEMESTER VII

OPEN ELECTIVE

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET415	CONTROL SYSTEMS ENGINEERING	OEC	2	1	0	3

Preamble: Control Engineering is not limited to any engineering discipline, but is equally applicable to mechanical, chemical, electrical, aeronautical engineering. The most characteristic quality of control engineering is the opportunity to control machines, industrial and economic process for the benefit of society. This course aims to provide a strong foundation on classical control theory. In this course modelling, time domain analysis, frequency domain analysis and stability analysis of linear systems based on transfer function approach will be discussed.

Prerequisite: Knowledge of Laplace transforms.

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Identify the elements of control system.
CO 2	Develop transfer function models of systems.
CO 3	Analyse the relation between pole locations with the transient response of first and second order systems.
CO 4	Determine the stability of LTI systems.
CO 5	Apply the concept of Root locus to assess the performance of linear systems.
CO 6	Determine the frequency domain specifications from Bode plot, Polar plot and Nyquist plot.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	-	-	-	-	-	-	-	-	-	1
CO 2	3	2	-	-	-	-	-	-	-	-	-	1
CO 3	3	2	-	-	2	-	-	-	-	-	-	1
CO 4	3	2	-	-	-	-	-	-	-	-	-	1
CO 5	3	2	-	-	2	-	-	-	-	-	-	1
CO 6	3	2	-		2	-	-	-	-	-	-	1

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Explain with an example how does he feedback element affects the performance of a closed loop system.(K3,PO1, PO2 and PO12)
2. What is the function of controller and sensor in a closed loop system? (K2, PO1)
3. What are the modifications required to convert an open loop system to a closed loop system?(K1, PO1, PO12)

Course Outcome 2 (CO2)

1. Problems related to derivation of transfer function of mechanical systems. (K3,PO1 and PO12)
2. Define transfer function and derive the transfer function of an RC network. (K3, PO1, PO2 and PO12)
3. Write short notes on Force- voltage and Force – current analogy? (K1, PO1, PO12)

Course Outcome 3 (CO3)

1. What is the effect of location of roots on S-plane on the transient response of a system? (K1, PO1, PO12)
2. What is the change in transient response of a second order system due to the addition of poles? Illustrate with an example. (K1, PO1, PO2, PO12)
3. What is the significance of settling time in control system? (K1, PO1, PO12)

Course Outcome 4 (CO4)

1. Problems related to application of Routh's stability criterion for analysing the stability of a given system. (K3, PO1, PO2, PO12)
2. Plot the impulse response of a second order system for different location of poles on S-plane. (K3, PO1, PO2, PO12)

3. How can we relate asymptotic stability to location of roots of characteristic equation? K2, PO1, PO2, PO12)

Course Outcome 5 (CO5)

1. Determine the value of K such that the closed loop system with $G(s)H(s) = \frac{K}{s\,(s+1)\,(s+4)}$ is oscillatory, using Root locus. (K3, PO1, PO2, PO12)
2. Construct the Root locus for the closed loop system with $G(s)H(s) = \frac{K}{s\,(s^2 + 2s + 2)}$ and determine the value of K to achieve a damping factor of 0.5. (K3, PO1, PO2, PO12)
3. Problems on root locus for systems with positive feedback. (K3, PO1, PO2, PO12)

Course Outcome 6 (CO6)

1. Problems related to assess the stability of the given system using Bode plot. (K3, PO1, PO2, PO3, PO12)
2. Problems related to Polar plot. (K3, PO1, PO2, PO12)
3. Explain Nyquist stability criterion. (K2, PO1, PO2, PO12)

Model Question Paper PAGES: 2

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Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH & YEAR

Course Code**: EET415**

Course Name: **CONTROL SYSTEMS ENGINEERING**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

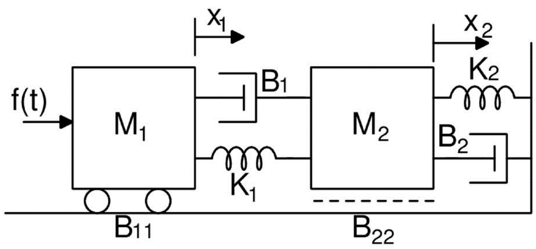
1. Write short notes on Force- voltage and Force – current analogy?
2. Explain Mason's gain formula?
3. Define damping ratio.
4. Derive and sketch the time response of a first order system.
5. What are dynamic error coefficients? What are their merits?
6. Define BIBO Stability. What is the requirement of BIBO Stability?
7. How to determine break away and break in point in root locus plot?
8. What is the significance of dominant pole?
9. Write a short note on the correlation between time and frequency response
10. Explain Nyquist stability criterion

PART B

Answer any one full question from each module. Each question carries 14 Marks

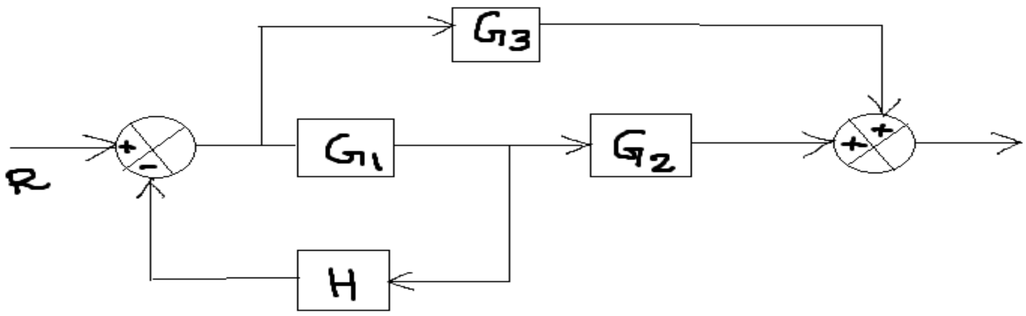
Module 1

9. a. Derive the transfer function for the mechanical system shown in figure. 10



b. Distinguish between open loop system and closed loop system 4

10. a. Reduce the block diagram shown in figure 10



b. Define transfer function and derive the transfer function of an RC network 4

Module 2

11 a. Sketch the time response of a general second order underdamped system and explain the specifications 6

b. The damping ratio of a system is 0.6 and the natural frequency of oscillation is 8 rad/sec. Determine the rise time, peak overshoot and peak time 8

12a. Distinguish between type and order of a system 5

b. The open loop transfer function of a unity feedback system is

$$G(s) = 20/s(s+10)$$

What is the nature of response of closed loop system for unit step input? 9

Module 3

13 a. Plot the impulse response of a second order system for different location of poles on S-plane. 9

b. What is the effect of location of roots on S-plane on the transient response of a system? 5

14 a. A unity feedback system has a open loop transfer function of 7

$$G(s) = 10/(s+1)(s+2)$$

Determine steady state error for unit step input

b. Using Routh criterion determine the value of K for which the unity feedback closed loop system with $G(s) = \dfrac{K}{s(s^2 + 20s + 8)}$ is stable. **7**

Module 4

15 a. What is the relation between stability and coefficient of characteristic polynomial? 2

b. Explain the methods to find the crossing points of Root locus in imaginary axis. 4

c. Sketch the root locus for the unity feedback system whose open loop transfer function is given by: 8

$$G(s) = \frac{K}{s(s+4)(S^2+4S+20)}$$

16. Draw the root locus for a unity feedback system having forward path transfer function,

$$G(s) = \frac{K}{s(s+1)(s+5)}$$ 8

(a)Determine value of K which gives continuous oscillations and the frequency of oscillation.

(b)Determine the value of K corresponding to a dominant closed loop pole with damping ratio 0.7 6

Module 5

17. Consider a unity feedback system having an open loop transfer function

$$G(s) = k/s(1+0.2s)(1+0.05s)$$

(a) Sketch the polar plot 8

(b) Determine the value of K so that

(i) Gain margin is 18 db

(ii) Phase margin is 60° 6

18. (a)The open loop transfer function of a system is given by

$$G(s) = k/s(1+0.2s)(1+0.5s)$$

Sketch the Bode plot 8

(b)From the Bode plot determine the value of K so that

(i) Gain margin of the system is 6 db
(ii) Phase margin of the system is 25^{o} 6

Syllabus

Module 1

Feedback Control Systems (10 hours)

Open loop-and closed loop control systems: Transfer function of LTI systems- Mechanical and Electromechanical systems – Force voltage and force current analogy - block diagram representation - block diagram reduction - signal flow graph - Mason's gain formula - characteristic equation..

Module 2

Performance Analysis of Control Systems (5 hours)

Time domain analysis of control systems: Transient and steady state responses - time domain specifications - first and second order systems - step responses of first and second order systems.

Module 3

Error Analysis and Stability (6 hours)

Error analysis: Steady state error analysis and error constants -Dynamic error coefficients.
Stability Analysis: Concept of BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems - Routh's stability criterion-

Module 4

Root Locus Technique (6 hours)

Root locus technique: Construction of Root locus- stability analysis- effect of addition of poles and zeroes.

Module 5

Frequency Domain Analysis (9 hours)

Frequency domain specifications- correlation between time domain and frequency domain responses.
Polar plot: Concepts of gain margin and phase margin- stability analysis
Bode Plot: Construction- Concepts of gain margin and phase margin.
Nyquist stability criterion (criterion only)

Text books

1. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers
2. Ogata K, Modern Control Engineering, 5/e, Prentice Hall of India.
3. Nise N. S, Control Systems Engineering, 6/e, Wiley Eastern
4. Dorf R. C. and Bishop R. H, Modern Control Systems, 12/e, Pearson Education

Reference Books

1. Kuo B. C, Automatic Control Systems, 7/e, Prentice Hall of India
2. Desai M. D., Control System Components, Prentice Hall of India, 2008
3. Gopal M., Control Systems Principles and Design, 4/e, Tata McGraw Hill.
4. Imthias Ahamed T. P, Control Systems, Phasor Books, 2016

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**Feedback Control Systems (10 hours)**	
1.1	Terminology and basic structure of Open loop and Closed loop control systems- Examples of Automatic control systems (block diagram representations only).	2
1.2	Transfer function approach to feed back contr.ol systems- Mechanical and Electromechanical systems	2
1.3	Force –voltage , force –current analogy.	2
1.4	Block Diagram Reduction Techniques.	2
1.5	Signal flow graph- Mason's gain formula, Characteristic Equation.	2
2	**Performance Analysis of Control Systems (5 hours)**	
2.1	Time domain analysis of control systems: Transient and steady state responses- Impulse and Step responses of first and second order systems Time domain specifications.	4
2.2	Time domain specifications.	1
3	**Error analysis and Stability(6 hours)**	
3.1	Error analysis: Steady state error analysis - static error coefficient of Type 0, 1, 2 systems. Dynamic error coefficients.	2
3.2	Stability Analysis: Concept of stability-BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems.	2
3.3	Application of Routh's stability criterion to control system analysis- Relative stability.	2
4	**Root Locus Technique (6 hours)**	
4.1	Root locus technique: General rules for constructing Root loci – stability from root loci -	5
4.2	Effect of addition of poles and zeros on Root locus	1

5	**Frequency domain analysis (9 hours)**	
5.1	Frequency domain specifications- correlation between time domain and frequency domain responses.	2
5.2	Polar plot: Concepts of gain margin and phase margin- stability analysis.	2
5.3	Bode Plot: Construction of Bode plots- gain margin and phase margin- Stability analysis based on Bode plot .	4
5.4	Nyquist stability criterion	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET425	INTRODUCTION TO POWER PROCESSING	OEC	2	1	0	3

Preamble: The recent advances in power electronics has resulted in the development of various industrial and household devices/equipment that employ power processing. It is important for engineering professionals to understand the fundamental principles behind such devices/systems. This course provides an overview of various essential elements of power electronics used for power processing, and their principle of operation. Power electronics deals with the processing and control of 'raw' electrical power from an electrical source. The power levels handled can vary from a few watts to several hundreds of megawatts. It is an enabling technology with a very wide range of applications. The course contents enable the students to understand the principles of power electronics and provide an introduction to various applications such as industrial drives, renewable energy, power supplies and electrical /hybrid vehicles.

Prerequisite: EST 130 Basics of Electrical and Electronics Engineering

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Explain different elements of power electronics.
CO 2	Explain various power electronic converters.
CO 3	Describe the basic principles of ac and dc motor drives.
CO 4	Describe the structure of power processing systems in power supplies, renewable energy conversion and EVs.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2											
CO 2	2											
CO 3	2								2			
CO 4	2						2		2			

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	20	40
Understand	30	30	60
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum of 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the principle of operation of MOSFET. (K2, PO1)
2. What is the difference between thyristors and controllable switches? (K1, PO1)
3. Why are IGBTs becoming popular in their applications to controlled converters ?
4. Enumerate some applications of IGBTs. (K1, PO1)
5. What are the applications of power electronic systems? (K1, PO1)

Course Outcome 2 (CO2)

1. With a neat circuit and waveforms, explain the working of a boost DC-DC converter.(K2, PO1)
2. With the help of waveform explain sinusoidal pulse width modulation used in single phase inverter. (K2, PO1)
3. Explain the working of a single-phase half bridge square wave inverter with pure R load. Draw the output voltage and output current waveforms.(K2, PO1)
4. Illustrate how a thyristor based 1-phase fully controlled rectifier can be used to convert ac into variable dc. Draw the waveforms of output voltage and output current for both R and RL load at α= 30 degree.(K2, PO1)

Course Outcome 3(CO3):

1. Give the classification of DC motors based on their field winding excitation with neat diagrams.(K2, PO9)
2. What is meant by armature reaction? What are its effects on main field flux? (K1, PO9)
3. Explain V/F control of induction motor drives. (K2, PO9)
4. Explain why we use starters for starting a DC motor. (K2, PO9)

Course Outcome 4 (CO4):

1. Explain a standalone solar PV system with a block diagram. (K2, PO7, PO9)
2. Explain the components of a linear power supply. (K2, PO7, PO9)
3. Distinguish between HEV and PHEV. (K2, PO7, PO9)
4. Explain the powertrain in an EV. (K2, PO7, PO9)

Model Question Paper

QP CODE:

PAGES:

Reg. No:______________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR Course Code: EET425

Course Name: INTRODUCTION TO POWER PROCESSING

Max. Marks: 100 **Duration: 3 Hours**

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks.

1. Explain the principle of operation of SCR.
2. What are wide bandgap devices? What are its advantages?
3. With a neat circuit explain the working of single phase fully controlled SCR based bridge rectifiers with R load.
4. With neat circuit, explain the working of a boost DC-DC converter
5. Differentiate between voltage source inverter and current source inverter.
6. With the help of waveform explain sinusoidal pulse width modulation used in single phase inverter.
7. What is meant by armature reaction?
8. Explain why we use starters for starting a DC motor.
9. What is the difference between on grid and off grid Solar PV installations?
10. Give three advantages of electric vehicles over the conventional IC engine driven vehicles.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) What are the advantages, disadvantages and applications of power electronic systems? (10)

(b)Compare a diode and a thyristor. (4)

12. (a) Describe the working of IGBT. How does latch-up occur in an IGBT? Why are IGBTs becoming popular in their applications to controlled converters? Enumerate some applications of IGBTs. (10)

(b) With a neat block diagram, explain a typical power electronic system. (4)

Module 2

13. (a) Illustrate how a thyristor based 1-phase fully controlled rectifier can be used to convert ac into variable dc. Draw the waveforms of output voltage and output current for RL load at α= 30 degree. (10)

(b) Discuss the significance of a freewheeling diode. (4)

14 (a) Explain with a circuit diagram and necessary waveforms, the working of a buck regulator for continuous current mode. (10)

(b) Explain the phenomenon of inductive kick. (4)

Module 3

15 (a) Explain the working of a single-phase half bridge square wave inverter with pure R load. Draw the output voltage and output current waveforms. (10)

(b) What is its main drawback? Explain how this drawback is overcome. (4)

16 (a) What is an ac voltage controller? List some of its industrial applications. Enumerate its merits and demerits. (7)

(b) Describe the operation of a single phase ac voltage controller with R load with necessary waveforms. (7)

Module 4

17. (a)With a neat schematic explain the components of an electric drive system (7)

(b)Explain the four-quadrant operation of a dc motor (7)

18 (a) List various control strategies used in induction motor drives (4)

(b) ExplainV/F control of induction motor drives. (10)

Module 5

19. (a) Explain the operation of a grid connected solar PV system with a neat block schematic (7)
    (b) Explain the components of a linear power supply. (7)

20. (a) Distinguish between HEV and PHEV (4)

    (b)Explain different energy storage systems used in Electric Vehicles (10)

Syllabus

Module 1

Introduction to power processing, elements of power electronics, power semiconductor devices. Uncontrolled, Semicontrolled and Fully controlled switches: Diode, SCR, MOSFETs and IGBTs- principle of operation. Advantages of wide bandgap devices-SiC, GaN.

Module 2

Basic power conversion circuits- converter circuits: Controlled rectifiers: Single- phase fully controlled SCR based bridge rectifier with R and RL load (continuous mode only). Principle of operation and waveforms (No analysis required).

DC-DC Converters (Non-isolated) : Buck, Boost and Buck-Boost converter. Circuit operation, voltage gain and waveforms in continuous conduction mode (No analysis required).

Module 3

Single phase half and full bridge Inverter: Square-wave operation with R load. Types of PWM - single pulse, multiple pulse and sinusoidal PWM. Total Harmonic Distortion(THD).

Three phase voltage source inverter with R load- 120 and 180 degree conduction mode - waveforms

Single phase AC voltage controller with R load- waveforms.

Module 4

Applications: 1. *Motor drives*:

Introduction to electric motor drive- Block diagram

4-quadrant operation of a separately excited dc motor (circuit diagram and waveforms only).

Induction motor drives: Principle of operation- v/f control

Module 5

Applications 2: *Renewable energy*- solar PV installations-off grid and on grid systems: Principle of operation - Block diagram.

Applications 3: *Power supplies* - Principle of operation of linear and switched mode power supply- requirements of power supplies- Isolation, protection and regulation.

Applications 4: *Electric vehicles* - Introduction to HEV, PHEV and BEV-Block schematic of power train. Introduction to energy storage in EVs - Li Batteries, Hydrogen Fuel Cell.

Text/Reference Books

1. Ned Mohan, Tore m Undeland, William P Robbins, "Power electronics converters applications and design", John Wiley and Sons, 2003.
2. Muhammad H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education, 2009.
3. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 2012.
4. Dubey G. K. "Fundamentals of Electrical drives" Narosa Publishing House, 1995.
5. Andrzej M. Trzynadlowski, Introduction to Modern Power Electronics, 3rd Edition, Wiley, 2015.
6. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
7. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001.
8. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
9. Non conventional energy sources, NPTEL lecture by Prof.Prathap Haridoss, IIT Chennai.
10. Abad, Gonzalo, ed. Power electronics and electric drives for traction applications. USA: Wiley, 2017.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction to power processing (6 hours)**	
1.1	Introduction to power electronics and its objectives, Advantages, disadvantages, applications, typical power electronic system	1
1.2	Elements of power electronics, power semiconductor devices.	1
1.3	Symbol and principle of operation of diode and SCR	1
1.4	Symbol and principle of operation of MOSFET	1
1.5	Symbol and principle of operation of IGBT	1
1.6	Advantages of wide bandgap devices- SiC, GaN	1
2	**Basic power conversion circuits (6 hours)**	
2.1	Converter circuits	1
2.2	Single- phase fully controlled SCR based bridge rectifier with R (continuous mode only), Principle of operation and waveforms (No analysis required)	1
2.3	Single- phase fully controlled SCR based bridge rectifier with RL load (continuous mode only), Principle of operation and waveforms (No analysis required)	1
2.4	DC-DC Converters (Non-isolated) : Buck converter. Circuit operation, voltage gain and waveforms in continuous conduction mode (No analysis required).	1
2.5	Boost converter. Circuit operation, voltage gain and waveforms in continuous conduction mode (No analysis required).	1
2.6	Buck-Boost converter. Circuit operation, voltage gain and waveforms in continuous conduction mode (No analysis required).	1
3	**Inverter circuits, AC voltage controllers (6 hours)**	
3.1	Voltage source inverters	1
3.2	Single phase half and full bridge Inverter-Square-wave operation	1

	with R load	
3.3	Types of PWM - single pulse, multiple pulse and sinusoidal PWM Total Harmonic Distortion (THD)	1
3.4	Three phase voltage source inverter with R load- 120 degree conduction mode - waveforms	1
3.5	Three phase voltage source inverter with R load- 180 degree conduction mode - waveforms	1
3.6	Single phase AC voltage controller with R load- waveforms.	1
4	**Applications of power processing in Drives (9 hours)**	
4.1	Introduction to electric drives, components of electric drive, advantages of electric drives.	1
4.2	DC motor – principle of operation – back emf – necessity of motor starter-classification,	2
4.3	Four quadrant operation of separately excited DC Motor	2
	Three phase induction motor-squirrel cage and slip ring induction motor, Working principle-synchronous speed, slip	2
4.4	Induction Motor Drives, V/F control	2
5	**Applications of power processing in renewable energy generation, power supplies and EVs (5 hours)**	
5.1	Solar PV installations-Off grid and On grid	1
5.2	Linear and Switch Mode Power Supplies, Functional Block Diagram and operation	2
5.3	Introduction to Electric Vehicle, Various Types, Types of Energy Storage	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET435	RENEWABLE ENERGY SYSTEMS	OEC	2	1	0	3

Preamble: Objective of this course is to inculcate in students an awareness of new and renewable energy sources.

Prerequisite: Students who have taken EET383 MINOR are not eligible to take this course.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Choose the appropriate energy source depending on the available resources.
CO 2	Explain the concepts of solar thermal and solar electric systems.
CO 3	Illustrate the operating principles of wind, and ocean energy conversion systems.
CO 4	Outline the features of biomass and small hydro energy resources
CO 5	Describe the concepts of fuel cell and hydrogen energy technologies

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1	2					
CO 2	3											
CO 3	3					1	1					
CO 4	3					1	1					
CO 5	3											

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	50
Understand	20	20	40
Apply	5	5	10
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum of 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write short notes on the advantages and disadvantages of any three types of non conventional energy sources.(K1, PO1)

2. What are the points to be considered while constructing a house for energy efficiency? (K2, PO1, PO6, PO7)

Course Outcome 2 (CO2)

1. Explain construction of solar flat plate collector with a neat diagram. (K2, PO1)

2. Draw the block diagram of a solar thermal electric plant and explain its working. (K1, PO1)

3. Discuss the effect of temperature and insolation on the characteristics of solar cell. Draw the P-V characteristics of Solar cell under varying temperature and irradiation level. (K3, PO1)

Course Outcome 3 (CO3):

1. Derive the expression for power in the wind turbine. (K1, PO1, PO6, PO7)

2. Classify tidal power plants and brief explain any two of them. (K1, PO1, PO6, PO7)

3. With the help of a block diagram explain the working of a hybrid OTEC. (K2, PO1, PO6, PO7)

Course Outcome 4 (CO4):

1. What are the factors that affect biogas generation? (K1, PO1, PO6, PO7)

2. Compare the construction and performance of floating drum type and fixed dome type biogas plants with the help of neat sketches. (K2, PO1, PO6, PO7)

3. Discuss the selection criteria of turbines for a small hydro project. (K1, PO1, PO6, PO7)

Course Outcome 5 (CO5):

1. What is small hydro power? How is it classified? Obtain an expression for the power that can be generated from a small hydro power station. (K1, PO1)

2. Explain the hydrogen energy system with necessary diagram. (K2, PO1)

3. What do you mean by the conversion efficiency of a fuel cell? (K1, PO1)

Model Question Paper

Total Pages:2

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EET435

Course Name: RENEWABLE ENERGY SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1 Differentiate between flat plate collectors and solar concentrators.

2 Discuss advantages and limitations of conventional energy sources.

3 With the help of a block diagram explain the working of a hybrid OTEC.

4 List out the advantages and disadvantages of a tidal power plant.

5 Discuss the different types of wind turbine rotors used to extract wind power.

6 The Danish offshore wind farm has a name plate capacity of 209.3 MW. As of January 2017 it has produced 6416 GWh since its commissioning 7.3 years ago. Determine the capacity factor of above wind farm.

7 What are the factors that affect biogas generation

8 Discuss the process of biomass to ethanol conversion

9 What are the components of micro hydel power plant.

10 Enumerate the design and selection of different types of turbines used for small hydro plants

PART B

Answer any one full question from each module. Each question carries 14 marks

Module 1

9 a) With the aid of a neat diagram, explain the working of a central tower collector type solar thermal electric plant (9)

b) Define (i) Open Circuit Voltage (ii) Short circuit Current (iii) Fill factor and (iv) Efficiency of the solar cell (5)

10 a) Compare the components and working of a standalone and grid connected PV system (5)

b) How energy resources are classified. Compare conventional and non conventional sources of energy resources (9)

Module 2

11 What are the site selection criteria for OTEC? Draw the block diagram and explain the working of Anderson cycle based OTEC system. Explain how biofouling affects efficiency of energy conversion and how can it be minimised? (14)

12 Explain the principle of operation of a tidal power plant. How it is classified? Draw the layout of a double basin tidal power plant and label all the components.Explain the function of each component (14)

Module 3

13 a) Prove that the maximum wind turbine output can be achieved when $V_d = \frac{1}{3}V_u$ $V_d = \frac{1}{3}V_u$, where V_d V_d and $V_u V_u$ are down-stream and up-stream wind velocity respectively (10)

b) What is pitch control of wind turbine? Explain. (4)

14 a) Determine the power output of a wind turbine whose blades are 12m in diameter and when the wind speed is 6m/s, the air density is about 1.2kg/m^3 and the maximum power coefficient of the wind turbine is 0.35. (5)

b) Explain the parts, their function and working of a wind power plant. What are the site selection criteria of a wind power plant? (9)

Module 4

15 a) With a neat schematic diagram , explain the biomass gasification based electric power generation system (5)

b) Explain the how urban waste is converted into useful energy (9)

16 a) Compare the construction and performance of floating drum type and fixed dome type biogas plants with the help of neat sketches (10)

b) Explain the importance of biomass programme in India (4)

Module 5

15 a) Explain the operation of a phosphoric acid fuel cell with the help of a suitable diagram (7)

b) What are the different methods used for the production and storage of hydrogen (7)

16 a) Draw the layout of a mini hydro project and explain its working (7)

b) Describe the working and constructional features of PEM fuel cell (7)

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Syllabus

Module 1

Introduction, Classification of Energy Resources- Conventional Energy Resources - Availability and their limitations- Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison.

SOLAR THERMAL SYSTEMS- Principle of Conversion of Solar Radiation into Heat – Solar thermal collectors. – Flat plate collectors. Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector).

SOLAR ELECTRIC SYSTEMS- Solar Thermal Electric Power Generation – Solar Photovoltaic – Solar Cell fundamentals - characteristics, classification, .construction. Solar PV Systems – stand-alone and grid connected- Applications .

Module 2

ENERGY FROM OCEAN- Ocean Thermal Energy Conversion (OTEC)- Principle of OTEC system- Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle. Site-selection criteria- Biofouling- Advantages & Limitations of OTEC.

TIDAL ENERGY – Principle of Tidal Power- Components of Tidal Power Plant (TPP)- Classification-single basin- double basin types –Limitations -Environmental impacts.

Module 3

WIND ENERGY- Introduction- Basic principles of Wind Energy Conversion Systems (WECS) wind speed measurement-Classification of WECS- types of rotors. wind power equation -Betz limit. Electrical Power Output and Capacity Factor of WECS- Advantages and Disadvantages of WECS -site selection criteria.

Module 4

BIOMASS ENERGY- Introduction- Biomass fuels-Biomass conversion technologies -Urban waste to Energy Conversion- Biomass Gasification- Biomass to Ethanol Production- Biogas production from waste biomass- factors affecting biogas generation-types of biogas plants – KVIC and Janata model-Biomass program in India.

Module 5

SMALL HYDRO POWER- Classification as micro, mini and small hydro projects - Basic concepts and types of turbines- selection considerations.

EMERGING TECHNOLOGIES: Fuel Cell-principle of operation –classification- conversion efficiency and losses - applications .Hydrogen energy -hydrogen production -electrolysis - thermo chemical methods -hydrogen storage and utilization.

Text Books

1. G. D. Rai, “ Non Conventional Energy Sources”, Khanna Publishers, 2010.
2. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 1999

Reference Books

1. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
2. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
3. Sab S. L., Renewable and Novel Energy Sources, MI. Publications, 1995.
4. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
5. Tiwari G. N., Solar Energy- Fundamentals, Design, Modelling and Applications, CRC Press, 2002.
6. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
7. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001..
8. Boyle G. (ed.), Renewable Energy - Power for Sustainable Future, Oxford University Press, 1996

9. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
10. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 197
11. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978 62.
12. Khan B.H, Non Conventional Energy resources Tata McGraw Hill, 2009.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures (35 hours)
1	**INTRODUCTION (7 HOURS)**	
1.1	Classification of Energy Resources- Conventional Energy - Resources - Availability and their limitations	1
1.2	Non-Conventional Energy Resources – Classification, Advantages, Limitations, Comparison.	1
1.3	SOLAR THERMAL SYSTEMS- Principle of Conversion of Solar Radiation into Heat – Solar thermal collectors.	1
1.4	Flat plate collectors. Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector)	1
1.5	SOLAR ELECTRIC SYSTEMS- Solar Thermal Electric Power Generation	1
1.6	Solar Photovoltaic – Solar Cell fundamentals - characteristics, classification, construction.	1
1.7	Solar PV Systems – stand-alone and grid connected- Applications	1
2	**ENERGY FROM OCEAN (7 hours)**	
2.1	Ocean Thermal Energy Conversion (OTEC)- Principle of OTEC system-	1
2.2	Open Cycle (Claude cycle), Closed Cycle (Anderson cycle)	1
2.3	Hybrid cycle. Site-selection criteria	1
2.4	Biofouling- Advantages & Limitations of OTEC	1
2.5	TIDAL ENERGY – Principle of Tidal Power- Components of Tidal Power Plant (TPP)-	1
2.6	Classification-single basin- double basin types –Limitations and environmental impacts	2
3	**WIND ENERGY (7 hours)**	
3.1	Introduction- Basic principles of Wind Energy Conversion Systems (WECS)	1
3.2	Wind speed measurement	1

3.3	Classification of WECS- types of rotors	2
3.4	Wind power equation -Betz limit	1
3.5	Electrical Power Output and Capacity Factor of WECS	1
3.6	Advantages and Disadvantages of WECS -site selection criteria	1
4	**BIOMASS ENERGY (6 hours)**	
4.1	Urban waste to Energy Conversion	1
4.2	Biomass Gasification- Biomass to Ethanol Production	1
4.3	Biogas production from waste biomass	2
4.4	Types of biogas plants – KVIC and Janata model	1
4.5	Biomass program in India.	1
5	**SMALL HYDRO POWER (8 hours)**	
5.1	Classification as micro, mini and small hydro projects	1
5.2	Basic concepts and types of turbines- selection considerations.	2
5.3	EMERGING TECHNOLOGIES: Fuel Cell-principle of operation	1
5.4	Classification- conversion efficiency and losses - applications	1
5.5	Hydrogen energy -hydrogen production	1
5.6	Electrolysis -thermo chemical methods	1
5.7	Hydrogen storage and utilization.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET445	ELECTRIC VEHICLES	OEC	2	1	0	3

Preamble: This course introduces basic knowledge about electric vehicles. Basic knowledge about the drives used in EV and HEV, battery management system , energy sources and communication networks are also discussed.

Prerequisite: NIL.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basic concept of electric and hybrid electric vehicle
CO 2	Choose proper energy storage systems for vehicle applications
CO 3	Identify various communication protocols and technologies used in vehicle networks

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1	1					1
CO 2	2					1	1					1
CO 3	2					1	1					1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List various vehicle performance indices. (K1, PO1, PO6, PO7)

2. List various hybrid electric vehicle topologies.(K1, PO1)

3. Highlight the importance of control of electric motor drives in electric and hybrid electric vehicle powertrains. (K2, PO1, PO6, PO7)

Course Outcome 2 (CO2)

1. State the different characteristics of the energy storage system used in electric and hybrid electric vehicles .(K2, PO1, PO6, PO7)

2. Describe how the battery size can be reduced in electric and hybrid electric vehicles. (K2, PO1, PO6, PO7)

3. Illustrate the different methods used for increasing the battery life in electric and hybrid electric vehicles. (K2, PO1, PO6, PO7)

Course Outcome 3 (CO3):

1. List the general objectives of energy management strategies employed in electric and hybrid electric vehicles. (K1, PO1, PO6, PO7)

2. Identify various communication protocols used in electric and hybrid electric vehicles. (K1, PO1, PO6)

3. Illustrate how fuel economy is maintained in hybrid electric vehicles. (K2, PO1, PO6, PO7)

Model Question Paper

QP CODE:

PAGES: 3

Reg. No:______________
Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET455

Course Name: Electric Vehicles

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. List the reasons that led to the evolution of hybrid electric vehicles.
2. List the characteristics of the transmission system in a vehicle.
3. Mention one instance, when the internal combustion engine shall take up extra torque in the drivetrain of a parallel hybrid while being driven.
4. List major components in the drivetrain of an electric vehicle.
5. Discuss the advantage and disadvantage of using DC motors in the drivetrain of electric and hybrid electric vehicles.
6. List any three motors that can be used in the drivetrain of electric and hybrid electric vehicles.
7. Explain the C-rating of a battery
8. Explain the basic fuel cell structure with the help of a neat diagram
9. What are the seven layers of Open System Interconnection (OSI)?
10. What is meant by CAN transfer protocol

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11.	Explain the history of electric and hybrid electric vehicles.	14
12.	Explain the essential characteristics in the power sources intended to be used in electric and hybrid electric vehicles.	14

Module 2

13.	a. Highlight various factors that influence the component sizing in the power trains of hybrid electric vehicles.	7
b.	Illustrate how an internal combustion engine is always operated in its maximum operating efficiency region in a hybrid electric vehicle.	7
14.	a. Highlight the limitations posed by the battery during the power flow control in electric drive-train topologies.	8
b.	Suggest various methods to minimize the battery size and maximize battery life during the power flow control in electric drive-train topologies.	6

Module 3

15.	a. List the desired characteristics of motors used in the drive trains of electric and hybrid electric vehicles.	7
b.	Demonstrate the control of separately excited DC motors in electric vehicles.	7
16.	a. Explain the block diagram of electric drive system used in electric vehicles.	7
b.	Demonstrate the Field Oriented Control of Induction Motors in the powertrain of electric vehicles.	7

Module 4

17.	Explain about Lithium ion batteries with the help of necessary diagram. Write the chemical reactions involved in it.	14

18. What are the various battery parameters? Briefly explain 14

Module 5

19. Compare various energy management strategies in electric vehicles. 14

20. Discuss about a typical CAN layout in a hybrid electric vehicle with the help of block diagram 14

Syllabus

Module 1 (6 hrs)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance

Module II (8 hrs)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, Introduction to electric components used in hybrid electric vehicles

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies.

Module III (8 hrs)

Block diagram of electric drive system, Introduction to electric motors used in hybrid and electric vehicles: configuration and control of separately excited DC motors, Induction Motors (block diagram representation of FOC).

Module IV (7 hrs)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage, Hybridization of different energy storage devices, Introduction to Super capacitor and Hydrogen energy storage.

Module V (7 hrs)

Communications, supporting subsystems: In vehicle networks- CAN

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Text/References Books

1 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

2. NPTEL (notes) – Electrical Engineering – Introduction to Hybrid and Electric Vehicles

3 K Sundareswaran, Elementary Concepts of Power Electronic Drives: CRC Press, Taylor & Francis Group

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Hybrid Electric Vehicles (6)**	
1.1	History of hybrid and electric vehicles,	1
1.2	Social and environmental importance of hybrid and electric vehicles	1
1.3	Basics of vehicle performance	1
1.4	Vehicle power source characterization, transmission characteristics	1
1.5	Mathematical models to describe vehicle performance	1
1.6	Dynamics of electric motion	1
2	**Hybrid Electric Drive -trains and Electric drive trains (8)**	
2.1	Basic concept of hybrid traction	1
2.2	Introduction to various hybrid drive-train topologies	1

2.3	Power flow control in hybrid drive-train topologies	2
2.4	Basic concept of electric traction	1
2.5	Introduction to various electric drive-train topologies,	1
2.6	Power flow control in electric drive-train topologies	2
3	**Electric drive system in electric and hybrid electric vehicles (8)**	
3.1	DC motors and induction motors	2
3.2	Introduction to Electric drive system	2
3.3	Separately excited DC motor speed control	1
3.4	V/f control of induction motor drive	1
3.5	Introduction to vector control (block diagram representation only)	2
4	**Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles (7)**	
4.1	Battery based energy storage	**3**
4.2	Fuel Cell based energy storage	**2**
4.3	Hybridization of different energy storage devices	**1**

	Introduction to Super capacitor and Hydrogen energy storage	**1**
5	**Communications, supporting subsystems and energy management strategies (7)**	
5.1	Communications networks	**2**
5.2	Introduction to energy management strategies used in hybrid and electric vehicles	**1**
5.3	Classification of different energy management strategies	**2**
5.4	Comparison of different energy management strategies	**2**

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET455	ENERGY MANAGEMENT	OEC	2	1	0	3

Preamble: This course introduces basic knowledge about energy management and audit. Energy management opportunities in electrical and mechanical systems are discussed. Economic analysis of different energy conservation measures is also described.

Prerequisite: Basics of Mechanical Engineering and Basics of Electrical Engineering.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the significance and procedure for energy management and audit.
CO 2	Discuss the energy efficiency and management of electrical loads.
CO 3	Discuss the energy efficiency in boilers and furnaces.
CO 4	Explain the energy management opportunities in HVAC systems
CO 5	Compute the economic feasibility of the energy conservation measures.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1	1		2	1		1
CO 2	2					1	1					
CO 3	2					1	1					
CO 4	2					1	1					
CO 5	2					1	1					1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	25	25	50
Understand	15	15	30
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define energy management. (K1, PO1, PO6, PO7)
2. List the different phases involved in energy management planning.(K1)
3. State the need for energy audit. (K2, PO1, PO9, PO10, PO12)

Course Outcome 2 (CO2)

1. State the different methods which can be adopted to reduce energy consumption in lighting.(K2, PO1, PO6, PO7)
2. Describe how energy consumption can be reduced by energy efficient motors.(K2, PO1, PO6, PO7)
3. Illustrate the different methods used for controlling peak demand.(K2, PO1, PO6, PO7)

Course Outcome 3 (CO3):

1. List the energy conservation opportunities in boiler.(K1, PO1)
2. Define Steam trapping.(K1, PO1)
3. Demonstrate how fuel economy measures can be done in furnaces.(K2, PO1, PO6, PO7)

Course Outcome 4 (CO4):

1. Define Coefficient of performance(K1, PO1)
2. Demonstrate how waste heat recovery can be done.(K2, PO1, PO6, PO7)
3. Describe how energy consumption can be reduced by cogeneration.(K2,PO1, PO6, PO7)

Course Outcome 5 (CO5):

1. State the need for economic analysis of energy projects.(K2, PO6, PO7, PO12)

2. Define payback period.(K1, PO12)

3. Demonstrate how life cycle costing approach can be used for comparing energy projects.(K3, PO6, PO7, PO12)

Model Question Paper

QP CODE:

PAGES: 3

Reg. No:______________

Name:______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET455

Course Name: ENERGY MANAGEMENT

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Explain what do you mean by energy audit report.
2. Write notes on building management system.
3. Compare the efficacy of different light sources.
4. Write notes on types of industrial loads.
5. Discuss any two opportunities for energy savings in steam distribution.
6. Explain how boiler efficiency can be assessed using direct method.
7. Explain the working of a waste heat recovery system.
8. Write notes on computer aided energy management.
9. What are the advantages and disadvantages of pay back period method.
10. What do you mean by time value of money?

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a.	With the help of case studies, explain any four energy management principles.	8
b.	Explain the different phases of energy management planning.	6
12. a.	Explain in detail the different steps involved in a detailed energy audit.	7
b.	Discuss the different instruments used for energy audit.	7

Module 2

13. a.	With the help of case studies, explain any four methods to reduce energy consumption in lighting.	8
b.	Explain how energy efficient motors help in reducing energy consumption.	6
14. a.	With the help of case studies, explain any four methods to reduce energy consumption in motors.	8
b.	Explain the different methods used for peak demand control.	6

Module 3

15. a.	Explain any four energy conservation opportunities in furnaces.	7
b.	What is meant by a steam trap? Explain the operation of the thermostatic steam trap.	7
16. a.	Discuss the different energy conservation opportunities in boilers.	7
b.	Explain in detail, the reasons for low furnace efficiency.	7

Module 4

17. a.	Explain any five energy saving opportunities in heating, ventilating and air conditioning systems.	7
b.	Explain the working of different types of cogeneration systems.	7
18. a.	Explain the impact of evaporator and condenser temperature on the power consumption of a refrigerator.	7
b.	Explain the working of any two waste heat recovery devices.	7

Module 5

19. a. Calculate the energy saving and payback period which can be achieved by replacing a 11 kW, existing motor with an EEM. The capital investment required for EEM is Rs. 40,000/-. Cost of energy/kWh is Rs. 5. The loading is 70% of the rated value for both motors. Efficiency of the existing motor is 81% and that of EEM is 84.7%. 8

b. Compare internal rate of return method with present value method for the selection of energy projects. 6

20. a. Explain how the average rate of return method can be used for the selection of energy projects. 6

b. Compare the following motors based on life cycle costing approach. 8

	Motor A	**Motor B**
Output rating	10 kW	10 kW
Conversion efficiency	80%	90%
Initial cost	Rs. 50000	Rs. 75000
Replacement life	5 yrs	20 yrs
Salvage value	Rs. 2500	Rs. 3000
Annual maintenance and overhead costs	Rs. 1000	Rs. 1000
Electricity cost	Rs. 5 per kWh	
Operating schedule	8 hrs/day, 22 days/ month	

Syllabus

Module 1 (7 hours)

Energy Management - General Principles and Planning:

General principles of energy management and energy management planning

Energy Audit: Definition, need, types and methodologies. Instruments for energy audit, Energy audit report - Power quality audit

Energy conservation in buildings: ECBC code (basic aspects), Building Management System (BMS).

Module 2 (8 hours)

Energy management in Electricity Utilization:

Energy management opportunities in Lighting and Motors, Electrolytic Process and Electric heating.

Types of industrial loads.

Peak demand controls and methodologies

Module 3 (8 hours)

Energy management in boilers and furnaces:

Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler.

Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings.

Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control.

Module 4 (6 hours)

Energy management in HVAC systems:

HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities.

Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities

Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study.

Computer aided energy management

Module 5 (6 hours)

Energy Economics:

Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.

Text/ Reference Books

1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003.

2. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons, 1996.

3. Craig B. Smith, Energy management principles, Pergamon Press. 4. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2007

5. G.G. Rajan, Optimizing energy efficiencies in industry -, Tata McGraw Hill, Pub. Co., 2001.

6. IEEE recommended practice for energy management in industrial and commercial facilities,

7. IEEE std 739 - 1995 (Bronze book).

8. M Jayaraju and Premlet, Introduction to Energy Conservation and Management, Phasor Books, 2008

9. Paul O'Callaghan, Energy management, McGraw Hill Book Co.

10. Wayne C. Turner, Energy management Hand Book - - The Fairmount Press, Inc., 1997.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Energy Management - General Principles and Planning; Energy audit (7 hours)**	
1.1	Energy management; General principles of energy management	2
1.2	Energy management planning	1
1.3	**Energy audit:** Definition, need, types and methodologies.	2
1.4	Instruments for energy audit, Energy audit report Power quality audit	2
2	**Energy management in Electricity Utilization (8 hours)**	
2.1	Energy management opportunities in Lighting.	2
2.2	Energy management opportunities in Motors.	2
2.3	Electrolytic Process and Electric heating.	2
2.4	Types of Industrial Loads. Peak Demand controls and Methodologies	2
3	**Energy management in boilers and furnaces (8 hours)**	
3.1	Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler.	2
3.2	Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping	2
3.3	Condensate and flash steam recovery system, Identifying opportunities for energy savings.	2
3.4	Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.	2
4	**Energy management in HVAC systems (6 hours)**	
4.1	HVAC system: Coefficient of performance, Capacity	1

4.2	Factors affecting Refrigeration and Air conditioning system performance and savings opportunities.	1
4.3	Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities	2
4.4	Cogeneration-Types and Schemes, Optimal operation of cogeneration plants	2
5	**Energy Economics (6 hours)**	
5.1	Economic analysis methods	1
5.2	Cash flow model, time value of money, evaluation of proposals	1
5.3	Pay-back method, average rate of return method, internal rate of return method	2
5. 4	Present value method, life cycle costing approach, Case studies.	2

SEMESTER VII

MINOR

ECD481	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project : A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic;
- Preparing an Action Plan for conducting the investigation, including team work;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
- Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3					3	3		2
CO2	3			3				3	3	3	3	
CO3	3	3	3	3	3					3		
CO4					3			3	3	3		1
CO5	3	3	3	3				3		3	3	1

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews**.**

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

SEMESTER VII

HONOURS

CST495	CYBER FORENSICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		VAC	3	1	0	4	2019

Preamble: The course on Cyber Forensics aims at exploring the basics of Cyber Forensics and Cyber security, the forensic investigation process and principles and the different types of cybercrimes and threats. This course also focuses on the forensic analysis of File systems, the Network, the Windows and Linux Operating systems. The course gives a basic understanding of the forensics analysis tools and a deep understanding of Anti forensics practices and methods. All the above aspects are dealt with case studies of the respective areas.

Prerequisite: Knowledge in File Systems, Operating systems, Networks and a general awareness on Cyber Technologies.

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain thebasic concepts in Cyber Forensics, Forensics Investigation Process and Cyber security(**Cognitive Knowledge Level: Understand**)
CO2	Infer the basic concepts of File Systems and its associated attribute definitions (**Cognitive Knowledge Level: Understand)**
CO3	Utilize the methodologies used in data analysis and memory analysis for detection of artefacts**(Cognitive Knowledge Level: Apply)**
CO4	Identify web attacks and detect artefacts using OWASP and penetration testing. **(Cognitive Knowledge Level: Apply)**
CO5	Summarize anti-forensics practices and data hiding methods **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓				✓						✓
CO2	✓	✓										✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓			✓							✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (Percentage)	Test2 (Percentage)	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1(Cyber Forensics and Cyber Security)

Computer Forensics: History of computer forensics, preparing for computer investigations, understanding Public and private investigations- Forensics Investigation Principles - Forensic Protocol for Evidence Acquisition - Digital Forensics -Standards and Guidelines - Digital Evidence – Data Acquisition - storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions, Cyber Forensics tools- Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert

Cyber Security: Cybercrimes, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends - Case Study: Sim Swapping Fraud, ATM Card Cloning, Hacking email for money, Google Nest Guard, Email Crimes, Phishing, Types of Phishing.

Module-2 (File System Forensics)

File system Analysis: FAT and NTFS concepts and analysis -File system category, Content category, Metadata category, File name category, Application category,Application-level search techniques, Specific file systems, File recovery, Consistency check. FAT data structure-Boot sector, FAT 32 FS info, directory entries, Long file name directory entries

Module-3 (Operating System Forensics)

Windows Forensics: Live Response- Data Collection- Locard's Exchange Principle, Order of Volatility Volatile and Non Volatile Data Live-Response Methodologies: Data Analysis- Agile Analysis, Windows Memory Analysis, Rootkits and Rootkit detection.

Linux Forensics: Live Response Data Collection- Prepare the Target Media, Format the Drive, Gather Volatile Information, Acquiring the Image, Initial Triage, Data Analysis- Log Analysis, Keyword Searches, User Activity, Network Connections, Running Processes, Open File Handlers, The Hacking Top Ten, Reconnaissance Tools

Module-4 (Network Forensics)

The OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Case Study: Wireshark. Web Attack Forensics: OWASP Top 10, Web Attack Tests, Penetration Testing.

Module-5 (Anti-Forensics)

Anti-forensic Practices - Data Wiping and Shredding- Data Remanence, Degaussing, Case Study: USB Oblivion, Eraser - Trail Obfuscation: Spoofing, Data Modification, Case Study: Timestamp – Encryption, Case Study: VeraCrypt, Data Hiding: Steganography andCryptography, Case Study: SilentEye, Anti-forensics Detection Techniques, Case Study: Stegdetect

Text Books

1. Bill Nelson, Amelia Phillips and Christopher Steuart, Computer forensics - Guide to Computer Forensics and Investigations, 4/e, Course Technology Inc.
2. Brian Carrier, File System Forensic Analysis, Addison Wesley, 2005.
3. Harlan Carvey, Windows Forensic Analysis DVD Toolkit, 2/e, Syngress.
4. Cory Altheide, Todd Haverkos, Chris Pogue,Unix and Linux Forensic Analysis DVD Toolkit, 1/e, Syngress.
5. William Stallings,Network Security Essentials Applications and Standards, 4/e, Prentice Hall
6. Eric Maiwald, Fundamentals of Network Security, McGraw-Hill, 2004.

References

1. Michael. E. Whitman, Herbert. J. Mattord, Principles of Information Security, Course Technology, 2011.
2. William Stallings, Cryptography and Network Security Principles and Practice, 4/e, Prentice Hall.
3. Niranjan Reddy, Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations, Apress, 2019.

Sample Course Level Assessment Questions

CourseOutcome1(CO1): Explain the Forensics principles and protocols for evidence acquisition.

Discuss the different cyber forensics tools used for image acquisition.

CourseOutcome2(CO2): Explain the pros and cons of NTFS and FAT File systems. Also give the challenges the investigators would face in extracting evidences from these file systems.

CourseOutcome3 (CO3): Apply any memory forensics methodologies/tools to extract volatile and nonvolatile data from a Windows based system.

CourseOutcome4 (CO4): Use web attacks test tools like netcraft to identify web application vulnerabilities of a particular site say **www.xyz.com**

Course Outcome 5 (CO5): Explain the different anti-forensics practices used to destroy or conceal data in order to prevent others from accessing it.

Model Question Paper

QP CODE:

Reg No: ______________

Name:__________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST495

Course Name: Cyber Forensics

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Distinguish between public and private investigations.

2. What are the three computer forensics data acquisitions formats?

3. List any three features of NTFS which are not in FAT.

4. Define the terms file slack, RAM slack and drive slack.

5. What is Locard's exchange principle? Why is it important in forensic investigations?

6. Why would you conduct a live response on a running system?

7. What are the different tools used in Network Forensics?

8. Explain how Risk Analysis and Penetration Testing are different.

9. Why we are using Steganography?

10. How is data wiping done in hard drive?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Discuss the different types of Cybercrimes. List the tools used for identifying Cyber Crimes. **(8)**

(b) Differentiate between Static acquisition and Live acquisition with example. **(6)**

OR

12. (a) Explain the principles of Digital Forensic Investigation? Why is it important? Comment. **(8)**

(b) When you perform an acquisition at a remote location, what should you consider preparing this task? **(6)**

13. (a) Discuss the FAT File Structure. **(8)**

(b) Does Windows NT use FAT or NTFS? Explain. **(6)**

14. (a) What is Metadata? Discuss the first 16 metadata records you would find in the MFT? **(6)**

(b) Explain the different data categories in a File System. **(8)**

15. (a) What is Agile requirement analysis? **(6)**

(b) Explain the different types of volatile information in a live response system. List any two tools used for obtaining volatile information. **(8)**

16. (a) What are the main live response methodologies? **(6)**

(b) What is Physical Memory Dump? Explain how a physical memory dump is analysed. **(8)**

17. (a) What is OWASP? Also mention the Top 10 web application vulnerabilities in 2021. **(8)**

(b) How would you setup Wireshark to monitor packets passing through aninternet router? **(6)**

18. (a) What are the goals of conducting a pentesting exercise? **(3)**

(b) Discuss the types of penetration testing methodologies. **(5)**

(c) Define OSI Layers. **(6)**

19. (a) How is Steganography done? **(7)**

(b) Why does data need Cryptography? **(4)**

(c) What is the difference between a Cryptographer and a Crypter? **(3)**

OR

20. (a) Explain the different types of Anti-forensics Detection Techniques. **(8)**

(b) What is Spoofing? How to prevent spoofing attack? **(6)**

TEACHING PLAN

Sl.No.	**Contents**	**No of Lecture Hrs (44hrs)**
Module-1 (Cyber Forensics and Cyber Security) (11 Hrs)		
1.1	History of computer forensics, preparing for computer investigations	1 hour
1.2	Understanding Public and private investigations- Forensics Investigation Principles	1 hour
1.3	Forensic Protocol for Evidence Acquisition	1 hour
1.4	Digital Forensics -Standards and Guidelines - Digital Evidence	1 hour
1.5	Data Acquisition - storage formats for digital evidence, determining the best acquisition method	1 hour
1.6	Contingency planning for image acquisitions, Cyber Forensics tools	1 hour
1.7	Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert	1 hour
1.8	Cybercrimes, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends	1 hour
1.9	Case Study: Sim Swapping Fraud, ATM Card Cloning	1 hour
1.10	Case Study:Hacking email for money, Google Nest Guard	1 hour
1.11	Email Crimes, Phishing, Types of Phishing	1 hour
Module-2 (File System Forensics) (9 Hrs)		

2.1	FAT and NTFS concepts and analysis	1 hour
2.2	File system category, Content category	1 hour
2.3	Metadata category	1 hour
2.4	File name category,Application category	1 hour
2.5	Application-level search techniques	1 hour
2.6	Specific file systems, File recovery, Consistency check	1 hour
2.7	FAT data structure-Boot sector	1 hour
2.8	FAT 32 FS info, directory entries	1 hour
2.9	Long file name directory entries	1 hour
Module-3 (Operating System Forensics) (11 Hrs)		
3.1	Live Response- Data Collection- Locard’s Exchange Principle	1 hour
3.2	Order of Volatility, Volatile and Non Volatile Data	1 hour
3.3	Live-Response Methodologies: Data Analysis- Agile Analysis	1 hour
3.4	Windows Memory Analysis	1 hour
3.5	Rootkits and Rootkit detection	1 hour
3.6	Linux Forensics: Live Response Data Collection	1 hour
3.7	Prepare the Target Media, Format the Drive, Gather Volatile Information	1 hour
3.8	Acquiring the Image, Initial Triage	1 hour
3.9	Data Analysis- Log Analysis, Keyword Searches, User Activity	1 hour

3.10	Data Analysis- Network Connections, Running Processes, Open File Handlers	1 hour
3.11	The Hacking Top Ten, Reconnaissance Tools	1 hour
Module-4 (Network Forensics) (7 Hrs)		
4.1	OSI Model	1 hour
4.2	Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts	1 hour
4.3	ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools	1 hour
4.4	Web Attack Forensics	1 hour
4.5	OWASP Top 10, Web Attack Tests	1 hour
4.6	Penetration Testing-1	1 hour
4.7	Penetration Testing.-2	1 hour
Module – 5 (Anti-Forensics) (6 Hrs)		
5.1	Anti-forensic Practices - Data Wiping and Shredding	1 hour
5.2	Data Remanence, Degaussing	1 hour
5.3	Trail Obfuscation: Spoofing, Data Modification	1 hour
5.4	Role of Encryption in Forensics	1 hour
5.5	Data Hiding: Steganography and Cryptography	1 hour
5.6	Anti-forensics Detection Techniques	1 hour

CST 395	NEURAL NETWORKS AND DEEP LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble:

Neural networks is a biologically inspired programming paradigm which enables a computer to learn from observational data and deep learning is a powerful set of techniques for training neural networks. This course introduces the key concepts in neural networks, its architecture andlearning paradigms, optimization techniques, basic concepts in deep learning, Convolutional Neural Networks and Recurrent Neural Networks. The students will be able to provide best solutions to real world problems in domains such as computer vision and natural language processing.

Prerequisite: A Sound knowledge in Computational fundamentals of machine learning

Course Outcomes: After the completion of the course the student will be able to

CO1	Demonstrate the basic concepts of machine learning models and performance measures. **(Cognitive Knowledge Level : Understand)**
CO2	Illustrate the basic concepts of neural networks and its practical issues**(Cognitive Knowledge Level : Apply)**
CO3	Outline the standard regularization and optimization techniques for deep neural networks (**Cognitive Knowledge Level : Understand)**
CO4	Build CNN and RNN models for different use cases. **(Cognitive Knowledge Level : Apply)**
CO5	Explain the concepts of modern RNNs like LSTM, GRU **(Cognitive Knowledge Level : Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓								✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test1 (%)	Test2 (%)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern

Attendance **10 marks**

Continuous Assessment Tests **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions(preferably, 2 questions each from the completed modules and 1 question from the partlycovered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Syllabus

Module - 1 (Basics of Machine Learning)

Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve(ROC), Area Under Curve(AUC).

Module -2 (Neural Networks)

Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.

Module 3 (Deep learning)

Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

Module -4 (Convolutional Neural Network)

Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST.

Module- 5 (Recurrent Neural Network)

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.

Text Book

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Reference Books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Predict the price of a 1000 square feet house using the regression model generated from the following data.

No.	Square feet	Price(Lakhs)
1	500	5
2	900	10
3	1200	13
4	1500	18
5	2000	25
6	2500	32
7	2700	35

2. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm. Compute the confusion matrix, accuracy, precision, recall, sensitivity and specificity on the following data.

Sl.**No.**	Actual	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man

5	man	woman
6	woman	woman
7	woman	man
8	man	man
9	man	woman
10	woman	woman

Course Outcome 2 (CO2):

1. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
2. Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.

Course Outcome 3 (CO3):

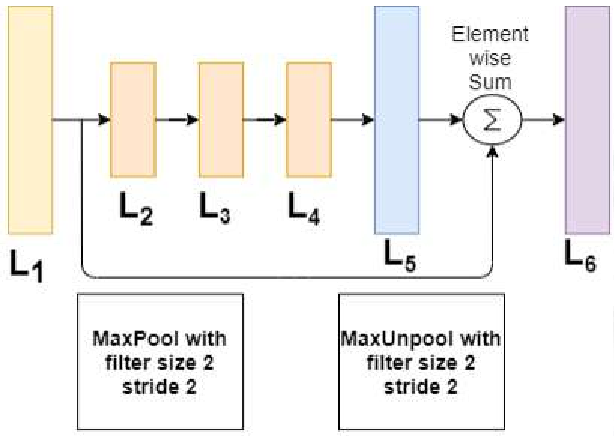
1. Derive a mathematical expression to show L2 regularization as weight decay.
2. Explain how L2 regularization improves the performance of deep feed forward neural networks.
3. Explain how L1 regularization method leads to weight sparsity.

Course Outcome 4 (CO4):

1. Draw and explain the architecture of convolutional neural networks.
2. You are given a classification problem to classify the handwritten digits. Suggest a learning and/or inference machine with its architecture, an objective function, and an optimization routine, along with how input and output will be prepared for the classifier.

3. In a Deep CNN architecture the feature map L_1 was processed by the following operations as shown in the figure. First down sampled using max pool operation of size2 and stride 2, and three convolution operations and finally max unpool operation and followed by an element wise sum. The feature map L_1 and L_4 are given below. Compute the matrix L6.

$$L_1 = \begin{matrix} 10 & 20 & 15 & 22 \\ 20 & 16 & 28 & 30 \\ 30 & 12 & 20 & 16 \\ 20 & 20 & 40 & 12 \end{matrix} \qquad L_4 = \begin{matrix} 10 & 20 \\ 20 & 30 \end{matrix}$$



4. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Course Outcome 5 (CO5):

1. Draw and explain the architecture of LSTM.
2. List the differences between LSTM and GRU

Model Question Paper

QP CODE: **PAGES:4**

Reg No:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(HONORS), MONTH & YEAR

Course Code: CST 395

Course Name: Neural Networks and Deep Learning

Max.Marks:100 **Duration:3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. List and compare the types of machine learning algorithms
2. Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the

accuracy, precision and recall for the data

3. Illustrate the limitation of a single layer perceptron with an example

4. Specify the advantages of ReLU over sigmoid activation function.

5. Derive weight updating rule in gradient descent when the error function is a) mean squared error b) cross entropy

6. List any three methods to prevent overfitting in neural networks

7. What happens if the stride of the convolutional layer increases? What can be the maximum stride? Justify your answer.

8. Consider an activation volume of size 13×13×64 and a filter of size 3×3×64. Discuss whether it is possible to perform convolutions with strides 2, 3 and 5. Justify your answer in each case.

9. How does a recursive neural network work?

10. List down three differences between LSTM and RNN

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Prove that the decision boundary of binary logistic regression is linear **(9)**

(b) Given the following data, construct the ROC curve of the data. Compute the AUC. **(5)**

Threshold	**TP**	TN	FP	FN
1	0	25	0	29
2	7	25	0	22
3	18	24	1	11
4	26	20	5	3
5	29	11	14	0

6	29	0	25	0
7	29	0	25	0

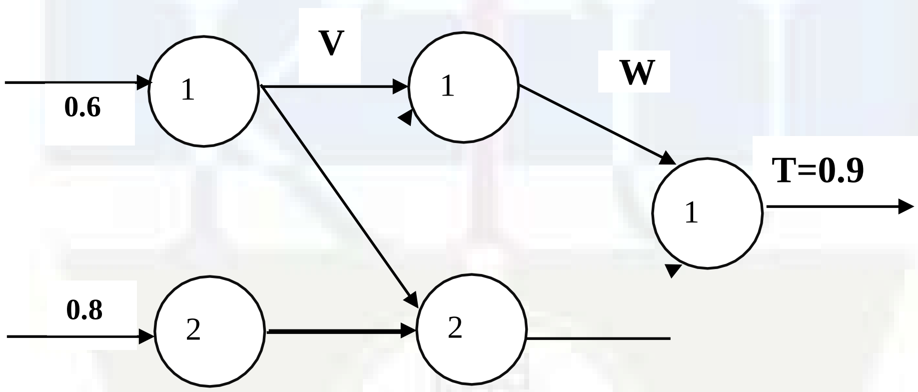
OR

12. (a) With an example classification problem, explain the following terms:
a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance **(8)**

(b) Determine the regression equation by finding the regression slope coefficient and the intercept value using the following data. **(6)**

x	55	60	65	70	80
y	52	54	56	58	62

13. (a) Update the parameters V_{11} in the given MLP using back propagation with learning rate as 0.5 and activation function as sigmoid. Initial weights are given as V_{11}= 0.2, V_{12}=0.1, V_{21}=0.1, V_{22}=0.3, V_{11}=0.2, W_{11}=0.5, W_{21}=0.2 **(10)**

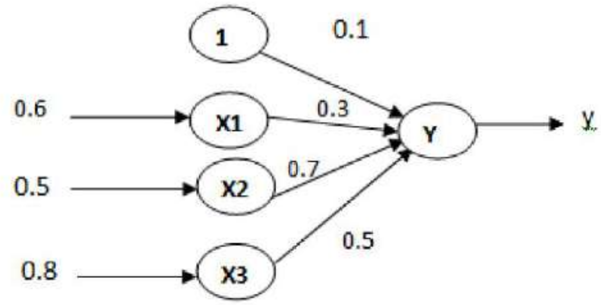


(b) Explain the importance of choosing the right step size in neural networks **(4)**

OR

14. (a) Explain in detail any four practical issues in neural network training **(8)**

(b) Calculate the output of the following neuron Y with the activation function as a) binary sigmoid b) tanh c)ReLU **(6)**



15. (a) Explain, what might happen in ADAGRAD, where momentum is expressed as $\Delta x_t = -\eta g_t / \sqrt{(\sum_{\tau=1}^{t} g_\tau^2)}$ where the denominator computes the L2 norm of all previous gradients on a per-dimension basis and η is a global learning rate shared by all dimensions. **(6)**

(b) Differentiate gradient descent with and without momentum. Give equations for weight updation in GD with and without momentum. Illustrate plateaus, saddle points and slowly varying gradients. **(8)**

OR

16. (a) Suppose a supervised learning problem is given to model a deep feed forward neural network. Suggest solutions for the following a) small sized dataset for training b) dataset with both labelled and unlabeled data c) large data set but data from different distribution **(9)**

(b) Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization. **(5)**

17. (a) Draw and explain the architecture of Convolutional Neural Networks **(8)**

(b) Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved? **(6)**

OR

18. (a) Explain the following convolution functions a)tensors b) kernel flipping c) down sampling d) strides e) zero padding. **(10)**

	(b)	What is the motivation behind convolution neural networks?	**(4)**
19.	(a)	Describe how an LSTM takes care of the vanishing gradient problem. Use some hypothetical numbers for input and output signals to explain the concept	**(8)**
	(b)	Explain the architecture of Recurrent Neural Networks	**(6)**

OR

20.	(a)	Explain LSTM based solution for anyone of the problems in the Natural Language Processing domain.	**(8)**
	(b)	Discuss the architecture of GRU	**(6)**

Teaching Plan

Module 1 : [Text book 1: Chapter 5, Textbook 2: Chapter 2](9 hours)		
1.1	Introduction, Learning algorithms - Supervised, Unsupervised, Reinforcement	1 hour
1.2	Overfitting, Underfitting, Hyperparameters	1 hour
1.3	Validation sets, Estimators -Bias and Variance. Challenges in machine learning.	1 hour
1.4	Simple Linear Regression	1 hour
1.5	Illustration of Linear Regression	1 hour
1.6	Logistic Regression	1 hour
1.7	Illustration of Logistic Regression	1 hour
1.8	Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, ROC, AUC.	1 hour
1.9	Illustrative Examples for performance measures	1 hour
Module 2 : Text book 2, Chapter 1 (8 hours)		
2.1	Introduction to neural networks -Single layer perceptrons	1 hour
2.2	Multi Layer Perceptrons (MLPs), Representation Power of MLPs	1 hour
2.3	Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function	1 hour

2.4	Training MLPs with backpropagation	1 hour
2.5	Illustration of back propagation algorithm	1 hour
2.6	Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems	1 hour
2.7	Difficulties in convergence, Local and spurious Optima, Computational Challenges.	1 hour
2.8	Applications of neural networks	1 hour
Module 3 : Text book 1: Chapter 7, 8, Text book 2, Chapter 3, 4 (10 hours)		
3.1	Introduction to deep learning, Deep feed forward network	1 hour
3.2	Training deep models - Introduction, setup and initialization issues	1 hour
3.3	Solving vanishing and exploding gradient problems	1 hour
3.4	Concepts of optimization, Gradient Descent (GD), GD with momentum.	1 hour
3.5	Nesterov accelerated GD, Stochastic GD.	1 hour
3.6	AdaGrad, RMSProp, Adam.	1 hour
3.7	Concepts of Regularization, L1 and L2 regularization.	1 hour
3.8	Early stopping, Dataset augmentation	1 hour
3.9	Parameter sharing and tying, Injecting noise at input, Ensemble methods	1 hour
3.10	Dropout, Parameter initialization.	1 hour
Module 4 : Text book 1, Chapter 9, Text book 2: Chapter 8 (8 hours)		
4.1	Convolutional Neural Networks, architecture	1 hour
4.2	Convolution and Pooling operation with example	1 hour
4.3	Convolution and Pooling as an infinitely strong prior	1 hour
4.4	Variants of convolution functions, structured outputs, data types	1 hour
4.5	Efficient convolution algorithms.	1 hour
4.6	Practical use cases for CNNs	1 hour
4.7	Case study - Building CNN with MNIST and AlexNet.	1 hour
4.8	Case study - Building CNN with MNIST and AlexNet	1 hour
Module 5 : Text book 1 :Chapter 10, 11, Text book 2:Chapter 7 (10 hours)		

5.1	Recurrent neural networks – Computational graphs, RNN design	1 hour
5.2	Encoder – decoder sequence to sequence architectures	1 hour
5.3	Deep recurrent networks- Architecture	1 hour
5.4	Recursive neural networks	1 hour
5.5	Modern RNNs - LSTM	1 hour
5.6	Modern RNNs - LSTM	1 hour
5.7	GRU	1 hour
5.8	Practical use cases for RNNs.	1 hour
5.9	Case study - Natural Language Processing.	1 hour
5.10	Case study - Natural Language Processing.	1 hour

COURSE CODE	COURSE NAME	L-T-P-CREDITS	YEAR OF INTRODUCTION
EOT495	**OPERATION AND CONTROL OF AC/DC SMART GRIDS**	**3-1-0-4**	**2019**

Preamble: This course introduces various advancements in the area of smart grid. It also introduces microgrid, its protection issues and different control schemes of smart grid. In addition, cloud computing and power quality issues in smart grids are also introduced.

Prerequisite: Basics in Power Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the features of Smart Grid. (UN)
CO 2	Explain the basic concepts of micro grid and its protection issues. (UN)
CO 3	Demonstrate the different control mechanisms in smart grid. (UN)
CO 4	Identify the hierarchical control scheme for microgrids and muti micro grid coordination. (AP)
CO 5	Formulate cloud computing infrastructure for smart grid. (AP)
CO 6	Assess the influence of smart grid on power system and categorize power quality issues. (AP)

Mapping of course outcomes with program outcomes

	POl	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12
CO1	3	2				2						1
CO2	3	2	2	2								1
CO3	3	3	3	3		2						1
CO4	3	3	3	3		2						1
CO5	3	3	3	3	3	3						1
CO6	3	3	3	3	3	3						1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Percentage)	Test 2 (Percentage)	
Remember (K1)	**30**	**30**	**30**
Understand (K2)	**40**	**40**	**40**
Apply (K3)	**30**	**30**	**30**
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Explain the need and functions of smart grid.
2. What are the fundamental components of smart grid design?
3. What are the key features to be concentrated for renewable integration?

Course Outcome 2 (CO 2):

1. Explain the concept of microgrid.
2. Explain the concept of islanding and different islanding scenarios.
3. What are the major protection issues of standalone microgrid?

Course Outcome 3 (CO 3):

1. Explain different microgrid configurations and its interconnection methods.
2. What are the different control mechanisms in AC microgrids?
3. Explain the different schemes used in DC microgrid control.

Course Outcome 4 (CO 4):

1. What are the different hierarchical control schemes for microgrid?
2. What are the key features of multi microgrid coordination and control?
3. Explain the reactive power control in smart grid.

Course Outcome 5 (CO 5):

1. What are the application for Cloud computing in smart grid.
2. Explain the cloud architecture of smart grids.
3. What are the cyber security concerns in smart grid?

Course Outcome 6 (CO 6):

1. What are the different power quality issues of smart grid?
2. What are some of the common harmonic sources in households?
3. Classify power quality disturbances.

Model Question Paper

Course Code: EOT495

Course Name: OPERATION AND CONTROL OF AC/DC SMART GRIDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carry 3 marks.

1. Illustrate the concept of smart grid. Compare it with the conventional grid. **(3)**
2. What are the key components of a smart grid? **(3)**
3. What is microgrid? List the characteristics. **(3)**
4. Explain the concept of islanding in microgrids. **(3)**
5. What are the challenges faced in microgrids. **(3)**
6. Explain the important factors to be considered while interconnecting microgrids. **(3)**
7. List the advantages of centralized and distributed control schemes. **(3)**
8. Write short notes on microgrid clustering. **(3)**
9. List the advantages of cloud computing. **(3)**
10. What are the power quality issues with smart grid? **(3)**

PART B

Answer any one full question, each carry 14 marks.

11. Explain in detail the architecture of smart grid. Explain the functions of smart grid and opportunities. **(14)**

OR

12. a) Explain in detail the fundamental components in smart grid designs. Also discuss the present development in smart grids. **(9)**

    b) Generalise the prominent international policies in smart grid**.** **(5)**

PART C

Answer any one full question, each carry 14 marks.

13. Explain in detail the architecture of microgrid and its control. **(14)**

OR

14. a) Explain the major protection issues in microgrids. **(7)**

    b) Explain the concept of islanding and different islanding scenarios. **(7)**

PART D

Answer any one full question, each carry 14 marks.

15. With neat sketch explain different microgrid configurations. **(14)**

OR

16. a) Explain the control mechanism of DGs connected in microgrids. **(8)**

    b) Illustrate the remedies to achieve active power sharing in microgrids. **(6)**

PART E

Answer any one full question, each carry 14 marks.

17. Explain in detail, implementation of hierarchical control with centralized and distributed control schemes for AC and DC microgrids. **(14)**

OR

18. Discuss in detail multi-microgrid coordination and control. Also explain load frequency control in microgrid. **(14)**

PART F

Answer any one full question, each carry 14 marks.

19. a) Explain the cloud computing architecture of smart grid. **(8)**

    b) Enumerate Advanced Metering Infrastructure and its benefits, **(6)**

OR

20. a) List and explain the various harmonic sources in grid. **(7)**

    b) Briefly explain the different power quality concerns associated with smart grid. **(6)**

SYLLABUS

Module 1: Smart Grid (8 Hours)
Introduction to smart grid, definition of smart grid, need for smart grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration, Present development & International policies in Smart Grid. Case study of Smart Grid.
Module 2: Microgrid and protection issues (10 Hours)
Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects, protection & control of micro grid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources. Protection issues for Microgrids: Introduction, Islanding, Different islanding scenarios, Major protection issues of stand-alone Microgrid - Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols.
Module 3: Microgrid configurations and control (10 Hours)
Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economical advantages of Microgrid - Challenges and disadvantages of Microgrid AC-microgrids: Control Mechanism of the DGs connected in microgrid. Virtual synchronous generator (VSG) and Droop control. Transient frequency response, active power Response, reactive power sharing and voltage regulation DC microgrid control mechanism, droop control, issues in achieving active power sharing with impedance droop, remedies to achieve active power sharing.
Module 4: Smart grid control schemes (10 Hours)
Hierarchical control scheme for microgrids: Control Objectives in AC Microgrids, bottleneck with only local control, need of secondary and tertiary control, implementation of hierarchical control with centralized and distributed control schemes for AC and DC microgrids. Advantages and disadvantages of centralized and distributed control schemes. Multi-microgrid coordination and control: AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, frequency, voltage regulations and volt-VAR support. Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid.
Module 5: Cloud computing and Power quality (8 Hours)
Introduction to Cloud Computing in Smart Grid - Cloud computing in smart grid, Cloud computing architecture, Demand Response - Geographical Load- Balancing - Dynamic Pricing - Virtual Power Plant - Advanced Metering Infrastructure - Cloud-Based Security and Privacy

Power quality aspects with smart grids, Harmonic sources: SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights)

TEXT BOOKS/REFERENCES:

1. S. Borlase , Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013, 1st Edition.
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, ISBN: 978-0-470-88939-8, Wiley
3. N. D. Hatziargyriou, Microgrids Architecture and control, IEEE Press Series, John Wiley & Sons Inc, 2013, 1st Edition
4. S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active DistributionNetworks, ISBN 978-1-84919-014-5, IET, 2009
5. H. Bevrani, B. François, and T. Ise, Microgrid Dynamics and Control, John Wiley & Sons, 2017, 1st Edition.
6. R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, "Electrical Power System Quality",McGraw-Hill
7. Kenneth C. Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014.

Course Contents and Lecture Schedule

Sl.No.	Topic	No. of Lectures
1	**Smart Grid**	**8 Hours**
1.1	Introduction to smart grid, definition of smart grid, need for smart grid	1
1.2	Functions of Smart Grid, Opportunities & Barriers of Smart Grid,	1
1.3	Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures,	2
1.4	The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation,	2
1.5	Renewable Integration, Present development & International policies in Smart Grid. Case study of Smart Grid.	2
2	**Microgrid and Protection issues**	**10 Hours**
2.1	Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control	2
2.2	operational aspects, protection & control of micro grid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.	2
2.3	Protection issues for Microgrids: Introduction, Islanding	2
2.4	Different islanding scenarios, Major protection issues of stand-	2

	alone Microgrid	
2.5	Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols.	2
3	**Microgrid configuration and control**	**10 Hours**
3.1	Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids	2
3.2	Technical and economical advantages of Microgrid - Challenges and disadvantages of Microgrid	1
3.3	AC-microgrids: Control Mechanism of the DGs connected in microgrid. Virtual synchronous generator (VSG) and Droop control.	2
3.4	Transient frequency response, active power Response, reactive power sharing and voltage regulation	2
3.5	DC microgrid control mechanism, droop control, issues in achieving active power sharing with impedance droop, remedies to achieve active power sharing.	3
4	**Smart grid control schemes**	**10 HOURS**
4.1	Hierarchical control scheme for microgrids: Control Objectives in AC Microgrids, bottleneck with only local control, need of secondary and tertiary control	2
4.2	Implementation of hierarchical control with centralized and distributed control schemes for AC and DC microgrids. Advantages and disadvantages of centralized and distributed control schemes.	3
4.3	Multi-microgrid coordination and control: AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, frequency, voltage regulations and volt-VAR support.	2
4.4	Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System	2
4.5	Reactive Power Control in Smart Grid	1
5	**Introduction to cloud computing and Power quality**	**8 HOURS**
5.1	Introduction to Cloud Computing in Smart Grid - Cloud computing architecture	2
5.2	Demand Response - Geographical Load- Balancing - Dynamic Pricing - Virtual Power Plant	2
5.3	Advanced Metering Infrastructure - Cloud-Based Security and Privacy	1
5.4	Power quality aspects with smart grids, Harmonic sources: SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights)	3

SEMESTER - VIII

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT402	POWER SYSTEM ENGINEERING	PCC	2	1	0	3

Preamble: The basic objective of this course is to deliver fundamental concepts of the power system. The basic principles of generation, transmission distribution and protection systems are comprehensively covered in this course ranging extensively from the conventional ones to the modern discoveries.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Differentiate the power generation methods for optimal scheduling
CO 2	Develop mathematical models of power transmission systems
CO 3	Analyse the performance of a power system in steady state
CO 4	Analyse the performance of a power system under faulty conditions
CO 5	Identify protective relays and circuit breakers employed in real life power systems
CO6	Apply the economic principles in efficient power distribution

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											
CO 2	3	2	1									
CO 3	3	2	2									
CO 4	3	2	2									
CO 5	3	1										
CO 6	3	1										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10

Understand (K2)	20	20	20
Apply (K3)	20	20	70
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Draw the schematic diagram of a steam power station and explain its operation. (KI)

2. Explain the terms load factor and diversity factor. How do these factors influence the cost of generation? (K1, K2)

3. Problems to calculate i) the number of units supplied annually (ii) the diversity factor and (iii) the demand factor. (K2, K3)

4.What do you understand by (i) base load and (ii) peak load of a power station (K2)

Course Outcome 2 (CO2)

1. Explain the principle and cause of skin effect using appropriate figures (K2)

2. What is different types of HVDC links. (K1)

3. Problems from calculation of inductance and capacitance of single-phase lines. (K3)

Course Outcome 3(CO3):

1. What are the different types of buses in the system (K1)

2. Why admittance bus id used for load flow analysis (K1, K2)

3. Problems to calculate Y BUS matrix of a small power network (K2, K3)

Course Outcome 4 (CO4):

1.Obtain the sequence network diagram for a single line to ground fault (K1, K2).

2. Problems on symmetrical and unsymmetrical faults (K3)

Course Outcome 5 (CO5):

1. What are the essential qualities required by any insulating medium used for arc quenching? What are the usual insulating media used? (K2)

3.Explain with a block diagram the working of Microprocessor based over current relays (K2).

Course Outcome 6 (CO6):

1. How does power factor affect HT consumer's electricity bill? (K2).

2. Problems to calculate the reactive power delivered by capacitor banks for pf improvement (K3)

3. Explain smart grid architecture (K2)

Model Question paper

QP CODE: PAGES:3

Reg.No: _______________

Name: _______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHT SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT 402

Course Name: POWER SYSTEM ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Explain load factor, how does this influence the cost of generation?
2. Explain the functions of the following related to hydro plant: (i) spillways (iii) surge tank
3. What is skin effect? Why is it absent in dc system?
4. What are the objectives of Flexible AC transmission system?
5. List the advantages of Newton Raphson load flow method?

6. A single line to ground fault occurs at the terminals of a 30 MVA, 11 kV generator. The positive, negative and zero sequence impedances in pu are j0.2, j0.2 and j0.05 respectively. Find the line currents under faulted conditions. Assume that the generator is solidly grounded.

7. What are the essential qualities required by the insulating medium used in circuit breakers?

8. Explain the working of a static instantaneous over current relay.

9. What are the impacts of low power factor in an electrical power system?

10. Write short notes on the following: (i) Power factor tariff. (iii) Three-part tariff.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Draw and explain the block diagram of a steam power station and explain its operation. (7)

b) A generating station has a maximum demand of 25MW, a load factor of 60%, a plant capacity factor of 50% and a plant use factor of 72%. Find (i) the reserve capacity of the plant (ii) the daily energy produced and (iii) maximum energy that could be produced daily if the plant while running as per schedule, were fully loaded. (7)

or

12 a) Draw the block diagram of a nuclear power station and explain its operation. (7)

b) A power station has the following daily load cycle:

Time in Hours	6 —8	8 —12	12 —16	16 —20	20 —24	24 —6
Load in MW	20	40	60	20	50	20

Plot the load curve and load duration curve. Also calculate the energy generated per day. (7)

Module 2

13 a) A single-phase transmission line has two parallel conductors 3 m apart, the radius of each conductor being 1 cm. Calculate the loop inductance per km length of the line (5)

b) Enumerate the benefits of FACTS (5)

c) List the merits and demerits of high voltage ac transmission (4)

or

14 a) A single-phase transmission line has two parallel conductors 3 metres apart, radius of each conductor being 1 cm. Calculate the capacitance of the line per km (5)

b) Explain the construction of UG cable with a neat figure (5)

c)Explain the different types of DC links with figures. (4)

Module 3

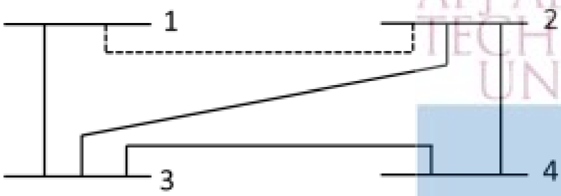
15 a) Draw the flowchart for load flow analysis by Newton-Raphson Method. (7)

b) The symmetrical components of phase a voltage in a 3-phase unbalanced system is Va0=10∠180 V, Va1=50∠0 V and Va2=20∠90 V.Determine the phase voltages (7)

or

16 a) The figure shows the SLD of a simple four bus system. The table gives the line impedance identified by the buses on which these terminate. The shunt admittance at all the buses is assumed to be negligible.

i) Find YBUS, assuming that the line shown dotted is not connected.
ii)What modifications need to be carried out in YBUS if the line shown dotted is connected
(10)



Line, Bus to Bus	R pu	X pu
1-2	0.05	0.15
1-3	0.10	0.30
2-3	0.15	0.45
2-4	0.10	0.30
3-4	0.05	0.15

b) Explain the different types of unsymmetrical fault that can occur on the power system? (4)

Module 4

17 a) With the help of a block diagram explain the working of a microprocessor based over current relay. (7)

b) With a neat sketch explain the principle of operation of an Air Blast Circuit Breaker (7)

or

18 a) With a neat diagram, explain the arc extinction in VCB. What are its advantages. (8)

b) Explain the significant features of a Microprocessor based relays . (6)

Module 5

19 a) A single phase motor connected to 400 V, 50 Hz supply takes 31·7A at a power factor of 0·7 lagging. Calculate the capacitance required in parallel with the motor to raise the power factor to 0·9 lagging. (8)

b) Explain Distribution Automation systems (6)

or

20 a) Explain the architecture of smart grid (6)

b) A factory has a maximum load of 240 kW at 0·8 p.f. lagging with an annual consumption of 50,000 units. The tariff is Rs 50 per kVA of maximum demand plus 10 paise per unit. Calculate the flat rate of energy consumption. (8)

Syllabus

Module 1 (6 hours)

Power System evolution, Generation and variable load on power station- Evolution of Power System – Indian Power Scenario - Overview of energy sources-Hydro, Thermal and Nuclear, Renewables - Economic Factors - Load factor, diversity factor, Load curve, peak load and base load -Numerical Problems.

Module 2 (8 hours)

Power Transmission System (Electrical Model)- Line parameters -Resistance, inductance and capacitance of 1-Φ, 2 wire lines-Numerical Problems. Transmission line modelling-short, medium and long lines – Nominal T and Nominal π modelling (Derivation not Required). Transmission line as two port network-ABCD parameters (Derivation not Required). Overview of Real and Reactive Power in transmission system.
Underground cables-Construction – classification.
Introduction to EHVAC, HVDC and FACTS: Principle, classification and advantages/disadvantages

Module 3 (8 hours)

Load flow and fault analysis -Introduction-Per Unit system fundamentals - Symmetrical components Calculation- (Numerical Problems) Unsymmetrical faults - single line to ground, line to line, double line to ground faults .

Types of buses- formation of bus admittance matrix- Numerical Problems. Gauss-Seidel, Newton-Raphson Load flow techniques (Qualitative analysis only)

Module 4 (6 hours)

Switch gear-Need for protection-circuit breakers –Introduction to ACB, OCB, VCB, SF6 -Arc quenching principles. Overview of Gas Insulated Substations**.** Protective relays –Evolution, Principles of overcurrent, Differential, Distance Relays, Directional Relay - Static Relays - Microprocessor Relays – Numerical / Digital relay.

Module 5 (7 hours)

Power Distribution Systems- Tariff-Characteristics-Types- (Numerical Problems). Power factor improvement using capacitors-(Numerical Problems). Distributed generation Introduction - challenges and benefits - Smart Grid architecture – AC and DC Microgrids. Introduction to energy markets, Distribution Automation systems.

Text Books

1. Cotton H. and H. Barber, Transmission & Distribution of Electrical Energy, 3/e, Hodder and Stoughton, 1978.

2. Gupta J.B., Transmission & Distribution of Electrical Power, S.K. Kataria& Sons, 2009.

3. Kothari D. P. and I. J. Nagrath, Power System Engineering, McGraw Hill, 3rd Edition, 2019

4. Soni, M.L., P. V. Gupta and U. S. Bhatnagar, A Course in Electrical Power, DhanpatRai& Sons, New Delhi, 1984.

5. Stevenson W. D., Elements of Power System Analysis, 4/e, McGraw Hill, 1982.

6. Uppal S. L. and S. Rao, Electrical Power Systems, Khanna Publishers, 2009.

7. Wadhwa C. L., Electrical Power Systems, 33/e, New Age International, 2009

8. Badri Ram and D. N. Viswakarma, Power System Protection and Switchgear, 2/e, Tata McGraw Hill Publication, 2011.

9. A. S. Pabla, Electric Power Distribution, 6/e, Tata McGraw Hill Publication, 2011 (or 5/e 2004).

10. Weedy B. M., B. J. Cory, N. Jenkins, J. B. Ekanayake and G. Strbac, Electric Power System, John Wiley & Sons, 2012.

11. James Momoh, SMART GRID Fundamentals of Design and Analysis, JOHN WILEY & SONS, 2012

12. IEC 61850 Communication Protocol Manual

13. Hadi Saadat, Power System Analysis, 2/e, McGraw Hill, 2002

14. Gupta B. R., Power System Analysis and Design, S. Chand, New Delhi, 2006.

15. Kothari D. P. and I. J. Nagrath, Modern Power System Analysis, 2/e, TMH, 2009

16. K.R Padiyar," FACTS Controllers for Transmission and Distribution" New Age International, New Delhi

17. Blackburn, J.L., Applied Protective Relaying, Westinghouse Electric Corporation, New .

    York, 1982

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Power System evolution, Generation and variable load on power station (6 hours)**	
1.1	Evolution of Power System – Indian Power Scenario -Overview of conventional energy sources-Hydro, Thermal and Nuclear (Block schematic details, special features, environmental and ethical factors, advantages, disadvantages)	3
1.2	Load factor, diversity factor, Load curve ,peak load and base load (Brief description only) -Numerical Problems.	3
2	**Power Transmission System (Electrical Model) (8hours)**	
2.1	Line parameters -Resistance, inductance and capacitance of 1-Φ, 2 wire lines-Numerical Problems	3
2.2	Transmission line modelling-short, medium and long lines – Nominal T and Nominal π modelling (Derivation not Required)	1
2.3	Transmission line as two port network-ABCD parameters (Derivation not Required). Overview of Real and Reactive Power in the transmission system.	1
2.4	Underground cables-Construction - classification	1
2.5	Introduction to EHVAC, HVDC and FACTS: Principle, classification and advantages/disadvantages	2
3	**Load flow and Fault studies (8 hours)**	
3.1	Introduction-types of buses- formation of bus admittance matrix-Numerical Problems	2
3.2	Introduction-Per Unit system fundamentals - Symmetrical components Calculation- (Numerical Problems)	1
3.3	Unsymmetrical faults - single line to ground, line to line, double line to ground faults .	2
3.4	Types of buses- formation of bus admittance matrix- Numerical Problems.	1
3.5	Gauss-Seidel, Newton-Raphson Load flow techniques (Qualitative analysis only)	2
4	**Circuit breakers and Relays (6 hours)**	
4.1	Need for protection-circuit breakers	
4.1	Introduction to ACB, OCB, VCB, SF6 -Arc quenching principles. Overview of Gas Insulated Substations.	2
4.2	Protective relays –Evolution, Principles of overcurrent, Differential, Distance Relays, Directional Relay (Block Diagram, working, advantages, disadvantages)	2
4.3	Static Relays - Microprocessor Relays – Numerical / Digital relay.	2

	(Block diagram, working, advantages, disadvantages)	
5	**Power Distribution Systems (7 hours)**	
5.1	Tariff-Characteristics-Types- Numerical Problems	1
5.2	Power factor improvement using capacitors- (Numerical problems on capacitor value evaluation)	2
5.3	Distributed generation Introduction - challenges and benefits	1
5.4	Microgrid -Introduction Benefits -Architecture	1
5.5	Smart Grid architecture – AC and DC Microgrids. – Introduction - challenges and benefits — architecture of smart grid	1
5.6	Distribution Automation Systems-Architecture	1

PROGRAM ELECTIVE - III

CST414	DEEP LEARNING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: Deep Learning is the recently emerged branch of machine learning, particularly designed to solve a wide range of problems in Computer Vision and Natural Language Processing. In this course, the building blocks used in deep learning are introduced. Specifically, neural networks, deep neural networks, convolutional neural networks and recurrent neural networks. Learning and optimization strategies such as Gradient Descent, Nesterov Accelerated Gradient Descent, Adam, AdaGrad and RMSProp are also discussed in this course. This course will helps the students to attain sound knowledge of deep architectures used for solving various Vision and NLP tasks. In future, learners can master modern techniques in deep learning such as attention mechanisms, generative models and reinforcement learning.

Prerequisite: Basic understanding of probability theory, linear algebra and machine learning

Course Outcomes: After the completion of the course, the student will be able to

CO1	Illustrate the basic concepts of neural networks and its practical issues (**Cognitive Knowledge Level: Apply)**
CO2	Outline the standard regularization and optimization techniques for deep neural network (**Cognitive Knowledge Level: understand)**
CO3	Implement the foundation layers of CNN (pooling, convolutions) **(Cognitive Knowledge Level: Apply)**
CO4	Implement a sequence model using recurrent neural networks **(Cognitive Knowledge Level: Apply)**
CO5	Use different neural network/deep learning models for practical applications. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔		✔									✔
CO2	✔	✔	✔		✔							✔
CO3	✔		✔		✔							✔
CO4	✔	✔	✔		✔							✔
CO5	✔	✔	✔	✔	✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**

Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Neural Networks)

Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. , Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.

Module-2 (Deep learning)

Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

Module-3 (Convolutional Neural Network)

Convolutional Neural Networks – convolution operation, motivation, pooling, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.

Module- 4 (Recurrent Neural Network)

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU.

Module-5 (Application Areas)

Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deepbelief networks.

Text Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C.
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Reference Books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected to 1 neuron which is in the hidden layer with activation function sigmoid. Calculate the output of the hidden layer neuron.

2. Design a single layer perceptron to compute the **NAND (not-AND)** function. This function receives two binary-valued inputs $\mathbf{x_1}$ and $\mathbf{x_2}$, and returns 0 if both inputs are 1, and returns 1 otherwise.

3. Suppose we have a fully connected, feed-forward network with no hidden layer, and 5 input units connected directly to 3 output units. Briefly explain why adding a hidden layer with 8 linear units does not make the network any more powerful.

4. Briefly explain one thing you would use a validation set for, and why you can't just do it using the test set.

5. Give a method to fight vanishing gradients in fully-connected neural networks. Assume we are using a network with Sigmoid activations trained using SGD.

6. You would like to train a fully-connected neural network with 5 hidden layers, each with 10 hidden units. The input is 20-dimensional and the output is a scalar. What is the total number of trainable parameters in your network?

Course Outcome 2(CO2):

1. Derive a mathematical expression to show L2 regularization as weight decay. Explain how L2 regularization improves the performance of deep feed forward neural networks.

2. In stochastic gradient descent, each pass over the dataset requires the same number of arithmetic operations, whether we use minibatches of size 1 or size 1000. Why can it nevertheless be more computationally efficient to use minibatches of size 1000?

3. State how to apply early stopping in the context of learning using Gradient Descent. Why is it necessary to use a validation set (instead of simply using the test set) when using early stopping?

4. Suppose that a model does well on the training set, but only achieves an accuracy of 85% on the validation set. You conclude that the model is overfitting, and plan to use L1 or L2 regularization to fix the issue. However, you learn that some of the examples in the data may be incorrectly labeled. Which form of regularisation would you prefer to use and why?

5. Describe one advantage of using Adam optimizer instead of basic gradient descent.

Course Outcome 3(CO3):

1. Draw and explain the architecture of convolutional neural networks.

2. Consider a convolution layer. The input consists of 6 feature maps of size 20×20. The output consists of 8 feature maps, and the filters are of size 5 x 5. The convolution is done with a stride of 2 and zero padding, so the output feature maps are of size 10 x 10.

    a. Determine the number of weights in this convolution layer.

    b. Determine the number of weights if we made this a fully connected layer, but the number of input and output units are kept the same as in the network.

3. Suppose two people A and B have implemented two neural networks for recognizing handwritten digits from 16 x 16 grayscale images. Each network has a single hidden layer, and makes predictions using a softmax output layer with 10 units, one for each digit class.

    a. A’s network is a convolutional net. The hidden layer consists of three 16 x 16 convolutional feature maps, each with filters of size 5 x 5, and uses the logistic nonlinearity. All of the hidden units are connected to all of the output units.

    b. B’s network is a fully connected network with no weight sharing. Thehidden layer consists of 768 logistic units (the same number of units as inA’s convolutional layer).

4. Briefly explain one advantage of A’s approach and one advantage of B’s approach.

5. Why do the layers in a deep architecture need to be non-linear?

6. Give two benefits of using convolutional layers instead of fully connected ones for visual tasks.

7. You have an input volume of 32 x 32 x 3. What are the dimensions of the resulting volume after convolving a 5 x 5 kernel with zero padding, stride of 1, and 2 filters?

Course Outcome 4(CO4): .

1. Draw and explain the architecture of LSTM.
2. Name at least one benefit of the LSTM model over the bag-of-vectors model.
3. Give one advantage of GloVe over Skipgram/CBOW models.
4. What are two ways practitioners deal with having two different sets of word vectors **U** and **V** at the end of training both Glove and word2vec?
5. If we have a recurrent neural network (RNN), we can view it as a different type of network by "unrolling it through time". Briefly explain what that means.
6. Briefly explain how “unrolling through time” is related to “weight sharing” in convolutional networks.

Course Outcome 5(CO5):

1. Development a deep learning solution for problems in the domain i) natural language processing or ii) Computer vision
2. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.
3. Is an autoencoder for supervised learning or for unsupervised learning? Explain briefly.
4. Sketch the architecture of an autoencoder network.
5. Describe how to train an autoencoder network.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST414

Course Name: Deep Learning

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Discuss the limitation of a single layer perceptron with an example.

2. List the advantages and disadvantages of sigmoid and ReLU activation functions.

3. Derive weight updating rule in gradient descent when the error function is a) mean squared error b) cross entropy.

4. Discuss methods to prevent overfitting in neural networks.

5. What happens if the stride of the convolutional layer increases? What can be the maximum stride? Explain.

6. Draw the architecture of a simple CNN and write short notes on each block.

7. How does a recursive neural network work?

8. List down the differences between LSTM and RNN.

9. Illustrate the use of deep learning concepts in Speech Recognition.

10. What is an autoencoder? Give one application of an autoencoder

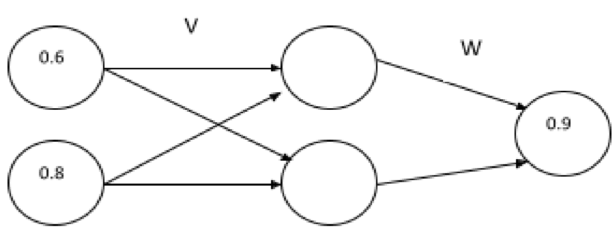
(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Update the parameters in the given MLP using gradient descent with learning rate as 0.5 and activation function as ReLU. Initial weights are given as **(10)**

$V = $ 0.1 0.2 0 .1 0.1 W= 0.1 0.1

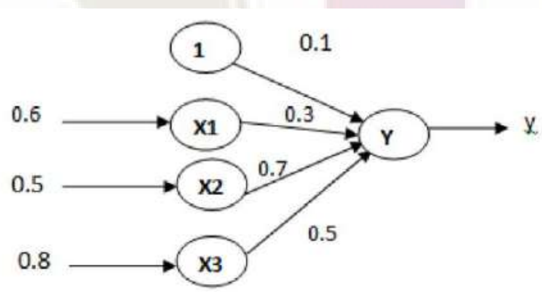


(b) Explain the importance of choosing the right step size in neural networks. **(4)**

OR

12. (a) Draw the architecture of a multi-layer perceptron. Derive update rules for parameters in the multi-layer neural network through the gradient descent **(10)**

(b) Calculate the output of the following neuron Y if the activation function is a binary sigmoid. **(4)**



13. (a) Explain, what might happen in ADAGRAD, where momentum is expressed as $\Delta w_t = -\eta g_t / \sqrt{(\sum_{r=1} g_r^2)}$ where the denominator computes the L2 norm of all previous gradients on a per-dimension basis and □ is a global learning rate shared by all dimensions. **(6)**

(b) Differentiate gradient descent with and without momentum. Give equations for weight updation in GD with and without momentum. Illustrate plateaus, saddle points and slowly varying gradient. **(8)**

OR

14. (a) Suppose a supervised learning problem is given to model a deep feed forward neural network. Suggest solutions for the following a) small sized dataset for training b) dataset with unlabeled data c) large data set but data from different distribution. **(9)**

(b) Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization **(5)**

15. (a) Draw and explain the architecture of Convolutional Neural Networks **(8)**

(b) Suppose that a CNN was trained to classify images into different categories.It performed well on a validation set that was taken from the same source as the training set but not on a testing set, which comes from another distribution. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved? **(6)**

OR

16. (a) What is the motivation behind convolution neural networks? **(4)**

(b) Discuss all the variants of the basic convolution function. **(10)**

17. (a) Describe how an LSTM takes care of the vanishing gradient problem. Use some hypothetical numbers for input and output signals to explain the concept. **(8)**

(b) Draw and explain the architecture of Recurrent Neural Networks **(6)**

OR

OR

18. (a) Explain the application of LSTM in Natural Language Processing. **(8)**

(b) Discuss the architecture of GRU. **(6)**

19. (a) Explain any two word embedding techniques **(8)**

(b) Explain the merits and demerits of using Autoencoders in Computer Vision. **(6)**

OR

20. (a) Illustrate the use of representation learning in object classification. **(7)**

(b) Compare Boltzmann Machine with Deep Belief Network. (7)

Teaching Plan

No	**Contents**	**No. of Lecture Hours (36 hrs)**
	Module-1 (Neural Networks) (7 hours)	
1.1	Introduction to neural networks -Single layer perceptrons	1
1.2	Multi Layer Perceptrons (MLPs), Representation Power of MLPs	1
1.3	Activation functions - Sigmoid, Tanh, ReLU, Softmax. , Risk minimization, Loss function	1
1.4	Training MLPs with backpropagation	1
1.5	Illustration of back propagation algorithm	1
1.6	Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems	1
1.7	Difficulties in convergence, Local and spurious Optima, Computational Challenges.	1
	Module-2 (Deep learning) (9 hours)	
2.1	Introduction to deep learning, Deep feed forward network	1
2.2	Training deep models, Concepts of Regularization and optimization,	1

2.3	Gradient Descent (GD), GD with momentum,	1
2.4	Nesterov accelerated GD, Stochastic GD,	1
2.5	AdaGrad, RMSProp, Adam,	1
2.6	L1 and L2 regularization, Early stopping, Dataset augmentation,	1
2.7	Parameter sharing and tying, Injecting noise at input, Ensemble methods	1
2.8	Parameter sharing and tying, Injecting noise at input, Ensemble methods	1
2.9	Dropout, Parameter initialization.	
Module-3 (Convolutional Neural Network) (6 hours)		
3.1	Convolutional Neural Networks – convolution operation	1
3.2	motivation, pooling	1
3.3	Convolution and Pooling as an infinitely strong prior	1
3.4	Variants of convolution functions	1
3.5	structured outputs, data types.	1
3.6	Efficient convolution algorithms.	1
Module- 4 (Recurrent Neural Network) (5 hours)		
4.1	Recurrent neural networks – Computational graphs, RNN design	1
4.2	Encoder – decoder sequence to sequence architectures	1
4.3	Deep recurrent networks, recursive neural networks	1
4.4	Modern RNNs LSTM	1
4.5	GRU	1
Module-5 (Application Areas)(9 hours)		
5.1	Computer vision. (TB1: Section 12.2)	1
5.2	Speech recognition. (TB1: Section 12.3)	1
5.3	Natural language processing. (TB1: Section 12.4)	1
5.4	Common Word Embedding - Continuous Bag-of-Words, Word2Vec (TB3: Section 2.6)	1

5.5	Common Word Embedding - Global Vectors for Word Representation(GloVe) (TB3: Section 2.9.1- Pennigton 2014)	1
5.6	Brief introduction on current research areas - Autoencoders, Representation learning. (TB3: Section 4.10)	1
5.7	Brief introduction on current research areas - representation learning. (TB3: Section 9.3)	1
5.8	Brief introduction on current research areas - Boltzmann Machines, Deep belief networks. (TB1: Section 20.1, TB3 Section 6.3)	1
5.9	Brief introduction on current research areas - Deep belief networks. (TB1: Section 20.3)	1

CST424	PROGRAMMING PARADIGMS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: The course provides the learners a clear understanding of the main constructs of contemporary programming languages and the various systems of ideas that have been used to guide the design of programming languages. This course covers the concepts of Names, Bindings & Scope, Statement-Level Control Structures, Sub Programs, Support for Object Oriented Programming, Exception Handling, Concurrency Control, Functional Programming and Logic Programming. This course helps the learners to equip with the knowledge necessary for the critical evaluation of existing and upcoming programming languages. It also enables the learner to choose the most appropriate language for a given programming task, apply that language's approach to structure or organize the code, classify programming languages based on their features and to design new generation languages.

Prerequisite: Sound knowledge in Programming in C and Object-Oriented Programming.

Mapping of course outcomes with program outcomes

CO1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages (**Cognitive Knowledge Level: Understand**)
CO2	Illustrate the characteristics of data types and variables (**Cognitive Knowledge Level: Apply**)
CO3	Comprehend how control flow structures and subprograms help in developing the structure of a program to solve a computational problem (**Cognitive Knowledge Level: Apply)**
CO4	Explain the characteristics of Object-Oriented Programming Languages (**Cognitive Knowledge Level: Understand)**
CO5	Compare concurrency constructs in different programming languages (**Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓										✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓										✓
CO5	✓	✓	✓									✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**

Apply	**30**	**30**	**30**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of Internal Tests 1 & 2) **25 marks**

Continuous AssessmentAssignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the two completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed two modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Course Level Assessment Questions

Course Outcome1 (CO1):

1. Compare any three programming languages based on the language evaluation criteria. Prepare a list of characteristics that affect the language evaluation criteria.
2. Identify the advantages and disadvantages of imperative, functional and logic programming languages.

Course Outcome 2 (CO2):

1. Two most important design issues that are specific to character string types are
   (1) whether a string is simply a special kind of character array or a primitive type.
   (2) whether strings have static or dynamic length.
   Identify the implementations options for the above two cases.
2. Consider the following records of a particular language. Let the size of each char variable be 1 byte, int be 4 bytes and and Boolean be 1 bit.

```
Struct Student
{
        int id;
        char name[2];
        int age;
        boolean scholarship;
}
```

   Draw and comment on the possible memory layouts for the record for a 32-bit aligned machine

Course Outcome 3(CO3):

1. Explain three situations where a combined counting and logical looping statement is needed.
2. Describe the ways that aliases can occur with pass-by-reference parameters.
3. Identify the two fundamental design considerations for parameter-passing methods.
4. What will be the output of the given program segment if it uses the following parameter passing mechanisms:
   a) call by reference
   b) call by value

```
x : integer – – global
procedure foo(y : integer)
y := 3
print x
. . .
```

```
x := 2
foo(x)
print x
```

Course Outcome 4 (CO4):

1. Describe the role of a virtual method table in implementing dynamic method binding.
2. Identify the merits and demerits of inheritance.

Course Outcome 5 (CO5):

1. Evaluate the use of semaphores and monitors for providing competition synchronization and cooperation synchronization.

Syllabus

Module – 1

Introduction – Role of Programming Languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade-offs, Implementation Methods. Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.

Module - 2

Data Types – Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer & Reference Types, Type Checking, Strong Typing, Type Equivalence. Expressions – Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment - Assignment Statements, Mixed-mode Assignment.

Module - 3

Statement-Level Control Structures – Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands. Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines

Module - 4

Support for Object Oriented Programming – Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object-oriented Constructs. Exception Handling – Basic Concepts, Design Issues.

Module - 5

Concurrency – Subprogram Level Concurrency, Semaphores, Monitors, Message Passing. Functional Programming Languages – Introduction to LISP and Scheme, Comparison of

Functional and Imperative Languages. Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.

Text Books

1. Robert W Sebesta, Concepts of Programming Languages, 10th Edition, Pearson.
2. Scott M L, Programming Language Pragmatics, 3rd Edition, Morgan Kauffman Publishers.

ReferenceBooks

1. Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edition, Cengage Learning.
2. Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edition. –TMH.
3. Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edition., Pearson Education.
4. David A. Watt, Programming Language Design Concepts, Wiley Dreamtech.

Model Question Paper

QP CODE:

Reg No: _______________

Name: _________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST424

Course Name: Programming Paradigms

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate between readability and writability.
2. Define binding and binding time.
3. What are the advantages of user-defined enumeration types?
4. Define narrowing and widening conversions.
5. Why for statement in C language is more flexible than that of older languages?

6. What are the advantages and disadvantages of dynamic local variables i subprograms?

7. Illustrate the concept of dynamic method binding with an example.

8. Is it mandatory to use constructors in object-oriented languages? Justify your answer.

9. What are the applications of logic programming languages?

10. Explain the working of let and let-rec constructs in Scheme.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain different criteria used for evaluating languages. **(7)**

(b) Consider the following pseudocode: **(7)**

```
x : integer := 3
y : integer := 4
procedure add
x := x + y
procedure second(P : procedure)
x : integer := 5
P()
procedure first
y : integer := 6
second(add)
first()

write integer(x)
```

(a) What does this program print if the language uses static scoping? Give reasons.

(b) What does it print if the language uses dynamic scoping? Give reasons.

OR

12. (a) With respect to storage binding, explain the meanings, purposes, advantages and disadvantages of four categories of scalar variables. **(7)**

(b) What is meant by referencing environment of a statement? Show the **(7)** referencing environment at the indicated program points (1), (2), (3) & (4) for the following program segment. Assume that the programming language is statically scoped.

```
program example;
        var a, b : integer;
        procedure sub1;
            var x, y: integer;
                begin { sub1 }
                 ………..                        (1)
                end { sub1 }
        procedure sub2;
            var x : integer;
            ……..
            procedure sub3;
                var x: integer;
                    begin { sub3 }
                        ………..   (2)end
                    { sub3 }
                begin { sub2 }
                    ………..                (3)
                end { sub2}
        begin {example}
                    ………..              (4)
        end {example }
```

13. (a) Explain any two issues associated with the pointer data types and also indicate how dangling pointer problem can be solved. **(7)**

(b) Describe the lazy and eager approaches for reclaiming garbage. **(7)**

OR

14. (a) What is meant by side effect and illustrate the advantages of referential transparency? **(8)**

(b) Explain the terms: compound assignment operator, coercion and short circuit evaluation. **(6)**

15. (a) Illustrate the different categories of iteration control statements. **(8)**

(b) Explain the techniques used for identifying the correct referencing environment for a subprogram that was sent as a parameter. **(6)**

OR

16. (a) Describe the implementation models of Parameter passing. **(10)**

(b) Differentiate coroutines from conventional subprograms. **(4)**

17. (a) What is meant by an exception handler? Explain how exceptions are handled in object-oriented languages. **(7)**

(b) Describe the design issues in object-oriented languages. **(7)**

OR

18. (a) Illustrate how a virtual method table can be used for implementing dynamic method binding. **(7)**

(b) Explain the different categories, merits and demerits of inheritance. **(7)**

19. (a) Compare functional and imperative programming languages. **(7)**

(b) Explain the role of monitors in concurrency. **(7)**

OR

20. (a) Explain the searching strategies used in Prolog. Why backward chaining is preferred over forward chaining in Prolog? **(10)**

(b) **(4)**

```
(let ((a 6)
(b 8)
(square (lambda (x) (* x x)))
(plus +))
(sqrt (plus (square a) (square b))))
```

Write the output of the above code? Explain how let and lambda construct works?

Teaching Plan

No	Contents	No. of Lecture Hours (36 hrs.)
Module-1 (7 hours)		
1.1	Introduction: Reasons for studying Concepts of programming languages, Programming Domains	1 hour
1.2	Language Evaluation Criteria	1 hour
1.3	Influence on Language Design, Language Design Trade-offs	1 hour
1.4	Implementation Methods	1 hour
1.5	Names, Variables	1 hour
1.6	Concept of Binding	1 hour
1.7	Scope and Lifetime, Referencing Environments	1 hour
Module-2 (7 hours)		
2.1	Primitive Data Types, Character String Types	1 hour
2.2	User-Defined Ordinal Types, Array Types	1 hour
2.3	Record Types, List Types, Pointer and Reference Types	1 hour
2.4	Implementation of pointer and reference types, Type Checking, Strong Typing, Type Equivalence	1 hour
2.5	Expressions and Assignment Statements, Arithmetic Expressions	1 hour
2.6	Overloaded Operators, Type Conversions	1 hour
2.7	Relational and Boolean Expressions, Short-Circuit Evaluation, Assignment Statements, Mixed-mode Assignment	1 hour
Module-3 (8 hours)		
3.1	Selection Statements, Iterative Statements	1 hour
3.2	Unconditional Branching	1 hour

3.3	Guarded Commands	1 hour
3.4	Subprograms: Design Issues of Subprograms	1 hour
3.5	Local Referencing Environments	1 hour
3.6	Parameter Passing Methods	1 hour
3.7	Subprograms as Parameters, Overloaded Subprograms	1 hour
3.8	Closures, Co-routines	1 hour
Module-4 (7 hours)		
4.1	Inheritance	1 hour
4.2	Dynamic Binding	1 hour
4.3	Design Issues for Object Oriented Languages	1 hour
4.4	Support for Object Oriented Programming in C++	1 hour
4.5	Implementation of Object-Oriented Constructs	1 hour
4.6	Exception Handling – Basic Concepts	1 hour
4.7	Exception Handling - Design Issues	1 hour
Module-5 (7 hours)		
5.1	Subprogram Level Concurrency	1 hour
5.2	Semaphores, Monitors	1 hour
5.3	Message Passing	1 hour
5.4	Introduction to LISP and Scheme	1 hour
5.5	Comparison of Functional and Imperative Languages	1 hour
5.6	Basic Elements of Prolog	1 hour
5.7	Applications of Logic Programming	1 hour

EOT 434	CRYPTOGRAPHY	Category	L	T	P	Credit	Year of Introduction
		PEC	3	1	0	4	2019

Preamble:

The course on Cryptography aims at exploring various algorithms deployed in offering confidentiality, integrity, authentication and non-repudiation services. This course covers classical encryption techniques, symmetric and public key crypto-system, key exchange and management, and authentication functions. The concepts covered in this course enable the learners in effective use of cryptographic algorithms for real life applications.

Prerequisite: A sound background in Number Theory**.**

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify the security services provided for different types of security attacks. (**Cognitive Knowledge Level : Understand**)
CO2	Summarize the classical encryption techniques for information hiding. (**Cognitive Knowledge Level: Apply**)
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.(**Cognitive Knowledge Level: Apply**)
CO4	Interpret key management techniques for secure communication.(**Cognitive Knowledge Level: Understand)**
CO5	Summarize message authentication functions in a secure communication scenario.(**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO1 0	PO11	PO1 2
CO1	✓	✓	✓									✓

CO2	✓	✓	✓		✓	✓						✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓	✓						✓
CO5	✓	✓	✓	✓	✓	✓						✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test1 (Percentage)	**Test2 (Percent**	

		age)	
Remember	**30**	**30**	**30**
Understand	**30**	**30**	**30**
Apply	**40**	**40**	**40**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Tests : **25 marks**

Continuous Assessment Assignment : **15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks.

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to the Concepts of Security)

Need for security, Security approaches, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques - Substitution techniques, Transposition techniques. Stream cipher, Block cipher, Public key cryptosystems vs. Symmetric key cryptosystems, Encrypting communication channels.

Module-2 (Symmetric Key Cryptosystems)

Overview of symmetric key cryptography, Block cipher principles, Data Encryption Standard (DES), Differential and Linear cryptanalysis, Double DES, Triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Algorithm (AES),Block cipher modes of operation, Stream cipher, RC4.

Module-3 (Public Key Cryptosystems)

Principles of public key cryptosystems, RSA algorithm, RSA illustration, Attacks, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems.

Module-4 (Key Management)

Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, Generating keys, transferring keys, Verifying keys, Updating keys, Storing keys, Backup keys, Compromised keys, Public key infrastructure.

Module – 5 (Authentication)

Authentication requirements, Authentication functions, Message authentication codes (MAC), Hash functions, Security of Hash functions and MAC, Message Digest 5 (MD5), Secure Hash Algorithm (SHA)-512, Hash-based Message Authentication Code (HMAC), Cipher-based Message Authentication Code (CMAC), X.509 Authentication services.

Text Books

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.
2. Bruice Schneier, Applied Cryptography Protocols, Algorithms and source code in C, Wiley,2e.

References

1. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.

2. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.

3. DouglasR. Stinson, Cryptography Theory and Practice, 3e,Chapman & Hall/CRC, 2006.

4. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2011.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Consider an automated teller machine (ATM) in which users provide a personal identification number (PIN) and a card for account access. Give examples of confidentiality, integrity, and availability requirements associated with the system and, in each case, indicate the degree of importance of the requirement.

2. Discuss the different security services provided for preventing security attacks.

Course Outcome 2 (CO2):

1. The encryption key in a transposition cipher is (3,2,6,1,5,4). Find the decryption key

2.Discuss the process of encryption in Vernam cipher

Course Outcome 3 (CO3):

1. Devise a meet-in-the-middle attack for a triple DES.

2. Write an algorithm for the InvSubBytes transformation and implement using python (**Assignment**)
3. Consider the following elliptic curve signature scheme. We have a global elliptic curve, prime *p*, and "generator" G. Alice picks a private signing key X_A and forms the public verifying $Y_A = X_AG$. To sign a message *M*:
    - Alice picks a value k
    - Alice sends Bob *M*, k and the signature $S = M - kX_AG$.
    - Bob verifies that $M = S + kY_A$.

   Show that the verification process produces an equality if the signature is valid.
4. Write an algorithm to add two points on an elliptic curve over GF(*p*) and implement using Python. **(Assignment)**
5. Write an algorithm for encryption using knapsack cryptosystem and implement using Java. **(Assignment)**

Course Outcome4 (CO4):

1. List four general categories of schemes for the distribution of public keys.
2. What are the essential ingredients of a public-key directory?

Course Outcome 5 (CO5):

1. State the value of the length field in SHA-512 if the length of the message is 1919 bits and 1920 bits.
2. Write an algorithm in pseudo code for HMAC and implement using Python (**Assignment**)

Model Question Paper

QP CODE:

Reg No:______________

Name :______________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT 434

Course Name: Cryptography

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. State the two approaches in attacking a cipher.

2. Define Substitution Cipher. Encrypt using one time pad M = HONORS and K = CIPHER.

3. Specify the purpose of S-Boxes in Data Encryption Standard (DES).

4. Differentiate between diffusion and confusion.

5. Perform encryption using RSA Algorithm for the following p=7; q=11; e=13; M=5.

6. Is Diffie-Hellman key exchange protocol vulnerable? Justify.

7. List the techniques for distribution of public keys.

8. Define a certificate authority and its relation to public key cryptography.

9. Distinguish between integrity and message authentication.

10. What types of attacks are addressed by message authentication?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) With a neat sketch, Explain OSI Security architecture model. **(8)**

(b) How does link encryption differ from end-to-end encryption? Explain. **(6)**

OR

12. (a) Encrypt the text "cryptography" using the Hill Cipher with the key $\begin{pmatrix} 9 & 4 \\ 5 & 7 \end{pmatrix}$. Show the calculations. **(8)**

(b) Illustrate the steps involved in encrypting a plain text using playfair cipher with an example. **(6)**

13. (a) With a neat sketch, explain a single round in DES. **10**

(b) Explain encryption and decryption using 2 keys and 3 keys of triple DES. **(4)**

OR

14. (a) Explain the block cipher modes i) Cipher feedback mode ii) Output feedback mode. **(8)**

(b) Describe the four types of transformations in AES. **(6)**

15. (a) Write an algorithm for generating public and private key using Elliptical curve cryptography. **(10)**

	(b)	The equation $y^2=x^3 +x+1$, the calculation is done modulo 13. Add two points R= P+Q, where P= (4,2) and Q= (10,6).	**(4)**

OR

16.		User A and B use the Diffie-Hellman key exchange technique with a common prime q=71 and primitive root alpha=7.	
	(a)	If user A has private key X_A =3, What is A's public key Y_A?	**(7)**
	(b)	If user B has private key X_B =6, What is A's public key $Y_{\mathbf{B}}$?	**(7)**
17.	(a)	Define a session key and show how a KDC can create can create a session key between Alice and Bob.	**(7)**
	(b)	What are the requirements for the use of a public-key certificate scheme?	**(7)**

OR

18.	(a)	What are the core components of a PKI? Briefly describe each component.	**(8)**
	(b)	Describe the following (i) Updating keys (ii) Compromised Keys.	**(6)**
19.	(a)	Describe how SHA-512 logic produce message digest	**(10)**
	(b)	Distinguish between HMAC and CMAC	**(4)**

OR

20.	(a)	Specify the format for X.509 certificate. Explain the steps required to obtain user's certificate.	**(7)**
	(b)	With suitable block diagrams, explain the types of functions that may be used to produce an authenticator.	**(8)**

Teaching Plan

No	Contents	No of Lecture Hrs
Module - 1 (Introduction to the Concepts of Security) (7 hrs)		
1.1	Need for security, Security approaches	1 hour
1.2	Principles of security, Types of attacks OSI Security Architecture	1 hour
1.3	Classical encryption techniques: Substitution techniques(Caesar cipher, Monoalphabetic cipher, Playfair cipher)	1 hour
1.4	Classical encryption techniques: Substitution techniques (Hill cipher, Polyalphabetic cipher, One-time pad)	1 hour
1.5	Classical encryption techniques: Transposition techniques	1 hour
1.6	Stream cipher, Block cipher, Public- key cryptosystems vs. Symmetric key cryptosystems	1 hour
1.7	Encrypting communication channels	1 hour
Module - 2 (Symmetric key cryptosystems) (9 hrs)		
2.1	Overview of symmetric key cryptography, Block cipher principles	1 hour
2.2	Data Encryption Standard (DES)	1 hour
2.3	DES design criteria	1 hour
2.4	Differential and Linear cryptanalysis	1 hour
2.5	Double DES, Triple DES, IDEA	1 hour
2.6	Advanced Encryption Algorithm (AES structure)	1 hour

2.7	Advanced Encryption Algorithm (Transformations)	1 hour
2.8	Block cipher modes of operation	1 hour
2.9	Stream cipher, RC4	1 hour
Module - 3 (Public key cryptosystems) (5 hrs)		
3.1	Principles of public key cryptosystems	1 hour
3.2	RSA algorithm	1 hour
3.3	RSA illustration, Attacks ElGamal cryptographic system	1 hour
3.4	Knapsack algorithm Diffie-Hellman key exchange algorithm	1 hour
3.5	Elliptical curve cryptosystems(Elliptical curve arithmetic)	1 hour
Module - 4 (Key Management) (8 hrs) [Text book-2]		
4.1	Symmetric key distribution using symmetric encryption	1 hour
4.2	Symmetric key distribution using asymmetric encryption	1 hour
4.3	Distribution of public keys	1 hour
4.4	Generating keys, Transferring keys	1 hour

4.5	Verifying keys, Updating keys	1 hour
4.6	Storing keys, Backup keys	1 hour
4.7	Compromised keys	1 hour
4.8	Public key infrastructure	1 hour
Module - 5 (Authentication) (7 hrs)		
5.1	Authentication requirements, Authentication functions	1 hour
5.2	Message Authentication Codes (MAC)	1 hour
5.3	Hash functions	1 hour
5.4	Security of Hash functions and MAC	1 hour
5.5	MD5	1 hour
5.6	SHA-512	1 hour
5.7	HMAC, CMAC X.509 Authentication services	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EOT414	MECHATRONICS	PEC	2	1	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Mechatronics.

Prerequisite: Nil

Course Outcome: After the successful completion of the course the student will be able to :

CO1	Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application
CO2	Formulate and simulate models of mechatronics systems
CO3	Explain the standard fabrication techniques and principle of operation of MEMS devices
CO4	Explain the implementation of PLC in mechatronics applications
CO5	Design and Analysis of commonly encountered mechatronics systems for real time Application

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3		1			2					3
CO4	3	3	2									3
CO5	3	3										3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application

1. Illustrate the working of a strain gauged load cell
2. Explain the working of any one non-contact temperature measurement system
3. Explain the principle of operation and suggest two applications of Hall effect sensor in mechatronic systems.
4. With neat sketches explain the working of a double acting hydraulic actuator.
5. Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.
6. Explain any two situations when pneumatic actuators are preferred over hydraulic ones.

Course Outcome 2 (CO2): Formulate models of mechatronics systems

1. Derive the mathematical model of a general electrical system and draw its analogy with a mechanical system.
2. Explain the working of a mechanical device using closed loop control systemwith the help of a suitable example.

10s time delay, B– occurs and stop at that point until the start switch is triggered again.

Course Outcome 3(CO3): Explain the standard fabrication techniques and principle of operation of MEMS devices

1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions.
2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems.
3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques.

Course Outcome 4 (CO4): Explain the implementation of PLC in mechatronics applications

1. Explain 'latching' in PLC logic with an example.
2. Illustrate the significance of Internal Relays in PLC program
3. Consider a pneumatic system with single-solenoid controlled valves and involving two cylinders A and B, with limit switches a–, a+, b–, b+ detectingthe limits of the piston rod movements. Design a ladder programme with the requirement being when the start switch is triggered, the sequence A+, B+, A–,B-

Course Outcome 5 (CO5): Design and Analysis of commonly encountered mechatronics systems for real time applications

1. With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system
2. Explain with a neat sketch the mechatronic implementation of a household weighing machine
3. With a neat sketch, explain the physical system and working of a pick and place robot.

SYLLABUS

MODULE I **(10 hrs)**

Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. vibration sensors.Force and tactile sensors. Range finders: ultrasonic and light based range finders

MODULE II **(7 hrs)**

Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive.Magnetostrictive actuators and piezoelectric actuators.

MODULE III **(7 hrs)**

Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS -Surface and Bulk, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.

MODULE IV **(8 hrs)**

System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.

Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.

MODULE V **(8 hrs)**

Mechatronics in Robotics- choice of Sensors and Actuators. Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.

Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, pick and place robot, automatic car park barrier system, automobile engine management system.

Text Books:

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007

2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: IntegratedMechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.

3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education ,Inc., New Delhi, 2006.

4. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, Thomson Learning Publishing Company, Vikas publishing house, Second edition, 2001.

Reference Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.

2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.

3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.

5. Bishop, Robert H. The Mechatronics Handbook-2 Volume Set. CRC press, 2002.

Course Plan Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures
1	Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach	2
	Sensors - Characteristics -Temperature, flow, pressure sensors.	1
	Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods	2
	Encoders: incremental and absolute. Resolvers and synchros.	1
	Piezoelectric sensors. Acoustic Emission sensors. vibration sensors, Force and tactile sensors	3
	Range finders: ultrasonic and light based range finders	1
2	Actuators: Hydraulic and Pneumatic actuators - Directional control Valves	1
	pressure control valves, process control valves,	1
	Rotary actuators.	1
	Development of simple hydraulic and pneumatic circuits using standard Symbols.	1
	Electrical drives: DC, AC, and brushless, servo stepper motors	2
	Harmonic drive.	1
3	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography	1
	Micromachining methods for MEMS -Surface and Bulk,	2
	Deep Reactive Ion Etching (DRIE) and LIGA processes.	1
	Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope	3
4	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems	1
	Typical elements of open and closed loop control systems.	1
	Adaptive controllers for machine tools	1
	Programmable Logic Controllers (PLC) –Basic structure, input/ output processing.	2
	Programming: Timers, Internal Relays, Counters and Shift registers.	1
	Development of simple ladder programs for specific purposes	2
	Mechatronics in Robotics- choice of Sensors and Actuators.	1
	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras.	1
	Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.	2

5	Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, picks and place robot,	3
	automatic car park barrier system, automobile engine management system.	1
	Total	**40**

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B TECH DEGREE EXAMINATION
COURSE: EOT 414 **MECHATRONICS**
TIME: 3 HRS MAX. MARKS: 100

PART A
Answer All Questions

1	Differentiate between absolute and incremental encoders	3
2	List six examples of temperature sensors	3
3	Explain how cushioning is achieved in pneumatic actuators with a sketch.	3
4	Mention any two differences between finite position and infinite position valves	3
5	List any two controlling factors in wet etching.	3
6	Sketch and label a MEMS based pressure sensor	3
7	What is latching? Draw a simple latched circuit	3
8	Write down the describing equations of basic mechanical building blocks	3
9	Illustrate the histogram processing technique for enhancing the image contrast	3
10	Bring out any 3 difference between CCD and CID camera.	3

PART B
Answer one question from each module. Each question carries 14 marks.

Module I

11(A)	Explain the working of an optical absolute encoder. How the number of tracks and sectors of absolute encoder is related to the resolution of the encoder?	*6*	
11(B)	Explain the structure of a mechatronics system. How is it different form the traditional approach?	*8*	
	OR		
12(A)	Explain the sensor characteristics to be considered when choosing a sensor for a mechatronics application	*8*	
12(B)	Compare the working of resolver and synchro	*6*	
	Module II		
13(A)	Develop a pneumatic circuit with standard symbols, to operate two cylinders in sequence. Explain its working.	*8*	

13(B)	Explain the constructional features and working of brushless DC motor	*6*	
	OR		
14(A)	Illustrate the working of Harmonic Drives with neat sketches	*8*	
14(B)	Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.	*6*	
	Module III		
15(A)	Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions	*6*	
15(B)	Compare and contrast various micro manufacturing techniques	*8*	
	OR		
16(A)	Describe the various mechanical problems associated with surface micromachining	*6*	
16(B)	Explain the LIGA process associated with MEMS fabrication	*8*	
	Module IV		
17(A)	Draw and explain the block diagram of a feedback control system.	*4*	
17(B)	Develop a PLC ladder program for the following sequence: Start a motor with push switch, and then after a delay of 90s, start a pump. When the motor is switched off, the pump will get switched off after a delay of 5s. Mention the logic used for each rung in the program to substantiate your answer.	*10*	
	OR		
18(A)	Explain how a PLC can be used to handle analog inputs?	*4*	
18(B)	Explain the model a fluid flow system with basic building blocks, clearly mention all assumptions	*10*	
	Module V		
19(A)	With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system	*10*	
19(B)	List any four applications of robotic vision systems	*4*	
	OR		
20(A)	Explain the working of Barcode reader with reference to the coding schemes. Mention the steps to process the digits in a barcode for a particular product. Develop the steps in a program for reading the barcode.	*10*	
20(B)	List the steps in thresholding technique in image processing	*4*	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET444	ELECTRICAL MACHINE DESIGN	PEC	2	1	0	3

Preamble: This course provides an introduction to the design of DC and AC machines and gives a general idea to the computer aided design of electrical machines.

Prerequisite: 1. EET202 DC Machines and Transformers

2. EET307 Synchronous and Induction Machines

Course Outcomes: After the completion of the course the student will be able to:

CO1	Identify the general design considerations of electrical machines.
CO2	Design armature and field system of DC machines.
CO3	Design core, yoke, windings and cooling systems of transformers.
CO4	Design stator and rotor of induction machines.
CO5	Design stator and rotor of synchronous machines.
CO6	Apply software tools in electrical machine design.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-
CO6	3	2	1	1	1	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand(K2)	10	10	20
Apply (K3)	30	30	60
Analyse (K4)			
Evaluate(K5)			
Create(K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. **Part A:** 10 Questions x 3 marks=30 marks; **Part B:** 5 Questions x 14 marks =70 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. List five types of enclosures used in electrical machines. (K1,PO2)
2. Explain the various insulation classes and the modern insulating materials. (K1,PO1)
3. Problems based on temperature rise calculations. (K2,PO2)

Course Outcome 2 (CO2)

1. Derive the output equation of a DC machine. (K2, PO1)
2. Discuss the factors that influence the choice of number of poles in a DC machine. (K1,PO2)
3. Problems based on the design of main dimensions and armature of a DC machine. (K3,PO3)
4. Problems based on the design of field system of a DC machine. (K3,PO3)

Course Outcome 3 (CO3)

1. Define window space factor in transformer design. (K1,PO2)
2. Derive output equation of transformers. (K2,PO1)
3. Problems based on the dimensions of transformers. (K3,PO3)

Course Outcome 4 (CO4)

1. Derive the expression for end ring current of a squirrel cage induction motor. (K2,PO1)
2. Write a short note on selection of current density in an induction motor in consideration to the insulation system. (K2,PO2)
3. Problems based on the design of an induction motor. (K3,PO3)

Course Outcome 5 (CO5)

1. Briefly explain the factors affecting the choice of specific electric and magnetic loadings in a synchronous machine. (K2,PO2)

2. Problems based on the design of synchronous machines. (K3,PO3)
3. Briefly explain the features of a brushless alternator. (K1,PO1)

Course Outcome 6 (CO6)

1. Explain how the finite element method is used for the analysis of electrical machines. (K2,PO1)
2. Explain various methods for the computer aided design of electrical machines. (K1,PO2)
3. Explain the analysis method with flow chart for computer aided design of electrical machines. (K1,PO2)

N*ote: Design, simulation and optimization using electromagnetic field simulation software can be achieved* ***through assignments****. (PO3, PO4 and PO5)*

Model Question Paper

QP CODE:

PAGES: 3

Reg. No: _________________

Name : __________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EET444

Course Name: ELECTRICAL MACHINE DESIGN

Max. Marks: 100

Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all questions. Each question carries 3 marks

1. List any four types of enclosures used in electrical machines.
2. Derive the gap contraction factor for slots.
3. Derive the output equation of a DC machine.
4. Explain the importance of proper pole proportions while separating the values of D and L in a DC machine.
5. Derive the output equation of a single phase transformer.
6. Briefly explain the cast resin transformer.
7. Discuss the choice of specific magnetic loading and specific electric loading in induction machines.
8. Derive the expression for end ring current in a squirrel cage induction motor.
9. Explain the synthesis method for computer aided design with a flow chart.
10. Briefly explain the features of a brushless alternator.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11. a) Discuss the thermal and dielectric properties of the following insulating materials used in electrical machines. i) Nomex and ii) Polyamide films. (4 marks)

    b) The temperature rise of a transformer is 25°C after one hour and 37.5°C after 2 hours starting from cold conditions. Calculate its final steady temperature rise and the heating time constant. If its temperature falls from the final steady value to 40°C in 2.5 hours when disconnected, calculate its cooling time constant. The ambient temperature is 30°C. (10 marks)

12. a) What is Carter's coefficient and how does it help in the estimation of mmf of a machine with slotted armature? (6 marks)

    b)Derive the expression for the temperature rise in a machine. Is heating time constant greater than cooling time constant? Justify your answer. (8 marks)

Module 2

13. a) Discuss the factors that influence the choice of number of poles in DC machines. (4 marks)

    b) Find out the main dimensions of a 50kW, 4 pole, 600rpm DC shunt generator to give a square pole face. The full load terminal voltage being 220 V. The maximum gap density is 0.83Wb/m^2 and the ampere conductors per meter is 30000. Assumethat full load armature voltage drop is 3 percent of rated terminal voltage and that the field current is 1 percent of rated full load current. Ratio of pole arc to pole pitch is 0.67. (10 marks)

14. a) Explain the design procedure of brushes and commutators for a DC machine. (4 marks)

    b) The following particulars refer to the shunt field coil for a 440V, 6pole, DC generator: mmf per pole = 7000A; depth of winding = 50mm; length of inner turn = 1.1m; length of outer turn = 1.4m; loss radiated from outer surface excluding ends = 1400 W/m2; space factor = 0.62; resistivity = 0.02 Ω/m and mm^2. Calculate a) the diameter of wire b) length of coil c) no. of turns and d) exciting current. Assume a voltage drop of 20% of terminal voltage across the field regulator. (10 marks)

Module 3

15. a) Compare distribution and power transformers. (4 marks)

    b) Determine the dimensions of core and window of a 5kVA, 50 Hz, single phase core type transformer. A rectangular core is used with long side twice as long as short side. The window height is 3 times the width. Voltage per turn is 1.8 V, space factor is 0.2, current density is 1.8A/mm^2 and flux density is 1Wb/m^2. (10 marks)

16. a) Define window space factor in transformer design. (4 marks)

b) A 300kVA, 11000/400V, 3 phase, core type transformer has a total loss of 5000Wat full load. The transformer tank is 1.25m in height and 1m x 0.75 m in plan. Designa suitable design for tubes if average temperature rise is to be limited to 360C. The diameter of the tube is 50mm and is placed 75mm apart. Average height of tubes is 1.05m, specific heat dissipation due to radiation = $6W/m^2$ ^oC and specific heat dissipation due to convection = $6.5W/m^2$ ^oC. Assume that convection is improved by 35 percent due to provision of tubes. (10 marks)

Module 4

17. Find the main dimensions, number of radial ducts, number of stator slots and number of turns per phase of a 3.7kW, 4 pole, 50 Hz, squirrel cage induction motor to be started by star-delta starter. Work out the winding details. The average flux density in the air gap = 0.45 T, ampere conductors per meter = 23000, efficiency = 0.85, power factor = 0.84. Choose main dimensions to achieve cheap design. Winding factor = 0.955, Iron stacking factor = 0.9. (14 marks)

18. a) What is cogging in an induction motor? (4 marks)

b) Determine approximate values for the stator bore and the effective core length of a 55kW, 415V, 3-phase, star connected, 50Hz, four pole induction motor, Efficiency = 90%, power factor= 0.91, winding factor = 0.955, Assume suitable data wherever necessary with proper justification. (10 marks)

Module 5

19. a) What is short circuit ratio? How does the value of SCR affect the design of a synchronous generator? (4 marks)

b) Determine the main dimensions of a 2500 kVA, 187.5rpm, 50Hz, 3 phase, 3 kV, salient pole alternator. The generator is to be a vertical, water wheel type. The specific magnetic loading is $0.6Wb/m^2$ and the specific electric loading is 34000A/m. Use circular poles with ratio of core length to pole pitch= 0.65. Specify the type ofpole construction used if the run-away speed is about 2 times the normal speed.

(10 marks)

20. a) Explain the design procedure for a synchronous generator using finite element software technique. (4 marks)

b) Determine the diameter, core length, size, no. of conductors and no. of slots for stator of a 15MVA, 11kV, 50Hz, 2 pole, star connected turbo-alternator with 60^0 phase spread. Assume specific magnetic loading = 0.55 Tesla, specific electric loading = 36,000, current density = $5A/mm^2$, peripheral speed = 160m/s. The winding should be arranged to eliminate 5^{th} harmonic. (10 marks)

Syllabus

Module 1 (7 hours)

Principles of electrical machine design: General design considerations, types of enclosures - types of ventilation. Heating - cooling and temperature rise calculation – numerical problems. Continuous, short time and intermittent ratings. Insulation classes – Introduction to modern insulating materials, such as Nomex, Polyamide films and Silicone. Types of cooling in transformers and rotating electrical machines.

Magnetic system - Carter's coefficient – real and apparent flux density. Unbalanced magnetic pull and its practical aspects.

Module 2 (7 hours)

DC Machines: Output equation - main dimensions - choice of specific electric and magnetic loadings corresponding to the insulating materials, magnetic material and type of cooling considered - choice of speed and number of poles - design of armature conductors, slots and winding - design problems. Design of air-gap - design of field system – design problems. Fundamental design aspects of interpoles, compensating winding, commutator and brushes.

Module 3 (7 hours)

Transformers: Design of transformers - single phase and three phase transformers - distribution and power transformers - output equation - core design with due consideration to percentage impedance required - window area - window space factor - overall dimensions of core – design problems. Windings - no. of turns - current density in consideration to the insulation scheme - conductor section. Design of cooling tank with tubes – design problems. Essential design features of cast resin dry type transformers. Fundamentals of K-factor rated transformer, ECBC standards for transformers, BEE Star rating of transformers.

Module 4 (7 hours)

Induction machines: Output equation - main dimensions - choice of specific electric and magnetic loadings corresponding to the insulating materials, magnetic material and type of cooling considered - design of stator and rotor windings - round conductor or rectangular conductor - design of stator and rotor slots, air-gap of slip ring and squirrel cage motors - calculation of rotor bar and end ring currents in cage rotor - design of slip ring rotor winding - design problems. Design aspects of induction motor for drive applications (basic principles only).

Module 5 (8 hours)

Synchronous Machines: Output equation - salient pole and turbo alternators - main dimensions - choice of specific electric and magnetic loadings corresponding to the insulating materials, magnetic material and type of cooling considered - significance of short circuit ratio - choice of speed and number of poles - design of armature conductors, slots and winding - round conductor or rectangular conductor - design of air-gap - design problems.

Fundamental design aspects of the field system and damper winding. Features of brushless alternators.

Introduction to computer aided design: Analysis and synthesis methods - hybrid techniques. Introduction to machine design softwares using Finite Element Method.

Design, simulation and optimization using electromagnetic field simulation software (Assignment only).

Text Books

1. Sawhney A K, A Course in Electrical Machine Design, Dhanpat Rai & Co., 2016.
2. Say M G, The Performance and Design of AC Machines, CBS Publishers, New Delhi, 3rd edition, 2002.
3. Clayton A E & Hancock N N, Performance and Design of DC Machines, ELBS, 1971.

References

1. IS 1180 (Part 1):2014, Bureau of Indian Standards. https://bis.gov.in
2. S.O. No. 4062 (E) for Distribution Transformer dated 16th December, 2016, Bureau of Energy Efficiency, Govt. of India, Ministry of Power. https://www.beestarlabel.com
3. M. V. Deshpande, "Design and Testing of Electrical Machines", Wheeler Publishing.
4. R. K. Agarwal, "Principles of Electrical Machine Design", Essakay Publications, Delhi.
5. Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press.
6. M. N. O. Sadiku, "Numerical techniques in Electromagnetics", CRC Press Edition-2001.

Course Contents and Lecture Schedule

No.	**Topic**	**No. of Lectures**
1	**Principles of electrical machine design (7 hours)**	
1.1	General design considerations, types of enclosures - types of ventilation.	1
1.2	Heating - cooling and temperature rise calculation – numerical problems.	1
1.3	Continuous, short time and intermittent ratings.	1
1.4	Insulation classes – Introduction to modern insulating materials,	1

	such as Nomex, Polyamide films and Silicone.	
1.5	Types of cooling in transformers and rotating electrical machines.	1
1.6	Magnetic system - Carter's coefficient – real and apparent flux density.	1
1.7	Unbalanced magnetic pull and its practical aspects.	1
2	**Design of DC Machines (7 hours)**	
2.1	Output equation - main dimensions	1
2.2	Choice of specific electric and magnetic loadings corresponding to the insulating materials, magnetic material and type of cooling considered	1
2.3	Choice of speed and number of poles	1
2.4	Design of armature conductors, slots and winding	1
2.5	Design problems and design of air-gap	1
2.6	Design of field system – design problems.	1
2.7	Fundamental design aspects of interpoles, compensating winding, commutator and brushes	1
3	**Design of Transformers (7 hours)**	
3.1	Single phase and three phase transformers - distribution and power transformers - output equation	1
3.2	Core design with due consideration to percentage impedance required	1
3.3	Window area - window space factor - overall dimensions of core – design problems.	1
3.4	Windings - no. of turns - current density in consideration to the insulation scheme - conductor section.	1
3.5	Design of cooling tank with tubes – design problems.	1
3.6	Essential design features of cast resin dry type transformers.	1
3.7	Fundamentals of K-factor rated transformer, ECBC standards for transformers, BEE Star rating of transformers.	1
4	**Design of Induction machines (7 hours)**	
4.1	Output equation - main dimensions	1
4.2	Choice of specific electric and magnetic loadings corresponding to the insulating materials, magnetic material and type of cooling considered	1
4.3	Design of stator and rotor windings - round conductor or rectangular conductor	1
4.4	Design of stator and rotor slots, air-gap of slip ring and squirrel cage motors - calculation of rotor bar and end ring currents in cage rotor	1
4.5	Design of slip ring rotor winding	1
4.6	Design problems	1
4.7	Design aspects of induction motor for drive applications (basic principles only).	1

5	**Design of Synchronous Machines and Introduction to computer aided design (8 hours)**	
5.1	Output equation - salient pole and turbo alternators - main dimensions	1
5.2	Choice of specific electric and magnetic loadings corresponding to the insulating materials, magnetic material and type of cooling considered	1
5.3	Significance of short circuit ratio - choice of speed and number of poles	1
5.4	Design of armature conductors, slots and winding - round conductor or rectangular conductor - design of air-gap	1
5.5	Design problems	1
5.6	Fundamental design aspects of field system and damper winding. Features of brushless alternators.	1
5.7	Analysis and synthesis methods - hybrid techniques.	1
5.8	Introduction to machine design softwares using Finite Element Method. Design, simulation and optimization using electromagnetic field simulation software (Assignment only).	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET434	SMART GRID TECHNOLOGIES	PEC	2	1	0	3

Preamble: This course introduces various advancements in the area of smart grid. It also introduces distributed energy resources and micro-grid. In addition, cloud computing, cyber security and power quality issues in smart grids are also introduced.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basic concept of distributed energy resources, micro-grid and smart grid
CO 2	Choose appropriate Information and Communication Technology (ICT) in smart grid
CO 3	Select infrastructure and technologies for consumer domain of smart grid
CO 4	Select infrastructure and technologies for smart substation and distribution automation
CO 5	Formulate cloud computing infrastructure for smart grid considering cyber security
CO 6	Categorize power quality issues and appraise it in smart grid context

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3	3	3	3	2							
CO 3	3	3	3	3	2							
CO 4	3	3	3	3								
CO 5	3	3	3	3	3							
CO 6	3	3	3	3	3							

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	30	30	60
Apply (K3)	10	10	20
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum of 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Explain the drivers, functions, opportunities, barriers, challenges, technologies and standards of smart grid (K2, PO1)
2. Explain the basic concept of distributed energy resources and their grid integration. (K2, PO1, PO2)
3. Explain the basic concept of microgrid. (K1, PO1)

Course Outcome 2 (CO2)

1. Choose appropriate communication technology for smart grid. (K3, PO1, PO2, PO3, PO4, PO5)

2. Explain the communication protocols and standards in Smart grid. (K2, PO1)

Course Outcome 3 (CO3)

1. Explain the features and merits of Smart Meters, for smart grid implementation. (K2, PO1, PO2, PO3)
2. Explain the role of real time pricing in smart grid. (K3, PO1, PO2, PO3)
3. Describe the concept and role of AMR and AMI in smart grid. (K2, PO1, PO2)
4. Choose various end use devices and explain their role in Home & Building Automation. (K3, PO1, PO2, PO3, PO4, PO5)
5. Explain the various methods for energy management and role of technology for its implementation. (K3, PO1, PO2, PO3, PO4, PO5)

Course Outcome 4 (CO4)

1. Explain the concept of smart substation. (K1, PO1)
2. Describe the functionalities and applications of IED in substation and distribution automation. (K2, PO1, PO2, PO3, PO4)
3. Explain the architecture components and applications of Wide Area Monitoring Systems. (K3, PO1, PO2, PO3)
4. Explain the role of PMU in WAMS. (K2, PO1, PO2,)
5. Explain the role of various application modules in distribution automation. (K2, PO1, PO2, PO3)

Course Outcome 5 (CO5)

1. Classify cloud computing based on its deployment and services. (K2, PO1)
2. Design cloud architecture of smart grid. (K3, PO1, PO2, PO3, PO4, PO5)
3. Explain the challenges and solutions related to cyber security in smart grid. (K2, PO1, PO2, PO3, PO4, PO5)

Course Outcome 6 (CO6)

1. Explain the power quality issues in smart grid. (K2, PO1, PO2)
2. Choose technologies for the mitigation of power quality issues in the smart grid. (K3, PO1, PO2, PO3, PO4, PO5)

Model Question Paper

QP CODE: Pages:

Reg No.:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER

B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course code: EET 434

Course Name: SMART GRID TECHNOLOGIES (E)

Max. Marks: 100 **Duration: 3hrs**

PART A

(Answer all questions. Each question carries 3 marks)

1. Define smart grid concept and explain its necessity.
2. Explain the concept of resilient and self-healing grid.
3. Write a note on ZIGBEE.
4. Discuss 61850 standard and its benefits.
5. Explain how automatic meter reading can make the system smarter.
6. What is meant by real time pricing?
7. Describe substation automation.
8. Explain outage management system.
9. Explain the necessity of cyber security in smart grid
10. Write a note on power quality conditioners in smart grid.

PART B

11. (a) With the help of block diagram explain the architecture of smart grid (7)

(b) What are the challenges of smart grid technology? (7)

OR

12. (a)Explain smart grid drivers (6)

(b)What are the functions of smart grid components (8)

13. (a) Explain the various communication protocols used in smart grid. (7)

(b) Write a note on Wi-Max based communication in smart grid. (7)

OR

14. (a) Write a note on various mobile communication technologies used in smart grid. (7)

(b) Explain the role of HAN in smart grid. (7)

15. (a) Explain plug in electric vehicles (7)

(b) Explain the role of phasor measurement unit in smart grid (7)

OR

16. (a) What are the advantages of smart meters? (5)

(b) What are IEDs? What are their application in monitoring and protection (9)

17. (a) With the help of block diagram explain the main features of smart substation (10)

(b) Explain GIS (4)

OR

18. (a) Explain demand side ancillary services. (7)

(b) Write a note on smart inverters. (7)

19. (a) Describe cloud architecture of smart grid. (7)

(b) Explain the role of EMC in the smart grid. (7)

OR

20. (a)Why is cyber security of prime importance in smart grid and how can it be achieved? (7)

(b) Describe the power quality issues of grid connected renewable energy source (7)

Syllabus

Module 1 Introduction to Smart Grid: Evolution of electric grid, Definitions, Need for smart grid, Smart grid drivers, Functions of smart grid, Opportunities and barriers of smart grid, Difference between conventional grid and smart grid, Concept of resilient and self- healing grid.

Components and architecture, Inter-operability, Impacts of smart grid on system reliability, Present development and international policies in smart grid, Smart grid standards.

Module 2 Information and Communication Technology in Smart Grid: Wired and wireless communication -radio mesh, ZIGBEE, 3G, 4G and 5G. Digital PLC, DSL, Wi-Max, LAN, NAN, HAN, Wi-Fi, Bluetooth, Bluetooth Low Energy (BLE), Li-Fi.
Communication Protocols in Smart grid, Introduction to IEC 61850 standard and benefits, IEC Generic Object-Oriented Substation Event - GOOSE, Substation model.

Module 3 Smart grid Technologies Part I: Introduction to smart meters, Electricity tariff, Real Time Pricing- Automatic Meter Reading (AMR) - System, Services and Functions, Components of AMR Systems, Advanced Metering Infrastructure (AMI).

Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid (V2G), Grid to Vehicle (G2V), Smart Sensors, Smart energy efficient end use devices, Home & Building Automation.

Intelligent Electronic Devices (IED) and their application for monitoring & protection: Digital Fault Recorder (DFR), Digital Protective Relay (DPR), Circuit Breaker Monitor (CBM), Phasor Measurement Unit (PMU), Standards for PMU. Time synchronization techniques, Wide Area Monitoring System (WAMS), control and protection systems (Architecture, components of WAMS, and applications: Voltage stability assessment, frequency stability assessment, power oscillation assessment, communication needs of WAMS, remedial action scheme).

Module 4 Smart grid Technologies Part II: Smart substations, Substation automation, Feeder automation, Fault detection, Isolation, and Service Restoration (FDISR), Geographic Information System (GIS), Outage Management System (OMS).
Introduction to Smart distributed energy resources and their grid integration, Smart inverters, Concepts of microgrid, Need and application of microgrid – Energy Management- Role of technology in demand response- Demand side management, Demand side Ancillary Services, Dynamic line rating.

Module 5 Cloud computing in smart grid: Private, Public and hybrid cloud. Types of cloud computing services- Software as a Service (SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS), Data as a service (DaaS), Cloud architecture for smart grid.
Cyber Security - Cyber security challenges and solutions in smart grid**,** Cyber security risk assessment, Security index computation.
Power Quality Management in Smart Grid- Fundamentals, Power Quality (PQ) & Electromagnetic Compatibility (EMC) in smart grid, Power quality conditioners for smart grid.
Case study of smart grid.

Text/Reference Books

1. **Stuart Borlase** “Smart Grid Infrastructure Technology and Solutions”, CRC Press; 2nd edition.
2. **James Momoh**, “Smart Grid: Fundamentals of Design and Analysis”, Wiley, 2012.
3. **S. Chowdhury**, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 2009.
4. **Janaka Ekanayake, Kythira Liyanage, Jianzhong Wu, Akihiko Yokohama, Nick Jenkins-** “Smart Grids Technology and Applications”, Wiley, 2012.
5. **Clark W.Gellings,** “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press.
6. **Jean Claude Sabonnadière, Nouredine Hadjsaïd,** “Smart Grids”, Wiley Blackwell.
7. **James Larminie, John Lowry**, Electric Vehicle Technology Explained, Wiley, 2003.
8. **Chris Mi, M. AbulMasrur, David WenzhongGao**, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, 2011, Wiley publication.
9. **Danda B. Rawat; Chandra Bajracharya,** Cyber security for smart grid systems: Status, challenges and perspectives IEEE SoutheastCon 2015, DOI: 10.1109/SECON.2015.7132891.
10. **Pillitteri, V. and Brewer, T. (2014),** Guidelines for Smart Grid Cybersecurity, NIST Interagency/Internal Report (NISTIR), National Institute of Standards and Technology, Gaithersburg, MD, [online], https://doi.org/10.6028/NIST.IR.7628r1.
11. **Barker, Preston, Price, Rudy F**., “Cybersecurity for the Electric Smart Grid: Elementsand Considerations”, Nova Science Publishers Inc, 2012.
12. **Eric D. Knapp, Raj Samani, “**Applied Cyber Security and the Smart Grid: Implementing Security Controls into the Modern Power Infrastructure”, Syngress; 1stedition (26 February 2013).
13. **Richard J. Campbell, “**The Smart Grid and Cybersecurity: Regulatory Policy and Issues”, Congressional Research Service, 2011.
14. **Dariusz Kloza, Vagelis Papakonstantinou, Sanjay Goel, Yuan Hong**, “Smart grid security”, Springer.
15. **Roger C. Dugan**, “Electrical Power Systems Quality”, McGraw-Hill Publication, 3/e.
16. **G.T.Heydt**, “Electric Power Quality”, Stars in a Circle Publications, 2/e.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Smart Grid**:	**(7)**
1.1	Evolution of electric grid, definitions need for smart grid, smart grid drivers, functions of smart grid, opportunities and barriersof smart grid, difference between conventional grid and smart grid, concept of resilient and self- healing grid	3
1.2	Components and architecture, inter-operability, impacts of Smart Grid on system reliability	2
1.3	Present development and international policies in smart grid.	2

	smart grid standards.	
2	**Information and Communication Technology in Smart Grid**:	**(8)**
2.1	Wired and wireless communication -radio mesh, ZIGBEE, 3G, 4G and 5G, digital PLC, DSL, Wi-Max, LAN, NAN, HAN, Wi- Fi, bluetooth, Bluetooth Low Energy (BLE), Light-Fi, substation event - GOOSE, IEC 61850 substation model	4
2.2	Communication protocols in smart grid, introduction to IEC 61850 standard and benefits, IEC Generic Object-Oriented Substation Event - GOOSE.	2
2.3	IEC 61850 ,Substation model	2
3	**Smart grid Technologies Part I**	**(7)**
3.1	Introduction to smart meters, electricity tariff, real time pricing- Automatic Meter Reading (AMR) System, services and functions, components of AMR systems, Advanced Metering Infrastructure (AMI)	2
3.2	Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Grid to Vehicle.	1
3.3	Smart sensors, smart energy efficient end use devices, home & building automation, Intelligent Electronic Devices (IED) and their application for monitoring & protection, DFRA, DPRA, CBMA	1
3.4	Phasor Measurement Unit (PMU), standard for PMU. time synchronization techniques, Wide Area Monitoring, control and protection systems - architecture, components of WAMS, and applications: voltage stability assessment, frequency stability assessment, power oscillation assessment, communication needs of WAMS, remedial action scheme.	3
4.	**Smart grid Technologies Part II**	**(7)**
4.1	Smart substations, substation automation, feeder automation, fault detection, isolation, and service restoration, Geographic Information System (GIS), Outage Management System (OMS).	2
4.2	Introduction to smart distributed energy resources and their grid integration, smart inverters.	2
4.3	Concepts of micro grid, need & application of micro grid – Energy Management-Role of technology in demand response- Demand Side Management, Demand Side Ancillary Services, Dynamic Line rating.	3
5	**Cloud computing in smart grid**:	**(8)**
5.1	Public and hybrid cloud, cloud architecture of smart grid, types of cloud computing services- IaaS, SaaS, PaaS, DaaS.	2
5.2	**Cyber Security -** Cyber security challenges and solutions in	2

	smart grid**,** cyber security risk assessment, security index computation .	
5.3	**Power Quality Management in Smart Grid-** Fundamentals, power quality & EMC in Smart Grid.	2
5.4	Power quality conditioners for smart grid -case study of smart grid	2

PROGRAM ELECTIVE IV

EOT416	ROBOTICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble : This course provides an introduction to the robots types, Configurations and application; Coordinate frames and types, Transformations and types; Forward and Inverse Kinematics of manipulator's; all types of robotic sensors; Open loop and closed loop control systems

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify the anatomy and specifications of robots for typical application
CO 2	Select the appropriate sensors and actuators for robots
CO 3	Identify robotic configuration and gripper for a particular application
CO 4	Solve forward and inverse kinematics of robotic manipulators
CO 5	Plan trajectories in joint space and Cartesian space
CO 6	Develop the dynamic model of a given robotic manipulator and its control strategy

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1										2
CO 2	2	1										2
CO 3	2	1	2									2
CO 4	3	3	3									2
CO 5	3	3	3									2
CO 6	3	3	3									2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	**2**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the anatomy of a robot which is used for pick and place tasks. (K2, PO1, PO12)
2. What are the specifications of a typical spray painting robot? (DOF, specialties, control method etc.) (K1, PO2, PO12)
3. Which control method is used for a spot welding robot? (Continuous path control or point to point control) (K2, PO2, PO12)

Course Outcome 2 (CO2):

1. Choose a sensor as per robotic application.(K2, PO1, PO12)
2. Describe the functional differences of stepper motors and ac motors.(K1, PO1, PO12)
3. Pneumatic actuators are not suitable for heavy loads under precise control. Justify it.(K2, PO1, PO2, PO12)

Course Outcome 3 (CO3):

1. Explain the features of SCARA, PUMA Robots?(K1, PO1, PO12)
2. What are the different classification of robots based on motion control methods and drive technologies? Explain(K1, PO1, PO2, PO12)
3. What are the factors affecting the selection of grippers?(K1, PO1, PO3, PO12)

Course Outcome 4 (CO4):

1. What do you mean by forward kinematics?(K1, PO1, PO2, PO12)
2. Explain the inverse kinematics of robots.(K1, PO1, PO3, PO12)
3. What are the different coordinate systems used by industrial robots?(K1, PO1, PO3, PO12)

Course Outcome 5 (CO5):

1. Explain about planning the trajectory in Cartesian space and Joint space for robotic manipulators.(K1, PO1, PO2, PO12)
2. Explain about the third order polynomial trajectory planning in Joint space.(K1, PO1, PO2, PO12)
3. A two-degree-of-freedom planar robot is to follow a straight line in Cartesian space between the start (2,6) and the end (12,3) points of the motion segment. Find the joint variables for the robot if the path is divided into 10 segments. Each link is 9 inches long.(K2, PO1, PO3, PO12)

Course Outcome 6 (CO6):

1. Obtain the dynamic model of 1 DOF robot.(K2, PO1, PO2, PO12)
2. Explain the steps to design a PID controller for a single link manipulator.(K2, PO1, PO3, PO12)
3. Write short note on computed torque control.(K1, PO1, PO2, PO12)

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH. DEGREE EXAMINATION

Course Code: EOT416

Course Name: ROBOTICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1		Define reach and stroke of a robotic manipulator.	(3)
2		What are the characteristics of a spot welding robot?	(3)
3		A strain gauge of gauge factor 2 and resistance of the unreformed wire 100 Ω is used to measure the acceleration of an object of mass 3kg. If the strain is 10^{-6}, cross sectional area=10mm^2 and Young's modulus =6.9 x 10^{-10} N/m^2, compute the acceleration of the object.	(3)
4		Compare hydraulic and pneumatic actuators.	(3)
5		Explain the features of a SCARA robot.	(3)
6		What are the advantages and disadvantages of a pneumatic gripper?	(3)
7		If a point $P = [3\ 0\ -1\ 1\ ]^T$, find the new location of the point P, if it is rotated by π about the z-axis of the fixed frame and then translated by 3 units along the y-axis.	(3)
8		How will you compute the end effector position and orientation of a robotic arm?	(3)
9		What is the necessity of dynamic modelling of robotic manipulators?	(3)
10		Is a robotic system linear or nonlinear? Justify your answer.	(3)

PART B

Answer any one full question from each module, each carries 14 marks.

MODULE1

11	a)	Explain in detail the specifications of a robotic manipulator.	(10)
	b)	What is the typical anatomy of a robotic manipulator?	(8)
12	a)	Explain in detail any two industrial applications of Robots.	(10)

b) Compare point to point control and continuous path control. (4)

MODULE II

13 a) How will you choose an appropriate sensor for a robotic application? (8)

b) Mention the applications of vision sensor (6)

14 a) Outline the method of varying position using servo motor and stepper motor. (8)

b) Explain the working of a typical hydraulic actuator. (6)

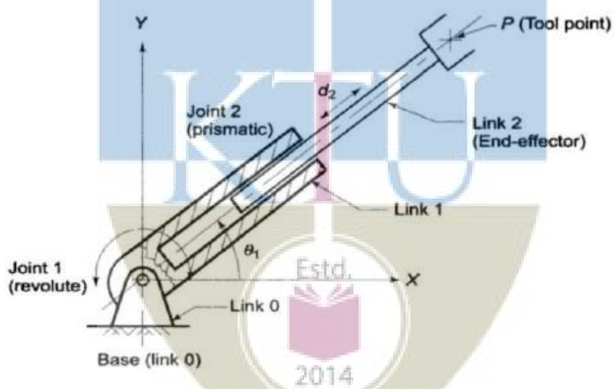
MODULE III

15 a) Explain in detail all robotic configurations. (14)

16 a) Describe the types of end effector & gripper mechanisms with simple sketches (14)

MODULE IV

17 a) Obtain the forward kinematic model of the following robot (14)



18 a) The second joint of a SCARA robot has to move from 15^0 to 45^0 in 3 sec. Find the coefficients of the cubic polynomial to interpolate a smooth trajectory. Also obtain the position, velocity and acceleration profiles (8)

b) How will you plan a straight line trajectory in Cartesian space? (6)

MODULE V

19 a) Obtain the dynamic model of 1 DOF robot operated by electric motor. (8)

b) How will you build a servo controlled robotic arm? (6)

20 a) Describe the schematic of PID controlled robotic manipulator and derive the closed loop transfer function. Explain how gains are computed for the PID controller? (10)

b) Comment on the stability of the above controller (4)

****

SYLLABUS

Module 1

Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot considerations for an application- number of axes, work volume, capacity & speed, stroke & reach, Repeatability, Precision and Accuracy, Operating environment, point to point control or continuous path control.

Robot Applications- medical, mining, space, defence, security, domestic, entertainment, Industrial Applications-Material handling, welding, Spray painting, Machining.

Case study- anatomy and specifications of a typical material handling robot

Module 2

Sensors and Actuators

Sensor classification- Touch, force, proximity, vision sensors.

Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non-contact type; Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors.

Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors; Hydraulic actuators- Components and typical circuit, advantages and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages and disadvantages.

Case study- sensors and actuators needed for a differential drive robot which is capable of autonomous navigation, study of sensors and actuators for an autonomous pick and place robot

Module 3

Robotic configurations and end effectors

Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots; Classification of robots based on motion control methods and drive technologies; 3R concurrent wrist;

Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, factors affecting selection of grippers.

Case study- typical robotic configuration for a pick and place robot capable picking objects from a moving conveyor

Module 4

Kinematics and Motion Planning

Robot Coordinate Systems- Fundamental and composite rotations, homogeneous coordinates and transformations, Kinematic parameters, D-H representation, Direct Kinematics. The Arm equation- forward and inverse Kinematics of typical robots upto 3 DOF.

Motion Planning- joint space trajectory planning-cubic polynomial, linear trajectory with parabolic blends; Cartesian space planning, Point to point vs continuous path planning.

Case study- Obtain the joint profiles of a 2 DOF planar manipulator, if the end effector is moving through an arc.

Module 5

Dynamics and Control of Robots

Dynamics- Dynamic model of a robot using Lagrange's equation, dynamic modelling of 1 DOF robot.

Control Techniques- Transfer function and state space representation, Performance and stability of feedback control, PID control of a single link manipulator, selection of PID controller gains; nonlinear nature of manipulators, and need for nonlinear control techniques, Computed torque control.

Case study: Closed loop PID control a typical 2 DOF planar robotic manipulator

Case Studies/Assignments: Any of the three case studies can be given as assignments.

Text Books

1. Introduction to Robotics by S K Saha, Mc Graw Hill Eduaction
2. Robert. J. Schilling, "Fundamentals of robotics – Analysis and control", Prentice Hall of India 1996.

3. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi, 2003.
4. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
5. Ashitava Ghosal, “Robotics-Fundamental concepts and analysis”, Oxford University press.
6. Robotics Technology and Flexible Automation, Second Edition, S. R. Deb.
7. Introduction to Robotics, Saeed B. Nikku, Pearson Education, 2001.
8. Rachid Manseur, ‘Robot Modeling and Kinematics’, Lakshmi publications, 2009.

Reference Books

1. D Roy Choudhury and shaail B. jain, ‘Linear Integrated circuits’, New age international Pvt.Ltd 2003
2. Boltans w. ”Mechatronics” Pearson Education , 2009

Course Contents and Lecture Schedule

No	**Topic**	**No. of Lectures**
1	**Introduction**	
1.1	Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots;	1
1.2	Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom;	1
1.3	Robot considerations for an application- number of axes, work volume, capacity & speed, stroke & reach, Repeatability, Precision and Accuracy, Operating environment, point to point control or continuous path control.	1
1.4	Robot Applications- medical, mining, space, defence, security, domestic, entertainment	1
1.5	Industrial Applications-Material handling, welding, Spray painting, Machining.	1
2	**Sensors and Actuators**	

2.1	Sensor classification- touch, force, proximity, vision sensors	1
2.2	Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors;	1
2.3	External sensors-contact type, non-contact type;	1
2.4	Vision-Elements of vision sensor, image acquisition, image processing; Selection of sensors.	1
2.5	Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors;	2
2.6	Hydraulic actuators- Components and typical circuit, advantages and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages and disadvantages.	2
3	**Robotic configurations and end effectors**	
3.1	Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots	2
3.2	Classification of robots based on motion control methods and drive technologies; 3R concurrent wrist;	2
3.3	Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, factors affecting selection of grippers.	3
4	**Kinematics and Motion Planning**	
4.1	Robot Coordinate Systems- Fundamental and composite rotations, homogeneous coordinates and transformations.	2
4.2	Kinematic parameters, D-H representation, Direct Kinematics. The Arm equation- forward Kinematic analysis of a typical robots up to 3 DOF.	4
4.3	Motion Planning- joint space trajectory planning-cubic polynomial, linear trajectory with parabolic blends; Cartesian space planning, Point to point vs continuous path planning.	2
5	**Dynamics and Control of Robots**	
5.1	Dynamics- Dynamic model of a robot using Lagrange’s equation, dynamic modelling of 1 DOF robot	2

5.2	Control Techniques- Transfer function and state space representation, Performance and stability of feedback control.	3
5.3	PID control of a single link manipulator, selection of PID controller gains; nonlinear nature of manipulators, and need for nonlinear control techniques, Computed torque control.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EOT426	ELECTRIC & HYBRID VEHICLES	PEC	2	1	0	3

Preamble : **Electric and Hybrid vehicles are gaining popularity globally. This course introduces the fundamental concepts of electric, hybrid and autonomous vehicles, drive trains, electrical machines used, energy storage devices, charging systems and different communication protocols.**

Prerequisite : Nil

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Explain the basic concepts of Conventional, Electric, Hybrid EV and Autonomous Vehicles
CO 2	Describe different configurations of electric and hybrid electric drive trains
CO 3	Discuss the propulsion unit for electric and hybrid vehicles
CO 4	Compare various energy storage and EV charging systems
CO 5	Select drive systems and various communication protocols for EV

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1					2					
CO 2	3	2										
CO 3	3	2										
CO 4	3	3	2									
CO 5	3	1	2									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	

Remember (K1)	20	20	40
Understand (K2)	20	20	40
Apply (K3)	10	10	20
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : **10 marks**

Continuous Assessment Test (2 numbers) : **25 marks**

Assignment/Quiz/Course project : **15 marks**

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Give questions indicating bloom's taxonomy level under each CO

Course Outcome 1 (CO1):

1. Which are the resistive forces that retard the motion of a four wheel vehicle?(PO1,K1)
2. Explain briefly the performance parameters of the vehicle.(PO1, PO2,K1)
3. What are the social and environmental importance of EV.(PO7, K1)

Course Outcome 2 (CO2):

1. Architecture and power flow control of hybrid electric vehicle.(PO2, K2)
2. Subsystems of an electric vehicle.(PO1, K1)
3. What is regenerative braking?(PO1, K1)

Course Outcome 3 (CO3):

1. Electric components of an electric vehicle. (PO1, K1)
2. Control of orthogonal flux and torque in a separately excited DC motor(PO2, K2)
3. FOC control concept in PMSM motors.(PO1, PO2,K2)

Course Outcome 4 (CO4):

1. Battery management supporting system for hybrid vehicle.(PO1, K2)
2. Numerical problems in sizing and selection of batteries (PO3, K3)
3. Pin diagrams and differences of various connectors used for EV charging.(PO2,K2)

Course Outcome 5 (CO5):

1. Torque - speed envelope curves of drive train motors (PO2,K1)
2. Numerical Problems in sizing of drive systems (PO3,K3)
3. Different communication protocols used in EV (PO1, K2)

Model Question Paper

QP CODE: **Pages:**

Reg No.:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EOT 426

Course Name: ELECTRIC AND HYBRID VEHICLES

Max. Marks: 100 **Duration: 3 hours**

PART A

Answer all questions; each question carries 3 marks.

1. Explain rolling resistance and aerodynamic drag in vehicles. (3)

2.	Write short notes on gradeability of the automobile system		(3)
3.	With the help of a block diagram, explain the major components of an electric vehicle.		(3)
4.	What is axial balancing?		(3)
5.	What are the electric components used in the propulsion unit of EV/HEV?		(3)
6.	List the advantages of PMSM motors over DC and induction motors.		(3)
7.	Explain the terms specific energy and energy density as applied to batteries.		(3)
8.	Explain the V2G concept.		(3)
9.	What is meant by Constant Power Speed Ratio as applied to an electric motor?		(3)
10.	What is the significance of a communication network in electric/hybrid vehicles?		(3)

PART B

Answer any one complete question from each section; each question carries 14 marks

11	(a)	Draw and explain ideal traction power plant characteristics of various power plants and various power source characteristics used in electric and hybrid electric vehicles.	(8)
	(b)	Why is a gear system needed for an ICE? Explain with relevant characteristic curves.	(6)
		OR	
12	(a)	Explain the levels of automation and its significance in autonomous vehicles (5 marks)	
	(b)	What are the resistive forces acting on the vehicle movement? Obtain the dynamic equation of the vehicle movement.	
13	(a)	Draw and explain different classification of electric vehicles based on power source configurations.	(7)
	(b)	Explain the different power flow control modes of a typical parallel hybrid system with the help of block diagrams.	(7)
		OR	
14	(a)	Explain in detail the EV drivetrain alternatives based on drivetrain configurations	(6)

	(b)	Explain the different power flow control modes of a typical ICE dominated series-parallel hybrid system with the help of block diagrams	(8)
15	(a)	Explain the Permanent Magnet Synchronous Motor control for application in EV.	(10)
	(b)	Describe the advantages of independent control of flux and torque in SEDC Motor	(4)
		OR	
16	(a)	Discuss in detail the various electrical components used in HEV.	(10)
	(b)	List the advantages of FOC control.	(4)
17	(a)	What is meant by the C rating of a battery? Explain with an example.	(4)
	(b)	Explain the operation, advantages and disadvantages of Fuel cells used in EV.	(10)
		OR	
18	(a)	Explain briefly the different charging systems used for charging of EV.	(8)
	(b)	With pin diagrams, describe the CCS Type 2 connectors used for EV charging.	(6)
19	(a)	A hybrid electric vehicle has two sources- an ICE with output power of 80kW and battery storage. The battery storage is a 150 Ah, C10 battery at 120V. (i).Calculate the battery energy capacity (ii). Without de-rating the Ahr capacity,what is the maximum power that can be supported by the battery? (iii). What is the electrical motor power output if the total efficiency of power converter and motor combination is 98%? (iv). What is the maximum power that can be transmitted to the wheels if the transmission efficiency is 95%?	(8)
	(b)	Explain briefly the factors to be considered while sizing the electric motor for EV.	(6)
		OR	
20	(a)	What does CP and PP pins denote in connectors and explain its functions	(5)
	(b)	Draw and explain the FLEXRAY communication systems used in EV.	(9)

Syllabus

Module 1 - 8 hrs

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. (2 hrs)

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. (5 hrs)

Autonomous Vehicles: Levels of automation, significance & effects of automation in vehicles (1 hr)

Module 2 - 7 hrs

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. (4 hrs)

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.(3 hrs)

Module 3 - 7 hrs

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles (2 hrs)

DC Drives: Review of Separately excited DC Motor control – Speed and torque equations - Independent control of orthogonal flux and torque - Closed loop control of speed and torque (block diagram only) (2 hrs)

PMSM Drives: PMSM motor basics – Independent control of orthogonal flux and torque (concept only)- Field Oriented Control (FOC) – Sensored and sensorless control (block diagram only) (3 hrs)

Module 4 - 7 hrs

Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems,Battery Management System, Types of battery- Fuel Cell based energy storage systems- Supercapacitors-Hybridization of different energy storage devices (3 hrs)

Overview of Electric Vehicle Battery Chargers - On-board chargers, Electric Vehicle Supply Equipment (EVSE) - Grid to EVSE to On-board chargers to battery pack power flow block schematic diagrams – Types of charging stations - AC Level 1 & 2, DC - Level 3 –V2G concept-Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences (4hrs)

Module 5 - 5 hrs

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics (3 hrs)

Vehicle Communication protocols : Need & requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY (Basics only)- Power line communication (PLC) in EV (2 hrs)

Text Books

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

References:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. Chris Mi, M A Masrur, D W Gao, " Hybrid Electric Vehicles – Principles and applications with practical perspectives," Wiley, 2011
4. Anderson JM, Nidhi K, Stanley KD, Sorensen P, Samaras C, Oluwatola OA, Autonomous vehicle technology: A guide for policymakers, Rand Corporation,2014

Online Resources:

1. NPTEL courses/Materials (IITG, IITM,IITD) – Electric and Hybrid vehicles
   https://nptel.ac.in/courses/108/103/108103009/ (IIT Guwahati)
   https://nptel.ac.in/courses/108/102/108102121/ (IIT Delhi)
   https://nptel.ac.in/courses/108/106/108106170/ (IIT Madras)
2. FOC Control - video lecture by Texas Instruments
   https://training.ti.com/kr/field-oriented-control-permanent-magnet-motors
3. Sensored and sensorless FOC control of PMSM motors – Application notes (TI, MATLAB)
   https://www.ti.com/lit/an/sprabz0/sprabz0.pdf?ts=1620018267996&ref_url=https%253A%252F%252Fwww.google.com%252F
   https://in.mathworks.com/help/physmod/sps/ref/pmsmfieldorientedcontrol.html
4. Electric Vehicle Conductive AC Charging System
   https://dhi.nic.in/writereaddata/UploadFile/REPORT%20OF%20COMMITTEE636469551875975520.pdf
   Electric Vehicle Conductive AC Charging System

Course Contents and Lecture Schedule:

No.	Topic	No. of Lectures
1	**Introduction to hybrid/electric, conventional & autonomous vehicles (8 hours)**	
1.1	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles	1
1.2	Impact of modern drive-trains on energy supplies	1
1.3	Conventional Vehicles: Basics of vehicle performance	1
1.4	Vehicle power source characterization, transmission characteristics	2
1.6	Mathematical models to describe vehicle performance	2
1.7	Autonomous Vehicles: Levels of automation, significance & effects of automation in vehicles	1
2	**Hybrid & Electric drive-trains (7 hours)**	
2.1	Hybrid Electric Drive-trains: Basic concept of hybrid traction	1
2.2	Introduction to various hybrid drive-train topologies	1
2.3	Power flow control in hybrid drive-train topologies, fuel efficiency analysis.	2
2.4	Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies	1
2.5	Power flow control in electric drive-train topologies, hub motors, fuel efficiency analysis.	2
3	**Electric Propulsion System (7 Hours)**	
3.1	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles	2
3.2	DC Drives: Review of Separately excited DC Motor control – Speed and torque equations - Independent control of orthogonal flux and torque – Closed loop control of speed and torque (block diagram only)	2
3.3	PMSM Drives: PMSM motor basics – Independent control of orthogonal flux and torque (concept only)	2
3.4	Field Oriented Control (FOC) of Permanent Magnet Synchronous Motor – Sensored and sensorless control (block diagram only)	1

4	**Energy Storage (7 Hours)**	
4.1	Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System	1
4.2	Types of battery-Lithium ion, Lead acid	1
4.3	Fuel Cell based energy storage systems- Supercapacitors-Hybridization of different energy storage devices	1
4.4	Overview of Electric Vehicle Battery Chargers – On-board chargers, Electric Vehicle Supply Equipment (EVSE) - Grid to EVSE to On-board chargers to battery pack power flow block schematic diagrams	2
4.5	Types of charging stations - AC Level 1 & 2, DC - Level 3	1
4.6	V2G concept-Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences	1
5	**Sizing the drive system (5 Hours)**	
5.1	Sizing the drive system **:**Matching the electric machine and the internal combustion engine (ICE)	1
5.2	Sizing the propulsion motor	1
5.3	Sizing the power electronics	1
5.4	Vehicle Communication protocols : Need and requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins	1
5.5	Communication Protocols - CAN, LIN, FLEXRAY(Basics only) –Power Line Communication (PLC) in EV	1

EOT436	IMAGE PROCESSING TECHNIQUE	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course helps the learners understand the core concepts and applications of Digital Image Processing. It covers Digital Image Fundamentals, Image Transforms, Image Enhancement in Spatial and Frequency Domain, Image Restoration & Image Segmentation and Morphological Operations & Representation and Description. The learners will be able to develop new algorithms, tools, and application software for real-world applications involving image processing.

Prerequisite: A basic knowledge of Computer Graphics and Image representation

Course Outcomes: After the completion of the course, the student will be able to

CO1	Explain the concepts of image formation and the basis of digital image processing. **(Cognitive Knowledge Level: Understand)**
CO2	Demonstrate the role of image transforms in representing, highlighting, and modifying image features. **(Cognitive Knowledge Level: Apply)**
CO3	Solve image enhancement problems using spatial and frequency domain techniques. **(Cognitive Knowledge Level: Apply)**
CO4	Make use of the concept of image restoration and image segmentation techniques in real-world problems. **(Cognitive Knowledge Level: Apply)**
CO5	Interpret morphological operations, image representation, and description techniques. **(Cognitive Knowledge Level: Understand)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										1
CO2	2	1			2							1
CO3	2	1	1									1
CO4	2	1	1	1	1	1						1
CO5	2	1										1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and teamwork
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	**30**	**30**	**30**
Understand	**40**	**40**	**40**
Apply	**30**	**30**	**30**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. The first series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which students should answer anyone. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module – 1 (Digital Image Fundamentals)

Elements of Visual Perception, A Simple Image Formation Model. Spatial and Intensity Resolution. Image Interpolation. Classification of Digital Images. Image Types. Image Storage Mechanisms. Arithmetic and Logical Operations. Geometric Spatial Transformations and Image Registration. Image File Formats. Colour Fundamentals and Colour Models.

Module - 2 (Image Transforms)

Basic concept of spatial domain and frequency domain, Unitary transform, Discrete Fourier Transform- 2D DFT, 4 order DFT Transform coefficients, Forward and inverse transform, Discrete Cosine Transform- 2D DCT, 4 order DCT Transform Coefficients(No derivation needed), Forward and Inverse DCT, Hadamard Transform.

Module - 3 (Image Enhancement in Spatial and Frequency Domain)

Point operations- Clipping and Thresholding, Digital Negative, Intensity Level Slicing, Bit Extraction, Range Compression. Spatial Operations- Fundamentals of spatial convolution and correlation, Spatial averaging and spatial Low pass filtering, Directional Smoothing, Median Filtering, Unsharp masking and Crispening.

Basics of Filtering in Frequency Domain, Filters, Smoothing Frequency Domain Filters- Sharpening Frequency Domain Filters

Module - 4 (Image Restoration & Image Segmentation)

Image degradation model, Noise models, Mean Filters, Order Statistic filter, Adaptive filters.
Edge Detection, gradient operators, Laplace operators and zero crossings. Thresholding, Basic Global Thresholding, Optimum global thresholding using Otsu method, Multiple thresholds, Variable thresholding, Multivariable thresholding. Region-Based Approach to Segmentation.

Module - 5 (Morphological Operations & Representation and Description)

Structuring Element, Dilation and Erosion, Opening and Closing, Hit or Miss Transformation.

Boundary Following. Chain Codes. Polygonal Approximation. Boundary Descriptors. Regional Descriptors. Relational Descriptors.

Text Books

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition, Pearson India, 2013
2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

Reference Books

1. Al Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2008.
3. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education, 2009.

Course Level Assessment Questions

Course Outcome1 (CO1) :

1. Find the number of bits required to store a 256 X 256 image with 32 gray levels.
2. Explain the reasons for blocking artifacts and false contours in an image.

Course Outcome 2 (CO2) :

1. Compare different image transforms based on their roles, properties and applications.
2. Compute the inverse 2D DFT of the transform coefficients F(k,l) given below.

$$F(k,l) = \begin{pmatrix} 64 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

3. Use Discrete Fourier transform to construct 2D DFT for a 4x4 image given below. Assume that indices start from (0,0)

6	6	6	6
6	6	6	6
6	6	6	6
6	6	6	6

Course Outcome 3 (CO3) :

1. Perform intensity level slicing on the 3 BPP (Bit Per Pixel) image. Let r1=3 and r2=5. Draw the modified image with/without background transformations.

$$\begin{bmatrix} 2 & 1 & 2 & 2 & 1 \\ 2 & 3 & 4 & 5 & 2 \\ 6 & 2 & 7 & 6 & 0 \\ 2 & 6 & 6 & 5 & 1 \\ 0 & 3 & 2 & 2 & 1 \end{bmatrix}$$

2. Let y(m) = {2,3,8,4,2}. Obtain the median filter output for the window W = [-1,0,1,2] and show how salt and pepper noise is reduced.
3. Consider a 3*3 spatial mask that averages the four closest neighbors of a point(x,y), but excludes the point itself from the average.

   (a) Find the equivalent filter H(u,v) in the frequency domain.

   (b) Show that H(u,v) is a lowpass filter (ASSIGNMENT)

Course Outcome 4 (CO4) :

1. Compare Region and Edge-based techniques in segmentation.

2. Consider a noisy image that is restored using arithmetic mean filter of size 3x3 and using the geometric mean filter of the same size. Which image will be less blurred and why?
3. Suppose that you want to help a radiologist to extract the tumor portion from an MRI image for volumetric analysis. This volumetric analysis determines the effect of treatment on the patient, which can be judged from the extracted size and shape of the abnormal portion. Manual tracing of the tumor regions is very difficult since the tumor portion on the MRI image is inhomogeneous, with complex shapes and ambiguous boundaries. Suggest a sequence of steps that you may use to automate this process as an image processing student. (ASSIGNMENT)

Course Outcome 5 (CO5) :

4. Explain the significance of structuring elements in morphological operations with example.
5. Explain how chain codes are used to represent boundaries of a region with examples.

Model Question Paper

QP CODE:

Reg No: _______________

Name: ____ PAGES : 4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EOT436

Course Name: IMAGE PROCESSING TECHNIQUE

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Give an image representation model and describe how the representation changes in different types of images.

2. Describe any three types of color models.

3. Obtain the HADAMARD basis matrix for N=8.

4. Prove that DFT is a unitary transform.

5. Sketch perspective plot of a 2-D ideal low pass filter transfer function and filter cross-section. List its usefulness in Image enhancement.

6. Explain the significance of directional smoothing technique.

7. Specify the significance of the Zero crossing detector.

8. Describe region growing technique for image segmentation.

9. Define 'Structuring Element' used in morphological operations. Give samples for Structuring Elements.

10. Explain image boundary representation using polygonal approximation.

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain a Simple Image Formation Model with the help of a neat diagram. **(7)**

(b) Explain the relationship between image size, spatial resolution, and image quality. Compare gray level and intensity resolution. **(7)**

OR

12. (a) Describe arithmetic, logical and geometrical operations on Image. **(7)**

(b) Explain the significance of image interpolation and describe its various types. **(7)**

13. (a) State the advantages of Discrete Cosine Transform over Discrete Fourier Transform. **(4)**

(b) You are given a 4 X 4 image patch Compute 2D DCT for the image patch. Reconstruct the original image patch by neglecting the last four coefficients in 2D DCT. Comment on the observed result. **(10)**

OR

14. (a) Discuss the concept of sequency in Hadamard transform. **(4)**

(b) Find the 2D forward DFT of the image segment **(10)**

1 1 1 1

1 1 1 1

1 1 1 1

Prove the unitary property of the given image segment.

15. (a) Explain the output and application of the following point processing techniques **(9)**

(i)Range Compression (ii) Bit Extraction (iii) Thresholding

(b) State and explain the features of median filtering. Compute the output of the median filtering for Y(m)={2,4,8,3,2} , w={-1,0,1,2} where Y(m) is an array and w is a window. **(5)**

OR

16. (a) Describe the role of Unsharp masking with its applications **(4)**

(b) Explain and compare the basic frequency domain filters for image sharpening **(10)**

17. (a) A 4×4 image is given by **(8)**

2	4	8	7
12	6	9	8
13	7	4	3
8	12	4	9

Filter the above image using

(a) MIN filter (b) MAX filter using the filter mask

0 1 0
1 1 1
0 1 0

(Assume replicate padding of the input image)

(b) Explain any two types of thresholding techniques. Describe the threshold detection algorithm using Otsu's method. **(6)**

OR

18. (a) Explain Image degradation model with the help of a neat diagram. **(8)**

(b) Illustrate the split and merge algorithm for image segmentation using neat sketches. **(6)**

19. (a) Explain the purpose of morphological operations in digital image? Describe the opening and closing operations with examples. **(7)**

(b) Illustrate Hit or Miss Transformation. **(7)**

OR

20. (a) Explain the concept of the chain coding scheme with its applications. **(6)**

(b) Describe in detail any two boundary representation schemes and illustrate with examples. **(8)**

No	**Contents**	**No. of Lecture Hours (36 hrs)**
Module-1 (Digital Image Fundamentals) (7 hours)		
1.1	Elements of Visual Perception, A Simple Image Formation Model	1
1.2	Spatial and Intensity Resolution, Image Interpolation, Classification of Digital Image.	1
1.3	Image Types, Image Storage Mechanisms.	1
1.4	Arithmetic and Logical Operations.	1
1.5	Geometric Spatial Transformations and Image Registration.	1
1.6	Image File Formats.	1

1.7	Colour Fundamentals and Colour Models.	1
Module-2 (Image Transforms) (8 hours)		
2.1	Basic concept of spatial domain and frequency domain.	1
2.2	Need of Image Transform, Basic properties of unitary transform.	1
2.3	Discrete Fourier transform, Proof DFT is Unitary.	1
2.4	4 order DFT Transform coefficients (Derivation).	1
2.5	Problems (4 order DFT).	1
2.6	Discrete Cosine Transform- 2D DCT.	1
2.7	4 order DCT Transform Coefficients(No derivation needed).	1
2.8	Hadamard Transform.	1
Module-3 (Image Enhancement in spatial and frequency domain) (8 hours)		
3.1	Point operations- Clipping and Thresholding, Digital Negative. Intensity Level Slicing.	1
3.2	Bit Extraction, Range Compression + (Work out problems).	1
3.3	Spatial Operations-Fundamentals of spatial convolution and correlation.	1
3.4	Spatial averaging and spatial Low pass filtering, Directional Smoothing.	1
3.5	Median Filtering, Unsharp masking and Crispening.	1
3.6	Basics of Filtering in Frequency Domain.	1
3.7	Smoothing Frequency Domain Filters : Ideal Low Pass Filter; Gaussian Low Pass Filter; Butterworth Low Pass Filter;	1
3.8	Sharpening Frequency Domain Filters: Ideal High Pass Filter; Gaussian High Pass Filter; Butterworth High Pass filter.	1
Module-4 (Image Restoration & Image Segmentation) (6 hours)		
4.1	Image degradation model, Noise models.	1
4.2	Mean Filters – Order Statistic filter – Adaptive filters.	1
4.3	Edge Detection, Gradient operators, Laplace operators and zero crossings.	1

4.4	Thresholding- Basic Global Thresholding, Optimum global thresholding using Otsu method.	1
4.5	Multiple thresholds, Variable thresholding, Multivariable thresholding.	1
4.6	Region-Based Approach to Segmentation.	1
Module-5 (Morphological Operations & Representation and Description) (7 hours)		
5.1	Structuring Element. Dilation and Erosion,	1
5.2	Morphological Opening, Closing.	1
5.3	Hit or Miss Transformation.	1
5.4	Boundary Following. Chain Codes, Polygonal Approximation.	1
5.5	Boundary Descriptors.	1
5.6	Regional Descriptors.	1
5.7	Relational Descriptors.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET416	NONLINEAR SYSTEMS	PEC	2	1	0	3

Preamble: Most of the systems that we come across are nonlinear. Nonlinear systems exhibit interesting oscillatory behaviours and indeed unexpected phenomena like limit cycles, bifurcation, chaos etc. The course aims in understanding the basic phenomena of limit cycles, determine their existence and non-existence in systems using various theorems. This course also aims to investigate the behaviour of nonlinear systems, analyze their stability using the Lyapunov direct/indirect methods, frequency-domain methods and design various control schemes. For understanding the concepts, a basic mathematical foundation is also built throughout the course.The course will provide the basis for designing controllers for various applications such as aerospace, power systems, robotics, electric drives etc.

Prerequisites: EET 302 Linear Control Systems and EET 401 Advanced Control Systems

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Analyse the qualitative behaviour of nonlinear systems about their equilibrium points.
CO 2	Identify the existence and uniqueness of solutions of nonlinear differential equations, the existence of periodic orbits/limit cycles for nonlinear systems.
CO 3	Analyse the stability of nonlinear systems.
CO 4	Design feedback control systems for nonlinear systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	-	-	-	-	-	-	-	-	-	1
CO 2	3	3	-	-	-	-	-	-	-	-	-	1
CO 3	3	3	-	-	-	-	-	-	-	-	-	1
CO 4	3	2	-	-	-	-	-	-	-	-	-	1

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	15	15	30
Apply (K3)	25	25	50
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern: There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer anyone. Each question carries 14 marks and can have sub-divisions.

Course Level Assessment Questions:

Course Outcome 1 (CO1)

1. Discuss the characteristics of non-linear systems? (K1, PO1)
2. Model a given nonlinear system. (K2, PO1, PO12)
3. Identify and classify the equilibrium solutions of nonlinear systems. (K2, PO1)
4. Analyse the qualitative behaviour of a given system about its equilibrium points and plot a rough sketch of the phase portrait. (K3, PO2, PO12)
5. What are bifurcations? (K1, PO1)
6. Problems to identify the type of bifurcation. (Saddle-node and Pitchfork only) (K2, PO1)

Course Outcome 2 (CO2):

1. Identify the existence of limit cycles using the Poincare Bendixson theorem. (K3, PO2, PO12)
2. Identify the non-existence of limit cycles using Bendixson's theorem. (K3, PO2, PO12)
3. Problems to check the existence and uniqueness of initial value problems. (K2, PO2)

Course Outcome 3 (CO3):

1. Explain the concept of stability (local and global), instability in the sense of Lyapunov. (K2, PO1)
2. Apply Lyapunov direct/indirect methods to analyze the stability of nonlinear systems. (K3, PO2, PO12)
3. Analyze the stability using LaSalle's invariance theorem. (K3, PO2, PO12)
4. Construct Lyapunov functions using Variable gradient and Krasovskii's method. (K3, PO2)
5. Explain memoryless systems and passivity. (K1, PO1)
6. Examine whether a given system transfer function is positive real or not. (K2, PO1)
7. Explain sector nonlinearity and absolute stability. (K1, PO1)
8. Define KYP Lemma (without proof). (K1, PO1)
9. Examine the stability of the sector nonlinearity using Circle criterion. (K3, PO2)
10. Explain Popov criterion for stability. (K1, PO1)

Course Outcome 4 (CO5):

1. Define feedback control problem - state feedback and output feedback. (K1, PO1)
2. Use state feedback control law for stabilizing a given system. (K2, PO1)
3. Explain the concept of input-state and input-output linearization. (K1, PO1)
4. Examine whether a given system is input-output linearizable. (K3, PO2, PO12)
5. Explain stabilization via integral control. (K1, PO1)

Model Question Paper PAGES: 2

QP CODE:

Reg.No:______________

Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

MONTH & YEAR

Course Code**: EET416**

Course Name: **NONLINEAR SYSTEMS**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all questions

Each question carries 3 marks

1		Qualitatively analyse the following nonlinear system about the equilibrium point	3
2		What are limit cycles? Give significance and classify them based on stability.	3
3		Define Poincare Index theorem. Check whether there exist periodic orbits for the system defined below using Poincare index theorem.	3
4		State the conditions for uniqueness and existence of solutions.	3
5		Check the stability of the nonlinear system using Lyapunov direct method. $(x_1) = x_2$ $(x_2) = [-x_1 - 3x_2]$	3
6		What is meant by domain of attraction of a given system?	3
7		What are positive real transfer functions? Check whether G(s)= [s + 2] / [s + 3]	3

		is a positive real transfer function.	
8		Define absolute stability.	3
9		Find the relative degree for the controlled Van der Pol equation with output $y = x_1$ $$\dot{x}_1 = x_2$$ $$\dot{x}_2 = -x_1 + \varepsilon(1 - x_1^2)x_2 + u, \quad \epsilon > 0$$	3
10		What is the concept of gain scheduling?	3
PART B **(Answer any one full question from each module)**			
Module 1			
11	a)	Find the equilibrium points of the system defined by the system given below and determine the type of each isolated equilibrium point.Also, plot a rough sketch of the qualitative behaviour near the equilibrium points. $$\dot{x}_1 = 5x_1 - x_1 x_2$$ $$\dot{x}_2 = 3x_2 + x_1 x_2 - 3x_2^2$$	7
	b	The nonlinear dynamic equation for a pendulum is given by $ml\ddot{\theta} = -mg\sin(\theta) - kl\dot{\theta}$ where '*l=1*' is the length of the pendulum, 'm' is the mass of the bob, and θ is the angle subtended by the rod and the vertical axis through the pivot point. 'g' is the gravitational constant. Choose '*k/m=1*'. Find all the equilibria of the system and determine if the equilibria are stable or not.	7
12	a	What is saddle-node and Pitch fork bifurcation?	6
	b	Obtain the linearized representation of the following system around the origin and check the stability of the linearised system about the origin. $$\dot{x}_1 = x_2^2 + x_1 \cos x_2$$ $$\dot{x}_2 = x_2 + (x_1 + 1)x_1 + x_1 \sin x_2$$	8

		Module 2	
13	a	Define a) Bendixson theorem b) Poincare - Bendixson theorem	6
	c	Check whether the following functions are locally Lipchitz. Give reasons for your claim. (*i*) $f(x,y) = 2xy^{1/3}$ for (x,y) = [0,0] (ii) $f(t,x) = 2tx^2$ for (x,y) = [0,3]	8
14	a)	Obtain the Lipschitz constant for (i) $f(t,y) = -3y + 2$ (ii) $f(t,y) = 2ty^2$	7
	b	Check whether the system given below has a stable or unstable limit cycle. $((x_1)^{\cdot} = x_2 - x_1(x_1^2 + x_2^2 - 1))^{\cdot}$ $(x_2)^{\cdot} = -x_1 - x_2(x_1^2 + x_2^2 - 1)$	7
		Module 3	
15		Explain the concept of the domain of attraction using an example.	5
	c)	Use variable gradient method to find a suitable Lyapunov function for the system given below $(x_1)^{\cdot} = -2x_1$ $(x_1)^{\cdot} = -2x_2 + 2x_1 x_2^2$	9
16	a	Define stability in the sense of Lyapunov. What is the difference between asymptotic and exponential stability?	6
	b	State LaSalle's invariance principle. Show that the origin is locally asymptotically stable for the following system using LaSalle's principle. $(x_1)^{\cdot} = x_2$ $(x_2 = -3x_2)^{\cdot} - x_1^3$	8

Module 4			
17	a)	What is KYP Lemma?	4
	b	State circle criterion. Determine a stability sector from the Nyquist plot of the system using circle criterion. $$G(s) = 4/((s-1)(s/3+1)(s/5+1))$$	10
18	a)	Using circle criterion, find a sector [a,b] for which the following system is absolutely stable. $$G(s) = 1/((s+1)(s+2)(s+3))$$	8
	b	Describe Popov stability criterion.	6
Module 5			
19	a)	Define the following terms (i) Diffeomorphism (ii) Lie derivative	6
	b	Check whether the given system can be input-output linearized for output $y = x_1$ $$\dot{x}_1 = x_1$$ $$\dot{x}_2 = x_2 +$$	8
20	a)	What is input-output linearization?	6
	b	With a suitable feedback control law, linearize the following system $$\dot{x}_1 = a \sin x_2$$ $$\dot{x}_2 = -x_1^2 + u$$	8

Syllabus

Module 1

Introduction and background (7 hours)

Non-linear system characteristics and mathematical modelling of a non-linear system, Classification of equilibrium points, Stability of a nonlinear system based on equilibriumpoints, Bifurcation (construction not included), Phase plane analysis of nonlinear systems.

Module 2

Nonlinear characteristics (8 hours)

Periodic solution of nonlinear systems and existence of limit cycle, Open sets, closed sets, connected sets, Invariant set theorem, Bendixson's theorem and Poincare-Bendixson criteria, Existence and uniqueness of solutions to nonlinear differential equations (Proofs not required), Lipschitz condition.

Module 3

Stability Analysis (7 hours)

Lyapunov stability theorems (Proofs not required)- local stability - local linearization and stability in the small- region of attraction, the direct method of Lyapunov, Construction of Lyapunov functions - Variable gradient and Krasovskii's methods, La Salles's invariance principle.

Module 4

Analysis of feedback systems (8 hours)

Passivity and loop transformations, KYP Lemma (Proof not required), Absolute stability, Circle Criterion, Popov Criterion.

Module 5

Nonlinear control systems design (8 hours)

Feedback linearization, Input state linearization method, Input-output linearization method, Stabilization - regulation via integral control- gain scheduling.

Text Book:

1. Khalil H. K., "Nonlinear Systems", 3/e, Pearson, 2002
2. Gibson J. E., "Nonlinear Automatic Control", Mc Graw Hill, 1963
3. Slotine J. E. and Weiping Li, "Applied Nonlinear Control", Prentice-Hall, 1991

References:

1. Alberto Isidori, “Nonlinear Control Systems: An Introduction”, Springer-Verlag, 1985.
2. M. Vidyasagar, “Nonlinear Systems Analysis”, Prentice-Hall, India, 1991.
3. Shankar Sastry, “Nonlinear System Analysis, Stability and Control”, Springer, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction and background (7 hours)**	
1.1	Non-linear system characteristics and mathematical modelling of a non-linear system.	2
1.2	Classification of equilibrium points, Stability of a nonlinear system based on equilibrium points.	2
1.3	Bifurcation (construction not included), Phase plane analysis of nonlinear systems.	3
2	**Nonlinear characteristics (8 hours)**	
2.1	Periodic solution of nonlinear systems and existence of limit cycles	2
2.2	Open sets, closed sets, connected sets, Invariant set theorem, Bendixson's theorem and Poincare-Bendixson criteria	4
2.3	Existence and uniqueness of solutions to nonlinear differential equations (Proofs not required), Lipschitz condition.	2
3	**Stability Analysis (7 hours)**	
3.1	Lyapunov stability theorems (Proofs not required)- local stability - local linearization and stability in the small- region of attraction	2
3.2	The direct method of Lyapunov	2
3.3	Construction of Lyapunov functions, La Salles's invariance principle.	3
4	**Analysis of feedback systems (8 hours)**	

4.1	Passivity and loop transformations	2
4.2	KYP Lemma (Proof not required), Absolute stability	2
4.3	Circle Criterion	2
4.4	Popov Criterion	2
5	**Nonlinear control systems design (8 hours)**	
5.1	Feedback linearization	2
5.2	Input state linearization method	2
5.3	Input-output linearization method	2
5.4	Stabilization - regulation via integral control- gain scheduling	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET426	SPECIAL ELECTRIC MACHINES	PEC	2	1	0	3

Preamble: This course gives an overview of special electrical machines for control and industrial applications.

Prerequisite: EET202 DC Machines and Transformers

EET307 Synchronous and Induction Machines

Course Outcomes: After the completion of the course, the student will be able to:

CO 1	Analyse the performance of different types of permanent magnet motors.
CO 2	Analyse the performance of a stepper motor.
CO 3	Analyse the performance of different types of reluctance motors.
CO 4	Explain the construction and principle of operation of servo motors, single phase motors and linear motors.
CO 5	Analyse the performance of linear induction motors.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	-	-	2	-	-	-	-	-	2
CO 2	3	2	-	-	-	2	-	-	-	-	-	2
CO 3	3	2	-	-	-	2	-	-	-	-	-	2
CO 4	3	2	-	-	-	2	-	-	-	-	-	2
CO 5	3	2	-	-	-	2	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	15	15	30
Understand	25	25	50
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions (each carrying 3 marks) with 2 questions from each module. Students should answer all questions. Part B contains 2 questions from each module, out of which students should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Part A: 10 Questions x 3 marks=30 marks, **Part B:** 5 Questions x 14 marks =70 marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the principle of operation of any motor.[K1, PO1]
2. List the permanent magnets used in motors and explain their magnetization characteristics. [K1, PO1]
3. Problems based on emf and torque of PMBLDC motor and PMSM. [K2, PO2]

Course Outcome 2 (CO2):

1. Explain the working of any type of stepper motor with a neat diagram. [K1, PO1]
2. Explain the different configurations for switching the phases of a stepper motor. [K2, PO1]
3. Numerical problems from stepper motors. [K2, PO2]

Course Outcome 3(CO3):

1. Derive the torque equation of any motor. [K2, PO1]
2. Draw the phasor diagram of a synchronous reluctance motor. [K1, PO1]
3. Explain any two power converter circuits used for the control of SRM. [K1, PO1]

Course Outcome 4 (CO4):

1. Explain the constructional details of any servo motor. [K1, PO1]
2. Discuss the role of servo motors in automation systems. [K2, PO12]
5. Explain the constructional details and working principle of any motor. [K1, PO1]

Course Outcome 5 (CO5):

1. Explain the principle of operation of a LIM. [K1, PO1]
2. What are the different types of Linear motors?. [K1, PO1]
3. Derive the thrust equation of a LIM. [K2, PO1]

Model Question Paper

QP CODE: PAGES:

Reg. No:_______________

Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET426

Course Name: SPECIAL ELECTRIC MACHINES

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Explain the constructional details of PMBLDC Motor.
2. Explain the sensor less control of PMSM.
3. Define the following terms as applied to stepper motors (i) Holding Torque (ii) Step accuracy (iii) Detent position.
4. What is meant by micro stepping in stepper motors? What are its advantages?
5. Draw the torque -slip characteristics of a Reluctance motor and explain its shape.
6. Explain the drawbacks of a Switched Reluctance motor.
7. What are the applications of servo motors?
8. Draw and explain the performance characteristics of an ac servo motor.
9. Explain the working principle of a hysteresis motor.
10. Derive the expression for linear force in LIM.

PART B (14 x5= 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Explain the principle of operation of the PMBLDC motor with a neat circuit diagram showing the complete drive circuit. (10 marks)
    (b) Differentiate trapezoidal and sinusoidal back emf permanent magnet motors. (4 marks)
12. (a) Explain the demagnetisation characteristics and choice of permanent magnets in a Brushless DC motor. (10 marks)
    (b) Explain the constructional details and working principle of the permanent magnet dc motor. (4 marks)

Module 2

13. (a) With neat sketches, explain the constructional details and working principle of the variable reluctance stepper motor. (10 marks)
    (b) List any four applications of stepper motors. (4 marks)

14. (a) A permanent magnet stepper motor is driven by a series of pulses of duration20ms. It has 4 stator poles and 6 rotor poles. How long will it take for the motor to make a complete rotation? (4 marks)
    (b) Compare variable reluctance, permanent magnet and hybrid stepper motors. (6 marks)
    (c) Explain monofilar and bifilar windings. (4 marks)

Module 3

15. (a) With neat sketches explain the construction and operation of 8/6 SRM. (10 marks)
    (b) Draw and explain n+1 switches and diode configuration power converter for the SRM. (4 marks)
16. (a) Derive the torque equation of a synchronous reluctance motor. (8 marks)
    (b) Explain the basic principle of operation of a synchronous reluctance motor. (6 marks)

Module 4

17. (a) With the help of a schematic diagram, explain the working of the field controlled d.c servomotor. (8 marks)
    (b) Explain the working and applications of split field servomotors. (6 marks)
18. (a) Explain the constructional features and working principle of AC Servomotors. (10 marks)
    (b) Explain the characteristic difference between AC and DC servomotors. (4 marks)

Module 5

19. (a) Describe the properties of the materials used for the rotor construction of hysteresis motors. (5 marks)
    (b) Why is compensating winding used in AC series motors? Draw a series motor with different types of compensating windings. (5 marks)
    (c) What are the modifications to be made in the DC series motor to operate it in an AC supply? (4 marks)
20. (a) Develop the equivalent circuit of a LIM and describe the main factors affecting its performance. (10 marks)
    (b) Explain the transverse edge effect in LIM. (4 marks)

Syllabus

Module 1 (8 hours)

Permanent Magnet DC Motors – construction – principle of operation.
PM Brushless DC motor- Brushless DC motor-construction - permanent magnets – different types- demagnetization characteristics – arrangement of permanent magnets – magnetization of permanent magnets – axial and parallel magnetizations- principle of operation – Control of BLDC motor - applications.
Permanent Magnet Synchronous Motors-construction - principle of operation –Controlof PMSM - Self control - Sensor less Control– applications - Comparison with BLDC motors.

Module 2 (7 hours)

Stepper motors - Basic principle - different types - variable reluctance, permanent magnet, hybrid type - principle of operation – comparison. Monofilar and bifilar windings - modes of excitation- static and dynamic characteristics- open loop and closed loop control of Stepper Motor-applications.

Module 3 (7 hours)

Synchronous Reluctance Motor - Construction, principle of operation- phasor diagram - torque equation - applications.
Switched reluctance motors - principle of operation - torque equation – characteristics - power converter circuits - control of SRM - rotor position sensors- torque pulsations – sources of noise- noise mitigation techniques - applications.

Module 4 (6 hours)

DC Servo motors – DC servo motors – construction– principle of operation - transfer function of field and armature controlled dc servo motors -permanent magnet armature controlled dc servo motor- series split field dc servo motor- applications.
AC Servo motors -Construction – principle of operation- performance characteristics - damped ac servo motors - Drag cup servo motors- applications.

Module 5 (8 hours)

Single Phase Special Electrical Machines- AC series Motor, Repulsion Motor, Hysteresis Motor, Universal Motor- Construction - principle of operation - applications.

Linear Electric Machines: Linear motors – different types – linear reluctance motor- linear synchronous motors – construction – comparison.

Linear Induction Motor – Construction- Thrust Equation, Transverse edge and end effects- Equivalent Circuit, Thrust-Speed characteristics, Applications.

Text Book:

1. E. G. Janardhanan, ‘*Special Electrical Machines*’ PHI Learning Private Limited.

References:

1. R. Krishnan, ‘*Permanent magnet synchronous and Brushless DC motor Drives*’, CRC Press.
2. T. J. E. Miller, ‘*Brushless PM and Reluctance Motor Drives*’, C. Larendon Press, Oxford.
3. Theodore Wildi, ‘*Electric Machines, Drives and Power Systems*’, Prentice Hall India Ltd.
4. Veinott & Martin,’ *Fractional & Sub-fractional hp Electric Motors*’, McGraw Hill International Edn.
5. R. Krishnan, ‘*Switched Reluctance Motor Drives*’, CRC Press.
6. K. Venkataratnam, ‘*Special Electrical Machines*’, Universities Press.

Course Contents and Lecture Schedule

No.	**Topic**	**No. of Lectures**
1	**Permanent Magnet DC Motors (8 hours)**	
1.1	Permanent Magnet DC Motors – construction – principle of operation.	1
1.2	Brushless DC motor-construction - permanent magnets – different types-demagnetization characteristics	1
1.3	Arrangement of permanent magnets – magnetization of permanent magnets – axial and parallel magnetizations- principle of operation	2
1.4	Control of BLDC motor- applications.	1
1.6	Permanent Magnet Synchronous Motors-construction- principle of operation	1
1.7	Control methods of PMSM-Self control- Sensorless Control -applications-Comparison with BLDC	2
2	**Stepper motors (7 hours)**	
2.1	Stepper motors – construction and principle of operation	1
2.2	different types - variable reluctance , permanent magnet, hybrid type - principle of operation – comparison	2
2.3	Windings - Monofilar and bifilar windings- modes of excitation- Full step on mode, two phase ON mode, Half step mode.	2
2.4	Static and dynamic characteristics	1
2.5	Open loop and closed loop control of Stepper Motor-applications.	1
3	**Reluctance motors (7 Hours)**	
3.1	nchronous Reluctance Motor - Construction, principle of operation	1
3.2	Phasor diagram - torque equation- torque-slip characteristics- applications	2
3.3	Switched reluctance motors - principle of operation - torque equation-characteristics - power converter circuits .	2
3.4	Control of SRM - rotor position sensors-	1
3.5	Torque pulsations – sources of noise- mitigation techniques -	1

	applications.	
4	**Servo motors (6 Hours)**	
4.1	DC servo motors – construction– principle of operation - transfer function of field and armature controlled DC servomotors	2
4.2	Permanent magnet armature controlled - series split field DC servo motor- applications	2
4.3	**AC Servomotors -**Construction – principle of operation- performance characteristics	1
4.4	Damped AC servo motors - Drag cup servo motors- applications.	
5	**Single Phase Special Electrical Machines- (8 Hours)**	
5.1	AC series Motor, Repulsion Motor, Hysteresis Motor, Universal Motor- Construction -principle of operation - applications.	3
5.2	**Linear Electric Machines:** Linear motors – different types	1
5.3	Linear reluctance motor , linear synchronous motors – construction – comparison.	1
5.4	Linear Induction Motor – Construction- Thrust Equation, Transverse edge and end effects	2
5.5	Equivalent Circuit, Thrust-Speed characteristics, Applications.	1

CST466	DATA MINING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course helps the learner to understand the concepts of data mining and data warehousing. It covers the key processes of data mining, data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, web mining and text mining. It enables the learners to develop new data mining algorithms and apply the existing algorithms in real-world scenarios.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO#	CO
CO1	Employ the key process of data mining and data warehousing concepts in application domains. (**Cognitive Knowledge Level: Understand**)
CO2	Make use of appropriate preprocessing techniques to convert raw data into suitable format for practical data mining tasks (**Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the use of classification and clustering algorithms in various application domains (**Cognitive Knowledge Level: Apply**)
CO4	Comprehend the use of association rule mining techniques. (**Cognitive Knowledge Level: Apply)**
CO5	Explain advanced data mining concepts and their applications in emerging domains (**Cognitive Knowledge Level: Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓

CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓										✓

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**20**	**20**	**20**
Understand	**30**	**30**	**30**
Apply	**50**	**50**	**50**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Test(Average of Internal Test1&2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing the remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the seven questions, a student should answer any five.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have a maximum 2 subdivisions and carries 14 marks.

Syllabus

Module – 1 (Introduction to Data Mining and Data Warehousing)

Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture, Data Warehousing to Data Mining, Data Mining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Issues.

Module - 2 (Data Preprocessing)

Data Preprocessing-Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.

Module - 3 (Advanced classification and Cluster analysis)

Classification- Introduction, Decision tree construction principle, Splitting indices -Information Gain, Gini indexDecision tree construction algorithms-ID3, Decision tree construction with presorting-SLIQ, Classification Accuracy-Precision, Recall.

Introduction to clustering-Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK

Module 4: (Association Rule Analysis)

Association Rules-Introduction, Methods to discover Association rules, Apriori(Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm.

Module 5 (Advanced Data Mining Techniques)

Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining- Preprocessing, Data structures, Pattern Discovery, Pattern Analysis. Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques, Query Processing Techniques.

Text Books

1. Dunham M H, “Data Mining: Introductory and Advanced Topics”, Pearson Education, New Delhi, 2003.
2. Arun K Pujari, “Data Mining Techniques”, Universities Press Private Limited,2008.
3. Jaiwei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Elsevier, 2006

Reference Books

1. M Sudeep Elayidom, “Data Mining and Warehousing”, 1st Edition, 2015, Cengage Learning India Pvt. Ltd.
2. MehmedKantardzic, “Data Mining Concepts, Methods and Algorithms”, John Wiley and Sons, USA, 2003.
3. Pang-Ning Tan and Michael Steinbach, “Introduction to Data Mining”, Addison Wesley, 2006.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. (a) Explain the OLAP operations in a multidimensional model.
   (b) Compare the techniques used in ROLAP, MOLAP and HOLAP
2. Explain the various data mining issues with respect to mining methodology, user interaction and diversity of data types.
3. Suppose that a data warehouse consists of the three dimensions time, doctor, and patient, and the two measures count and charge, where charge is the fee that a doctor charges a patient for a visit.
   a) Draw star and snowflake schema diagrams for the data warehouse.
   b) Starting with the base cuboid [day; doctor; patient], what specific OLAP operations should be performed in order to list the total fee collected by each doctor in 2004?

Course Outcome 2 (CO2):

1. Use the methods below to normalize the following group of data:100, 200, 300, 400,550, 600, 680, 850, 1000
   (a) min-max normalization by setting min = 0 and max = 1
   (b) z-score normalization
   (c) Normalization by decimal scaling

   Comment on which method you would prefer to use for the given data, givingreasons as to why.
2. Identify a suitable dataset from any available resources and apply different preprocessing steps that you have learned. Observe and analyze the output obtained. (Assignment)

Course Outcome 3 (CO3):

1. Illustrate the working of ID3 algorithm with the following example

MOTOR	WHEEELS	DOORS	SIZE	TYPE	CLASS
NO	2	0	small	cycle	bicycle
NO	3	0	small	cycle	tricycle
YES	2	0	small	cycle	motorcycle
YES	4	2	small	automobile	Sports car
YES	4	3	medium	automobile	minivan
YES	4	4	medium	automobile	sedan
YES	4	4	large	automobile	sumo

2. Illustrate the working of K medoid algorithm for the given dataset. A1=(3,9), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9).

3. Take a suitable dataset from available resources and apply all the classification and clustering algorithms that you have studied on original and preprocessed datasets. Analyze the performance variation in terms of different quality metrics. Give a detailed report based on the analysis. (Assignment)

Course Outcome 4 (CO4):

1. A database has five transactions. Let min sup = 60% and min con f = 80%.

TID	*items_bought*
T100	{M, O, N, K, E, Y}
T200	{D, O, N, K, E, Y }
T300	{M, A, K, E}
T400	{M, U, C, K, Y}
T500	{C, O, O, K, I ,E}

a) Find all frequent item sets using Apriori and FP-growth, respectively. Compare the efficiency of the two mining processes.

b) List all of the strong association rules (with support s and confidence c) matching the following metarule, where X is a variable representing customers, and$iitem_{ii}$denotes variables representing items (e.g., “A”, “B”, etc.)

$$\forall x \in transactiion, buys(XX, iitem_1) \wedge buys(XX, iitem_2) \Rightarrow buys\ (XX, iitem_3) \quad [s, c]$$

2. Identify and list some scenarios in which association rule mining can be used, and then use at least two appropriate association rule mining techniques in one of the two scenarios. (Assignment)

Course Outcome 5 (CO5):

1. Consider an e-mail database that stores a large number of electronic mail (e-mail) messages. It can be viewed as a semi structured database consisting mainly of text data. Discuss the following.
   a. How can such an e-mail database be structured so as to facilitate multidimensional search, such as by sender, by receiver, by subject, and by time?
   b. What can be mined from such an e-mail database?
   c. Suppose you have roughly classified a set of your previous e-mail messages as junk, unimportant, normal, or important. Describe how a data mining system may take this as the training set to automatically classify new e-mail messages or unclassified ones.
2. Precision and recall are two essential quality measures of an information retrieval system.
   (a) Explain why it is the usual practice to trade one measure for the other.
   (b) Explain why the F-score is a good measure for this purpose.

(c) Illustrate the methods that may effectively improve the F-score in an information retrieval system.

3. Explain HITS algorithm with an example.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________ **PAGES : 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST466

Course Name: Data Mining

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate between OLTP and OLAP.
2. Compare the techniques of ROLAP, MOLAP and HOLAP
3. Explain Concept hierarchy with an example.
4. Explain heuristic methods of attribute subset selection techniques.
5. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm.

	Expected	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man
5	woman	man
6	woman	woman
7	woman	woman
8	man	man
9	man	woman
10	woman	woman

Calculate precision, recall of the data.

6. Given two objects represented by the tuples (22,1,42,10) and (20,0, 36,8). Compute the Euclideanand Manhattan distance between the two objects.

7. The pincer search algorithm is a bi-directional search, whereas the level wise algorithm is a unidirectional search. Express your opinion about the statement.

8. Define support, confidence and frequent set in association data mining context.

9. Distinguish between focused crawling and regular crawling.

10. Describe any two-text retrieval indexing techniques. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Suppose a data warehouse consists of three measures: customer, account and branch and two measures count (number of customers in the branch) and balance. Draw the schema diagram using snowflake schema and star schema. **(7)**

(b) Explain three- tier data warehouse architecture with a neat diagram. **(7)**

OR

12 (a) Illustrate different OLAP operations in multidimensional data model **(7)**

(b) Describe different issues in data mining **(7)**

13 (a) Suppose that the data for analysis includes the attribute age. The age values for the data tuples are (in increasing order) 13, 15, 16, 16, 19, 20, 20, 21, 22, 22, 25, 25, 25, 25, 30, 33, 33, 35, 35, 35, 35, 36, 40, 45, 46, 52, 70. **(8)**

(a) Use min-max normalization to transform the value 35 for age onto

the
range [0-1].

(b) Use z-score normalization to transform the value 35 for age, where the standard deviation of age is 12.94 years.

(c) Use normalization by decimal scaling to transform the value 35 for age.

(d) Use smoothing by bin means to smooth the above data, using a bin depth of 3. Illustrate your steps. Comment on the effect of this technique for the given data.

(b) With proper illustration, explain how PCA can be used for dimensionality reduction? Explain **(6)**

OR

14 (a) Suppose a group of 12 sales price records has been sorted as follows: 5, 10, 11, 13, 15, 35, 50, 55, 72, 92, 204, 215. Sketch examples of each of the following sampling techniques: SRSWOR, SRSWR, cluster sampling, stratified sampling. Use samples of size 5 and the strata “youth,” “middle- aged,” and “senior.” **(8)**

(b) Partition the above data into three bins by each of the following methods: **(6)**
(i) equal-frequency (equi-depth) partitioning
(ii) equal-width partitioning

15 (a) Explain the concept of a cluster as used in ROCK. Illustrate with examples **(9)**

(b) Consider the following dataset for a binary classification problem. **(5)**

A	B	Class Label
T	F	+
T	T	+
T	T	+
T	F	-
T	T	+
F	F	-
F	F	-
F	F	-
T	T	-
T	F	-

Calculate the gain in Gini index when splitting on A and B respectively. Which attribute would the decision tree induction algorithm choose?

OR

16 (a) For a sunburn dataset given below, find the first splitting attribute for the decision tree by using the ID3 algorithm. **(10)**

Name	**Hair**	**Height**	**Weight**	**Lotion**	**Class**
Sarah	Blonde	Average	Light	No	Sunburn
Dana	Blonde	Tall	Average	Yes	None
Alex	Brown	Tall	Average	Yes	None
Annie	Blonde	Short	Average	No	Sunburn
Emily	Red	Average	Heavy	No	Sunburn
Pete	Brown	Tall	Heavy	No	None
John	Brown	Average	Heavy	No	None
Katie	Blonde	Short	Light	Yes	None

(b) Explain the working of SLIQ algorithm. **(4)**

17 (a) Illustrate the working of Pincer Search Algorithm with an example. **(7)**

(b) Describe the working of dynamic itemset counting technique? Specify when to move an itemset from dashed structures to solid structures? **(7)**

OR

18 (a) A database has six transactions. Let min_sup be 60% and min_conf be 80%. **(9)**

TID	*items_bought*
T1	I1, I2, I3
T2	I2, I3, I4
T3	I4, I5
T4	I1, I2, I4
T5	I1, I2, I3, I5
T6	I1, I2, I3, I4

Find frequent itemsets using FP Growth algorithm and generate strong association rules from a three item dataset.

(b) Write partitioning algorithm for finding large itemset and compare its efficiency with apriori algorithm **(5)**

19 (a) Describe web content mining techniques. **(7)**

(b) Write an algorithm to find maximal frequent forward sequences to mine log traversal patterns. Illustrate the working of this algorithm. **(7)**

OR

20 (a) Explain how web structure mining is different from web usage mining and web content mining? Write a CLEVER algorithm for web structure mining. **(7)**

(b) Describe different Text retrieval methods. Explain the relationship between text mining and information retrieval and information extraction. **(7)**

Teaching Plan

No	**Contents**	**No. of lecture hours (36 Hrs)**
Module 1(Introduction to Data Mining and Data Warehousing) (Text3) (6 hours)		
1.1	Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema	1
1.2	OLAP Operations	1
1.3	DataWarehouse Architecture, Data Warehousing to Data Mining	1
1.4	Datamining Concepts and Applications, Knowledge Discovery in Database Vs Data mining	1
1.5	Architecture of typical data mining system,Data Mining Functionalities	1
1.6	Data Mining Functionalities, Data Mining Issues	1
Module 2(Data Preprocessing) (6 hours) (Text3)		
2.1	Data Preprocessing: Need of Data Preprocessing, Data Cleaning- Missing values, Noisy data.	1
2.2	Data integration	1
2.3	Data transformation	1
2.4	Data Reduction-Data cube aggregation, Attribute subset selection	1
2.5	Data Reduction-Dimensionality reduction	1

2.6	Numerosity reduction, Discretization and concept hierarchy generation	1
Module 3(Advanced classification and Cluster analysis)(9 hours)(Text2,Text3)		
3.1	Classification- Introduction, Decision tree construction principle, Splitting indices-Information Gain, Gini index	1
3.2	Decision Tree- ID3	1
3.3	Decision Tree- ID3	1
3.4	Decision tree construction with presorting- SLIQ	1
3.5	Accuracy and error measures, evaluation	1
3.6	Introduction to clustering, Clustering Paradigms	1
3.7	Partitioning Algorithm- PAM	1
3.8	Hierarchical Clustering-DBSCAN	1
3.9	Categorical Clustering-ROCK	1
Module 4(Association Rule Analysis) (8 hours) (Text2,Text3,Text1)		
4.1	Association Rules: Introduction, Methods to discover association rules	1
4.2	A priori algorithm (Level-wise algorithm)	1
4.3	A priori algorithm (Level-wise algorithm)	1
4.4	Partition Algorithm	1
4.5	Pincer Search Algorithm	1
4.6	Pincer Search Algorithm	1
4.7	Dynamic Itemset Counting Algorithm	1
4.8	FP-tree Growth Algorithm	1
Module 5(Advanced Data Mining Techniques) (7 hours) (Text1, Text3		
5.1	Web Mining - Web Content Mining	1
5.2	Web Structure Mining- Page Rank	1
5.3	Web Structure Mining –Clever algorithm	1
5.4	Web Usage Mining- Preprocessing, Data structures	1

5.5	Web Usage Mining -Pattern Discovery, Pattern Analysis	1
5.6	Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval	1
5.7	Text Retrieval methods, Text Indexing Techniques Query Processing Techniques	1

PROGRAM ELECTIVE V

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET438	ENERGY STORAGE SYSTEMS	PEC	2	1	0	3

Preamble: This course aims to introduce the importance and application of energy storage systems and to familiarize with different energy storage technologies.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify the role of energy storage in power systems
CO 2	Classify thermal, kinetic and potential storage technologies and their applications
CO 3	Compare Electrochemical, Electrostatic and Electromagnetic storage technologies
CO 4	Illustrate energy storage technology in renewable energy integration
CO 5	Summarise energy storage technology applications for smart grids)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3											
CO 3	3	2	1				1					
CO 4	3	2	1			1	1					1
CO 5	3	1	1			1	1					1

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	15	15	30
Understand (K2)	20	20	40
Apply (K3)	15	15	30
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. What are the different parts of a complete energy storage unit? (K1, PO1)
2. Explain the Dynamic Duty of storage plant. (K2, PO1,PO2)
3. What are the different types of central store? (K2, PO1)

Course Outcome 2 (CO2)

1. List the applications of thermal energy storage systems. (K1, PO1)
2. Explain hydrogen-based power utility concept.(K2,PO1)
3. What are the different storage containments of hydrogen? (K1, PO1)

Course Outcome 3(CO3)

1. Explain the working of fuel cell along with schematic diagram. (K2, PO1,PO2,PO7)
2. Write short notes on supercapacitors. (K2, PO1)
3. Explain the arrangement of a control and protection system for Super Conducting Magnetic Energy Storage.(K2 , PO1,PO3)

Course Outcome 4 (CO4)

1. Explain small-scale hydroelectric energy. (K2,PO1,PO3,PO6,PO7,PO12)
2. Write short notes on wave energy and its storage system. (K2, PO1, PO7,PO12)
3. What are the different types of renewable power sources? (K1, PO1, PO7,PO12)

Course Outcome 5 (CO5)

1. Explain distributed energy storage system. (K2, PO1, PO3,PO6,PO7,PO12)
2. What are the characteristics of smart grid system? (K1, PO1, PO6,PO7,PO12)
3. What is demand response? (K1, PO1, PO2)

Model Question Paper

QP CODE: Pages:

Reg No.:_______________

Name:__________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER

B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EET438

Course Name: ENERGY STORAGE SYSTEMS

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions; each question carries 3 marks.

1.	Discuss the power transformation of energy storage system.	(3)
2.	Explain the different components of energy storage system with schematic structure.	(3)
3.	Define Flow equation related to thermal energy storage system.	(3)
4.	Write the difference between hybrid and combined energy storage in power system.	(3)
5.	Explain the chemical reaction of lead acid batteries.	(3)
6.	Write down the basic principle of capacitor bank storage system.	(3)
7.	Classify hydro power plants based on their rated capacity.	(3)
8.	Briefly discuss small-scale hydroelectric energy system.	(3)

9. What is distributed energy storage system? (3)

10 List the various layers of smart grid. (3)

PART B

Answer any one complete question from each section; each question carries 14 marks

11	(a)	Explain static duty of energy storage plant.	(8)
	(b)	With neat diagram explain energy and power balance in a storage unit.	(6)
		OR	
12	(a)	Explain the econometric model of energy storage. Derive the expression for annual cost of the system.	(10)
	(b)	What are the key parameters considered for the comparison of energy storage in power system?	(4)
13	(a)	Discuss the working principle of compressed air energy storage system.	(7)
	(b)	Write short note on flywheel energy storage system.	(7)
		OR	
14	(a)	Write any three industrial methods to produce hydrogen.	(9)
	(b)	Explain 'power to gas' concept.	(5)
15	(a)	Explain the working of Li-ion batteries.	(7)
	(b)	Describe the typical voltage–discharge profile for a battery cell.	(7)
		OR	
16	(a)	Describe basic principle and working of superconducting magnetic energy storage system.	(7)
	(b)	With the help of a block diagram, explain the arrangement of control and	(7)

protection system for superconducting magnetic energy storage system.

17	(a)	What are the main features of renewable energy systems?	(4)
	(b)	Explain the role of storage systems in an integrated power system with grid-connected renewable power sources.	(10)
		OR	
18	(a)	Explain photovoltaics system.	(4)
	(b)	Discuss the role of storage in an isolated power system with renewable power sources.	(10)
19	(a)	Describe the distributed energy storage system.	(6)
	(b)	“HEV act as a distributed energy generator and storage”, justify your answer.	(8)
		OR	
20	(a)	What is demand response?	(5)
	(b)	Draw and explain the battery SCADA system.	(9)

Syllabus

Module 1

Introduction to energy storage in power systems (6)

Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store (CS) and charge–discharge control system (CDCS), Econometric model of storage system.

Module 2

Overview on Energy storage technologies (7)

Thermal energy: General considerations -Storage media- Containment- Thermal energy storage in a power plant, Potential energy: Pumped hydro-Compressed Air, Kinetic energy: Mechanical-Flywheel , Power to Gas : Hydrogen - Synthetic methane

Module 3

Overview on Energy storage technologies (8)

Electrochemical energy : Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy- Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Super conducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.

Module 4

Energy storage and renewable power sources (6)

Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources

Module 5

Energy storage Applications (7)

Smart grid, Smart microgrid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems - Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Battery SCADA, Hybrid energy storage systems: configurations and applications.

Text Books

1. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, Second Edition, TheInstitution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1- 84919-219-4),2011.

2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.

Reference Books

1. Electric Power Research Institute (USA), “Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits” (1020676), December 2010.

2. Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, “The Role of Energy Storage with Renewable Electricity Generation”, National Renewable Energy Laboratory (NREL) -a National Laboratory of the U.S. Department of Energy.

3. P. Nezamabadi and G. B. Gharehpetian, "Electrical energy management of virtualpower plants in distribution networks with renewable energy resources and energy storage systems”, IEEE *Power Distribution Conference*, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to energy storage for power systems: (6)**	
1.1	General considerations- different parts of energy storage unit- static duty of storage plant- dynamic duty of storage plant	2
1.2	Energy and power balance in a storage unit- schematic structure of energy storage	1
1.3	Mathematical model of storage system	1
1.4	Econometric model of storage- capital cost of energy storage- annual cost of storage facility	2
2	**Overview on Energy storage technologies: (7)**	
2.1	Principle of thermal energy storage- sensible heat storage – latent heat storage- containment- thermal energy storage in power plant application	2
2.2	Principle and operation of pumped hydroelectric storage (PHS)- general considerations- schematic diagram	1
2.3	Principle and operation of Compressed Air Energy Storage (CAES)- general considerations- basic principle-industrial application	1
2.4	Principle and operation of Flywheel Energy storage System (FESS)-general considerations -applications	1
2.5	General considerations- synthetic storage media-Hydrogen production-Hydrogen based power utility concept- storage containment for hydrogen-Methods of extraction of methane-	2

	Block diagram Power to gas concept	
3	**Overview on Energy storage technologies (8)**	
3.1	Basic concepts of conventional batteries and flow batteries- Battery parameters- C-rating-SoC- DoD- Specific Energy-Specific power (numerical examples), Fuel cell- Schematic diagram of an electrochemical fuel cell	2
23.2	Super conducting Magnetic Energy Storage (SMES)- basic circuit-principle-advantages	2
3.3	The Supercapacitor Energy Storage System- topology-principle-advantages	2
3.4	Comparative study of different energy storage system based on specific energy, specific power, cycling capability and life in years	2
4	**Energy storage and renewable power sources (6)**	
4.1	Types of renewable power sources- brief description	2
4.2	Storage role in isolated power system with renewable power sources	1
4.3	Storage role in an integrated power system with grid-connected renewable power sources	1
4.4	Small scale hydroelectric energy	1
4.5	Solar thermal technologies and photovoltaics	1
5	**Energy storage Applications (7)**	
5.1	Smart grid-concepts- characteristics- Smart metering	2
5.2	Field of Electromobility- thyristor based battery charger and DC power supply	1
5.3	Vehicle to grid and grid to vehicle charging point topology	1
5.4	Distributed energy storage	1
5.5	Battery SCADA- overview	1
5.6	Hybrid energy storage systems: configurations and applications	1

CST428	BLOCKCHAIN TECHNOLOGIES	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: The purpose of this course is to create awareness and understanding among students on the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc. The course enables students to develop simple decentralized applications using blockchain networks such as Ethereum.

Prerequisite: Basic knowledge in data structures and operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the cryptographic building blocks of blockchain technology. **(Cognitive Knowledge Level: Understand)**
CO2	Explain the fundamental concepts of blockchain technology. **(Cognitive Knowledge Level: Understand)**
CO3	Summarize the classification of consensus algorithms. (**Cognitive Knowledge Level: Understand)**
CO4	Explain the concepts of first decentralized cryptocurrency bitcoin. (**Cognitive Knowledge Level: Understand)**
CO5	Explain the use of smart contracts and its use cases. **(Cognitive Knowledge Level: Understand)**
CO6	Develop simple applications using Solidity language on Ethereum platform. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔										✔
CO2	✔	✔										✔

CO3	✔	✔										✔
CO4	✔	✔										✔
CO5	✔	✔										✔
CO6	✔	✔	✔	✔	✔							✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	**30**	**30**	**30**
Understand	**50**	**50**	**50**
Apply	**20**	**20**	**20**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests(Average of Internal Tests 1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

Internal Examination Pattern

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module – 1 (Fundamentals of Cryptography)

Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography – RSA. Elliptic curve cryptography, Digital signatures – RSA digital signature algorithms. Secure Hash Algorithms – SHA-256. Applications of cryptographic hash functions – Merkle trees, Distributed hash tables.

Module – 2 (Fundamentals of Blockchain Technology)

Blockchain – Definition, architecture, elements of blockchain, benefits and limitations, types of blockchain. Consensus – definition, types, consensus in blockchain.

Decentralization – Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization.

Module - 3 (Consensus Algorithms and Bitcoin)

Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault-tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS.
Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses. Transactions – Lifecycle, coinbase transactions, transaction validation. Blockchain – The genesis block.
Mining – Tasks of miners, mining algorithm, hash rate. Wallets – Types of wallets.

Module - 4 (Smart Contracts and Use cases)

Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations.
Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management.
Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.

Module - 5 (Ethereum and Solidity)

Ethereum – The Ethereum network. Components of the Ethereum ecosystem – Keys and addresses, Accounts, Transactions and messages. The Ethereum Virtual Machine, Blocks and blockchain.
The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types, control structures, events, inheritance, libraries, functions, error handling.
Smart contracts Case study: Voting, Auction.

Text Book

1. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Packt Publishing, Third edition, 2020.

References

2. Ritesh Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing, First edition, 2018.

3. Kumar Saurabh, Ashutosh Saxena, Blockchain Technology: Concepts and Applications, First Edition, Wiley Publications, First edition, 2020.

4. Chandramouli Subramanian, Asha A George, et al, Blockchain Technology, Universities Press (India) Pvt. Ltd, First edition, August 2020.

5. Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly Media, First edition, 2020.
6. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, First edition, 2018.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Distinguish between Symmetric cryptography and asymmetric cryptography.
2. Explain the working of AES algorithm.

Course Outcome 2 (CO2):

1. Categorize consensus mechanism used in blockchain.
2. Define Blockchain. Explain how decentralization of computing or processing power is achieved by a blockchain.

Course Outcome 3 (CO3):

1. Explain how Proof of Stake can achieve consensus among peers.
2. Explain the working of Raft protocol.

Course Outcome 4 (CO4):

1. Describe the use of genesis block.
2. Explain the mining algorithm used in bitcoin.

Course Outcome 5 (CO5):

1. Illustrate how blockchain technology can be used in supply chain management.
2. What are oracles in a blockchain ecosystem? Explain the generic data flow from a smart contract to an oracle.

Course Outcome 6 (CO6):

1. Develop a smart contract for voting process. In this application, delegated voting is allowed and the counting is automatic and completely transparent at the same time.
2. Develop a smart contract for auction process. The contract should be a blind auction where it is not possible to see the actual bid until the bidding period ends.

Model Question Paper

QP CODE:

Reg No: _______________

Name:__________________ **PAGES : 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST428

Course Name: BLOCK CHAIN TECHNOLOGIES

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Discuss the role of secure hash functions in blockchain.
2. List out the properties of digital signatures.
3. Illustrate the blockchain based decentralized system.
4. Explain how Proof of Stake can achieve consensus among peers.
5. If your blockchain network has 5 Byzantine nodes, what is the minimum number of nodes that are required to ensure Byzantine fault tolerance using PBFT protocol?
6. How are transactions verified in a Bitcoin network?
7. Explain how smart contracts can be used for enforcing agreements between parties in the form of business logic.
8. Explain the concept of blockchain-based digital identity cards.
9. Explain error handling in Solidity language.

10. With the help of a figure show the relationship between the transaction, transaction trie, and block header in Ethereum. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain the design of SHA-256 and its compression function using a diagram. **(9)**

(b) Explain how hash functions are used to build Merkle trees in blockchain. **(5)**

OR

12. (a) Explain public and private keys. Perform encryption and decryption using RSA for p=3, q=11, e= 7 and M=5. **(7)**

(b) Explain elliptic curve digital signature algorithm. **(7)**

13. (a) Illustrate and explain how blockchain works using a neat diagram. **(7)**

(b) Explain the benefits, features and limitations of blockchain. **(7)**

OR

14. (a) Explain consensus mechanisms used in blockchain. List out any six consensus algorithms used in the context of blockchain. **(7)**

(b) Define blockchain. Explain how decentralization of computing or processing power is achieved by a blockchain. **(7)**

15. (a) Explain and illustrate how Paxos protocol can be used to achieve consensus. **(7)**

(b) Show how Practical Byzantine Fault Tolerance can achieve consensus in the presence of Byzantine faults. **(7)**

OR

16. (a) Describe the various fields that make up a transaction in Bitcoin. **(7)**

(b) What is the role of a Bitcoin miner? Explain the mining algorithm used in **(7)**

Bitcoin with the help of a flowchart.

17. (a) Illustrate how blockchain technology can be implemented in finance sector. **(7)**

(b) Discuss oracles in a blockchain ecosystem. Explain the generic data flow from a smart contract to an oracle. **(7)**

OR

18. (a) Explain the design process of decentralized applications with diagrams. **(7)**

(b) Explain the use of blockchain technology in supply chain management. **(7)**

19. (a) Using Solidity language, create a simple bank contract that allows a user to deposit, withdraw and view balance. **(7)**

(b) Define block difficulty. Explain how block difficulty is adjusted in Ethereum blockchain network. **(7)**

OR

20. (a) Using Solidity language, create a simple voting smart contract where a chairperson will give the right to vote to each address individually. **(7)**

(b) Explain the concept of Gas in Ethereum. Explain how transaction cost can be calculated in an Ethereum blockchain network. **(7)**

Teaching Plan

No	Contents	No. of Lecture Hours (35 hours)
	Module-1 (Fundamentals of Cryptography) (7 hours)	
1.1	Introduction to cryptography	1 hour
1.2	Symmetric cryptography, AES	1 hour
1.3	Asymmetric cryptography, RSA	1 hour
1.4	Elliptic curve cryptography	1 hour
1.5	Digital signatures – RSA digital signature algorithm	1 hour
1.6	Secure Hash Algorithms – SHA-256	1 hour
1.7	Applications of cryptographic hash functions – Merkle trees, Distributed hash tables	1 hour
	Module-2 (Fundamentals of Blockchain Technology) (6 hours)	
2.1	Blockchain – definition and architecture	1 hour
2.2	Elements of blockchain.	1 hour
2.3	Blockchain – benefits and limitations, types.	1 hour
2.4	Consensus – definition, types, consensus in blockchain	1 hour
2.5	Decentralization using blockchain, Methods of decentralization	1 hour
2.6	Routes to decentralization, Blockchain and full ecosystem decentralization	1 hour
	Module-3 (Consensus Algorithms and Bitcoin) (7 hours)	
3.1	Consensus Algorithms – Crash fault-tolerance (CFT) algorithms – Paxos, Raft (working is expected).	1 hour
3.2	Byzantine fault-tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT) (working is expected).	1 hour
3.3	Proof of work (PoW), Proof of stake (PoS), Types of PoS	1 hour
3.4	Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses.	1 hour
3.5	Transactions – Lifecycle, coinbase transactions, transaction validation	1 hour

3.6	Blockchain – The genesis block. Mining – Tasks of miners	1 hour
3.7	Mining – mining algorithm, hash rate. Wallets – Types of wallets.	1 hour
Module-4 (Smart Contracts and Use cases) (6 hours)		
4.1	Smart Contracts – Definition, Smart contract templates	1 hour
4.2	Oracles, Types of oracles, Deploying smart contracts.	1 hour
4.3	Decentralization terminology –Decentralized applications, Decentralized Autonomous Organizations.	1 hour
4.4	Use cases of Blockchain technology – Government, Health care.	1 hour
4.5	Use cases of Blockchain technology – Finance, Supply chain management.	1 hour
4.6	Blockchain and Allied Technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.	1 hour
Module-5 (Ethereum and Solidity) (9 hours)		
5.1	Ethereum - The Ethereum network, Components of the Ethereum ecosystem – Keys and addresses, Accounts	1 hour
5.2	Components of the Ethereum ecosystem – Transactions and messages	1 hour
5.3	The Ethereum Virtual Machine	1 hour
5.4	Ethereum Blocks and blockchain	1 hour
5.5	The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types	1 hour
5.6	The Solidity language – control structures, events, inheritance, libraries	1 hour
5.7	The Solidity language – functions, error handling.	1 hour
5.8	Smart contracts Case study: Voting.	1 hour
5.9	Smart contracts Case study: Auction.	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET478	BIG DATA ANALYTICS	PEC	2	1	0	3

Preamble: This course is offered to introduce fundamental algorithmic ideas in processing data. The preliminary concepts of Hadoop and Map Reduce are included as part of this course.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the key concepts of data science.
CO 2	Describe big data and use cases from selected business domains
CO 3	Perform big data analytics using Hadoop and related tools like Pig and Hive.
CO 4	Perform preliminary analytics using R language on simple data sets.
CO 5	Differentiate various learning approaches in machine learning to process data, and to interpret the concepts of supervised and unsupervised learning

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											2
CO 2	3											2
CO 3	3	2	2		3							2
CO 4	3	2			3							2
CO 5	3	2			3							2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	15	15	30
Understand	25	25	50
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the main categories of data that we come across in data science. (K1)
2. Summarize distributed file system with examples. (K1)
3. List the significance of data science. (K2)

Course Outcome 2 (CO2)

1. What are the three characteristics of Big Data, and what are the main considerations in processing Big Data?(K1)
2. Explain Big Data Analytics Lifecycle. (K1)
3. Explain Apache Hadoop ecosystem. (K1)

Course Outcome 3(CO3):

1. Demonstrate the map reduce execution flow to perform word count on data set.(K3)
2. Explain the stages of Map Reduce. (K2)
3. Write short notes on Pig and Hive. (K1)

Course Outcome 4 (CO4):

1. How do you list the preloaded datasets in R? (K2)
2. Use R to find the highest common factor of two numbers. (K3)
3. Why is R useful for data science? (K2)

Course Outcome 5 (CO5):

1. Mention the difference between Data Mining and Machine learning? (K2)
2. What are the different Algorithm techniques in Machine Learning? (K2)
3. Give a popular application of machine learning that you see on day-to-day basis? (K2)

Model Question Paper

QP CODE: **Reg No:_______________**

PAGES:3 **Name :_______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER

B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET478

Course Name: BIG DATA ANALYTICS

Max. Marks: 100 Duration: 3 Hours

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. List any six Data Science applications.
2. Briefly explain the data transformation step in the process of Data Science.
3. Explain the important characteristics of Bigdata.
4. List the functions of Namenode in HDFS.
5. Identify the need of MapReduce Partitioner in Hadoop.
6. Differentiate between Hadoop MapReduce and Pig.
7. In R how missing values are represented.
8. How you can import Data in R.
9. Discuss any four examples of machine learning applications.
10. Describe the applications of clustering in various domains.

(10x3 = 30 marks)

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11.a) Illustrate with an example different stages of data science project.

b. Categorise the different roles associated with a data analysis project. (10+4 =14 marks)

Or

12. a) Explain the data cleansing subprocess of data science process.

b) Discuss in detail about Exploratory Data analysis. (8+6 =14 marks)

MODULE II

13.a) Explain the core components of Apache Hadoop.

b) Write short note on YARN. (8+6 = 14 marks)

Or

14. a) Explain read and write operations in HDFS.

b) What are Blocks in HDFS Architecture. (10+4 = 14 marks)

MODULE III

15.a) With a neat diagram, explain MapReduce architecture?

b) Describe the stages of MapReduce with an example. (5+9 = 14 marks)

Or

16. a) Write short note on Pig and HIVE.

b) Compare NoSQL & RDBMS (10+4 = 14 marks)

MODULE IV

17.a) Explain data frames in R. Illustrate attach (), detach () and search () functions in R.

b) Explain any three functions in R to visualize a single variable. (8+6 = 14 marks)

Or

18. a) What are the data structures in R that is used to perform statistical analyses and create graphs?

b) Mention how you can produce co-relations and covariances with example?

(9+5 = 14 marks)

MODULE V

19.a) Distinguish between classification and regression with an example.

b) Describe in detail with examples (i) Supervised Learning(ii) Unsupervised Learning (iii) Reinforcement Learning. (5+9 = 14 marks)

Or

20. a) Is regression a supervised learning technique? Justify your answer. Compare regression with classification with examples.?

b) Illustrate K means clustering algorithm with an example.? (8+6 = 14 marks)

Syllabus

Module I-Data science in a big data world: Benefits and uses of data science and big data-Facets of data-the big data ecosystem and data science-Data science process-roles-stages in data science project- Defining research goals-Retrieving data-Cleansing, integrating, and transforming data- Data Exploration-Data modelling - Presentation and automation.

(6 hours)

Module II-Big Data Overview–the five V's of big data-State of the Practice in Analytics-Examples of Big Data Analytics-Apache Hadoop and the Hadoop Ecosystem-HDFS-Design of HDFS, HDFS Concepts-Daemons-Reading and Writing Data-Managing File system Metadata- Map Reduce-The Stages of Map Reduce -Introducing Hadoop Map Reduce-Daemons-YARN (8 hours)

Module III-Analysing the Data with Hadoop using Map and Reduce-Developing a Map Reduce Application-Anatomy of a Map Reduce Job- Scheduling-Shuffle and Sort - Task execution.

Big data Management Tools: PIG- : Introduction to PIG, Execution Modes of Pig,Pig Latin, HIVE: Hive Architecture, HIVEQL, Introduction to NoSQL. (Introduction only)

(7 hours)

Module IV -Review of Basic Analytic methods using R- Introduction to R -Data Import and Export -Attribute and Data Types - ordered and unordered factors-arrays and matrices-lists and data frames -Descriptive Statistics-Exploratory Data Analysis-Dirty Data- Visualizing a Single Variable-Examining Multiple Variables-statistical models in R- Graphical Procedures-High-level plotting commands-Low-level plotting commands.

(7 hours)

Module V -Machine learning -Introduction to Machine Learning, Examples of Machine Learning applications-Supervised Learning- Regression – Single variable, Multi variable-Classification – Logistic Regression- Unsupervised Learning - Clustering: K-means-Reinforcement Learning-Model Selection and validation-k-Fold Cross Validation-Measuring classifier performance- Precision, recall

(7 hours)

Text/ Reference Books

1. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali ,"Introducing Data Science - Big data, machine learning, and more, using Python tools" , Dreamtech Press 2016
2. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses",Wiley,2013
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley ,January 2015
4. Tom White,"Hadoop: The Definitive Guide", Third Edition, O'Reilley,2012.
5. Eric Sammer,"Hadoop Operations",O'Reilly Media, Inc ,2012
6. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
7. "Programming Pig", Alan Gates, O'Reilley,2011.

8. Ethem Alpaydın, "Introduction to Machine Learning (Adaptive Computation and Machine Learning)", MIT Press, 2004.
9. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014
10. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
11. Matloff, Norman," The art of R programming: A tour of statistical software design". No Starch Press, 2011.
12. Crawley, Michael J. The R book. John Wiley & Sons, 2012.
13. Sourabh Mukherjee, Amit Kumar Das and Sayan Goswami, " Big Data Simplified", Pearson, 1st edition, 2019.
14. Murtaza Haider, "Getting Started with Data Science", Fist Edition, Kindle Edition, IBM Press, 2015.
15. Thomas Erl, Wajid Khattak and Paul Buhler " Big Data Fundamentals:Concepts, Drivers and Techniques", Prentice Hall, Pearson Service, 2016.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module I Data science in a big data world**	**6 hours**
1.1	Data science in a big data world, Benefits and uses of data science and big data-Facets of data	1
1.2	the big data ecosystem and data science-Data science process-roles	1
1.3	Defining research goals-Retrieving data	1
1.4	Cleansing, integrating, and transforming data	1
1.5	Data Exploration	1
1.6	Data modelling - Presentation and automation.	1
2	**Module II -Big Data Overview**	**8 hours**
2.1	the five V's of big data-State of the Practice in Analytics-Examples of Big Data Analytics	1
2.2	Apache Hadoop and the Hadoop Ecosystem- HDFS	2
2.3	Design of HDFS- HDFS Concepts-Daemons-Reading and Writing Data - Managing Filesystem Metadata	2
2.4	Map Reduce-The Stages of MapReduce -Introducing Hadoop MapReduce-Daemons	2
2.5	YARN	1
3	**Module III - Analysing the Data with Hadoop**	**7 hours**
3.1	**Analysing the Data with Hadoop using Map and Reduce-** Developing a Map Reduce Application	1
3.2	Anatomy of a Map Reduce Job- Scheduling-Shuffle and Sort - Task execution	2
3.3	Bigdata Management Tools: PIG- : Introduction to PIG, Execution Modes of Pig,Pig Latin	2
3.4	HIVE: Hive Architecture, HIVEQL,	1

3.5	Introduction to NoSQL	1
4	**Module IV -Review of Basic Analytic methods using R**	**7 hours**
4.1	Introduction to R -Data Import and Export -Attribute and Data Types - ordered and unordered factors-arrays and matrices	2
4.2	lists and data frames -Descriptive Statistics	1
4.3	Exploratory Data Analysis -Dirty Data	1
4.4	Visualizing a Single Variable-Examining Multiple Variables	1
4.5	statistical models in R-.	1
4.6	Graphical Procedures-High-level plotting commands-Low-level plotting commands	1
5	**Module V - Machine learning**	**7 hours**
5.1	Introduction to Machine Learning, Examples of Machine Learning applications	1
5.2	Supervised Learning- Regression – Single variable, Multi variable	2
5.3	Classification – Logistic Regression	1
5.4	Unsupervised Learning - Clustering: K-means	1
5.5	Model Selection and validation-k-Fold Cross Validation	1
5.6	Measuring classifier performance- Precision, recall	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET458	SOLAR PV SYSTEMS	PEC	2	1	0	3

Preamble: This course introduces solar PV system and its grid integration aspects. It also give insight to basic knowhow for the implementation of Solar PV system utilizing modern simulation software.

Prerequisite : Nil

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Explain the basics of solar energy conversion systems.(K1)
CO 2	Design a standalone PV system. (K3)
CO 3	Demonstrate the operation of a grid interactive PV system and its protection against islanding.(K2)
CO 4	Utilize life cycle cost analysis in the planning of Solar PV System (K3)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1										1
CO 2	3	3	3									2
CO 3	3	3	2									2
CO 4	3	3	2	1	2						1	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	25	25	50
Apply (K3)	15	15	30
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain what do you mean by solar constant (K1, PO1)
2. Discuss about the different instruments used for measuring solar radiation and sun shine (K2,PO2)

Course Outcome 2 (CO2):

1. Design a stand alone PV system. (K3, PO1, PO2, PO3)
3. Design an off grid PV system to backup 10kW system for 3 hours and draw the block level representation of the final system. (K3, PO1, PO2, PO3)

Course Outcome 3 (CO3):

1. Demonstrate the operation of a grid connected PV system. (K2, PO1, PO2,PO3).
2. Summarize the protection of PV system against islanding and reverse power flow. (K2, PO1, PO2,PO3).

Course Outcome 4 (CO4):

1. The life cycle cost of a system is Rs. 10000/- for a life period of 20 years. The rate of interest is 8% and the inflation rate is 5%. What is the annual life cycle cost for the system? (K3, PO1, PO2,PO3)
2. Design a grid connected PV system utilizing a suitable simulation software. (K3, PO1, PO2,PO3,PO4,PO5)

Model Question Paper

QP CODE:

PAGES:2

Reg. No:_______________
Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE
EXAMINATION, MONTH & YEAR

Course Code: EET458

Course Name: SOLAR PV SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. Explain briefly what do you mean by solar azimuth angle and zenith angle.
2. Differentiate between extraterrestrial and terrestrial solar radiation.

3. Write notes on the working of a solar cooker.
4. Discuss what do you mean by a solar green house.
5. Write notes on the different materials used for making solar cells.
6. Discuss the characteristics of a solar cell.
7. Give a description on of Power Quality related IEEE standards for distributed resource grid integration
8. Differentiate SoC and DoD of storage battery .
9. Write notes on the planned and unplanned islanding .
10. Explain life-cycle cost of renewable energy system.

PART B (14 x 5 = 70 Marks)

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a.With the help of a neat diagram, explain the working of a pyrheliometer. (7)
    b. Explain how monthly average solar radiation on inclined surfaces can be calculated. (7)
12. a. State the reasons for variation in the amount of solar energy reaching earth surface. (4)
    b. With the help of a neat diagram, explain the working of a sunshine recorder. (6)
    c. Explain the difference in the working of pyrheliometer and pyranometer. (4)

Module 2

13. a. Explain the different types of solar collectors based on the way they collect solar radiation. (7)
    b. Explain in detail, the working of a solar air conditioning system (7)
14. a.With the help of a diagram, explain the function of different components of a flat plate solar collector. (7)
    b. Design a solar water heater for domestic application. (7)

Module 3

15. a. Write notes on the efficiency of a solar cell. (3)
    b. Discuss the effect of shadowing on the performance of solar cells. (3)
    c. Explain how maximum power point tracking can be done using buck-boost converter. (8)
16. a. Compare the performance of single junction and multijunction PV modules. (4)
    b. Write notes on packing factor of a PV module. (3)
    c. Explain the Perturb and Observe MPPT method. Compare with incremental conductance method. (7)

Module 4

17.

a. Design an off grid PV system to backup 10kW system for 3 hours and draw the block level representation of the final system. (7)

b. Explain with a neat sketch, the working principle of a grid connected solar system. (7)

18.

a. In a water pumping system, the water is being pumped from a sump to an overhead tank situated 25m above ground. The sump bottom is 2m belowground. The motor-pump system is located at ground level. The water is being pumped at the rate of 24.6 litres/sec. The pipe inner diameter is 10 cm. The pipe is placed completely vertical with no horizontal part. The friction factor is 0.037. The efficiencies of the pump, motor and dc-dc converter are 70%, 80% and 90% respectively. If the system is being powered by a PV source, what is the output power requirement for the PV panels? (7)

b. Explain the voltage and frequency matching method in grid connected PV system. (7)

Module 5

19.

a. Detail the anti-islanding protection with suitable block diagram. (7)

b. The life cycle cost of a system is Rs. 10000/- for a life period of 20 years. The rate of interest is 8% and the inflation rate is 5%. What is the annual life cycle cost for the system? (7)

20.

a. Draw and explain the line of protection equipment in PV array installation. (6)

b. Suppose the energy-efficiency retrofit of a large building reduces the annual electricity demand for heating and cooling from 2.3 × 106 kWh to 0.8 × 106 kWh and the peak demand for power from by 150 kW. Electricity costs Rs. 5/kWh and demand charges are Rs. 500/kW per month, both of which are projected to rise at an annual rate of 5%. If the project costs Rs. 3,50,00,000, what is the internal rate of return over a project lifetime of 15 years? (8)

Syllabus

Module 1

Introduction - Basic Concept of Energy -Source of Solar Energy -Formation of the Atmosphere - Solar Spectrum. Solar Constant -Air Mass -Solar Time-Sun–Earth Angles- Solar Radiation-Instruments to Measure Solar Radiation-Pyrheliometer –Pyranometer - Sunshine Recorder -Solar Radiation on a Horizontal Surface - Extra-terrestrial Region.- Terrestrial Region -Solar Radiation on an Inclined Surface -Conversion Factors -Total Solar Radiation on an Inclined/Tilted Surface -Monthly Average Daily Solar Radiation on Inclined Surfaces .

Module 2

Solar Thermal system-Principle of Conversion of Solar Radiation into Heat, –Solar thermal collectors –General description and characteristics –Flat plate collectors –Heat transfer processes –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation. Applications -Solar heating system, Air conditioning and Refrigeration system, Pumping system, solar cooker, Solar Furnace, Solar Greenhouse - Design of solar water heater

Module 3

Solar PV Systems-Introduction -Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect -Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell - Generation of Solar Cell (Photovoltaic) Materials-.Photovoltaic (PV) Module and PV Array - Single-Crystal Solar Cell Module, Thin-Film PV Modules, III–V Single Junction and Multifunction PV Modules-Emerging and New PV Systems -Packing Factor of the PV Module - Efficiency of the PV Module -Energy Balance Equations for PV Modules -Seriesand Parallel Combination of PV Modules.- Effect of shadowing-MPPT Techniques-P&O , incremental conductance method-Maximum Power Point Tracker (MPPT) using buck-boost converter.

Module 4

Solar PV Systems –stand-alone and grid connected -Design steps for a Stand-Alone system – Storage batteries and Ultra capacitors. Design PV powered DC fan and pump without battery-Design of Standalone System with Battery and AC or DC Load. A Grid Interactive PV System - Phase , Frequency Matching and Voltage Consideration – Operation of a Grid Interactive Inverter –Overview of IEEE -2018 Standard for Interconnecting Distributed Resources with Electric Power Systems

Module 5

Protection Against Islanding and Reverse Power Flow – AC Modules Design of EMI Filters. Overcurrent protection of solar PV power system, Selective fuse links for PV String protection, PV fuse selection flow chart, Fuse rating for PV Applications.

Life cycle costing, Growth models, Annual payment and present worth factor, payback period, LCC with examples. Introduction to simulation software for solar PV system design.*(An assignment can be given corresponding to CO2,CO3 and CO4 utilizing the simulation tools)*

Text book:

1. D.P. Kothari, M Jamil. Grid Integration of Solar Photovoltaic Systems, CRC Press 2018

2. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies And Applications 3rd Edition, PHI
3. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers,2002
4. A.A.M. Saigh(Ed): Solar Energy Engineering, Academic Press, 1977

References:

1. Masters, Gilbert M., Renewable and efficient electric power systems, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004.
2. A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994.
3. Thomas E. Kissell, David M. Buchla, Thomas L. Floyd Renewable energy systems, Pearson 2017
4. G. N. Tiwari,ArvindTiwari,Shyam, Handbook of Solar Energy: Theory, Analysis and Applications, springer,2016.
5. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
6. Khan B. H., Non-Conventional Energy Resources, Tata McGraw Hill, 2009.
7. D.P.Kothari, K.C.Singal, RakeshRanjan, *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India, New Delhi, 2009.
8. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 1999.
9. Sab S. L., Renewable and Novel Energy Sources, MI. Publications, 1995.
10. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
11. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001.
12. Boyle G. (ed.), Renewable Energy -Power for Sustainable Future, Oxford University Press, 1996.
13. Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, Renewable Energy – Sources for Fuel and Electricity, Earth scan Publications, London, 1993.
14. Tara Chandra Kandpal, Hari Prakash Garg, Financial evaluation of renewable energy technologies, Mac Millam India Limited.,2003.
15. "IEEE Application Guide for IEEE Std 1547(TM), IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems," in IEEE Std 1547.2-2008 , vol., no., pp.1-217, 15 April 2009, doi: 10.1109/IEEESTD.2008.4816078

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Solar energy (7 hours)**	
1.1	Introduction - Basic Concept of Energy -Source of Solar Energy - Formation of the Atmosphere - Solar Spectrum.	1
1.2	Solar Constant -Air Mass -Solar Time-Sun–Earth Angles-Solar Radiation-Instruments to Measure Solar Radiation-Pyrheliometer – Pyranometer -Sunshine Recorder	2
1.3	Solar Radiation on a Horizontal Surface –Extra-terrestrial Region.- Terrestrial Region -Solar Radiation on an Inclined Surface -Conversion Factors	2
1.4	Total Solar Radiation on an Inclined/Tilted Surface -Monthly Average Daily Solar Radiation on Inclined Surfaces.	2
2	**Solar Thermal Systems (6 hours)**	
2.1	Principle of Conversion of Solar Radiation into Heat, –Solar thermal collectors –General description and characteristics	1
2.2	Flat plate collectors –Heat transfer processes –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation.	2
2.3	Applications -Solar heating system, Air conditioning and Refrigeration system	1
2.4	Pumping system, solar cooker, Solar Furnace, Solar Greenhouse	1
2.5	Design of solar water heater	1
3	**Solar PV systems (7 Hours)**	
3.1	Introduction -Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect -Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell -Generation of Solar Cell (Photovoltaic) Materials	2
3.2	Photovoltaic (PV) Module and PV Array - Single-Crystal Solar Cell Module, Thin-Film PV Modules, III–V Single Junction and Multijunction PV Modules -Emerging and New PV Systems	1
3.3	Packing Factor of the PV Module - Efficiency of the PV Module - Energy Balance Equations for PV Modules	1
3.4	Series and Parallel Combination of PV Modules.- Effect of shadowing-	1
3.5	MPPT Techniques-P&O , incremental conductance methd-Maximum Power Point Tracker (MPPT) using buck-boost converter.	2

4	**Stand Alone and Grid integrated PV System (9 Hours)**	
4.1	Solar PV Systems –stand-alone and grid connected -Design steps for a Stand-Alone system –Storage batteries and Ultra capacitors.	2
4.2	Design PV powered DC fan and pump without battery	2
4.3	Design of Standalone System with Battery and AC or DC Load.	2
4.4	A Grid Interactive PV System - Phase , Frequency Matching and Voltage Consideration – Operation of a Grid Interactive Inverter	2
4.5	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems	1
5	**GIPV System Protection and LCC (7)**	
5.1	Protection Against Islanding and Reverse Power Flow	1
5.2	AC Modules Design of EMI Filters. .	1
5.3	Overcurrent protection of solar PV power system, Selective fuse links for PV String protection, PV fuse selection flow chart, Fuse rating for PV Applications	2
5.4	Life cycle costing, Growth models, Annual payment and present worth factor, payback period of solar PV system, LCC with examples.	2
5.5	Introduction to simulation software for solar PV system design like PV syst, PV SOL etc.	1

CST458	SOFTWARE TESTING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This is a course in theoretical computer science that introduces the concepts and methods in software testing. It covers various techniques for test case design used to test software artifacts, including requirements, design, and code, the different techniques for test case design based on graphs, programming language syntaxes and symbolic execution using PEX tool. It enables the learners to follow a systematic software testing approaches while developing applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to:-

CO1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit.**(Cognitive Knowledge Level: Understand)**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.**(Cognitive Knowledge Level: Apply)**
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program.**(Cognitive Knowledge Level: Understand**)
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.**(Cognitive Knowledge Level: Apply)**
CO5	Illustrate the use of PEX tool with symbolic execution.**(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	✔	✔	✔									✔
CO2	✔	✔	✔	✔	✔					✔		✔
CO3	✔	✔	✔							✔		✔
CO4	✔	✔	✔	✔								✔

CO5	✔	✔	✔	✔	✔					✔		✔

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests(Average of SeriesTests1& 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Eachquestion can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module - 1 (Introduction to Software Testing)

Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing,integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, WhiteBox testing, Grey Box testing.

Module - 2 (Unit Testing)

Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junitand Muclipse.

Module - 3 (Unit Testing - White Box Approaches)

Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.

Module - 4 (Unit Testing - Black Box Approaches)

Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study -Black Box testing approaches using JUnit.

Module - 5 (Grey Box Testing Approaches)

Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

Text Books

1. Paul Ammann and JeffOffutt , Introduction to Software Testing, Cambridge University Press
2. Kshirasagar Naik and Priyadarshi Tripathy, Software Testing And Quality Assurance: Theory And Practice, Wiley.

Reference Materials

1. King, James C, "Symbolic Execution and Program Testing", Association for Computing Machinery, July 1976.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

Explain the following types of testing methods with examples.

(i) Balck-box testing.

(ii) White-box testing.

(iii) Grey-box testing.

Course Outcome 2 (CO2):

Define 12 mutants for the following method *power*() using effective mutation operators. Try to use each mutation operator at least once. Approximately, how many mutants do you think there would be, if all mutants for *power*() were created?

```
public static int power (int left, int right)
{
//**************************************
// Raises Left to the power of Right
// precondition : Right >= 0
// postcondition: Returns Left**Right
//**************************************
```

```
intrslt;
rslt = Left;
if (Right == 0)
{
rslt = 1;
}
else
{
for (int i = 2; i <= Right; i++)
rslt = rslt * Left;
}
return (rslt);
}
```

Course Outcome 3 (CO3):

Draw the control flow graph and data flow graph of given piece of code.

```
public static double ReturnAverage(int value[],int AS, int MIN, int MAX){
/*
Function: ReturnAverageComputes the averageof all those numbers in the input array in
the positive range [MIN, MAX]. The maximum size of the array is AS. But, the array size
could be smaller than AS in which case the end of input is represented by -999.
*/
int i, ti, tv, sum;
doubleav;
i = 0; ti = 0; tv = 0; sum = 0;
while (ti< AS && value[i] != -999) {
ti++;
if (value[i] >= MIN && value[i] <= MAX) {
tv++;
sum = sum + value[i];
}
i++;
}
```

```
if (tv> 0)
av = (double)sum/tv;
else
av = (double) -999;
return (av);
}
```

Course Outcome 4 (CO4):

Explain the following with examples.

1. Input domain modelling.
2. All Combinations Coverage (ACoC)
3. Each Choice Coverage (ECC)
4. Pair-wise Coverage
5. T-wise Coverage
6. Base Choice Coverage
7. Multiple Base Choices Coverage.

Course Outcome 5 (CO5):

Draw the symbolic execution tree for the following program code and explain the symbolic execution of testme (α1, α2).

```
int twice (int v) {
 return 2 ∗ v;
 }
 void testme (int x, int y ) {
 z = twice ( y);
 if ( z == x ){
if ( x > y + 10)
ERROR;
 }
 }
int main() {
 x = sym input();
y = sym input();
testme ( x , y);
```

return(0);

Model Question Paper

QP CODE: **PAGES: 3**

Reg No:______________ **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST458

Course Name: Software Testing

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Explain the differences between Validation and Verification?
2. Explain the differences between Fault, Error, and Bug?
3. Define Ground string, Mutation score, and Mutants?
4. What are the functions of Test driver and Test stubs in dynamic unit testing?
5. Define Node coverage, Edge coverage and Prime path coverage in a control flow graph?
6. What are du paths and du pairs in a data flow graph?
7. Explain the two approaches in input domain modelling?
8. Explain the difference between Equivalence Class Partitioning and Boundary Value Analysis?
9. Briefly explain three techniques of Grey box testing?
10. Explain the concept of symbolic execution with the help of a toy example?

(10x3=30)

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) Explain the following types of testing

(i) Black Box testing (ii) White Box testing (iii) GreyBox testing (iv) Unit testing (v) Integration testing (vi) System testing (vii) Acceptance testing **(14)**

OR

12. (a) Explain the following coverage criterias based on the code fragment given below? (i) Functional coverage (ii) Statement coverage (iii)Conditional coverage (iv)Branch coverage **(8)**

```
int foo (int x, int y){
    int z = 0;
    if ((x > 0) && (y > 0)){
    z = x;}
    return z;
    }
```

(b) Write positive and negative test cases for an ATM Machine? **(6)**

13. (a) Explain Dynamic unit test environment with a neat figure. **(8)**

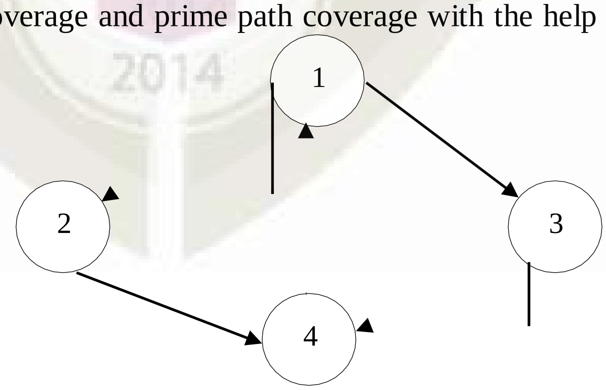
(b) Explain the major difference between control flow testing and data flow testing**.** **(6)**

OR

14. (a) Explain seven types of mutation operators with neat examples? **(14)**

15. (a) Explain touring, side trips and detours with a neat example **(7)**

(b) Explain simple path coverage and prime path coverage with the help of CFG given below? **(7)**



OR

16. (a) Draw CFG fragment for **(7)**

(i) Simple *if* (ii) Simple *while* loop (iii) Simple *for* loop

(b) Explain the following concepts with examples? **(7)**

(i)Call graph (ii) Inheritance graph (iii) Coupling du-pairs

17. (a) What are the four important steps in functional testing? **(7)**

(b) Briefly explain input domain modelling approaches? **(7)**

OR

18. (a) Consider the triangle classification program with a specification: **(6)**

The program reads floating values from the standard input. The three values *A*, *B*, and *C* are interpreted as representing the lengths of the sides of triangle. The program then prints a message to the standard output that states whether the triangle, if it can be formed, is scalene, isosceles, equilateral, orright angled. Determine the following for the above program:

(i) For the boundary condition $A + B > C$ case (scalene triangle), identify test cases to verify the boundary.

(ii) For the boundary condition $A = C$ case (isosceles triangle), identify testcases to verify the boundary.

(iii) For the boundary condition $A = B = C$ case (equilateral triangle), identify testcases to verify the boundary.

(b) Develop a decision table to generate test cases for this specification. **(8)**

19. (a) Explain the importance of grey box testing, its advantages and disadvantages? **(9)**

(b) Explain the concept of symbolic execution tree? **(5)**

OR

20. (a) Consider the code fragment given below: - **(7)**

1. POWER: PROCEDURE(X, Y);
2. Z ← 1;

3. J ← 1;
4. LAB: IF Y ≥ J THEN
5. DO; Z← Z * X;
6. J ← J + 1;
7. GO TO LAB; END;
8. RETURN (Z) ;
9. END;

a) Explain Symbolic execution of POWER (αl, α2).

(b) Explain Execution tree for POWER (αl, α2). **(7)**

TEACHING PLAN

No	Contents	No of Lecture Hrs (35 hrs)
Module 1 (Introduction to Software Testing) -(7 Hours)		
1.1	Some Popular Errors– Ariane 5, Therac 25, Intel Pentium Bug.	1 Hour
1.2	What is Software testing? Why should it be tested? Software Quality, Role of Testing.	1 Hour
1.3	Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking.	1 Hour
1.4	Software Testing Terminologies- Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria.	1 Hour
1.5	Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing	1 Hour
1.6	Functional testing, Stress testing, Performance testing, Usability testing and Regression testing.	1 Hour
1.7	Testing Methods - Black Box testing, White Box testing, Grey Box testing.	1 Hour
Module 2 (Unit testing)- (6 Hours)		
2.1	Concept of Unit testing, Static Unit Testing	1 Hour

2.2	Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing.	1 Hour
2.3	Mutation testing - Mutation and Mutants, Mutation operators, Mutation score.	1 Hour
2.4	Junit - Framework for Unit testing.	1 Hour
2.5	Case Study - Mutation testing using Junit	1 Hour
2.6	Case Study - Mutation testing using Muclipse	1 Hour
Module 3 (Unit Testing:- White Box Approaches)- (8 Hours)		
3.1	Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage	1 Hour
3.2	Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage.	1 Hour
3.3	Data Flow Criteria - du paths, du pairs	1 Hour
3.4	Subsumption Relationships among Graph Coverage Criteria	1 Hour
3.5	Graph Coverage for Source Code – Control Flow Graphs (CFG) for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program - Statistics	1 Hour
3.6	Graph Coverage for Design Elements – Structural graph coverage and data flow graph coverage for design elements	1 Hour
3.7	Case Study - Graph Based testing using JUnit Framework. (Lecture 1)	1 Hour
3.8	Case Study - Graph Based testing using JUnit Framework. (Lecture 2)	1 Hour
Module 4 (Unit Testing:- Black Box Approaches) -(7 Hours)		
4.1	Domain Testing / Input Space Partitioning - Partitions of a set.	1 Hour
4.2	Input domain modelling - Interface-based approach, Functionality-based approach.	1 Hour

4.3	Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage.	1 Hour
4.4	Functional Testing - Functional Testing Concepts of Howden. Important Steps.	1 Hour
4.5	Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis	1 Hour
4.6	Decision Tables, Random Testing.	1 Hour
4.7	Case Study - Black Box testing approaches using JUnit.	1 Hour
Module 5 (Grey Box Testing Approaches)- (7 Hours)		
5.1	Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages.	1 Hour
5.2	Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing.	1 Hour
5.3	An Introduction to Pex - Parameterized Unit Testing, The Testing Problem.	1 Hour
5.4	Symbolic Execution – Example, Symbolic execution tree.	1 Hour
5.5	Case Study – PEX (Lecture 1)	1 Hour
5.6	Case Study – PEX (Lecture 2)	1 Hour
5.7	Case Study – PEX (Lecture 3)	1 Hour

CST468	BIOINFORMATICS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2019

Preamble: This course helps the learners to understand the fundamental concepts in Molecular Biology, Genomics, Proteomics and Modelling. This course introduces bio macromolecules such as genes and proteins, different biological databases, and tools and algorithms for biological data processing, analysis and interpretation, and the elements of the systems approach to Molecular Biology. This course enables the learners to contribute towards drug discovery and computational analysis and modelling of biological process.

Prerequisite: Basic background in higher secondary biology

Course Outcomes: After the completion of the course, the student will be able to

CO 1	Describe the basic concepts of Bioinformatics with an emphasis on structure, function and synthesis of biomolecules (**Cognitive knowledge level : Understand**)
CO 2	Identify biological data formats and databases, retrieve bio-sequences, and align bio-sequences to identify similarity (**Cognitive knowledge level : Apply)**
CO 3	Employ similarity searching tools and algorithms to align sequences to highlight the similarity, and describe the structure of genes (**Cognitive knowledge level : Apply)**
CO 4	Demonstrate Protein Structure, visualize protein structure using tools, and explain how proteins interact (**Cognitive knowledge level : Apply)**
CO 5	Explain the fundamental aspects of Systems Biology, Computational Modeling and properties of models (**Cognitive knowledge level : Understand**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓

CO4	✓	✓	✓	✓								✓
CO5	✓	✓			✓							✓

PO#	Broad PO	PO#	Broad PO
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	Test1 (%)	**Test2 (%)**	
Remember	**30**	**30**	**30**
Understand	**50**	**50**	**50**
Apply	**20**	**20**	**20**
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3

Continuous Internal Evaluation Pattern:

Attendance	**10 marks**
Continuous Assessment Tests (Average of Series Tests 1& 2)	**25 marks**
Continuous Assessment Assignment	**15 marks**

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. Therewill be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer allquestions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Outof the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 full questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module-1 (Introduction to bioinformatics)

Introduction to bioinformatics, Nature & Scope of Bioinformatics, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation

Module-2 (Introduction to bio sequences and analysis)

Introduction to Biological Databases, NCBI, Genbank, Bio sequence formats- FASTA, Sequence alignment- Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices - PAM and BLOSUM

Module-3 (Database Similarity Searching and genomics)

Database Similarity Searching, BLAST – Variants -BLASTN, BLASTP, BLASTX, Statistical Significance, Needleman and Wunsch and Smith–Waterman Method, Multiple Sequence Alignment, scoring function, Clustal, introduction to structure of prokaryotic and eukaryote gene

Module-4 (Proteomics)

Protein Structure, Ramachandran Plot, Hierarchies of Protein Structure, Determination of Protein three-dimensional structure, protein structure database-PDB, Protein structure visualization, introduction to Protein protein interaction, STRING database

Module-5 (Systems Biology)

Introduction to Systems Biology, Models and Modelling, Properties of models, Systems state and steady state, Variables, Parameters, and Constants in modelling, Purpose and Adequateness of Models, Advantages of Computational Modelling, Model Development, Network Versus Elements, Modularity, Robustness and Sensitivity, Data Integration

Text books

1. Zvelebil, Marketa J., and Jeremy O. Baum. *Understanding bioinformatics*. Garland Science, 2007.
2. Xiong, Jin. *Essential bioinformatics*. Cambridge University Press, 2006.
3. Klipp, E., Herwig, R., Kowald, A., Wierling, C., &Lehrach, H. *Systems biology in practice: concepts, implementation and application*. John Wiley & Sons. 2005

References

1. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. *Bioinformatics*. John Wiley & Sons, 2020.
2. Shaik, Noor Ahmad, et al. *Essentials of Bioinformatics, Volume I.* Springer, 2019

3. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, *Applied bioinformatics. An introduction–Springer, Verlag,*, 2008.
4. S C Rastogi, N Mendiratta and PRastogi, *Bioinformatics: Methods and Applications* , PHI Learning Private Limited, New Delhi, 2015.
5. D E Krane and M L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education, 2006.
6. Andreas D.Baxevanis, B F Francis Ouellette, *Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins*, Third Edition, John Wiley & Sons INC. , U.K. 2006
7. Neil C Jones and Pavel A Pevzner, *An Introduction to Bioinformatics Algorithms*, MIT press, 2004.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast the DNA and RNA on the basis of structure and functions.
2. Demonstrate with the help of a flow diagram the generation of protein using the transcription and translation process.

Course Outcome 2 (CO2):

1. Download DNA sequence of human insulin form NCBI
2. Identify the following qualifiers for GenBank and give their definitions: [ACCN], [ALL], [AUTH], [ECNO], [FKEY], [GENE], [JOUR], [KYWD]
3. Construct a dot plot and find the sequence alignment between the following two sequences:
   Sequence1: GATTCTATCTAACTA, Sequence2: GTTCTATTCTAAC

Course Outcome 3 (CO3):

1. Apply Needleman-Wunsch Algorithm to perform sequence alignment for the following sequences: CGTGAATTCAT (sequence #1), GACTTAC (sequence #2)
2. Construct a BLAST procedure for sequence alignment(HSP) if a sequence and its corresponding database sequence are given. Assume the necessary data and demonstrate the procedure.

Course Outcome 4 (CO4):

1. Differentiate between the different protein molecular structure visualizations. Also mention the advantages and uses of each visualization technique.
2. Make use of an example and demonstrate the steps in protein comparison. Show how root mean square deviationis calculated while comparing two proteins.

Course Outcome 5 (CO5):

1. Explain how systems biology is used in data integration.
2. Explain the process of model development.

Model Question Paper

QP CODE:

Reg No: ______________

Name: __________________ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST468

Course Name: Bioinformatics

Max. Marks : 100 **Duration: 3 Hours**

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate DNA, Gene, genome and chromosome.
2. What are the functions of mRNA, tRNA and rRNA?
3. What do you mean by Gene expression?
4. Write difference between local and global alignment.
5. Write short note on Gap penalties and its usage in comparing Biological sequences.
6. List any three typesof BLAST and make short description on each.
7. What are the principle underlying the formation of Ramachandran plot?.
8. What are the experimental methods for determining protein structure?
9. What do you mean by steady state in a biological system.
10. Justify the statement - systems are modular. **(10x3=30)**

Part B

(Answer any one question from each module. Each question carries 14 Marks)

11. (a) What is the central dogma of molecular biology? **(6)**

(b) Explain the steps involved in the process of transcription. How is the primary transcript produced by a prokaryote different from that produced by a eukaryotic cell? **(8)**

OR

12. (a) Discuss translation process in protein synthesis. **(6)**

(b) Explain bio-molecules involved in central dogma, its structure and types. **(8)**

13. (a) Explain the importance of Primary and secondary databases in Bioinformatics **(6)**

(b) Illustrate the methods of pairwise sequence alignment. What is the use of assigning gap penalties in alignment? **(8)**

OR

14. (a) Illustrate sequence alignment. What are the applications of sequence alignment in Bioinformatics? **(7)**

(b) What is the use of scoring matrices? Differentiate between PAM and BLOSUM matrices and its usage in alignment. **(7)**

15. (a) Using Needleman and Wunsch dynamic programming method, construct the partial alignment score table for the following two sequences, using the scoring parameters: match score: +5, mismatch score: -1, gap penalty: -2. **(9)**

CCATGCU
GATTACA

Also write down the optimal global alignment between these sequences along with the optimal score.

(b) Interpret the blast result and statistical significance of the alignment by analyzing the results. **(5)**

OR

16. (a) Using Smith Waterman method construct the partial alignment scoring table and obtain the optimal local alignment of the following two sequences: **(9)**

ACGTATCGCGTATA
GATGCTCTCGGAJAA

(b) Illustrate multiple sequence alignment. **(5)**

17. (a) Discuss hierarchies of protein structure. **(6)**

(b) Explain how the protein structure is determined by using experimental techniques. **(8)**

OR

18. (a) Discuss protein interaction. How it contributes to the complexity of an organism? **(9)**

(b) Discuss on Protein Structure Database. **(5)**

19. (a) Discuss systems biology approach of understanding complex biological systems. **(6)**

(b) Explain on Variables, Parameters, and Constants in modeling biological systems. **(8)**

OR

20. (a) Explain on advantages of Computational Modeling of biological system. **(7)**

(b) What are the properties of models in biological system? **(7)**

TEACHING PLAN

No	Contents	No of Lecture (36 Hrs)
	Module-1 (Introduction to bioinformatics)(8 hrs) Text 1 (Relevant topics from chapter 1.1, 1.2, 1.3)	
1.1	Introduction to bioinformatics	1
1.2	Nature & Scope of Bioinformatics	1
1.3	DNA, RNA, and Protein	1
1.4	The Central Dogma introduction	1
1.5	Messenger RNA, tRNA, rRNA,	1
1.6	Genetic code,	1
1.7	Gene Structure and Control	1
1.8	Transcription, Translation	1
	Module-2 (Introduction to bio sequences and analysis) (7 hrs) Text 2 (Relevant topics from chapter 2, 3)	
2.1	Introduction to Biological Databases	1
2.2	NCBI Sequence retrieval	1
2.3	Genbank, Bio sequence formats- FASTA	1
2.4	Sequence alignment- Global Alignment and Local Alignment	1
2.5	Dot Matrix Method, Dynamic Programming Method	1

2.6	Gap Penalties	1
2.7	Amino Acid Scoring Matrices – PAM, BLOSUM	1
Module-3 (Database Similarity Searching and genomics) (7 hrs) Text 2 (Relevant topics from chapter 4 5 and 8)		
3.1	Database Similarity Searching, BLAST, Variants of BLAST - BLASTN, BLASTP, BLASTX	1
3.2	BLAST Analysis - Statistical Significance	1
3.3	Needleman and Wunsch Method	1
3.4	Smith–Waterman Method	1
3.5	Multiple Sequence Alignment, scoring function	1
3.6	Clustal tool	1
3.7	Gene Structure of prokaryotic, eukaryote	1

Module-4 (Proteomics) (7 hrs) Text 2 (Relevant topics from chapter 12, 13 and 19)		
4.1	Protein Structure, Ramachandran Plot	1
4.2	Hierarchies of Protein Structure	1
4.3	Determination of Protein three-dimensional structure	1
4.4	protein structure database-PDB	1
4.5	Protein structure visualization	1
4.6	Protein protein interaction	1
4.7	Protein protein interaction networks, STRING database	1
Module-5 (Systems Biology) (7 hrs) Text 3 (Relevant topics from Section 1.1-1.4)		
5.1	Introduction to Systems Biology, Properties of models	1
5.2	Systems state and steady state	1
5.3	Variables, Parameters, and Constants in modelling	1
5.4	Purpose and Adequateness of Models	1
5.5	Advantages of Computational Modelling ,Model Development (introduction only)	1
5.6	Network Versus Elements, Modularity,	1

5.7	Robustness and Sensitivity, Data Integration	1

EOT404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to becomecompetent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

EOD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	**0**	**0**	**12**	**4**

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator,expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the workdone so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence forthe originality of the work done by theteam . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end ofphase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budgetplan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extentafter phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to trackthe project. Material procurement if applicable is progressing well. Tasks areupdated and incorporated in the schedule.A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student hasno idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but islimited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

Phase-II Interim Evaluation - 2 Total Marks: 25

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledgein the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop anexcellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea isevolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable toderive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does notfollow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is roomfor improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII MINOR

EOD482	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project : A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a groupof three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic;
- Preparing an Action Plan for conducting the investigation, including team work;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
- Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3					3	3		2
CO2	3			3				3	3	3	3	
CO3	3	3	3	3	3					3		
CO4					3			3	3	3		1
CO5	3	3	3	3				3		3	3	1

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews**.**

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

SEMESTER VIII HONOURS

EOD496	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project : A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a groupof three/four students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic;
- Preparing an Action Plan for conducting the investigation, including team work;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
- Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3					3	3		2
CO2	3			3				3	3	3	3	
CO3	3	3	3	3	3					3		
CO4					3			3	3	3		1
CO5	3	3	3	3				3		3	3	1

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Assessment Pattern

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