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 '$\leq$ ' be the subset relation on the power set. Draw the Hasse diagram of (P(A), $\leq$).
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 ^ Q) => P→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 ∨ R is tautologically implied by (PVQ) ∧ (P→R) ∧ (Q→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

CST201	DATA STRUCTURES	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2019

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 structures to 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 item required 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 include waiting 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

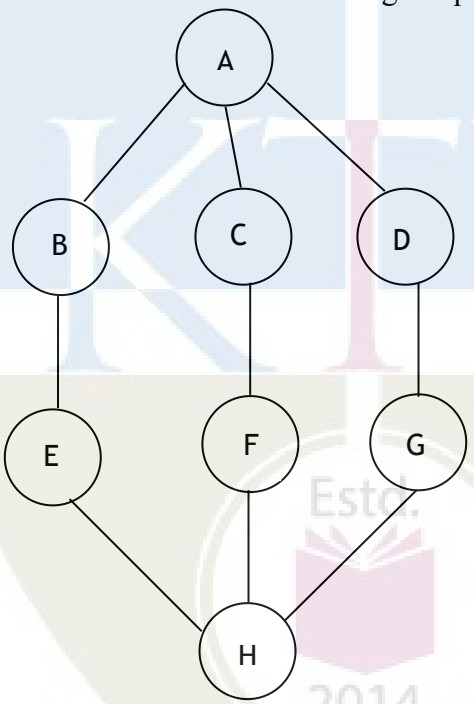
5. Write an algorithm to count the number of occurrences of a character in a linked list (each node contains only one character)

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

ERT203	DIGITAL SYSTEMS AND VLSI DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2021

Preamble: The objective of the course is to familiarize learners with the basics of Boolean algebra, digital systems, and VLSI design. This course covers the basic concepts of the number system and its conversions, the design of simple combinational and sequential logic circuits with hardware description language implementation, with a brief understanding of VLSI design concepts. These help to understand the basic digital system design concepts and working principles of computer systems with knowledge of peripheral design.

Prerequisite: Nil

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

COURSE OUTCOMES	
CO1	Understand the basic concepts of number systems and its conversions (**Cognitive Knowledge level: Understand**)
CO2	Apply the Boolean Functions to design, simplify and realize digital circuits with Logic Gates and Hardware Description Language (HDL) (**Cognitive Knowledge level: Apply**)
CO3	Apply the design procedures of combinational circuits and implement them with Logic Gates and HDL **(Cognitive Knowledge level: Apply)**
CO4	Apply the design procedures of sequential circuits and implement them with Logic Gates and HDL **(Cognitive Knowledge level: Apply)**
CO5	Understand the basic concepts of MOS devices (**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 Marks (%)
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
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 : 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: Number systems, Operations & Codes

Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers.

Module 2: Boolean Algebra

Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh- Map Method (upto four variables), Don't care conditions, Product of sums

simplification. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates. Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL.

Module 3: Combinational Logic Circuits

Design Procedure & Implementation of combinational logic circuits- Half adder, Full adder, Half subractor, full subtractor, Binary Parallel adder, BCD adder, Code converter, Magnitude comparator, Encoder, Decoder, Multiplexer, Demultiplexer. Implementation of combinational circuits using HDL.

Module 4: Sequential logic circuits

Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip-flops. Excitation table and characteristic equation. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter. Implementation of flip-flops & Counters using HDL.

Module 5: Shift registers & Introduction to MOS and related VLSI technology

Shift registers -Serial in Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams.

Introduction to MOS and related VLSI technology – The Metal Oxide Semiconductor (MOS) - N Channel Metal Oxide Semiconductors (NMOS)-P Channel Metal Oxide Semiconductors (PMOS)- Complementary Metal Oxide Semiconductors (CMOS)- Inverter – NAND- NOR

Text Books:

1. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
2. Thomas L Floyd, Digital Fundamentals, 10/e, Pearson Education, 2009.
3. M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

Reference Books:

1. M. Morris Mano, Michael D Ciletti , Digital Design With An Introduction to the Verilog HDL, 5/e, Pearson Education, 2013.
2. Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003

Sample Course Level Assessment Questions

Course Outcome1(CO1): Perform the following number base conversions:

a) $(250.55)_{10}$ to Hexadecimal b) $(357)_8$ to Decimal

Course Outcome 2(CO2): Given a Boolean function F and don't care conditions D, using Karnaugh map obtain the simplified expression in (i) SOP and (ii) POS:

$$F(A, B, C, D) = A'B'D' + A'CD + A'BC$$
$$D(A, B, C, D) = A'BC'D + ACD + AB'D$$

Course Outcome 3(CO3): Design a BCD to Excess-3 Code Convertor.

Course Outcome 4(CO4): Design a 4- bit binary ripple counter.

Course Outcome 5(CO5): Explain briefly about accumulation, depletion and inversion in MOSFETs

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: ERT203

Course name : DIGITAL SYSTEMS AND VLSI DESIGN

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Do the following base conversions

   a) $(73AE)_{16}$ to Decimal

   b) $(1111011100)_2$ to octal.

2. Subtract $(0101)_2$ from $(11110)_2$ using: i) complement and ii) complement arithmetic.
3. State and prove extended De Morgan's theorem
4. Simplify the Boolean function F= XY′+XY+YZ. Draw the circuit using basic gates. How many logic gates do you save by simplification?
5. Design a half subtractor with NAND gates only.
6. Differentiate between ripple counter and synchronous counter.
7. Construct D flip- flop using NAND gates. Also give its truth table.
8. Explain how a shift register is used for serial data transfer?
9. Draw & explain the structure of Metal Oxide Semiconductor
10. Illustrate the circuit of a CMOS inverter.

PART-B

(Answer any one full question from each module) **(14x5=70)**

11. a) Convert i) (687)10 to binary, octal, BCD and hexadecimal (4x1 Marks)

    ii) (354) to binary, octal, BCD and hexadecimal (4x1 Marks)

    b) Represent -246 and -517 in

    i) sign magnitude form (2x1 Marks)

    ii) 1's complement form (2x1 Marks)

    iii) 2's complement form (2x1 Marks)

OR

12. (a) Add the following numbers without converting them to decimal. (3x2 Marks)

(i) Binary numbers 1010111 and 101010.

(ii) Octal numbers 3674 and 7526

(iii) Hexadecimal numbers 364E and 7ADE

(b) (b) Represent the unsigned decimal numbers 78942 and 64521 in BCD, and then show the steps necessary to form their sum. (8)

13. (a) Prove that (i) $AB + A(B + C) + B(B + C) = B + AC$

(ii) $AB + A(B + C) + B(B + D) = A$

(b) Using K-map, simplify the Boolean function F in sum of products form, using the don't care conditions d: (4)

$$F(w, x, y, z) = w'(x'y + x'y' + xyz) + x'z'(y + w)$$
$$d(w, x, y, z) = w'x(y'z + yz') + wyz$$

OR

14. (a) Simplify the following expressions using Karnaugh- map method. (8)

(i) $F = \Sigma(0,2,4,6,9,11,13,15,17,21,25,27,29,31)$

(ii) $F = \Pi(0,2,5,7)$

(b) Convert the following to the other canonical form: (6)

(i) $F(x, y, z, a) = \sum (1,3,7)$

(ii) $F(x, y, z) = \Pi(0,3,6,7)$

(iii) $F(A, B, C, D) = \Pi(0,1,2,3,4,6,12)$

15. (a) Implement Full adder circuit using NAND gate only. (4)

(b) Design a code converter for converting BCD to Excess 3 code (10)

OR

16. (a) Write the HDL for a half adder using any 2 different styles of modelling (6)

(b) Design a Gray to binary code converter using a 4x1 MUX. Draw the circuit diagram and explain. (8)

17. (a) Design a counter that count the states 0,3,5,6,0… using T flip- flops. (10)

(b) Write the characteristics equation, excitation table of JK, T and D flipflop. (4)

OR

18. (a) Explain Johnson Counter with timing diagram (6)

(b) Design a synchronous Binary Up-Down Counter. (8)

19. (a) Explain the working of a CMOS inverter with neat diagram. (9)

(b) Write the differences between NMOS & PMOS (5)

OR

20. (a) Illustrate the 3 modes of operation in a MOSFET (8)

(b) Explain the working of NMOS & PMOS (6)

Teaching Plan

Module 1: Number systems, Operations & Codes (No algorithms)		**(7 hours)**
1.1	**Number Systems**: Decimal, Binary, Octal and Hexadecimal number systems, Number Base Conversions. (Lecture-1)	**1 hour**
1.2	**Number Systems**: Decimal, Binary, Octal and Hexadecimal number systems, Number Base Conversions. (Lecture-2)	**1 hour**
1.3	**Binary Arithmetic:** Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture-1)	**1 hour**
1.4	**Binary Arithmetic:** Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture-2)	**1 hour**
1.5	Representation of Negative Numbers- Complements, subtraction with complements.	**1 hour**
1.6	**BCD Arithmetic:** Addition and Subtraction of BCD Numbers	**1 hour**
1.7	**Octal and Hexadecimal Arithmetic**: Addition & Subtraction of Octal and Hexadecimal Numbers.	**1 hour**

Module 2: Boolean Algebra		**(10 hours)**
2.1	**Introduction to Boolean Algebra:** Postulates of Boolean Algebra , Basic theorems and Properties of Boolean Algebra	**1 hour**
2.2	**Boolean Functions:** Canonical and Standard Forms	**1 hour**
2.3	**Simplification of Boolean Functions**: Karnaugh -Map Method (upto four variables), Don't care conditions (Lecture-1)	**1 hour**
2.4	**Simplification of Boolean Functions**: Karnaugh -Map Method (upto four variables), Don't care conditions (Lecture-2)	**1 hour**
2.5	**Product of sums simplification**	**1 hour**
2.6	**Digital Logic Gates:** AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture-1)	**1 hour**
2.7	**Digital Logic Gates:** AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture-2)	**1 hour**
2.8	Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL. (Lecture-1)	**1 hour**
2.9	Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL. (Lecture-2)	**1 hour**
2.10	Introduction to Hardware Description Language (Verilog) – Implementation of basic gates using HDL. (Lecture-3)	**1 hour**
Module 3: Combinational Logic Circuits		**(10 hours)**
3.1	Design Procedure & Implementation of Combinational Circuits	**1 hour**
3.2	**Binary Adders:** Implementation of Half Adder, Full Adder (lecture-1)	**1 hour**
3.3	**Binary Adders:** Implementation of Half Adder, Full Adder (lecture-2)	**1 hour**
3.4	**Binary Subtractors:** Implementation of Half Subtractor, Full Subtractor	**1 hour**
3.5	Implementation of Binary Parallel Adder , BCD Adder	**1 hour**

3.6	**Implementation of Various Combinational Circuits:** Code Converters, Magnitude Comparator	**1 hour**
3.7	Implementation of Encoder , Decoder	**1 hour**
3.8	Implementation of, Multiplexer Demultiplexer	**1 hour**
3.9	Implementation of combinational circuits using HDL (lecture-1)	**1 hour**
3.10	Implementation of combinational circuits using HDL (lecture-2)	**1 hour**
Module 4: Sequential logic circuits		**(11 hours)**
4.1	**Flip flops:** SR, JK, T and D flip- flops (lecture-1)	**1 hour**
4.2	**Flip flops:** SR, JK, T and D flip- flops (lecture-2)	**1 hour**
4.3	Triggering of flip-flops- Master slave flip- flop, Edge- triggered flip-flops	**1 hour**
4.4	Excitation table and characteristic equations of flip- flops (Lecture-1)	**1 hour**
4.5	Excitation table and characteristic equations of flip- flops (Lecture-2)	**1 hour**
4.6	**Counter Design:** Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (lecture-1)	**1 hour**
4.7	**Counter Design:** Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (lecture-2)	**1 hour**
4.8	Synchronous counters- Binary Up- down counter, BCD counter (lecture-1)	**1 hour**
4.9	Synchronous counters- Binary Up- down counter, BCD counter (lecture-2)	**1 hour**
4.10	Implementation of flip-flops & Counters using HDL (lecture-1)	**1 hour**
4.11	Implementation of flip-flops & Counters using HDL (lecture-2)	**1 hour**
Module 5: Shift registers & Introduction to MOS and related VLSI technology		**(7 hours)**
5.1	**Shift Registers** - Serial In Serial Out, Serial In Parallel Out. Bidirectional Shift Register with Parallel load (lecture-1)	**1 hour**
5.2	**Shift Registers** - Serial In Serial Out, Serial In Parallel Out. Bidirectional Shift Register with Parallel load (lecture-2)	**1 hour**
5.3	**Shift register counters** - Ring Counter, Johnson Counter- timing sequences and state diagrams	**1 hour**
5.4	**Introduction to MOS and related VLSI technology** – The Metal Oxide Semiconductor (MOS)	**1 hour**
5.5	N Channel Metal Oxide Semiconductors (NMOS)-P Channel Metal Oxide Semiconductors (PMOS)-	**1 hour**
5.6	Complementary Metal Oxide Semiconductors (CMOS)- - Inverter – NAND- NOR (lecture-1)	**1 hour**
5.7	Complementary Metal Oxide Semiconductors (CMOS)- - Inverter – NAND- NOR (lecture-2)	**1 hour**

ERT205	ELECTRONIC DEVICES AND CIRCUITS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble : This course aims to develop the skill of the design of various analog circuits. in practical applications

Prerequisite: Fundamentals of Electronics and semiconductor devices

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

CO#	COURSE OUTCOMES
CO1	Design analog signal processing circuits using diodes and first order RC circuits. **(Cognitive Knowledge Level:Apply)**
CO2	Analyse various transistor biasing circuits and BJT amplifier circuits. **(Cognitive Knowledge Level:Apply)**
CO3	Identify a power amplifier with appropriate specifications for electronic circuit applications. **(Cognitive Knowledge Level:Apply)**
CO4	Design and analyse the wave- shaping multivibrator and oscillator circuits using BJT. **(Cognitive Knowledge Level:Apply)**
CO5	Design and develop feedback amplifiers and regulated power supply**(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**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	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 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 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 Wave shaping circuits: First order RC differentiating and integrating circuits, First order RC low pass and high pass filters. Diode Clipping circuits - Positive, negative and biased clipper. Diode Clamping circuits - Positive, negative and biased clamper.

Bipolar Junction Transistors: Review of BJT characteristics- Operating point of BJT – Factors affecting stability of Q point. DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilisation. Stability factor (Derivation of stability factors for Voltage Divider Biasing only).

Module 2: BJT Amplifiers: RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines, voltage gain and frequency response. Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance). High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier.

Module 3 : Multistage and Power Amplifiers

Multistage amplifiers: Direct, RC, transformer coupled Amplifiers, Applications. Power amplifiers using BJT: Class A, Class B, Class AB, Class C and Class D. Conversion efficiency – derivation (Class A and Class B). Distortion in power amplifiers.

Module 4 Wave Generating circuits: Multivibrator and Oscillator Circuits

Multivibrators - Types of multivibrators - Feedback concepts, Barkhausen's criterion for oscillation - Types of oscillators – RC phase shift, Wien bridge, Hartley, Colpitt's and crystal oscillators.(Analysis of RC phase shift and Wein bridge oscillator required)

Module 5 Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage- series and voltage-shunt feedback topologies - voltage gain, input and output impedance

Regulated power supply: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting, SMPS.

Text Book

1. Robert Boylestad and L Nashelsky, "Electronic Devices and Circuit Theory", 11/e Pearson, 2015.
2. Sedra A. S. and K. C. Smith, "Microelectronic Circuits", 6/e, Oxford University Press, 2013.

References

1. Razavi B., “Fundamentals of Microelectronics”, Wiley, 2015
2. Neamen D., “Electronic Circuits, Analysis and Design”, 3/e, TMH, 2007.
3. David A Bell, “Electronic Devices and Circuits”, Oxford University Press, 2008.
4. Rashid M. H., “Microelectronic Circuits - Analysis and Design”, Cengage Learning, 2/e,2011
5. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, McGraw-Hill, 2010.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. For the given specification design a differentiator / integrator circuit.
2. For the given transfer characteristics design clipping / clamping circuit.
3. Design first order RC low-pass / high-pass circuit for the given specification.
4. Compare the performance of voltage divider biasing and fixed biasing.
5. Draw the load line for voltage divider biasing and fix a suitable operating point to avoid signal distortion.

Course Outcome 2 (CO2):

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Design a RC coupled amplifier for a given gain.
3. Analyse the frequency response of BJT RC coupled amplifier using hybrid π model.

Course Outcome 3 (CO3):

1. Compare the efficiency of class A, class B and class C power amplifiers.
2. Define cross over distortion. How it can be avoided in class AB amplifier.
3. Derive the expression for maximum efficiency of class B power amplifiers.

Course Outcome 4 (CO4):

1. Design an a stable multi-vibrator for generating a 1kHz square waveform.
2. State the Barkhausen criteria for a sine wave oscillator, and explain why they must be fulfilled to sustain oscillations.
3. Draw the circuit diagram of a RC Phase shift, Wein bridge, Hartley and Colpitts oscillator.

Course Outcome 5 (CO5):

1. Discuss the different feedback topologies in amplifiers
2. Deduce the expression for voltage gain, input impedance and output impedance of the four feedback amplifier topologies.
3. Design voltage regulator for the given specifications.

Model Question Paper

Reg No: Name :

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER

B. TECH DEGREE EXAMINATION, Duration: 3 Hours

MONTH AND YEAR ***Course Code: EST205*** Max. Marks: 100

Course Name: ELECTRONIC DEVICES & CIRCUITS

PART A

Answer all questions, each carries 3 marks

1. Design the first order RC high pass filter with cut off frequency 2KHz.
2. With neat diagrams explain DC load lines in transistor. What is the significance of Q point?
3. Draw and explain the h parameter small signal low frequency model for BJT.
4. What is the significance of Miller effect on high frequency amplifiers?
5. Derive the maximum efficiency of the complementary-symmetry class B power amplifiers
6. Explain how cross over distortion is avoided in class AB amplifier
7. Design a Wein bridge oscillator to generate a sinusoidal waveform of 2 kHz
8. State and explain Barkhausen's criterion of oscillation.
9. Discuss the advantages of negative feedback amplifier.
10. What is line regulation and load regulation in the context of a voltage regulator?

PART B

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

Module 1

11. Design a voltage divider bias circuit to operate from a 18V supply in which bias conditions are to be $V_{CE}=V_E=6V$ and $I_C=1.5mA$. $\beta=90$. Also calculate the stability factor S? (14 Marks)

12. A) Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz. (7 marks)

B) Define operating point and explain the factors affecting the operating point stability. (7 Marks)

Module 2

13. A) Sketch the frequency response curve of RC coupled amplifier and discuss methods to improve gain bandwidth product? (7 marks)
B) Which are the internal capacitances of a BJT? How these are incorporated in the high frequency hybid pi model of BJT? (7 Marks)

14. A CE amplifier has the h-parameters given by hie= 1000Ω, hre = $2*10^{-4}$, hfe=50, hoe= 25μΩ. If both the load and source resistances are 1kΩ, determine the a) current gain and b) voltage gain (14 Marks)

Module 3

15. Define conversion efficiency of power amplifier. Prove that the maximum conversion efficiency of a series fed class A amplifier is 25%.
(14 Marks)

16. With neat circuit diagrams, explain the working of a two-stage RC coupled amplifier and derive the output relation of each stage.
(14 Marks)

Module 4

17. Design the RC elements of RC phase shift oscillator for the operation at f=3KHz and draw the oscillator circuit diagram.(14 Marks)

18. a) Draw the circuit of Hartley oscillator and derive the frequency of oscillation (8marks)

    b) Outline the advantages of crystal oscillator. (6marks)

Module 5

19. Give the block schematic of current-series feedback amplifier configuration and deduce the expression for gain, input impedance and output impedance with feedback. Design a practical circuit for this current-series feedback amplifier. (14 marks)

20. Design a discrete series voltage regulator with short circuit protection for regulated output voltage 10V and maximum current 100mA (14 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Wave Shaping Circuits**	**10**
1.1	First order RC differentiating and integrating circuits	1
1.2	First order RC low pass and high pass filters	1
1.3	Diode Clipping circuits - Positive, negative and biased clipper	1
1.4	Diode Clamping circuits - Positive, negative and biased clamper.	1
1.5	Diode Clamping circuits - Positive, negative and biased clamper	1

1.6	Bipolar Junction Transistors: Review of BJT characteristics- Operating point of BJT	1
1.7	Operating point of BJT,DC load line	1
1.8	Factors affecting stability of Q point.	1
1.9	DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilization	1
1.10	Stability factor (Derivation of stability factors for Voltage Divider Biasing only).	1
2	**BJT Amplifiers**	**9**
2.1	RC coupled amplifier (CE configuration) –Introduction	1
2.2	Need of various components and design	1
2.3	Concept of AC load lines, voltage gain and frequency response	1
2.4	Small signal hybrid- pi model of BJT	1
2.5	Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance).	1
2.6	High frequency hybrid- pi model of BJT	1
2.7	High frequency equivalent circuits of BJT, Miller effect	1
2.8	Analysis of high frequency response of CE amplifier.	1
2.9	Short circuit current gain and 3-db frequency	1
3	**Multistage amplifiers**	**8**
3.1	Direct & RC coupling	1
3.2	Transformer coupled Amplifiers, Applications	1
3.3	Power amplifiers using BJT:	1

3.4	Power amplifiers : introduction and characteristics	1
3.5	Class A, Class B Class AB, Class C and Class D	1
3.6	Conversion efficiency – derivation (Class A-Transformer coupled)	1
3.7	Conversion efficiency – derivation (Class B-push pull)	1
3.8	Distortion in power amplifiers.	1
4	**Wave Shaping Multivibrator and Oscillator Circuits**	**8**
4.1	Feedback concepts, feedback connection types	1
4.2	feedback connection types	1
4.3	Multivibrators - Types of multivibrators	1
4.4	Astable and monostable multivibrators	1
4.5	Barkhausen's criterion for oscillation	1
4.6	Types of oscillators – RC phase shift(Analysis of frequency of oscillation)	1
4.7	Wien bridge (Analysis of frequency of oscillation)	1
4.8	Hartley, Colpitt's and crystal oscillators.(No analysis required)	1
5	**Feedback amplifiers**	**10**
5.1	Effect of positive and negative feedback on gain	1
5.2	frequency response and distortion	1
5.3	The four basic feedback topologies	**1**
5.4	Block diagram schematic of four feedback topologies	1
5.5	Analysis of discrete BJT circuits in voltage-series feedback topologies - voltage gain, input and output impedance	1
5.6	Analysis of discrete BJT circuits in voltage- shunt feedback topologies - voltage gain, input and output impedance	1
5.7	Regulated power supply: Shunt voltage regulator	1
5.8	Series voltage regulator	1
5.9	Short circuit protection and fold back protection, Output current boosting	1
5.10	SMPS	1

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

ERL201	DIGITAL SYSTEMS AND VLSI DESIGN LAB	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2021

Preamble: This course aims to (i) familiarize students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates (ii) familiarize students with the HDL based Digital Design Flow

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

CO 1	Realize digital circuits with Logic Gates and Hardware Description Language (**Cognitive Knowledge level: Apply**)
CO 2	Design and implement combinational logic circuits. (**Cognitive Knowledge level: Apply**)
CO 3	Design and implement sequential logic circuits. (**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	✓	✓	✓	✓	✓			✓	✓			

LIST OF EXPERIMENTS

** Mandatory experiments

PART-A [Any six experiments]

1. Familiarization of logic gates**
2. Half adder and full adder using NAND**
3. Realization of 8:1 MUX and 1:8 DEMUX**
4. Realization of 8:3 encoder and 3:8 decoder**
5. Flip-flop circuits (SR, JK,T,D &Master slave)
6. Asynchronous up/down counter
7. Johnson and ring counters

PART-B [Any four experiments]

1. Familiarization of FPGA devices**
2. Implementation of basic gates using Verilog & simulate the result using test bench**
3. Implementation of half adder & full adder using Verilog & simulate the result using test bench**
4. Implementation of MUX & DEMUX using Verilog & simulate the result using test bench
5. Implementation of encoder & decoder using Verilog & simulate the result using test bench
6. Implementation of flipflops using Verilog & simulate the result using test bench

Reference Books:

1. Samir Palnikar"Verilog HDL: A Guide to Digital Design and Syntheis", Sunsoft Press
2. Bhasker J "A Verilog Hdl Primer" Bs Publications/bsp Books
3. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009
4. A. Ananthakumar," Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016

Assessment Pattern

Mark distribution :

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Continuous Evaluation including Viva	Internal Test	Total
15	30	30	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

SEMESTER III

MINOR

ERT 281	LOGIC CIRCUIT DESIGN	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: The objective of the course is to familiarize learners with the basic concepts of Boolean algebra and digital systems. This course covers the design of simple combinational and sequential logic circuits, representation and arithmetic algorithms for Binary, BCD (Binary Coded Decimal) and Floating point numbers which in turn are helpful in understanding organization & design of a computer system and understanding how patterns of ones and zeros can be used to store information on computers, including multimedia data.

Prerequisite: Nil

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

CO#	CO
CO1	Illustrate decimal, binary, octal, hexadecimal and BCD number systems, perform conversions among them and do the operations - complementation, addition, subtraction, multiplication and division on binary numbers (**Cognitive Knowledge level: Understand**)
CO2	Simplify a given Boolean Function and design a combinational circuit to implement the simplified function using Digital Logic Gates (**Cognitive Knowledge level: Apply**)
CO3	Design combinational circuits - Adders, Code Convertors, Decoders, Magnitude Comparators, Parity Generator/Checker and design the Programmable Logic Devices - ROM and PLA. **(Cognitive Knowledge level: Apply)**
CO4	Design sequential circuits - Registers, Counters and Shift Registers. **(Cognitive Knowledge level: Apply)**
CO5	Use algorithms to perform addition and subtraction on binary, BCD and floating point numbers **(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	Test 1 (%)	Test 2 (%)	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 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 any5.

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 (Number systems, Operations & Codes)

Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary codes- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC. Logic Gates – NOT, AND, OR, NAND, NOR, XOR, XNOR

Module- 2 (Boolean Algebra)

Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh-Map Method (up to four variables), Don't care conditions, Product of sums simplification, Tabulation Method. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates.

Module- 3 (Combinational Logic Circuits)

Design Procedure & Implementation of combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, Demultiplexer, Encoder, Multiplexer, Parity generator/ Checker.

Module- 4 (Sequential logic circuits)

Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip-flops. Excitation table and characteristic equation. Registers- register with parallel load. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter.

Module- 5 (Shift registers)

Shift registers – Serial In Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams. Memory - ROM -PROM – EPROM – RAM- Solid state drives Sequential Programmable Logic Devices - PAL, PLA, FPGA. Introduction to Verilog, Design using Verilog basic gates, arithmetic circuits, basic- combinational and sequential logic circuits

Text Book

1. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
2. Thomas L Floyd, Digital Fundamentals, 10/e, Pearson Education, 2009.
3. M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

References

1. M. Morris Mano, Michael D Ciletti , Digital Design With An Introduction to the Verilog HDL, 5/e, Pearson Education, 2013.
2. Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Perform the following operations (i)$D9CE_{16}$-$CFDA_{16}$ (ii) 6575_8-5732_8
2. Convert decimal 6,514 to both BCD and ASCII codes. For ASCII, an even parity bit is to be appended at the left.

Course Outcome 2 (CO2):

1. Simplify using K-map F(a,b,c,d) = Σ m (4,5,7,8,9,11,12,13,15)
2. Explain the operation of a 8x1 multiplexer and implement the following using an 8x1 multiplexer F(A, B, C, D) = Σ m (0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14)

Course Outcome 3 (CO3):

1. Draw the circuit and explain the operation of a TTL NAND gate
2. Compare TTL, CMOS logic families in terms of fan-in, fan-out and supply voltage

Course Outcome 4 (CO4):

1. Explain a MOD 6 asynchronous counter using JK Flip Flop
2. Realize a T flip-flop using NAND gates and explain the operation with truth table, excitation table and characteristic equation

Course Outcome 5 (CO5):

1. Draw the logic diagram of 3 bit PIPO shift register with LOAD/SHIFT control and explain its working
2. Draw the logic diagram of 3 bit SIPO shift register with LOAD/SHIFT with proper diagram

Model Question Paper

QP CODE:
Reg No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT281

Course name: LOGIC CIRCUIT DESIGN

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

PART-A

Answer All Questions. Each question carries 3 marks

1. Represent the decimal numbers (459)10 and (859)10 in hexadecimal and perform addition of these hexadecimal numbers.
2. Subtract (1101)2 from (11010)2 using: i) complement and ii) complement arithmetic.
3. Find the dual and complement of the boolean function F = AB′ + B(A + B′).
4. Using K-map, reduce the expression: AB+ABC+ABC+BC.
5. Design a half subtractor with NAND gates only.
6. Design a combinational circuit that multiplies an input decimal digit by 5 represented in BCD. The output is also in BCD. Show that the outputs can be obtained from the input lines without using any logic gates.
7. Differentiate between ripple counter and synchronous counter.
8. Construct D flip- flop using NAND gates. Also give its truth table.
9. Explain how a shift register is used for serial data transfer?
10. Write a Verilog code for D Flipflop.

(10 x 3 = 30 Marks)

PART-B

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

11. (a) Perform the following operations using 2's complement arithmetic: **(8 marks)**

(i) $88_{10} + (-37)_{10}$ (ii) $(-20)_{10} + (-12)_{10}$

(b) Perform the following base conversions: (i) $(101011.11)_2$ to octal **(6 marks)**

(i) $(3F\ 9B)_{16}$ to binary (iii) $(121)_{10}$ to binary (iv) $(3077)_8$ to binary

OR

12. (a) Find the 12 bit complement representation of the following decimal numbers. **(6 marks)**

(i) – 97 (ii) – 224 (iii) - 197.5

(b) Perform the following operations **(8 marks)**

(i) $(520)_8 + (488)_8$ (ii) $(520)_{16} - (488)_{16}$

13. (a) Prove that (i) $AB + A(B + C) + B(B + C) = B + AC$ **(4 marks)**

(ii) $AB + A(B + C) + B(B + D) = A$

(b) Using K-map, simplify the Boolean function F in sum of products form, using the don't care conditions d: **(10 marks)**

$F(w, x, y, z) = w'(x'y + x'y' + x\,yz) + x'z'(y + w)$

$d(w, x, y, z) = w'x\,(y'z + yz') + wyz$

OR

14. (a) Simplify the following expressions using Karnaugh- map method. **(8 marks)**

(i) $F = \Sigma(0,2,4,6,9,11,13,15,17,21,25,27,29,31)$

(ii) $F = \Pi(0,2,5,7)$

(b) Convert the following to the other canonical form: **(6 marks)**

(i) $F(x, y, z, a) = \sum (1,3,7)$

(ii) $F(x, y, z) = \Pi(0,3,6,7)$

(iii) $F(A, B, C, D) = \Pi(0,1,2,3,4,6,12)$

15. (a) Implement Full adder circuit using NAND gate only. **(4 marks)**

(b) Design a code converter for converting BCD to Excess 3 code **(6 marks)**

OR

16. (a) With a neat diagram explain 4-bit carry look-ahead adder **(6 marks)**

(b) Design a Gray to binary code converter using a 4x1 MUX. Draw the circuit diagram and explain. **(8 marks)**

17. (a) Design a counter that count the states 0,3,5,6,0… using T flip- flops. **(10 marks)**

(b) Write the characteristics equation, excitation table of JK, T and D flip-flop. **(4 marks)**

OR

18. (a) Explain race around condition and how it can be avoided. **(6 marks)**

(b) Design a synchronous Binary Up-Down Counter. **(8 marks)**

19. (a) With a neat diagram explain universal shift register. **(8 marks)**

(b) Explain Johnson Counter with timing diagram. **(6 marks)**

OR

20. (a) Differentiate between PROM, PLA and PAL. **(7 marks)**

(b) Write Verilog Code for a full adder circuit. **(7 marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module- 1 (Number systems, Operations & Codes) (No algorithms) (7 hrs)		
1.1	Number Systems: Decimal, Binary, Octal and Hexadecimal number systems, Number Base Conversions.	1
1.2	Binary Arithmetic: Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture 1)	1
1.3	Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture 2)	1
1.4	Representation of Negative Numbers- Complements, subtraction with complements.	1
1.5	BCD Arithmetic: Addition and Subtraction of BCD Numbers	1
1.6	Octal and Hexadecimal Arithmetic: Addition & Subtraction of Octal and Hexadecimal Numbers.	1

1.7	Binary Codes: Decimal Codes, Error detection codes, Reflected code, Character Coding Schemes-ASCII, EBCDIC, Logic Gates – NOT, AND, OR, NAND, NOR, XOR, XNOR	1
Module - 2 (Boolean Algebra) (9 hrs)		
2.1	Introduction to Boolean Algebra: Postulates of Boolean Algebra	1
2.2	Basic theorems and Properties of Boolean Algebra	1
2.3	Boolean Functions: Canonical and Standard Forms	1
2.4	Simplification of Boolean Functions: Karnaugh -Map Method (up to four variables), Don't care conditions (Lecture 1)	1
2.5	Simplification of Boolean Functions: Karnaugh -Map Method (up to four variables), Don't care conditions (Lecture 2)	1
2.6	Product of sums simplification	1
2.7	Tabulation method	1
2.8	Digital Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture 1)	1
2.9	Digital Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR, Implementation of Boolean functions using basic and universal gates. (Lecture 2)	1
Module – 3 (Combinational Logic Circuits) (9 hrs)		
3.1	Design Procedure & Implementation of Combinational Circuits	1
3.2	Binary Adders: Implementation of Half Adder, Full Adder	1
3.3	Binary Subtractors: Implementation of Half Subtractor, Full Subtractor	1
3.4	Implementation of Binary Parallel Adder ,Carry look ahead Adder, BCD Adder (Lecture 1)	1
3.5	Implementation of Binary Parallel Adder ,Carry look ahead Adder, BCD Adder (Lecture 2)	1

3.6	Implementation of Various Combinational Circuits: Code Converters, Magnitude Comparator	1
3.7	Implementation of Decoder, Demultiplexer	1
3.8	Implementation of Encoder, Multiplexer	1
3.9	Implementation of Parity Generator/Checker	1
Module - 4 (Sequential logic circuits) (9 hrs)		
4.1	Flip flops: SR, JK, T and D flip- flops (Lecture 1)	1
4.2	SR, JK, T and D flip- flops (Lecture 2)	1
4.3	Triggering of flip-flops- Master slave flip- flop, Edge- triggered flip-flops (Lecture 1)	1
4.4	Triggering of flip-flops- Master slave flip- flop, Edge- triggered flip-flops (Lecture 2)	1
4.5	Excitation table and characteristic equations of flip- flops	1
4.6	Registers- Register with parallel load	1
4.7	Counter Design: Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (Lecture 1)	1
4.8	Asynchronous counters- Binary and BCD counters- timing sequences and state diagrams. (Lecture 2)	1
4.9	Synchronous counters- Binary Up- down counter, BCD counter	1
Module- 5 (Shift registers, Arithmetic algorithms & PLD's) (11 hrs)		
5.1	Shift Registers - Serial In Serial Out, Serial In Parallel Out.	1
5.2	Bidirectional Shift Register with Parallel load	1

5.3	Shift register counters - Ring Counter, Johnson Counter- timing sequences and state diagrams	1
5.4	Memory - ROM -PROM – EPROM – RAM- Solid state drives	1
5.5	Sequential Programmable Logic Devices - PAL, PLA	1
5.6	FPGA	1
5.7	Introduction to Verilog	1
5.8	Design using Verilog basic gates	1
5.9	arithmetic circuits	1
5.10	basic- combinational logic circuits	1
5.11	basic- sequential logic circuits	1

CST 283	PYTHON FOR MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This is a programming course for awarding B. Tech. Minor in Computer Science and Engineering with specialization in ***Machine Learning***. The objective of the course is to provide learners an insight into Python programming, and develop programming skills to manage the development of software systems. It covers programming environment, important instructions, data representations, intermediate level features, Object Oriented Programming and file data processing of Python. 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

CO1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO2	Illustrate uses of conditional (if, if-else, if-elif-else and switch-case) and iterative (while and for) statements in Python programs **(Cognitive Knowledge level: Apply)**
CO3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python **(Cognitive Knowledge level: Apply)**
CO4	Implement Object Oriented programs with exception handling **(Cognitive Knowledge level: Apply)**
CO5	Write programs in Python to process data stored in files by utilizing the modules 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	✔	✔	✔	✔	✔	✔						✔

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	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 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.

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.

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.

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/

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.

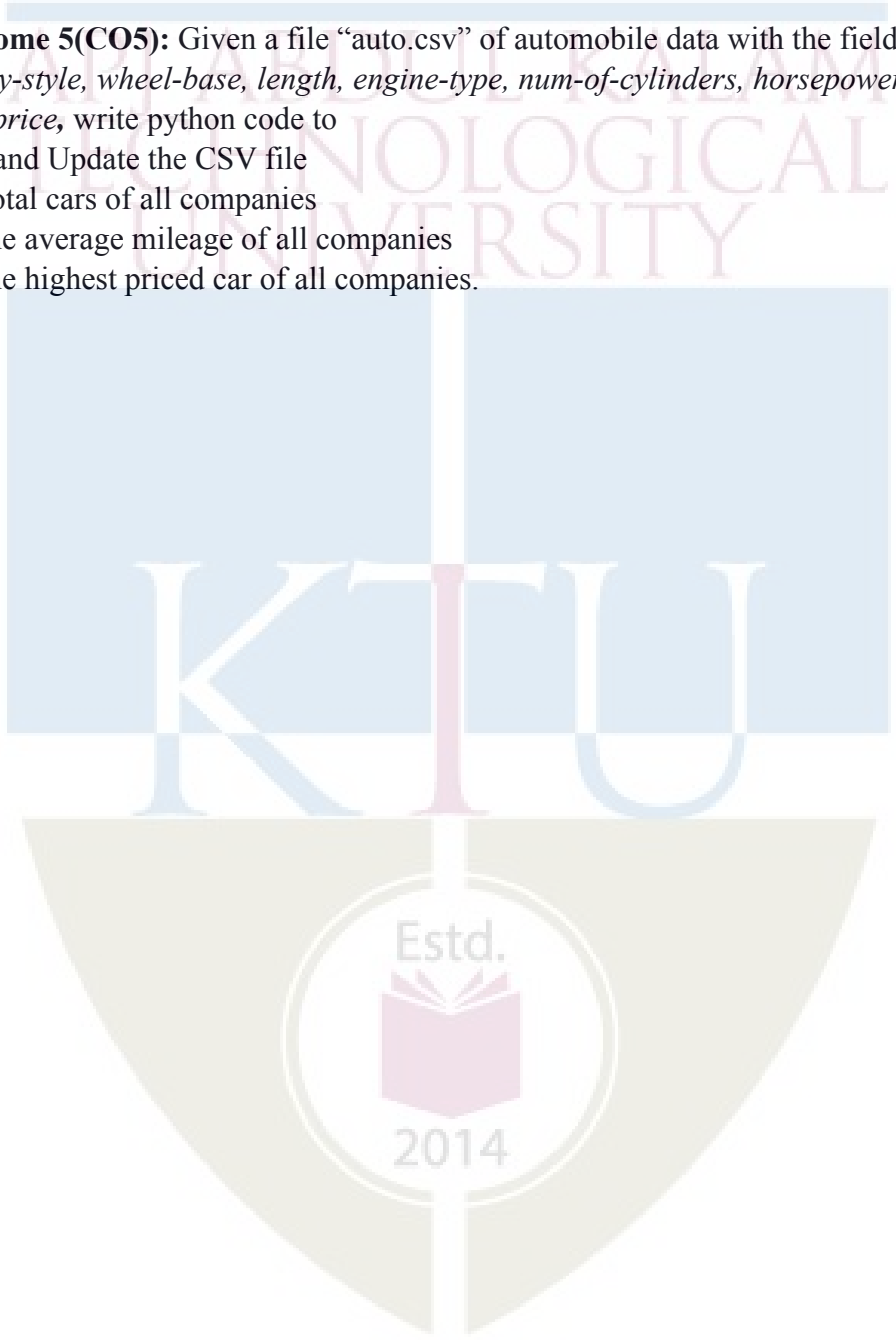
Course Outcome 3(CO3): Given is a list of of words, *wordlist*, and a string, *name.* Write a Python function which takes *wordlist* and *name* as input and returns a tuple. The first element of

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
THIRD SEMESTER B.TECH (MINOR) DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 283

Course name : PYTHON FOR MACHINE LEARNING

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)

$$\sin(x) - \frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$ 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. (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( )*

(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**

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 the bar chart
3) Calculate total sale data for last year for each product and show it using a Pie chart.

(14X5=70)

Teaching Plan

Module 1: Programming Environment and Python Basics		**(10 hours)**
1.1	Getting Started with Python Programming: Running code in the interactive shell Editing, Saving, and Running a script	**1 hour**
1.2	Using editors: IDLE	**1 hour**
1.3	Jupyter	**1 hour**
1.4	The software development process: Case Study.	**1 hour**
1.5	Basic coding skills: Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions,	**1 hour**
1.6	Working with numeric data, Type conversions, Comments in the program	**1 hour**
1.7	Input, Processing, and Output, Formatting output – How Python works	**1 hour**
1.8	How Python works – Detecting and correcting syntax errors	**1 hour**
1.9	Using built in functions and modules: Case – Using math module	**1 hour**
1.10	Using built in functions and modules: Case – Using math module (Examples)	**1 hour**

Module 2: Building Python Programs		**(8 hours)**
2.1	Control statements: Selection structure (if-else, switch-case),	**1 hour**
2.2	Iteration structure(for, while), Testing the control statements, Lazy evaluation	**1 hour**
2.3	Functions: Hiding redundancy and complexity, Arguments and return values,	**1 hour**
2.4	Variable scopes and parameter passing	**1 hour**
2.5	Named arguments, Main function,	**1 hour**
2.6	Working with recursion, Lambda functions	**1 hour**
2.7	Strings and number systems: String function	**1 hour**
2.8	Handling numbers in various format	**1 hour**
Module 3: Data Representation		**(9 hours)**
3.1	Lists: Basic list Operations and functions, List of lists	**1 hour**
3.2	Slicing, Searching and sorting list	**1 hour**
3.3	List comprehension	**1 hour**
3.4	Work with tuples, Sets	**1 hour**
3.5	Work with dates and times	**1 hour**
3.6	Dictionaries: Dictionary functions,	**1 hour**
3.7	Dictionary literals, adding and removing keys, accessing & replacing values	**1 hour**
3.8	Traversing dictionaries, reverse lookup	**1 hour**
3.9	Case Study: Data Structure Selection	**1 hour**
Module 4: Object Oriented Programming		**(8 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	Abstract Classes	**1 hour**
4.7	Exceptions : Handle a single exception	**1 hour**

4.8	handle multiple exceptions	**1 hour**
Module 5: Data Processing		**(10 hours)**
5.1	The *os* and *sys* modules	**1 hour**
5.2	Introduction to file I/O: Reading and writing text files	**1 hour**
5.3	Manipulating binary files	**1 hour**
5.4	NumPy : Basics, Creating arrays, Arithmetic, Slicing	**1 hour**
5.5	Matrix Operations, Random numbers.	**1 hour**
5.6	Matplotlib : Basic plot	**1 hour**
5.7	Matplotlib - Ticks, Labels, and Legends	**1 hour**
5.8	Working with CSV files	**1 hour**
5.9	Pandas : Reading, Manipulating	**1 hour**
5.10	Pandas : Processing Data and Visualize.	**1 hour**

CST 285	DATA COMMUNICATION	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This is a basic course in communication for awarding B. Tech. Minor in Computer Science and Engineering with specialization in ***Networing***. The purpose of this course is to prepare learners to understand the communication entities and the associated issues in the field of Computer Science. This course covers fundamental concepts of data transmission & media, digital & analog transmissions, multiplexing & spread spectrum, error detection & correction and switching. Concepts in data communication help the learner to understand the concepts in networking and mobile communication.

Prerequisite: NIL

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

CO1	Describe the characteristics of signals used for Analog and Digital transmissions (**Cognitive knowledge: Understand**)
CO2	Discuss the features and issues in data transmission (**Cognitive knowledge: Understand**)
CO3	Select transmission media based on characteristics and propagation modes (**Cognitive knowledge: Apply**)
CO4	Use appropriate signal encoding techniques for a given scenario (**Cognitive knowledge: Apply**)
CO5	Illustrate multiplexing and spread spectrum technologies (**Cognitive knowledge: Understand**)
CO6	Explain error detection & correction techniques and switching techniques used in data communication (**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	40	40	40
Apply	30	30	30
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

Data Transmission Basics

Communication model - Simplex, Half duplex, Full duplex transmission. Periodic Analog signals - Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.

Module 2

Transmission Media

Guided Transmission Media - Twisted pair, Coaxial cable, Optical fiber. Unguided media - Radio waves, Terrestrial microwave, Satellite microwave, Infrared. Wireless Propagation - Ground wave propagation, Sky Wave propagation, Line-of-Sight (LoS) Propagation.

Module 3

Digital Transmission and Analog Transmission

Digital data to Digital signal – Non-Return-to-Zero (NRZ), Return-to-Zero (RZ), Multilevel

binary, Biphase. Analog data to Digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to Analog signal: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK). Analog data to Analog signal: Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).

Module 4

Multiplexing and Spread Spectrum

Multiplexing - Frequency Division Multiplexing (FDM), Wave length Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread Spectrum Techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).

Module 5

Error Detection, Correction and Switching

Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of Errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming Distance, Hamming Code. Basic principles of Switching - Circuit Switching, Packet Switching, Message Switching.

Text Books

1. Forouzan B. A., Data Communications and Networking, 5/e, McGraw Hill, 2013.
2. William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc.

Reference Books

1. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009.
2. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): What is a periodic analog signal? List the main properties of a periodic analog signal.

Course Outcome 2 (CO2): What is attenuation? How can it be handled?

Course Outcome 3 (CO3): How can interference be reduced using optical fiber?

Course Outcome 4(CO4): Encode the data sequence 101011100 using Multilevel binary and Biphase schemes.

Course Outcome 5(CO5): Explain direct sequence spread spectrum with a neat diagram.

Course Outcome 6(CO6): Using Cyclic Redundancy Check (CRC), given the data-word 11110000 and the divisor 10011, show the generation of the codeword at the sender and the checking of the codeword at the receiver.

Model Question Paper

QP CODE: PAGES: ___

Reg No:_____
Name:_____

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

Course Code: CST 285
Course name : DATA COMMUNICATION

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

PART-A
(Answer All Questions. Each question carries 3 marks)

1. What is bandwidth? Find the lowest frequency, if a periodic signal has a bandwidth of 20 Hz and the highest frequency is 60 Hz. Draw the Spectrum if the signal contains all frequencies of same amplitude.
2. Assume that a TV picture is to be transmitted over a channel with 4.5 MHz bandwidth and a 35 dB Signal-to-Noise-Ratio. Find the capacity of the channel.
3. What is the purpose of cladding in optical fibres?
4. Which wireless propagation is suitable for satellite communication? Justify your answer.
5. Explain the working of Delta Modulation with an example.
6. Illustrate the equivalent square wave pattern of the bit string 01001101 using Non-Return-to-Zero(NRZ) - Level and NRZ-Invert encoding schemes.
7. Distinguish between synchronous and statistical Time Division Multiplexing.
8. Apply Direct Sequence Spread Spectrum to the data 101 using the Barker sequence 10110111000. Show the encoding and decoding steps.
9. Find the minimum hamming distance for the following cases:
    a) Detection of two errors
    b) Correction of two errors
    c) Detection of 3 errors or correction of 2 errors
    d) Detection of 6 errors or correction of 2 errors
10. Find the parity bit for simple even parity check for the following.
    a) 1001010
    b) 0001100
    c) 1000000
    d) 1110111

PART-B

(Answer ANY one full question from each module. Each question carries 14 marks)

11. a) With the help of suitable figures, distinguish between time domain and frequency domain. (4)

b) Describe the different types of transmission impairments. (10)

OR

12. a) Calculate the bandwidth, if a periodic signal is decomposed into 4 sine waves with frequencies 50 Hz, 100 Hz, 150 Hz and 200Hz. Draw the spectrum, assuming all components having amplitude in the range 6-12 V and all are multiple of two in the increasing order.

(6)

b) Distinguish between Nyquist bandwidth and Shannon capacity. Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with (i) Two signal levels and (ii) Four signal levels. Determine the maximum bit rate in both these cases.

(8)

13. a) For a parabolic reflective antenna operating at 12 GHz with a diameter of 2 m, calculate the effective area and the antenna gain.

(6)

b) List any four advantages and disadvantages of twisted pair, coaxial cable and fiber optic cable.

(8)

OR

14. a) Compare the features of terrestrial microwave and satellite microwave.

(6)

b) With the help of suitable diagrams, differentiate Multi-mode and Single-mode optical fibres. How the rays are propagated in Step-index and Graded-index Multi-mode fibres.

(8)

15. a) Distinguish between data rate and signal rate. (4)

b) What is polar encoding? Encode the pattern 010011001110 using the two Biphase schemes.

(10)

OR

16. a) Show the equivalent analog sine wave pattern of the bit string 010011010 using Amplitude Shift Keying, Frequency Shift Keying and Phase Shift Keying.

(4)

b) State Sampling theorem. Explain Pulse Code Modulation with suitable figures.

(10)

17. a) Four channels are multiplexed using Time Division Multiplexing. If each channel sends 100 bytes/sec and we multiplex one byte per channel, determine the frame size, duration of a frame, frame rate and bit rate of the link.

(6)

b) With the help of an example, explain the working of Frequency Hopping Spread Spectrum.

(8)

OR

18. a) Explain the different techniques by which the disparity in input data rate is handled by Time Division Multiplexing.

(4)

b) Suppose Alice and Bob are communicating using Code Division Multiple Access. Alice uses the code [+1 +1] and Bob uses the code [+1 -1]. Alice sends the data bit 0 and Bob sends the data bit 1. Show the data in the channel and how they can detect what the other person has sent.

(10)

19. a) Explain parity check with examples.

(4)

b) Describe the need for a switch. What are the different phases in circuit switching?

(10)

OR

20. a) With the help of a suitable example, explain the virtual circuit approach of packet switching. (6)

b) Find the Hamming code for the data-word 1011001. Assume odd parity. (8)

Teaching Plan

Module 1 : Data Transmission Basics		**(8 Hours)**
1.1	Introduction, Communication model - Simplex, Half duplex, Full duplex transmission	1
1.2	Periodic Analog signals - Sine wave, Amplitude, Phase, Wavelength	1
1.3	Time and frequency domain, Bandwidth	1
1.4	Analog data and signals	1
1.5	Digital data and signals	1
1.6	Transmission impairments - Attenuation, Delay distortion, Noise	1
1.7	Data rate limits - Noiseless channel, Nyquist bandwidth	1
1.8	Noisy channel, Shannon's capacity formula	1
Module 2: Transmission media		**(7 Hours)**
2.1	Guided Transmission Media - Twisted pair, Coaxial cable	1
2.2	Optical fiber	1
2.3	Unguided media - Radio waves	1
2.4	Terrestrial microwave, Satellite microwave	1
2.5	Infrared	1
2.6	Wireless Propagation - Ground wave propagation	1
2.7	Wave propagation, Line-of-Sight (LoS) Propagation	1
Module 3: Digital Transmission and Analog Transmission		**(10 Hours)**
3.1	Digital data to Digital signal – Non-Return-to-Zero (NRZ)	1
3.2	Return-to-Zero (RZ), Multilevel binary	1

3.3	Biphase	1
3.4	Analog data to Digital signal - Sampling theorem	1
3.5	Pulse Code Modulation (PCM)	1
3.6	Delta Modulation (DM)	1
3.7	Digital data to Analog signal: Amplitude Shift Keying (ASK)	1
3.8	Frequency Shift Keying (FSK), Phase Shift Keying (PSK)	1
3.9	Analog data to Analog signal: Amplitude Modulation (AM)	1
3.10	Frequency Modulation (FM), Phase Modulation (PM)	1
Module 4: Multiplexing and Spread Spectrum		**(9 Hours)**
4.1	Multiplexing - Frequency Division Multiplexing (FDM)	1
4.2	Wave length Division Multiplexing (WDM), Time Division Multiplexing (TDM)	1
4.3	Synchronous TDM, Statistical TDM	1
4.4	Spread Spectrum Techniques	1
4.5	Direct Sequence Spread Spectrum (DSSS)	1
4.6	Frequency Hopping Spread Spectrum (FHSS)	1
4.7	Code Division Multiplexing	1
4.8	Code Division Multiple Access (CDMA)	1
4.9	CDMA	1
Module 5: Error Detection, Correction and Switching		**(11 Hours)**
5.1	Digital data communication techniques - Asynchronous & Synchronous transmission	1
5.2	Detecting and correcting errors - Types of Errors	1
5.3	Parity check, Checksum	1
5.4	Cyclic Redundancy Check (CRC)	1
5.5	CRC	1
5.6	Forward Error Correction (FEC)	1
5.7	Hamming Distance, Hamming Code	1
5.8	Hamming Code	1
5.9	Basic principles of Switching - Circuit Switching	1

5.10	Packet Switching	1
5.11	Message Switching	1

SEMESTER IV

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT204	PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS	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 (3)
$$f(x) = \begin{cases} 2x - 4, & 2 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$$

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 $y' = y + x$, $y(0) = 0$, 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) 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 $0 \le x \le 1$, 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.

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CST202	COMPUTER ORGANIZATION 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 learners to 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

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH &

YEAR Course Code: CST202

Course Name: Computer organization 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

ERT 204	OBJECT ORIENTED PROGRAMMING USING JAVA	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0	4	2021

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	Utilize 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 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 Tests		End Semester Examination
	Test1 (Marks %)	Test2 (Marks %)	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):

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

Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments.

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.

Module 2 (Core Java Fundamentals):

Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, 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, Print Writer 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 value of(). Collections framework - Collection Interface, List Interface -Collections Class – Array List class. Accessing a Collection via an Iterator.

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):

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

Swings fundamentals-Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel , Swing Buttons, JText Field.

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

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: ERT204

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 Data Base 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	Basic Object-Oriented concepts, Java Buzzwords	1 hour
1.2	Object Modeling Using UML – UML diagrams, Use case model	1 hour
1.3	Class diagram, Activity diagram.	1 hour
1.4	Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java program structure, Comments	1hour
1.5	Primitive Data types - Integers, Floating Point Types, Characters, Boolean Literals, Type Conversion and Casting, Variables	1hour
1.6	Arrays, Strings, Vector class	1hour
1.7	Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.	1hour
1.8	Control Statements - Selection Statements, Iteration Statements and Jump Statements.	1hour
Module 2: Core Java Fundamentals		**(11 hours)**
2.1	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods.	1 hour
2.2	Constructors, ***this*** Keyword, Method Overloading,	1 hour
2.3	Using Objects as Parameters, Returning Objects	1 hour
2.4	Recursion, Access Control,	1 hour
2.5	Static Members, Final Variables	1 hour
2.6	Inner Classes, Command-Line Arguments, Variable Length Arguments	1 hour
2.7	Inheritance - Super Class, Sub Class, The Keyword ***super***,	1 hour
2.8	protected Members , Calling Order of Constructors,	1 hour
2.9	Method Overriding, Final Variables,	1 hour

2.10	Inner Classes, Command-Line Arguments, Variable Length Arguments	1 hour
2.11	the Object class, 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, Print Writer 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		**(8 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 value Of()	1hour
4.3	Collections framework – Collections overview, Collections Interfaces-Collection Interface	1hour
4.4	List Interface, Collections Class – Array List Class	1hour
4.5	Accessing Collections via an Iterator.	1hour
4.6	Multithreaded Programming: The Java Thread Model, The Main Thread, Creating Thread	1hour
4.7	Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	1hour
4.8	Suspending, Resuming and Stopping Threads.	1 hour
Module 5: Graphical User Interface and Database support of Java		**(10 hours)**

5.1	Event handling - Event Handling Mechanisms, Delegation Event Model	1hour
5.2	Event Classes, Sources of Events	1hour
5.3	Event Listener Interfaces	1hour
5.4	Swings fundamentals, Swing Controls,	1 hour
5.5	Components and Containers, Swing Layout Managers	1hour
5.6	Swing Packages, Event Handling in Swings.	1hour
5.7	Exploring Swings –JFrame, JLabel, The Swing Buttons, JText Field.	1 hour
5.8	JDBC overview, Creating and Executing Queries – create table, delete, insert, select (Basics only, DBMS course is not a prerequisite).	1 hour
5.9	Creating and Executing Queries – create table, delete, insert, select.	1hour
5.10	Creating and Executing Queries – create table, delete, insert, select.	1 hour

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
ERT206	INTEGRATED CIRCUITS	PCC	3	1	0	4	2021

Preamble: To familiarize students with the Integrated Circuits and make them learn to design and analyze circuits using op-amp and also using some specialized ICs, like 555, regulators ICs, ADC, DAC etc.

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

CO 1	Discuss about basics of operational amplifier and characteristics (DC and AC) of op amps. **(Cognitive Knowledge Level:Apply)**
CO 2	Design linear and nonlinear circuits using op-amp. **(Cognitive Knowledge Level:Apply)**
CO 3	Deign op-amp oscillators, waveform generators and voltage regulators**(Cognitive Knowledge Level:Apply)**
CO 4	Design circuits using PLL and discuss about DAC and ADC. **(Cognitive Knowledge Level:Apply)**
CO 5	Design active filters and analyze the characteristics of active filters**(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**	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks (%)**
	Test 1 (%)	**Test 2 (%)**	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	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 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 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: Operational amplifiers

Introduction of op amps- block level diagram of op amp –Basic information of op amp (741 op amp) - Power supply requirements. Characteristics of Operational Amplifiers Ideal op amp characteristics-DC characteristics-input bias current, input offset current, input offset voltage, thermal drift, CMRR, PSRR-AC characteristics- frequency response, stability of op amp, slew rate.

Module 2: Applications of Operational amplifiers

Basic applications-inverting amplifier, non-inverting amplifier, differential amplifier, scale changer, summing amplifier, subtractor, adder, voltage follower, V-I converter (grounded load type and floating load type), Howland constant current circuit and I-V converter. Instrumentation amplifier (3 op amp design)-op amp integrator- op amp differentiator- op amp circuit using diodes-rectifier (half and full wave), peak detector, sample and hold circuit, log and antilog amplifier, multiplier and divider. Comparator (inverting and non-inverting type)-applications of comparator-zero crossing detector, window detector, time marker generator

Module 3: Waveform generators and Oscillators using Operational amplifier

Timer IC 555- Functional diagram, Schmitt trigger-. - Astable and mono stable – Design and working. Wave generators- Triangular and saw tooth - RC phase shift and Wien bridge oscillators

Voltage regulator-Introduction, series op amp regulator-IC regulators-78XX and 79XX characteristics-voltage regulator as current source-boosting IC regulator output current- 723 general purpose IC regulator

Module 4: PLL and Data Converters

Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.

Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, ADC-Direct type -Flash type, counter type, Servo type, successive approximation type- Integrating type ADC -Single slope type and dual slope type

Module 5 : Active Filters

Introduction-LPF-first order filter, second order filter (sallen-key Butterworth), higher order filter-HPF- first order filter, second order filter (sallen-key Butterworth), higher order filter-BPF-wide BPF, Narrow band pass filter-BRF-wide BRF, narrow BRF (Twin T Notch design)-All pass filter-Switched capacitor filter. Quality factor–Design.

Text Books

1. D Roy Choudhury and Shail B Jain, “Linear Integrated Circuits”, New Age International Publishers, 4/e.

2. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Education; 4/e.

Reference Books

1. Coughlin & Driscoll,“Op amps and Linear Integrated circuits”, Pearson Education Asia.2000.
2. Sergio Franco, “Design with operational Amplifiers &Analog Integrated Circuits”, Mc Graw Hill India, 4/e.
3. Millman & Grabel, “Microelectronics”, McGraw Hill Education, 2/e.
4. K R Botkar, “Integrated Circuits”, Khanna Publishers, 10/e.
5. Gray, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5/e.
6. Horstian, “Micro Electronics”, Prentice Hall of India.
7. Sedra &Smith, “Microelectronic Circuits”, Oxford University Press, 5/e.
8. D A Bell, “Opamps and Linear Integrated Circuits”, Oxford University Press, 3/e.
9. Clayton,“Operational Amplifiers”, Butterworth &Co. (Publishers) Ltd. 5/e.

Course Level Assessment Questions

Course Outcome 1 (CO1)*:*

1. Discuss about basics of operational amplifier.
2. Explain the advantages of designing circuits using op amps.
3. Explain different characteristics of op amp.

Course Outcome 2 (CO2):

1. Explain different amplifiers design using op amps.
2. Explain the working of integrator, differentiator, log amplifier and antilog amplifier with derivations.

Course Outcome 3 (CO3):

1. Explain and design different networks like oscillators and waveform generators
2. Explain the working of voltage regulator.

Course Outcome 4 (CO4):

1. Explain the working of PLL
2. Explain the resolution and accuracy of ADC and DAC

Course Outcome 5 (CO5):

1. Explain the characteristics and requirement of active filters
2. Design different types of filters

Model Question Paper

Reg No.:_____

Name:_____

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

Course Code: EST206

Course Name: INTEGRATED CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. List out ideal op amp characteristics.
2. Explain about stability of op-amp?
3. Design a practical differentiator circuit with fa=1KHz and fb=10 KHz.
4. Design an instrumentation amplifier with gain=5.
5. Derive and explain Barkhausen criteria for oscillation.
6. Write a note on IC regulators.
7. Define the following terms with respect to DAC (i) Resolution (ii) Linearity (iii) Full scale output voltage
8. Explain the operation of Phase Locked Loop. What is lock range and capture range?
9. Draw the ideal and actual characteristic graph of LPF and HPF.
10. Design a first order wide BPF with lower cutoff frequency=1KHz and upper cutoff frequency=5KHz.

PART B

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

Module1

11. (a) Write a note on input bias current? Derive the equation for output offset voltage due to the input bias current? Also explain one method to overcome the effect of input bias

current. 10 marks

(b) Explain the term (1) CMRR (2) PSRR. 4 marks

12. (a) Write a note on input offset voltage? Derive the equation for output offset voltage due to input offset voltage? Also explain one method to overcome the effect of input offset voltage. (10 marks) (b) Output of op amp voltage follower circuit is a triangular waveform with Vpp=10V, and frequency= 2MHz, for a square wave input with frequency=2MHz and Vpp=8V, calculate the slew rate of the op amp. (4 marks).

Module2

13. Explain the working of basic integrator circuit with neat circuit diagram? List out the problems in the basic integrator circuit? Explain how this can be overcome by practical integrator circuit. (14 marks)

14. (a) Explain Instrumentation amplifier with neat circuit diagram and derive the equation for the output voltage. (10 marks)

(b) Explain zero crossing detector using op-amp (4 marks)

Module3

15. Explain the working of monostable multivibartor circuit using op amp and derive the equation for off time. Also design a monostable multivibrator circuit using op amp to generate an OFF pulse of duration=5msec. (14 marks)

16. Explain how short circuit, fold back protection and current boosting are done using IC723 voltage regulator. (14 marks)

Module4

17. Design a circuit to multiply the incoming frequency by a factor of 5 using 565 PLL IC?

(14 marks)

18. (a) Explain the working of successive approximation type ADC. (4 marks)

(b) Explain the working of dual slope ADC with neat circuit diagram and graphs. (10 marks)

Module 5

19. Explain the working of a second order low pass butterworth salen key filter, derive the equation and draw the characteristic graphs to prove that the filter exhibits a 40 db attenuation rate. (14 marks)

20. Explain Narrow band pass filter with neat circuit diagram and derive the equation for bandwidth, centre frequency and gain at centre frequency. (14 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Operational amplifiers**	**8**
1.1	Introduction of op amps- block level diagram of op amp	1
1.2	Basic information of op amp (741 op amp) - Power supply requirements	1
1.3	Characteristics of Operational Amplifiers	1
1.4	Ideal op amp characteristics	1
1.5	DC characteristics-input bias current, input offset current,	1
1.6	input offset voltage, thermal drift, CMRR, PSRR	1
1.7	AC characteristics- frequency response	1
1.8	stability of op amp, slew rate.	1
2	**Applications of Operational amplifiers**	**10**
2.1	Basic applications-inverting amplifier, non-inverting amplifier,	1
2.2	differential amplifier, scale changer	1
2.3	summing amplifier, subtractor, adder, voltage follower, V-I converter (grounded load type and floating load type)	1
2.4	Howland constant current circuit and I-V converter.	1
2.5	Instrumentation amplifier (3 op amp design)	1
2.6	op amp integrator- op amp differentiator-	1
2.7	op amp circuit using diodes-rectifier (half and full wave)	1
2.8	peak detector, sample and hold circuit, log and antilog amplifier, multiplier and divider	1
2.9	Comparator (inverting and non-inverting type)-applications of comparator	1
2.10	zero crossing detector, window detector, time marker generator	1
3	**Wave Shaping Multivibrator and Oscillator Circuits**	**9**
31	Timer IC 555- Functional diagram	1
3.2	Schmitt trigger-. – Astable design and working	1
3.3	Monostable design and working	1
3.4	Wave generators- Triangular and saw tooth	1

3.5	RC phase shift and Wien bridge oscillators	1
3.6	Voltage regulator-Introduction, series op amp regulator	1
3.7	IC regulators-78XX and 79XX characteristics	2
3.8	voltage regulator as current source-boosting IC regulator output current	
3.9	723 general purpose IC regulator	1
4	**PLL and Data Converters**	**9**
4.1	Phase Locked Loop – Operation	1
4.2	Closed loop analysis, Lock and capture range	1
4.3	, Basic building blocks	1
4.4	PLL IC 565, Applications of PLL.	1
4.5	Data Converters: Digital to Analog converters, Specifications	1
4.6	Weighted resistor type and R-2R Ladder type.	1
4.7	Analog to Digital Converters: Specifications, ADC-Direct type -Flash type, counter type	1
4.8	Servo type, successive approximation type- Integrating type ADC -	1
4.9	Single slope type and dual slope type	1
5	**Active Filters**	**9**
5.1	Introduction-LPF-first order filter	1
5.2	second order LP filter (sallen-key Butterworth), higher order filter	1
5.3	HPF- first order filter, second order filter (sallen-key Butterworth)	1
5.4	higher order filters	1
5.5	BPF-wide BPF	1
5.6	Narrow band pass filter-BRF-wide BRF,	1
5.7	narrow BRF (Twin T Notch design)	1

5.6	All pass filter-Switched capacitor filter	1
5.7	Quality factor–Design.	1

ERL 202	INTEGRATED CIRCUITS LAB	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2

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

CO 1	Use the various electronic instruments and for conducting experiments. (Cognitive Knowledge Level: **Apply**)
CO 2	Design and develop various electronic circuits using diodes and Zener diodes. (Cognitive Knowledge Level: **Apply**)
CO 3	Design and implement amplifier and oscillator circuits using BJT and JFET. (Cognitive Knowledge Level: **Apply**)
CO 4	Design and implement basic circuits using IC (OPAMP and 555 timers). (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	✓	✓	✓						✓			

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	**PO1 0**	Communication
PO5	Modern tool usage	**PO1 1**	Project Management and Finance
PO6	The Engineer and Society	**PO1 2**	Life long learning

LIST OF EXPERIMENTS

1. Measurement of current, voltage, frequency and phase shift of signal in a RC network using oscilloscope. *
2. Rectifier circuits. *
3. Clipping and clamping circuits using diodes. *
4. RC coupled amplifier using BJT in CE Configuration-Measurement of gain, BW and plotting of frequency response. *
5. Op-amp circuits – Design and set up of inverting and non-inverting amplifier, scale changer, adder, integrator, and differentiator. *
6. Op-amps circuits – Scale changer, adder, integrator, and differentiator. *
7. Precision rectifier using Op-amps.
8. Phase shift oscillator and Wein's Bridge oscillator using Op-amps. *
9. Waveform generation– Square, triangular and saw tooth waveform generation using OPAMPs.*
10. Basic comparator and Schmitt trigger circuits using Op-amp (Use comparator ICs such as LM311).
11. Design and testing of series voltage regulator using Zener diode.
12. Astable and Monostable circuit using 555 IC. *
13. A/D converters- counter ramp and flash type.
14. D/A Converters - R-2R ladder circuit, *
15. Study of PLL IC: free running frequency lock range capture range

** Mandatory

Reference Books

1. R E Boylstead and L Nashelsky: Electronic Devices and Circuit Theory, 9/e, Pearson Education.
2. Allan Mottershead, Electronic Devices &Circuits, Prentice Hall of India, NewDelhi, 2003.
3. Millman and Taub, Pulse, digital and Switching Waveforms, Tata McGrawHill, 2007.
4. Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.

Course Project

Students have to do a mandatory course project (group size not more than 4 students)

using to realise a functional analog circuit on PCB.

A maximum of 15 marks shall be awarded for this project (to be evaluated along with the final internal test). Report to be submitted.

Assessment Pattern

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Continuous Evaluation including Viva	Internal Test	Course Project	Total
15	30	15	15	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.

ERL 204	OBJECT ORIENTED PROGRAMMING LAB (IN JAVA)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2021

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 data types, 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	Continuous Evaluation including Viva	Internal Test	Course Project	Total
15	30	15	15	75

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 con- verted 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.

Course Project:

Students have to do a mandatory course project (group size not more than 4 students) using Java Programming. A maximum of 15 marks shall be awarded for this project (to be evaluated along with the final internal test). Report to be submitted.

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 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, Operations Performed, 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

The syllabus contains six sessions (A, B, C, D, E, F). Session A-E consists of three concrete Java exercises, out of which at least two questions are mandatory. Session F consists of a mandatory course project with report preparation.

(A) Basic programs using data types, 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 number of Sides( ). 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 number of Sides( ) 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) Course Project:

Design a Course project using Java Application Development techniques'.Use Swing class to create GUI based interface for the project.

** Mandatory

PRACTICE QUESTIONS

1) Write a Java program to reverse a 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).

SEMESTER IV

MINOR

ERT282	MICROPROCESSORS AND MICROCONTROLLERS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble:

The purpose of this course is to create awareness in students about the basics of microprocessors and microcontrollers.

Prerequisite: NIL

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

CO	CO
CO1	Describe the architecture, pin configuration and bus structure of 8085, also explain the timing diagram. **(Cognitive Knowledge Level: Understand)**
CO2	Discuss the instruction set of 8085 and explain various interfacing IC's with 8085, also Compare different x86 processors. **(Cognitive Knowledge Level: Understand)**
CO3	Describe the architecture, memory organization and instruction set of 8051 microcontroller. **(Cognitive Knowledge Level: Understand)**
CO4	Develop assembly language program of 8051 microcontroller and interface various peripheral devices with 8051. **(Cognitive Knowledge Level: Apply)**
CO5	Realize external communication interface to the microcontroller. **(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	50	30	30
Apply	20	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 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 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 any5.

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 (Basics of Microprocessor 8085)

Microprocessors: Introduction, organization of a microprocessor based system, evolution of microprocessors, 8085 architecture and its operation, microprocessor initiated operations and bus organization, pin configuration and functions, generation of control signals for external operations- fetch, IO/M, read/write. Machine cycles and bus timings.

Module - 2 (8085 instruction set and other microprocessors)

Instruction set of 8085.Simple examples in assembly language programming for 8085 (only for internal examination). Addressing modes. Overview/concept of peripheral IC interfacing with 8085 microprocessor (8255,8279). Introduction to 8086 and comparison between 8086,80286,80386,80486 and Pentium

Module - 3 (8051 microcontroller basics and instruction set)

8051 architecture, pin configuration, registers, internal memory, timers, Port structures, interrupts. Addressing modes, instruction set (brief study of 8051 instruction set is sufficient).

Module - 4 (Programming examples in 8051)

Simple programming examples in assembly language: addition, subtraction, multiplication and division, Programs using loops, interfacing of LCD display, keyboard, stepper motor, DAC, ADC with 8051.

Module - 5 (Open source embedded development boards)

Introduction Atmega 2560 microcontroller block diagram and pin description, Arduino mega 256 board: Introduction and pin description. Simple applications: Solar tracker, 4 digit 7 segment LED display, home security alarm system, digital thermometer, IOT applications.

Text Books

1. Ramesh S. Goankar. 8085 Microprocessors Architecture Application and Programming. Penram International, 5/e.
2. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition.

References

1. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage learning, 3/e.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe architecture of 8085 with diagram.
2. Describe the pin diagram of 8085.
3. Explain the bus structure of 8085.
4. Compare instruction cycle and machine cycle.
5. Draw the instruction cycle of various instructions.

Course Outcome 2 (CO2):

1. Explain the instruction set of 8085 with example.
2. Explain addressing modes of 8085 with example.

3. Draw the block diagram and explain the interfacing IC's 8279 and 8255.
4. Compare different x86 processors.

Course Outcome 3 (CO3):

1. Draw and explain the block diagram of 8051 microcontroller.
2. Explain the memory organization of 8051.
3. Discuss the instruction set of 8051 with examples.

Course Outcome 4 (CO4):

1. Write arithmetic and logic programs using 8051.
2. Explain LCD interfacing with 8051.
3. Explain stepper motor interfacing with 8051.
4. Explain keyboard interfacing with 8051.
5. Explain ADC and DAC interfacing with 8051.

Course Outcome 5 (CO5):

1. Draw the block diagram and pin diagram of Atmega 2560 microcontroller and Arduino mega 256 board.
2. Explain the following applications using Arduino mega 256 board: Solar tracker, 4 digit 7 segment LED display, home security alarm system, digital thermometer, IOT applications

Model Question Paper

QP CODE:
Reg No:_____
Name :_____ **PAGES : 3**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR Course Code: ERT 282

Course Name: Microprocessors and Microcontrollers

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Draw the bit pattern of 8085 flag register
2. Bring out the significance of the signals S0, S1 and IO/ M with reference to various operations of 8085 microprocessor
3. Compare the 8086 and 80386 processors

4. List out the addressing modes in 8085
5. Mention the specific features of 8051 microcontroller architecture
6. Compare the instruction CJNE and DJNZ.
7. What is an interrupt? List the interrupt sources of 8051
8. Write a program to subtract two 8 bit numbers present in the location 31h and 32h and store result in the location 33h in 8051.
9. Draw the block diagram of Arduino 256
10. Describe any one application of Arduino mega 256

(10 x 3 = 30 Marks)

PART B

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

11. The internal architecture of 8085 microprocessor has internal units capable to execute a program stored in external memory. Justify with relevant features and diagram.

(14 marks)

OR

12. (a) Illustrate with relevant timing diagram the sequence of operations involved for fetching and executing the instruction MVI C, 08H in 8085 microprocessors. **(7 marks)**

(b) How control signals are generating in 8085

(7 marks)

13. (a) Differentiate the instruction LDA and STA with examples?

(4 marks)

(b) Explain the block diagram and operation of the 8279 Keyboard/Display interface

(10 marks)

OR

14. (a) Explain the architecture of 8086 with a neat diagram **(7 marks)**

(b) Draw and explain the block diagram of 8051 **(7 marks)**

15. (a) Explain RAM organization in 8051 **(7 marks)**

(b) Draw and explain the block diagram of 8051

(7 marks)

OR

16. (a) Explain the addressing modes in 8051

(7 marks)

(b) Describe the data transfer instructions and arithmetic and logic instructions in 8051 with examples

(7 marks)

17. (a) Write a program to add two 16 bit numbers in 8051

(5 marks)

(b) Describe the Interfacing of a 16*2 alphanumeric LCD with 8051 and write the interfacing program.

(9 marks)

OR

18. (a) Write a program to find the sum of first 10 natural numbers.

(7 marks)

(b) Write a program to rotate a stepper motor 180 degree clockwise.

(7 marks)

19. (a) Draw and explain Atmega 2560 microcontroller block diagram.

(5 Marks)

(b) Write a program to interface 4 digit 7 segment LED display with Arduino mega 256 . Also draw the interfacing diagram.

(9 Marks)

OR

20. (a) Describe the pin diagram of Arduino mega 256 **(7 marks)**

(b) How Arduino mega 256 work as a digital thermometer **(7 Marks)**

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module – 1 (Basics of Microprocessor 8085) (8 hrs)		
1.1	Microprocessors: Introduction, organization of a microprocessor based system, evolution of microprocessors	1
1.2	8085 architecture and its operation	1
1.3	8085 operations	1
1.4	Microprocessor initiated operations and bus organization	1
1.5	Pin configuration and functions	1
1.6	Generation of control signals for external operations- fetch, IO/M, read/write	1
1.7	Machine cycles and bus timings	1
1.8	Timing diagram	1
Module - 2 (8085 instruction set and other microprocessors) (10 hrs)		
2.1	Instruction set of 8085	1
2.2	Instruction set of 8085	1
2.3	Instruction set of 8085	1
2.4	Simple examples in assembly language programming for 8085	1
2.5	Simple examples in assembly language programming for 8085	1
2.6	Addressing modes	1
2.7	Concept of peripheral IC interfacing with 8085-8279	1
2.8	Concept of peripheral IC interfacing with 8085-8255	1
2.9	Introduction to 8086 (architecture and concept of physical memory)	1
2.10	comparison between 8086,80286,80386,80486 and Pentium	1
Module - 3 (8051 microcontroller basics and instruction set) (9 hrs)		
3.1	8051 architecture, registers	1
3.2	Pin configuration	1

3.3	Memory organisation(RAM)	1
3.4	Memory organisation(ROM)	1
3.5	Timers, Port structures	1
3.6	Interrupts	1
3.7	Addressing modes	1
3.8	Instruction set	1
3.9	Instruction set	1
Module - 4 (Programming examples in 8051) (9 hrs)		
4.1	Simple Programming examples in 8051, Addition, Subtraction, multiplication and division	1
4.2	Other simple Programming examples in 8051	1
4.3	Programs using loops.	1
4.4	Programs using loops.	1
4.5	LCD interfacing	1
4.6	Keyboard interfacing	1
4.7	Stepper motor interfacing	1
4.8	ADC interfacing	1
4.9	DAC interfacing	1
Module - 5 (Open source embedded development boards) (9 hrs)		
5.1	Introduction Atmega 2560 microcontroller block diagram	1
5.2	Pin description	1
5.3	Arduino mega 256 board: Introduction	1
5.4	Pin description	1
5.5	Solar tracker	1
5.6	4 digit 7 segment LED display	1
5.7	Home security alarm system	1
5.8	Tilt sensor, digital thermometer	1
5.9	IOT applications	1

CODE	MATHEMATICS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
CST284		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

	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	√	√	√	√		√						√

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 - Change of 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. Find the set ***S*** of all solution sin***x*** of the following in homogeneous linear systems ***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 if possible

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

3. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue 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 $P(J \square T)$
   iii. Find $P(J \cap T')$
2. Let A and B be events such that $P(A)=0.45$, $P(B)=0.35$ and $P(A \cup B)=0.5$. Find $P(A|B)$.
3. A random variable **R** has the probability distribution as shown in the followingtable:

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 optimization problem 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 update when 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 constraints

$$\begin{aligned} x_1 + 2x_2 + 3x_3 + x_4 &\leq 5 \\ x_1 + x_2 + 2x_3 + 3x_4 &\leq 3 \\ x_1, x_2, x_3, x_4 &\geq 0 \end{aligned}$$

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: CST284

Course Name: MATHEMATICS FOR 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. $x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}$, $x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}$, $x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$	
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 $Tn, n = 0, \ldots, 5$ 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.	

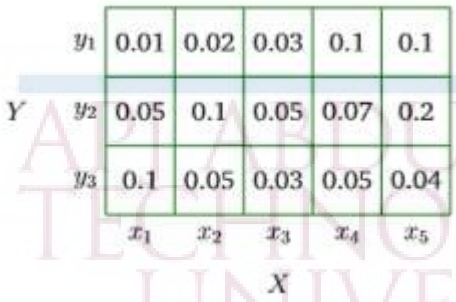
PART B

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 R^3. What is ***dim (W)*** and why?	(4)
	b)	A set of ***n*** linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3),(0, 1, 1),(0, 1,−1)** form a basis for 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 $\sum_{i=1}^{3} x_i = 1$.	(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 ***L*** be the line through the origin in 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 ***L*** which is closest to the point **(7, 1)** and find the point on ***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 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 $A = SDS^T$	

15	a)	Askierisonamountainwithequation$z=100-0.4x^2-0.3y^2$,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 $(0, \pi)$, and then use your answer to estimate $f(0.001, \pi)$.	(6)
		OR	
16	a)	Let ***g*** be the function given by $$g(x,y) = \begin{cases} \dfrac{x^2y}{x^2+y^2} & \text{if } (x,y) \neq (0,0); \\ 0 & \text{if } (x,y) = (0,0). \end{cases}$$ i. Calculate the partial derivatives of ***g*** at **(0,0)**. ii. Show that ***g*** is not differentiable at **(0,0)**.	(8)
	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’	(6)

		i. What is P(A|C)? ii. What is P(B|C)? iii. Are A and C independent? What about B and C?	
	b)	Consider the following bivariate distribution p(x,y) of two discrete random variables X and Y .  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).	(8)
19	a)	Find the extrema of $f(x,y,z) = x - y + z$ subject to $g(x,y,z) = x^2 + y^2 + z^2 = 2$.	(8)
	b)	Let $P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}$, $q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}$, and $r = 1$. Show that $x^* = (1, 1/2, -1)$ is optimal for the optimization problem $\min \quad \frac{1}{2}x^T Px + q^T x + r$ $\text{s.t.} \quad -1 \le x_i \le 1,\ i = 1, 2, 3.$	(6)
		OR	
20	a)	Derive the gradient descent training rule assuming that the target function is represented as $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. 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 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)
		***	

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

CST 286	INTRODUCTION TO COMPUTER NETWORKS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2019

Preamble: This is the second course for awarding B. Tech. Minor in Computer Science and Engineering with specialization in ***Networking***. Study of this course provides the learners a clear understanding of how computer networks from local area networks to the massive and global Internet are built and how they allow the usage of computers to share information and communicate with one another. This course covers the layers of OSI Reference models and inter-networking. This course helps the learners to compare and analyze the existing network technologies and to choose a suitable network design for a given system.

Prerequisite: Data Communication **(CST 255)**

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

CO 1	Explain the features of computer networks, protocols and network design models **(Cognitive Knowledge : Understand)**
CO 2	Discuss the design issues of data link layer, data link layer protocols, bridges and switches **(Cognitive Knowledge : Understand)**
CO 3	Illustrate wired LAN protocols (IEEE 802.3/4/5) and wireless LAN protocols (IEEE 802.11a/b/g/n, 802.15) **(Cognitive Knowledge : Understand)**
CO 4	Select appropriate routing algorithms, congestion control techniques and Quality of Service requirements for a network **(Cognitive Knowledge : Apply)**
CO 5	Illustrate the functions and protocols of network layer, transport layer and application layer in inter-networking **(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	✓	✓	✓			✓				✓		✓

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	40	30	30
Understand	60	50	50
Apply		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 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

Introduction – Uses of Computer Networks, Network Hardware, Network Software, Reference Models – The OSI Reference Model, The TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference models.

Module 2

The Data Link Layer - Data Link layer Design Issues, Error Detection and Correction, Elementary Data Link Protocols, Sliding Window Protocols, HDLC (High-Level Data Link Control) Protocol. The Medium Access Control (MAC) Sub layer – The Channel Allocation Problem, Multiple Access Protocols, Ethernet, Wireless LANs - 802.11 a/b/g/n, Bridges & Switches.

Module 3

Network Layer Design Issues. Routing Algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast Routing, Routing for Mobile Hosts. Congestion Control Algorithms, Quality of Service (QoS) - Requirements, Techniques for Achieving Good QoS.

Module 4

Network Layer in Internet – The IP Protocol, IP Addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (**RARP**), Bootstrap Protocol (**BOOTP**), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First (**OSPF**) Protocol, Border Gateway Protocol (**BGP**), Internet Multicasting, IPv6, ICMPv6.

Module 5

Transport Layer – The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives. The User Datagram Protocol (UDP), Transmission Control Protocol (TCP) – Overview of TCP, TCP Segment Header, Connection Establishment & Release, Connection Management Modeling, TCP Retransmission Policy, TCP Congestion Control.

Application Layer – File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, MIME, Simple Network Management Protocol (SNMP), World Wide Web – Architectural Overview.

Text Book

Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).

Reference Books

1. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill
2. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.
3. Fred Halsall, Computer Networking and the Internet, 5/e.
4. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.
5. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
6. W. Richard Stevens. TCP/IP Illustrated volume 1, Addison-Wesley, 2005.
7. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
8. Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html

Sample Course Level Assessment Questions

CourseOutcome1 (CO1): Compare TCP/IP Reference model and OSI Reference model.

CourseOutcome2 (CO2): Distinguish between switches and bridges.

CourseOutcome3 (CO3): Draw and explain the frame format for Ethernet.

CourseOutcome5 (CO4): Discuss remedies for count to infinity problem in routing.

CourseOutcome4 (CO5): Subnet the Class C IP Address 206.16.2.0 so that you have 30 subnets. What is the subnet mask for the maximum number of hosts? How many hosts can each subnet have?

Model Question Paper

QP CODE: PAGES: ___

Reg No:_____
Name:_____

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

Course Code: CST 286

Course name : INTRODUCTION TO COMPUTER NETWORKS

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

PART-A

(Answer All Questions. Each question carries 3 marks)

1. Why Layered Architecture is used in Computer Networks? Define the terms protocol and interface?
2. What are the different service primitives in Computer Networks?
3. Draw and explain Ethernet frame format.
4. What is the output string when the bit string 0111101111101111110 is subjected to bit stuffing?
5. Discuss the count to infinity problem in routing.
6. What is flooding? Describe any two situations where flooding is advantageous.
7. What is IP (Internet Protocol) subnetting? Illustrate with example.
8. How many octets does the smallest possible IPv6 (IP version 6) datagram contain?
9. Can TCP (Transmission Control Protocol) be used directly over a network (e.g. an Ethernet) without using IP? Justify your answer
10. What is the role of SNMP (Simple Network Management Protocol)?

(10x3=30)

Part B

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

Module I

11. (a) With a neat diagram, explain the OSI (Open Systems Interconnection) reference Model. **(8)**
(b) Compare OSI Reference model and the TCP/IP model **(6)**

OR

12. (a) Consider two networks providing reliable connection-oriented service. One of them offers a reliable byte stream and the other offers a reliable message stream. Are they identical? Justify your answer. **(8)**
(b) Compare LAN (Local Area Networks), MAN (Metropolitan Area Networks) and WAN (Wide Area Networks). **(6)**

Module II

13. (a) Discuss the different strategies used to avoid collisions in CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) . **(8)**
(b) Briefly explain the working of HDLC (High-Level Data Link Control). **(6)**

OR

14. (a) Explain the working of IEEE 802.11. **(10)**
(b) Distinguish between Bridges and Switches. **(4)**

Module III

15. (a) Illustrate Distance Vector Routing Algorithm with an example. **(8)**
(b) Explain the characteristics of RIP (Routing Information Protocol). **(6)**

OR

16. (a) Explain an Interior Gateway protocol that uses a link state algorithm to propagate routing information. **(6)**
(b) Explain how routing is performed in a Mobile network. **(8)**

Module IV

17. (a) Explain address resolution problem and RARP (Reverse Address Resolution Protocol) with an example network. **(10)**

(b) How IGMP (Internet Group Management Protocol) supports internet multicasting? Explain. **(4)**

OR

18. (a) Subnet the class C IP address 195.1.1.0 so that you have 10 subnets with a maximum of 12 hosts in each subnet. **(6)**

(b) Draw IPv6 Datagram format and explain its features **(8)**

Module V

19. (a) Distinguish between TCP and UDP (User Datagram Protocol) header formats. **(8)**

(b) Explain the principal DNS (Domain Name System) resource record types for IPv4. **(6)**

OR

20. (a) What is the role of SMTP (Simple Mail Transfer Protocol) in E-mail? **(6)**

(b) With the help of a basic model explain the working of WWW (World Wide Web). **(8)**

Teaching Plan

	Module 1	**(8 Hours)**
1.1	Introduction – Uses of Computer Networks.	1
1.2	Network Hardware – Local Area Networks (LAN), Metropolitan Area Networks (MAN), Wide Area Networks (WAN).	1
1.3	Network Hardware – Wireless Networks, Home Networks, Internetworks	1
1.4	Network Software — Protocol Hierarchies.	1
1.5	Network Software — Design issues for the layers.	1
1.6	Network Software – Connection Oriented and Connectionless Services, Service Primitives, Relationship of Services to Protocols.	1
1.7	Reference Models – The OSI Reference Model	1

1.8	Reference Models – The TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference models	1
Module 2		**(11 Hours)**
2.1	Data Link layer Design Issues.	1
2.2	Error Detection and Correction - Error Correcting Codes	1
2.3	Error Detection and Correction - Error Detecting Codes	1
2.4	Elementary Data link Protocols.	1
2.5	Sliding Window Protocols.	1
2.6	HDLC (High-Level Data Link Control) Protocol	1
2.7	The Medium Access Control (MAC) Sub layer – The Channel Allocation Problem, Multiple Access Protocols.	1
2.8	Ethernet - Ethernet Cabling, Manchester Encoding, The Ethernet MAC Sub layer Protocol, The Binary Exponential Backoff Algorithm.	1
2.9	Ethernet - Ethernet Performance, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.2: Logical Link Control.	1
2.10	Wireless LANs - 802.11 a/b/g/n.	1
2.11	Bridges & Switches.	1
Module 3		**(9 Hours)**
3.1	Network Layer Design Issues.	**1**
3.2	Routing Algorithms - The Optimality Principle, Shortest path routing, Flooding.	**1**
3.3	Distance Vector Routing, Link State Routing.	**1**
3.4	Link State Routing.	**1**
3.5	Multicast Routing, Routing for Mobile Hosts	**1**
3.6	Distance Vector Routing, Link State Routing	**1**

3.7	Congestion control algorithms - General Principles of Congestion Control, Congestion Prevention Policies, Congestion Control in Virtual-Circuit Subnets	**1**
3.8	Congestion control algorithms - Congestion Control in Datagram Subnets, Load Shedding, Jitter Control	**1**
3.9	Quality of Service – Requirements, Techniques for Achieving Good Quality of Service.	**1**
Module 4		**(9 Hours)**
4.1	Network layer in internet, IP Protocol	1
4.2	IP Addresses – Subnets, Classless Inter Domain Routing (CIDR)	1
4.3	IP Addresses - Network Address Translation (NAT)	1
4.4	Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP),	1
4.5	Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP)	1
4.6	Open Shortest Path First (**OSPF**) Protocol	1
4.7	Border Gateway Protocol (**BGP**)	1
4.8	Internet Multicasing.	1
4.9	IPv6, Internet Control Message Protocol version 6 (ICMPv6).	1
Module 5		**(8 Hours)**
5.1	The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives. The User Datagram Protocol (UDP)	1
5.2	Transmission Control Protocol (TCP) – Overview of TCP, TCP Segment Header, Connection Establishment & Release, Connection Management Modeling.	1
5.3	TCP Retransmission Policy, TCP Congestion Control.	1
5.4	Application Layer – File Transfer Protocol (FTP).	1
5.5	Domain Name System (DNS).	1

5.6	Electronic Mail.	1
5.7	Simple Network Management Protocol (SNMP)	1
5.8	World Wide Web – Architectural Overview	1

SEMESTER IV

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
ERT292	DIGITAL SYSTEM DESIGN	VAC	3	1	0	4

Preamble: The objective of the course is to familiarize basic digital concepts and digital system design. This covers the basic concepts of Quine Mc Clusky algorithm and design of combinational and sequential circuits. The course also gives an insight into Verilog programming of combinational and sequential modules.

Prerequisite: Fundamentals of Digital Systems and VLSI Design (ERT 203) course.

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

CO 1	Design combinational circuits. (Cognitive Knowledge Level: **Apply**)
CO 2	Design synchronous sequential circuits. (Cognitive Knowledge Level - **Apply**)
CO 3	Understand the concept of ASM charts and state reduction tables. (Cognitive Knowledge Level -**Understand**)
CO 4	Understand programming concepts in Verilog. (Cognitive Knowledge Level - **Understand**)
CO 5	Write various programs using Verilog programming Language. (Cognitive Knowledge Level- **Apply**)

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	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	✔	✔	✔	✔								✔

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	20	20	40
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. Give the relevance of combinational circuit design

2. Explain concept of Quine Mc Cluskey method.

Course Outcome 2 (CO2):

1. Give the relevance of sequential circuit design

2. Study and design FSM using Mealy and Moore models

Course Outcome 3 (CO3):

1. Explain the relevance of ASM.

2. Explain importance of reduction of state tables.

Course Outcome 4 (CO4):

1. List different operators in Verilog

2. write Verilog programs on simple combinational circuits

Course Outcome 5 (CO5):

1. Explain different programming concepts in verilog
2. Write Verilog programs on sequential circuits and test benches to simulate the program .

Syllabus

Module 1 (Combinational Circuit Design Overview)

Combinational circuit implementation using Quine Mc Cluskey algorithm, decoder, encoder, multiplexers, ROM and PLA ,Implementation of multi output gate implementation.

Module 2 (Finite State Machine)

Finite State machine: State diagram, State Table, State assignmemts, state graphs, capabilities and limitations of FSM, Metastability, clock skew, Mealy and Moore machines, Modelling of clocked synchronous circuits as Mealy and Moore machines: Serial binary adder , sequence detector design examples.

Module 3 (Arithmetic State Machine)

Digital System Design Hierarachy: state assignments, reduction of state tables, equivalent states, determination of state equivalence using implication table, Algorithm state machine, ASM charts,Design example.

Module 4 (Verilog Overview)

Introduction to Verilog HDL:Design units,Data objects, signal drivers, Delays,Data types, Language elements, operators, user defined primitives, modelling dataflow, behavioural, structural,Verilog implementation of simple combinational circuits, adder, code converter, decoder, encoder, multiplexer, demultiplexer.

Module 5 (Verilog Programming)

Verilog HDL implementation of binary multiplier, divider, barrel shifter, FSM, linear feedback shift register, simple test bench for combinational circuits.

Text Book:

1. Fundamentals of Digital Design (5 th Edition)- Charles H. Roth, Course Technology.

Reference Books:

1. Fundamentals of Digital Logic with Verilog HDL -S Brown &Z. Varanestic, Mc Graw Hill.
2. Verilog HDL a guide to digital design & synthesis -Samir Palitkar, Pearson.
3. Digital Principles of Design- Donald D Givone, McGraw Hill.

Model Question Paper

Reg

No.:_____Name:

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

MONTH AND YEAR **Course Code: ERT292**

Course Name: DIGITAL SYSTEM DESIGN

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

PART A

Answer all questions, each carries 3 marks

1. What are equivalent states?
2. Implement the function $F(A,B,C,D)=\sum_m(1,3,10,15)$using 4 bit input mux and NOR gates.
3. What is FSM?
4. What are the different types of sequential machines?
5. Design a priority encoder.
6. Draw ASM chart for 3 bit binary upcounter .
7. Write Verilog code for 2:1 mux and test bench for the same.
8. Explain data flow modelling with an example.
9. Explain Linear feedback shift register.
10. Write a Verilog for SISO shift register.

PART B

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

Module1

11. Impement the function f(a,b,c,d)=)=$\sum_m(0,1,2,5,6,7,8,9,10,14)$ using Quine Mc Cluskey Method. (14 marks)

12. A) Implement the function $F=\sum_m(0,2,5,7,8,10,12,15)$ using 8:1 mux. (7 marks)

B) Implement using PLA 1) $F_0=\sum_m(1,4)$ 2) $F_1=\sum_m(0,2)$ (7 Marks)

Module 2

13. What are the steps involved in deriving state table ,state graph & state diagram. Derive state diagram. (14 marks)

PS(Q(t)	J(t)K(t)			
	00	01	10	11
0	0	0	1	1
1	1	0	1	0
	NS Q(t+1)			

14. Design a Serial binary Adder using Mealy Machine. (14 Marks)

Module 3

15.Design a sequence detector that produces an output '1' whenever the non – overlapping sequence 1011 is detected. (14 Marks)

16. Draw the state diagram, state table,ASM chart for a 2 bit binary counter having one
17. Enabled ' E' such that E=1, counting enabled, and E=0, counting disabled. (14 Marks)

Module 4

18. Design a 4 bit full adder using dataflow modelling .Also write its test bench. (14 Marks)

19. a) What are blocking and Non-blocking assignments.? (5 marks)

b) What are different operators in Verilog. (9marks)

Module 5

20. Write a Verilog Code for Barrel shifter . (14 marks)

21. Write a Verilog code binary multiplier . (14 marks)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Combinational circuit Design Overview**	**9**
1.1	Combinational circuit implementation using Quine Mc Cluskey algorithm	1
1.2	Combinational circuit implementation using Quine Mc Cluskey algorithm	1
1.3	decoder	1
1.4	encoder	1
1.5	multiplexers	1
1.6	ROM	1
1.7	PLA	1
1.8	Implementation of multi output gate implementation	1
1.9	Implementation of multi output gate implementation	1
2	**FSM**	**11**
2.1	Finite State machine: State diagram	1
2.2	State Table, State assignments	1
2.3	state graphs,	1
2.4	capabilities and limitations of FSM	1
2.5	Metastability, clock skew	1
2.6	Mealy machine	1
2.7	Moore machines	1
2.8	Modelling of clocked synchronous circuits as Mealy and Moore machines	1
2.9	Modelling of clocked synchronous circuits as Mealy and Moore machines	1
2.10	Serial binary adder	1
2.11	sequence detector design examples	1
3	**ASM**	**8**
3.1	Digital System Design Hierarchy: state assignments,	1
3.2	reduction of state tables	1

3.3	equivalent states	1
3.4	Determination of state equivalence using implication table.	1
3.5	Algorithm state machine,	1
3.6	ASM charts	1
3.7	Design example	1
3.8	Design example	1
4	**Verilog overview**	**9**
4.1	Introduction to Verilog HDL: Design units,	1
4.2	Data objects, signal drivers	1
4.3	Delays, Data types, Language elements	1
4.4	operators, user defined primitives	1
4.5	Modelling dataflow, behavioural, structural	1
4.6	Verilog implementation of simple combinational circuits	1
4.7	adder,code converter	1
4.8	decoder, encoder	1
4.9	multiplexer, demultiplexer.	
5	**Verilog Programming**	**8**
5.1	Verilog HDL implementation of binary multiplier	1
5.2	Verilog HDL implementation of binary multiplier	1
5.3	Divider	1
5.4	Divider	1
5.5	Barrel shifter	1
5.6	FSM	1
5.7	linear feedback shift register	1
5.8	Simple test bench for combinational circuits.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT	Year of Introduction
CST292	NUMBER THEORY	VAC	4	0	0	4	2019

Preamble: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in ***Security in Computing***. The purpose of this course is to create awareness among learners about the important areas of number theory used in computer science. This course covers Divisibility & Modular Arithmetic, Primes & Congruences, Euler's Function, Quadratic Residues and Arithmetic Functions, Sum of Squares and Continued fractions. Concepts in Number Theory help the learner to apply them eventually in practical applications in Computer organization & Security, Coding & Cryptography, Random number generation, Hash functions and Graphics.

Prerequisite: A sound background in Higher Secondary School Mathematics

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

CO1	Illustrate modular arithmetic operations, methods and techniques **(Cognitive Knowledge Level:Understand)**
CO2	Use the methods - Induction, Contraposition or Contradiction to verify the correctness of mathematical assertions (**Cognitive Knowledge Level: Apply)**
CO3	Utilize theorems and results about prime numbers, congruences, quadratic residues and integer factorization for ensuring security in computing systems (**Cognitive Knowledge Level: Analyse)**
CO4	Illustrate uses of Chinese Remainder Theorem & Euclidean algorithm in Cryptography and Security (**Cognitive Knowledge Level: Apply)**
CO5	Explain applications of arithmetic functions in Computer Science **(Cognitive Knowledge Level:Understand)**
CO6	Implement Number Theoretic Algorithms using a programming language (**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 (Percentage)
	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

Divisibility and Modular Arithmetic:

Finite Fields – Groups, Rings and Fields.

Divisibility - Divisibility and Division Algorithms, Well ordering Principle,Bezout's Identity.

Modular Arithmetic- Properties, Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm, Least Common multiple, Solving Linear Diophantine Equations, Modular Division.

Module 2

Primes and Congruences:

Prime Numbers-Prime Numbers andprime-powerfactorization, Fermat and Mersenne primes., Primality testing and factorization.

Congruences-Linear congruences, Simultaneous linear congruences, Chinese Remainder Theorem, Fermat's little theorem, Wilson's theorem.

Module 3

Congruences with a Prime-Power Modulus&Euler's Function:

Congruences with a Prime-Power Modulus-Arithmetic modulo p, Pseudoprimes and Carmichael numbers, Solving congruences modulo prime powers.

Euler's Function-Euler's Totient function, Applications of Euler's Totient function, Traditional Cryptosystem, Limitations.

The Group of units- The group U_n,Primitive roots, Existence of primitive roots, Applications of primitive roots.

Module 4

Quadratic Residues & Arithmetic Functions :

Quadratic Residues- Quadratic Congruences, The group of Quadratic residues, Legendre symbol, Jacobi Symbol, Quadratic reciprocity.

Arithmetic Functions- Definition and examples, Perfect numbers, Mobius function and its properties, Mobius inversion formula, The Dirichlet Products.

Module 5

Sum of Squares and Continued Fractions:

Sum of Squares- Sum of two squares, The Gaussian Integers, Sum of three squares, Sum of four squares.

Continued Fractions -Finite continued fractions, Infinite continued fractions, Pell's Equation, Solution of Pell's equation by continued fractions.

Text Books

1. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.

2. Joseph Silverman, A Friendly introduction to Number Theory, Pearson Ed. 2009.

Reference Books

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Ed.

2. Tom M.Apostol, 'Introduction to Analytic Number Theory', Narosa Publishing House Pvt. Ltd, New Delhi, (1996).

3. Neal Koblitz, A course in Number Theory and Cryptography, 2nd Edition, Springer ,2004.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Describe the properties of modular arithmetic and modulo operator.

Course Outcome 2 (CO2): Prove that the equation $y^2 = x^3 - 2$ has only the integer solution $(3, \pm 5)$.

Course Outcome 3 (CO3): State the law of reciprocity for Jacobi symbols and use it to determine whether 888 is a quadratic residue or non residue of the prime 1999.

Course Outcome 4 (CO4): Using Chinese remainder theorem, solve the system of congruence $x \equiv 2 \pmod 3$, $x \equiv 3 \pmod 5$, $x \equiv 2 \pmod 7$

Course Outcome 5(CO5): State and prove Dirichlet product.

Course Outcome 6 (CO6): Use extended Euclid's algorithm to solve Diophantine equations efficiently. Given three numbers $a>0$, $b>0$, and c, the algorithm should return some x and y such that $a x + b y = c$.

Model Question Paper

QP CODE: PAGES: 03

RegNo : …..... Name :……..……

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER BTECH (HONOURS) DEGREE EXAMINATION, MONTH &YEAR

Course Code:CST 292 Course
Name: Number Theory

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

PART A

Answer all Questions. Each question carries 3 Marks (10x3=30)

1. State and prove well ordering principle.
2. Find gcd d of x=525 and y=231 and express d as ax + by where a and b are integers.
3. Solve the congruence equation 103 x≡ 57 (mod 211).
4. Use Fermat's Little theorem to show that 91 is not a prime.
5. If m is relatively prime to n , show that $\Phi(mn) = \Phi(m)\,\Phi(n)$.
6. Explain how public key cryptography can be used for digital signatures.
7. Define Mobius function and prove Mobius function is a multiplicative.
8. State and prove Dirichlet product.
9. Show that every prime of the form 4k+1 canbe represented uniquely as the sum of two squares.
10. Find the continued fraction representation of the rational number 55/89.

Part B

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

11. (a) State the Euclidean algorithm and its extension with an example. (7)
    (b) Find all the solutions of 24x + 34 y = 6. (7)

OR

12. (a) Describe the properties of modular arithmetic and modulo operator. (7)
    (b) Explain Extended Euclidean algorithm. Using the algorithm find the

multiplicative inverse of 135 mod 61 (7)

13. (a) State and prove Wilson's theorem . (7)

(b) Explain Fermat's factorization method and use it to factor 809009 (7)

OR

14. (a) Using Chinese remainder theorem, solve the system of congruences, $x \equiv 2 (\text{mod } 3)$, $x \equiv 3 (\text{mod } 5)$, $x \equiv 2 (\text{mod } 7)$ (7)

(b) Define Fermat primes. Show that any two distinct Fermat numbers are Relatively prime. (7)

15. (a) Distinguish between public key and private key encryption techniques. Also point out the merits and demerits of both. (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)Define a pseudo prime to a base and find all non trivial bases for which 15 is a pseudo prime. (6)

(b) Find an element of

i) order 5 modulo 11 ii) order 4 modulo 13

iii) order 8 modulo 17 iv) order 6 modulo 19 (8)

17. (a) Determine the quadratic residues and non residues modulo 17. Also determine whether 219 is a quadratic residue or non residue of the prime 383. (8)

(b) State the law of quadratic reciprocity. Determine those odd primes p for which 3 is a quadratic residue and those for which it is a non residue. (6)

OR

18. (a) State and prove properties of Legendre's symbol. (7)

(b) State the law of reciprocity for Jacobi symbols and using it determine whether 888 is a quadratic residue or non residue of the prime 1999. (7)

19. (a) Prove that the equation $y^2 = x^3 - 2$ has only the integer solution $(3, \pm 5)$. (7)

(b) Define a Gaussian integer. Factorize the Gaussian integer 440 − 55i. (7)

OR

20. (a) If *m*, and *n* can be expressed as sum of four squares, then show that *mn* can also be expressed the sum of four squares. (7)

(b) Find all the solutions of the Diophantine equation $x^2 - 6y^2 = 1$. (7)

Teaching Plan

Module 1: Divisibility and Euclidean Algorithm		**9 hours**
1.1	Finite Fields – Groups and Rings.	1 hour
1.2	Finite Fields – Fields.	1 hour
1.3	Divisibility and Division Algorithms, Well ordering Principle.	1 hour
1.4	Decimal Expansion of a positive Integer, Greatest Common Divisor, Bezout's Theorem.	1 hour
1.5	Modular Arithmetic- Properties of congruences, Modular Arithmetic Operations, Properties of Modular Arithmetic.	1 hour
1.6	Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm.	1 hour
1.7	Solving Linear Diophantine Equations.	1 hour
1.8	Least Common multiple and Modular Division.	1 hour
1.9	Implementation of Euclid's algorithm, Extended Euclid's Algorithm and solution of Linear Diophantine Equations.	1 hour
Module 2: Primes and Congruences		**9 hours**
2.1	Prime Numbersand prime-powerFactorization.	1 hour
2.2	Fermat and Mersenne primes.	1 hour
2.3	Primality testing and factorization, Miller -Rabin Test for Primality.	1 hour
2.4	Pollard's Rho Method for Factorization, Fermat's Factorization.	1 hour

2.5	Linear congruences, Simultaneous linear congruences.	1 hour
2.6	Chinese Remainder Theorem.	1 hour
2.7	Implementation of Chinese Remainder Theorem.	1 hour
2.8	Fermat's little theorem.	1 hour
2.9	Wilson's theorem.	1 hour
Module 3: Congruences with a Prime-Power Modulus &Euler's Function		**9 hours**
3.1	Congruences with a Prime-Power Modulus, Arithmetic modulo p.	1 hour
3.2	Pseudo-primes and Carmichael numbers.	1 hour
3.3	Solving congruences modulo prime powers.	1 hour
3.4	Definition of Euler Totient function, Examples and properties.	1 hour
3.5	Multiplicativity of Euler's Totient function.	1 hour
3.6	Applications of Euler’s function, Euler’s Theorem.	1 hour
3.7	Traditional Cryptosystem, Limitations, Public Key Cryptography.	1 hour
3.8	The Group of Units, Primitive Roots.	1 hour
3.9	Existence of primitive roots for Primes, Applications of primitive roots.	1 hour
Module 4: Quadratic Residues and Arithmetic Functions		**9 hours**
4.1	Quadratic congruences, The group of Quadratic Residues.	1 hour
4.2	Legendre symbol, Jacobi Symbol.	1 hour
4.3	Quadratic reciprocity.	1 hour
4.4	Quadratic residues for prime-power moduli.	1 hour
4.5	Arithmetic Functions: Definition and examples.	1 hour

4.6	Perfect numbers, Definition and proposition.	1 hour
4.7	Mobius inversion formula., application of the Mobius inversion formula.	1 hour
4.8	Mobius function and its properties.	1 hour
4.9	The Dirichlet Product, Definition and proof.	1 hour
Module 5: Sum of Squares and Continued Fractions		**9 hours**
5.1	Sum of Squares, Sum of two squares.	1 hour
5.2	The Gaussian Integers.	1 hour
5.3	Sum of three squares.	1 hour
5.4	Sum of four squares.	1 hour
5.5	Continued Fractions, Finite continued fractions.	1 hour
5.6	Continued Fractions, Finite continued fractions.	1 hour
5.7	Infinite continued fractions.	1 hour
5.8	Pell's Equation, Definition.	1 hour
5.9	Solution of Pell's equation by continued fractions.	1 hour

CODE CST294	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 - Change of 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. Find the set S of all solutions in x of the following inhomogeneous linear systems $Ax = b$, 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 if possible

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

3. Find the characteristic equation, eigenvalues, and eigenspaces corresponding to each eigenvalue 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 $P(J \square T)$
   iii. Find $P(J \cap T')$
2. Let A and B be events such that $P(A)=0.45$, $P(B)=0.35$ and $P(A \cup B)=0.5$. 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 optimization problem 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 update when 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 constraints

$$\begin{aligned} x_1 + 2x_2 + 3x_3 + x_4 &\leq 5 \\ x_1 + x_2 + 2x_3 + 3x_4 &\leq 3 \\ x_1, x_2, x_3, x_4 &\geq 0 \end{aligned}$$

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: CST294

Course Name: COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING

Max. Marks: 100 | Duration: 3 Hours

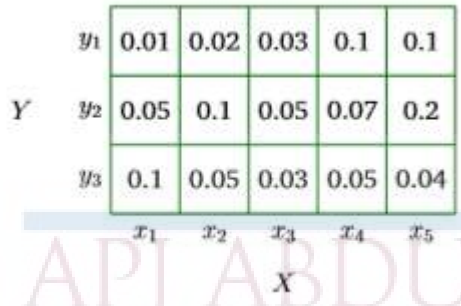
PART A

		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 $Tn, n = 0, \ldots, 5$ 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 R^3. What is ***dim (W)*** and why?	(4)
	b)	A set of ***n*** linearly independent vectors in R^n forms a basis. Does the set of vectors **(2, 4,−3),(0, 1, 1),(0, 1,−1)** form a basis for 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 $\sum_{i=1}^{3} x_i = 1$.	(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 ***L*** be the line through the origin in 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 ***L*** which is closest to the point **(7, 1)** and find the point on ***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 R^3 consisting of eigenvectors for the following matrix. $\begin{bmatrix} 1 & 0 & -2 \\ 0 & 5 & 0 \\ -2 & 0 & 4 \end{bmatrix}$	(8)
		ii. Find a 3×3 orthogonal matrix ***S*** and a 3×3 diagonal matrix ***D*** such that $A = SDS^T$	
15	a)	Ask ier is on a mountain with the equation $z = 100 – 0.4x^2 – 0.3y^2$, where ***z*** 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 begin skiing. **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 $$g(x,y) = \begin{cases} \dfrac{x^2 y}{x^2 + y^2} & \text{if } (x,y) \neq (0,0); \\ 0 & \text{if } (x,y) = (0,0). \end{cases}$$	(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 $f(x,y) = e^{-(x2+y2)} \cos(xy)$ 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 .  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 $f(x,y,z) = x - y + z$ subject to $g(x,y,z) = x^2 + y^2 + z^2 = 2$.	(8)
	b)	Let $P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}$, $q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}$, and $r = 1$. Show that $x^* = (1, 1/2, -1)$ is optimal for the optimization problem $\min \quad \frac{1}{2}x^T Px + q^T x + r$ $\text{s.t.} \quad -1 \le x_i \le 1,\ i = 1, 2, 3.$	(6)
		OR	
20	a)	Derive the gradient descent training rule assuming that the target function is represented as $o_d = w_0 + w_1x_1 + \ldots + w_nx_n$. 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 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)
		***	

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