

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER III

KTU



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, Cyclic group. 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 $\forall M, \exists RVS, \exists M, \exists S$ 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 $R = \{(x,y) / x \in Z, y \in Z, x - y \text{ is divisible by } 3\}$. 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, 3², 3³

Course Outcome 6 (CO6):

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

Model Question Paper

QP CODE:

Reg No: _____

Name : _____

PAGES : 3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT 203

Course Name: Discrete Mathematical Structures

Max.Marks :100

Duration: 3 Hrs

PART A

Answer all Questions. Each question carries 3 Marks

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

(10 x 3 = 30 Marks)

PART B

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

11.

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

(6 marks)

(b) Show that from

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

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

(8 marks)

OR

12.

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

(6 marks)

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

(i) If Jack misses many classes through illness, then he fails high school.

(ii) If Jack fails high school, then he is uneducated.

(iii) If Jack reads a lot of books, then he is not uneducated.

(iv) Jack misses many classes through illness and reads a lot of books.

(8 marks)

13.

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

(6 marks)

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

(i) How many of them are even?

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

(8 marks)

OR

14.

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

(6 marks)

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

(i) Two mathematical papers are consecutive?

(ii) Two mathematical papers are not consecutive?

(8 marks)

15.

- (a) Let $A = \{1,2,3,4,\dots,11,12\}$ and let R be the equivalence relation on $A \times A$ 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 $x \in \mathbb{R}$, where \mathbb{R} is the set of real numbers. Find $(g \circ f)$, $(f \circ g)$, $(f \circ f)$ and $(g \circ g)$

(8 marks)

- (b) Let R and S be two relations on a set A . If R and S are symmetric, Prove that $(R \cap S)$ 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 $a_n - 3a_{n-1} + 2 = 0$; $a_0 = 1$ $n \geq 1$, 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

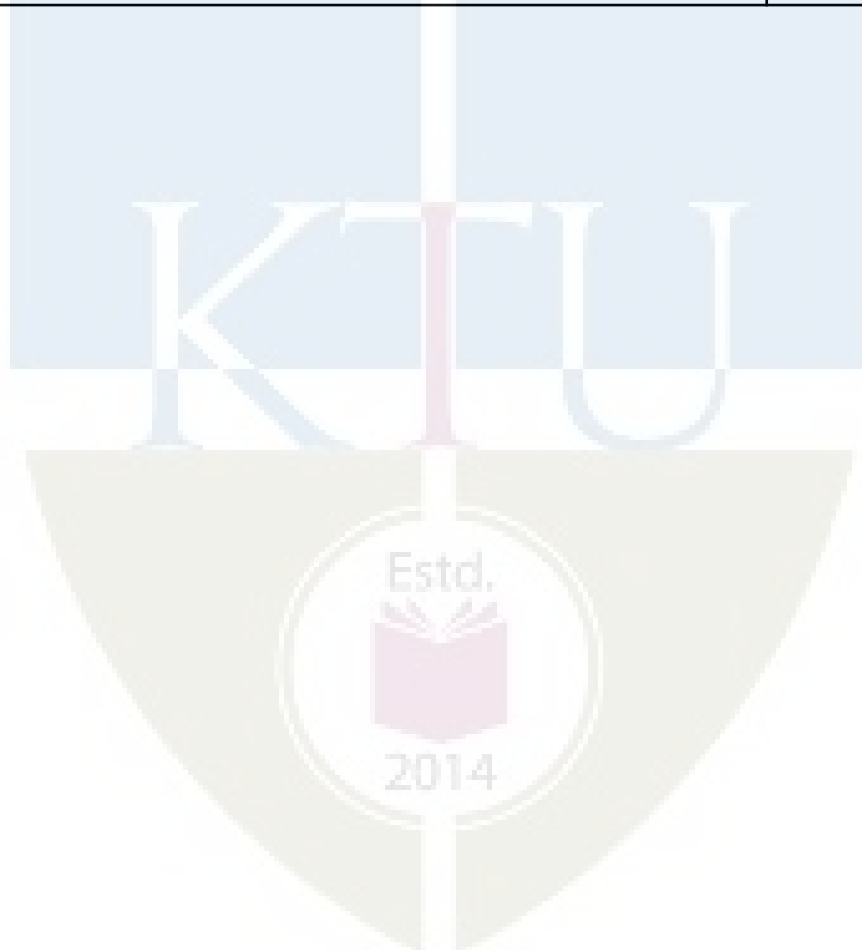
(6 Marks)

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

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

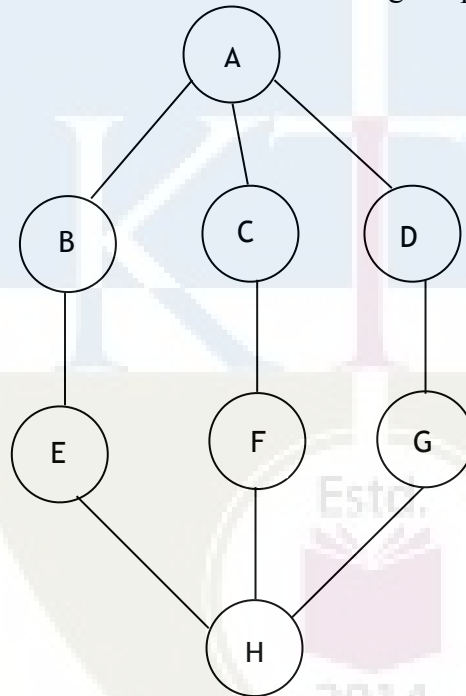
Answer all Questions. Each question carries 3 Marks

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 $O(n \log n)$ and $O(\log n)$ 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

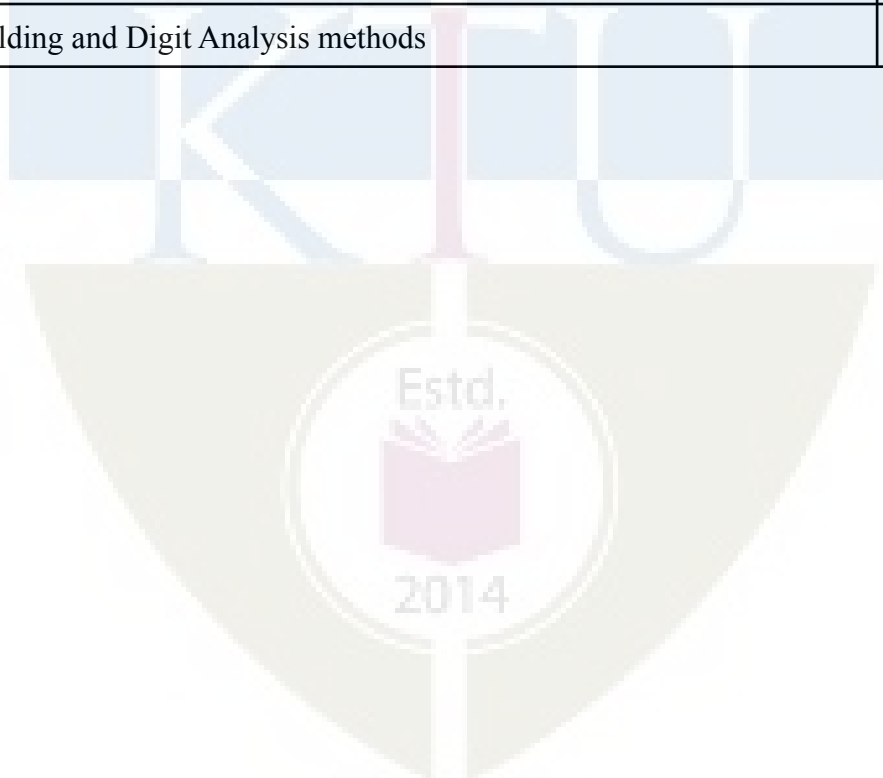
20. a) With examples discuss the different hash functions used for hashing (10)

b) Apply the hash function $h(x) = x \bmod 7$ 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	1 hour
Module 4 :Trees and Graphs		(8 hours)
4.1	Trees, Binary Trees	1 hour
4.2	Tree Operations, Binary Tree Representation,	1 hour
4.3	Tree Traversals	1 hour
4.4	Binary Search Trees	1 hour
4.5	Binary Search Tree Operations	1 hour
4.6	Graphs, Representation of Graphs	1 hour

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



CST 203	LOGIC SYSTEM DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0		

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	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
Analyse			
Evaluate			
Create			

Mark Distribution:

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

SYLLABUS**Module I****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.

Module II**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 five variables), Don't care conditions, Product of sums

simplification, Tabulation Method. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates.

Module III

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 IV

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 V

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.

Arithmetic algorithms

Algorithms for addition and subtraction of binary numbers in signed magnitude and 2's complement representations. Algorithm for addition and subtraction of BCD numbers. Representation of floating point numbers, Algorithm for addition and subtraction of floating point numbers.

Programmable Logic devices

ROM. Programmable Logic Array(PLA)- Implementation of simple circuits using PLA.

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:

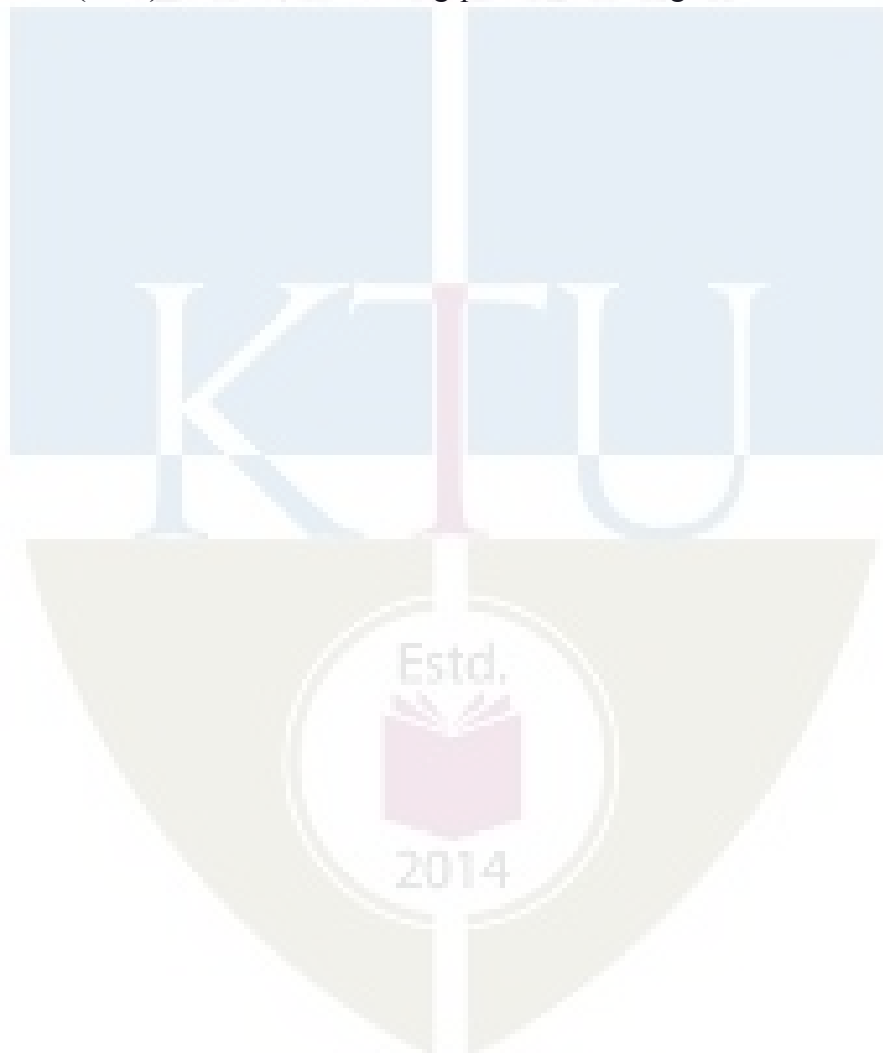
$$F(A, B, C, D) = A'B'D' + A'CD + A'BC$$

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

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): Demonstrate floating-point addition algorithm.



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: CST 203

Course name : LOGIC SYSTEM 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) 2's complement and ii) 1's 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 short notes on ROM.

PART-B

(Answer any one full question from each module)

(14X5=70)

11. (a) Perform the following operations using 2's complement arithmetic: (8)
- (i) $88_{10} + (-37)_{10}$ (ii) $(-20)_{10} + (-12)_{10}$

- (b) Perform the following base conversions: (i) $(101011.11)_2$ to octal (6)
(ii) $(3F9B)_{16}$ to binary (iii) $(121)_{10}$ to binary (iv) $(3077)_8$ to binary

OR

12. (a) Find the 12 bit 2's complement representation of the following decimal numbers. (6)

(i) -97 (ii) -224 (iii) -197.5

- (b) Perform the following operations (8)

(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)
(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)

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

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

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) With a neat diagram explain 4-bit carry look-ahead adder. (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 race around condition and how it can be avoided. (6)
 (b) Design a synchronous Binary Up-Down Counter. (8)
19. (a) With a neat diagram explain universal shift register. (8)
 (b) Explain Johnson Counter with timing diagram. (6)
- OR**
20. (a) Write algorithm for floating point addition and subtraction. (8)
 (b) Implement the functions $Y_1 = AB'C' + AB'C + ABC$ and $Y_2 = BC + AC$ using minimum gates Programmable Logic Array. (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.	1 hour
1.2	Binary Arithmetic: Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture 1)	1 hour
1.3	Addition, Subtraction, Multiplication & Division of Binary Numbers. (Lecture 2)	1 hour
1.4	Representation of Negative Numbers- Complements, subtraction with complements.	1 hour
1.5	BCD Arithmetic: Addition and Subtraction of BCD Numbers	1 hour
1.6	Octal and Hexadecimal Arithmetic: Addition & Subtraction of Octal and Hexadecimal Numbers.	1 hour

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

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

5.3	Shift register counters - Ring Counter, Johnson Counter- timing sequences and state diagrams	1 hour
5.4	Arithmetic Algorithms: Algorithm for addition and subtraction of binary numbers in Signed magnitude and 2's complement representations (Lecture 1)	1 hour
5.5	Algorithm for addition and subtraction of binary numbers in Signed magnitude and 2's complement representations (Lecture 2)	1 hour
5.6	Algorithm for addition and subtraction of BCD numbers	1 hour
5.7	Representation of floating point numbers (IEEE Standard representations).	1 hour
5.8	Algorithms for floating point addition and subtraction	1 hour
5.9	Programmable Logic devices - ROM	1 hour
5.10	PLA, Implementation of simple circuits using PLA(Lecture 1)	1 hour
5.11	PLA, Implementation of simple circuits using PLA(Lecture 2)	1 hour



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

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

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

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

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

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

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

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

SYLLABUS

Object Oriented Programming Using Java

Module 1

Introduction:

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

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

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

Module 2

Core Java Fundamentals:

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

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

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

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

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

Module 3

More features of Java:

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

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

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

Module 4

Advanced features of Java:

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

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

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

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

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

Module 5

Graphical User Interface and Database support of Java:

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

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

Text Books:

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

Reference Books:

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

Sample Course Level Assessment Questions

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

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

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

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

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

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

Model Question Paper

QP CODE:

PAGES:3

Reg No: _____

Name: _____

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

Course Code: CST 205

Course Name: Object Oriented Programming using Java

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

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

Part B

Answer any one question completely from each module

11.

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

(9)

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

OR

12.

- (a) Compare and contrast Java standard edition and Java enterprise edition. (5)
- (b) Why is Java considered to be platform independent? What is the role of Bytecode in making Java platform independent? (9)

13.

- (a) Explain in detail the primitive data types in Java. (8)
- (b) Explain automatic type conversion in Java with an example. What are the two conditions required for it? (6)

OR

14.

- (a) Using a suitable Java program explain the difference between *private* and *public* members in the context of inheritance. (8)
- (b) Is it possible to use the keyword *super* within a static method? Give justification for your answer. (6)

15.

- (a) Explain in detail about byte streams and character streams with suitable code samples. (6)
- (b) Describe in detail about exception handling, *try* block and *catch* clause with the help of a suitable Java program. (8)

OR

16.

- (a) Explain object streams in Java. Explain the role of Serializable interface with a suitable code sample. (8)
- (b) Explain *throw*, *throws* and *finally* constructs with the help of a Java program. (6)

17.

(a) Describe in detail the creation of a thread using the Runnable interface and the Thread class with suitable examples. (10)

(b) Explain List Interface. Mention any two exceptions thrown by its methods. (4)

OR

18.

(a) Explain in detail the Delegation Event model for event handling in Java. (7)

(b) Write a simple program by extending appropriate class to demonstrate the working of threads in java. (7)

19.

(a) Write a Java program to demonstrate the use of JLabel and JButton by adding them to JFrame. (7)

(b) Explain step-by-step procedure of using Java DataBase Connectivity in Java programs. (7)

OR

20.

(a) Explain the class hierarchy of Java Swing components. (7)

(b) Write a Java Program to create a student table and to add student details to it using JDBC. (7)

Estd.



2014

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

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

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



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

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 element to the queue.
 - 14.2. Delete an element from the queue.
 - 14.3. Display the queue after each operation.
15. Write a program to reverse the content of queue using stack
 16. Write a program to read two polynomials and store them using linked list. Calculate the sum of the two polynomials and display the first polynomial, second polynomial and the resultant polynomial.
 17. Write a program to read two polynomials and store them using linked list. Find the product of two polynomials and store the result using linked list. Display the resultant polynomial.
 18. Write a program for addition of polynomials containing two variables using linked list.
 19. The details of students (number, name, total-mark) are to be stored in a linked list. Write functions for the following operations:
 - 19.1. Insert
 - 19.2. Delete
 - 19.3. Search
 - 19.4. Sort on the basis of number
 - 19.5. Display the resultant list after every operation
 20. Create a Doubly Linked List from a string taking each character from the string. Check if the given string is palindrome in an efficient method.
 21. Create a binary tree with the following operations
 - 21.1. Insert a new node
 - 21.2. Inorder traversal.
 - 21.3. Preorder traversal.
 - 21.4. Postorder traversal.
 - 21.5. Delete a node.
 22. Write a program to create a binary search tree and find the number of leaf nodes
 23. Create a binary search tree with the following operations:
 - 23.1. Insert a new node .
 - 23.2. Inorder traversal.
 - 23.3. Preorder traversal.
 - 23.4. Postorder traversal.
 - 23.5. Delete a node.

24. Write a program to sort a set of numbers using a binary tree.
25. Represent any given graph and
- 25.1. Perform a depth first search .
 - 25.2. Perform a breadth first search
26. Create a text file containing the name, height, weight of the students in a class. Perform Quick sort and Merge sort on this data and store the resultant data in two separate files. Also write the time taken by the two sorting methods into the respective files.
- Eg.
- | | | |
|--------------|-----|----|
| Sony Mathew | 5.5 | 60 |
| Arun Sajeev | 5.7 | 58 |
| Rajesh Kumar | 6.1 | 70 |
27. Write a program to sort a set of numbers using Heap sort and find a particular number from the sorted set using Binary Search.
28. Implement a Hash table using Chaining method. Let the size of hash table be 10 so that the index varies from 0 to 9.
29. Implement a Hash table that uses Linear Probing for collision resolution



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

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

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

Course Outcomes:

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

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

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

Operating System to Use in Lab : Linux

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

Programming Language to Use in Lab : Java

Fair Lab Record:

All Students attending the Object Oriented Programming Lab (in Java) should have a Fair Record. The fair record should be produced in the University Lab Examination. Every 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). Each session consists of three concrete Java exercises, out of which at least two questions are mandatory.

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

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

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

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

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

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

(D) Exception handling and multi-threading applications:

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

(E) Graphics Programming:

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

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

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

** Mandatory

PRACTICE QUESTIONS

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

APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

SEMESTER IV

KTU



CODE MAT216	MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		BSC	3	1	0	4

Preamble: This course enables the learners to understand the mathematical foundations of Machine Learning concepts. This course covers Linear Algebra, Vector Calculus, Probability & Distributions and Optimization. Concepts in this course help the learners to identify the inherent assumptions & limitations of the current methodologies and develop new Machine Learning solutions.

Prerequisite: A sound background in higher secondary school Mathematics.

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

CO 1	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, Change of Basis, Image space and null (Kernel) space.

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.

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 : Axiomatic definition of probability, Discrete and Continuous random variables, Probability Space, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family.

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 by Springer
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press
4. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004 published by Cambridge University Press
5. Pattern Recognition and Machine Learning by Christopher M Bishop, 2006, published by Springer
6. Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Scholkopf and Smola, Alexander J Smola, 2002, published by MIT Press
7. Information Theory, Inference, and Learning Algorithms by David J. C MacKay, 2003 published by Cambridge University Press
8. Machine Learning: A Probabilistic Perspective by Kevin P Murphy, 2012 published by MIT Press.
9. The Nature of Statistical Learning Theory by Vladimir N Vapnik, 2000, published by Springer

Sample Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Find the set \mathcal{S} of all solutions in \mathbf{x} of the following linear systems $\mathbf{Ax} = \mathbf{b}$, where \mathbf{A} and \mathbf{b} are defined as follows:

$$\mathbf{A} = \begin{bmatrix} 1 & -1 & 0 & 0 & 1 \\ 1 & 1 & 0 & -3 & 0 \\ 2 & -1 & 0 & 1 & -1 \\ -1 & 2 & 0 & -2 & -1 \end{bmatrix}, \quad \mathbf{b} = \begin{bmatrix} 3 \\ 6 \\ 5 \\ -1 \end{bmatrix}$$

2. Determine the inverses of the following matrix if possible

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

3. Find the characteristic equation, eigenvalues, and eigen vectors 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 $x^2 + y^2 \leq 2$.
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 $P(J \cap T')$
 - 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 wins if

- i. A answers the first question,
 - ii. B answers the first question.
6. A coin for which $P(\text{heads}) = p$ 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 squares problem.
4. Consider the univariate function $f(x) = x^3 + 6x^2 - 3x - 5$. Find its stationary points and indicate whether they are maximum, minimum, or saddlepoints.
5. Consider the update equation for stochastic gradient descent. Write down the update when we use a mini-batch size of one.
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 your answer.
 - ii. Is $(1, -1)$ a local/global minimum? Justify your answer.
7. Is the function $f(x, y) = 2x^2 + y^2 + 6xy - x + 3y - 7$ convex, concave, or neither? Justify your answer.
 8. Consider the following convex optimization problem

$$\text{minimize } \frac{x^2}{2} + x + 4y^2 - 2y$$

Subject to the constraint $x + y \geq 4, x, y \geq 1$.

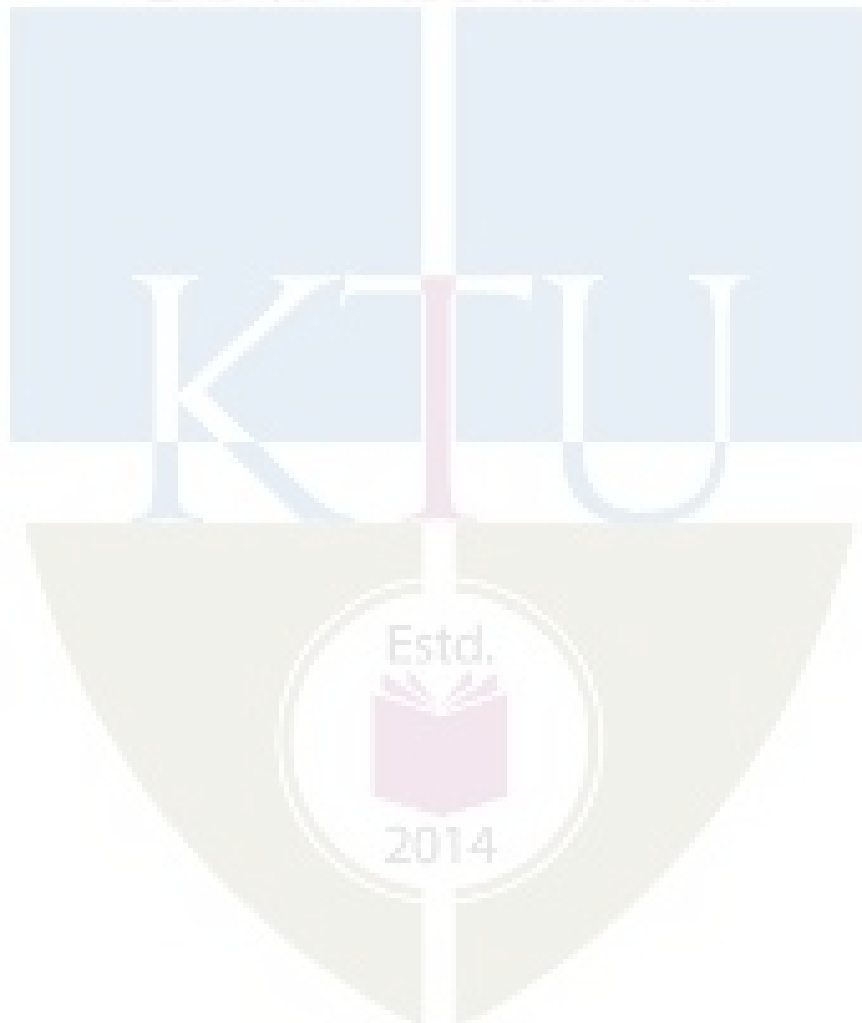
Derive an explicit form of the Lagrangian dual problem.

9. Solve the following LP problem with the simplex method.

$$\max 5x_1 + 6x_2 + 9x_3 + 8x_4$$

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 DEGREE EXAMINATION, MONTH and YEAR

Course Code: MAT 216

Course Name: MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

Marks

1 Show that with the usual operation of scalar multiplication but with addition on reals given by $x \# y = 2(x + y)$ is not a vector space.

2 Are the following sets of vectors linearly independent? Explain your answer.

$$x_1 = \begin{bmatrix} 2 \\ -1 \\ 3 \end{bmatrix}, \quad x_2 = \begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}, \quad x_3 = \begin{bmatrix} 3 \\ -3 \\ 8 \end{bmatrix}$$

3 Find the angle between the vectors $x = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $y = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$.

4 Find the eigen values of the following matrix in terms of k. Can you find an eigen vector corresponding to each of the eigen values?

$$\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$$

5 Let $f(x, y, z) = xye^r$, where $r = x^2 + z^2 - 5$. Calculate the gradient of f at the point $(1, 3, -2)$.

6 Compute the Taylor polynomials $T_n, n = 0, \dots, 5$ of $f(x) = \sin(x) + \cos(x)$ at $x_0 = 0$.

7 Let X be a continuous random variable with probability density function on $0 \leq x \leq 1$ 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 linear equations (4)

$$\begin{aligned} -4x + 5z &= -2 \\ -3x - 3y + 5z &= 3 \\ -x + 2y + 2z &= -1 \end{aligned}$$

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 your reasons. (6)

OR

12 a) Find all solutions in $x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \in R^3$ of the equation system $Ax = 12x$, (7)

where $A = \begin{bmatrix} 6 & 4 & 3 \\ 6 & 0 & 9 \\ 0 & 8 & 0 \end{bmatrix}$ and $\sum_{i=1}^3 x_i = 1$.

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) What is meant by the least square solution to the equation $Ax=b$? Find the least square solution to the equation $Ax=b$, where $A = \begin{bmatrix} 1 & 2 \\ 1 & 3 \\ 0 & 0 \end{bmatrix}$ and $b = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$ (7)

b) Find the SVD of the matrix. (7)

$$\begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}$$

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, A . (8)

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

- ii. Find a 3×3 orthogonal matrix S and a 3×3 diagonal matrix D such that $A = SDS^T$
- 15 a) A skier is on a mountain with equation $z=100-0.4x^2-0.3y^2$, where z denotes height. (8)
- 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.
 - 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 .
- 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 (8)
- $$g(x, y) = \begin{cases} \frac{x^2 y}{x^2 + y^2} & \text{if } (x, y) \neq (0, 0); \\ 0 & \text{if } (x, y) = (0, 0). \end{cases}$$
- Calculate the partial derivatives of g at $(0,0)$.
 - Show that g is not differentiable at $(0,0)$.
- b) Find the second order Taylor series expansion for $f(x,y) = e^{-(x^2+y^2)} \cos(xy)$ about $(0, 0)$. (6)
- 17 a) There are two bags. The first bag contains four mangos and two apples; the second bag contains four mangos and four apples. We also have a biased coin, which shows “heads” with probability 0.6 and “tails” with probability 0.4. If the coin shows “heads”. we pick a fruit at random from bag 1; otherwise we pick a fruit at random from bag 2. Your friend flips the coin (you cannot see the result), picks a fruit at random from the corresponding bag, and presents you a mango. (6)
- What is the probability that the mango was picked from bag 2?
- 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 : (8)
- $$p(x | \mu) = \mu^x (1 - \mu)^{1-x}, \quad x \in \{0, 1\}$$
- Choose a conjugate prior for the Bernoulli likelihood and compute the

posterior distribution $p(\mu | x_1, \dots, x_N)$.

OR

- 18 a) Two dice are rolled. (6)

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?

- b) Consider the following bivariate distribution $p(x,y)$ of two discrete random variables X and Y. (8)

Y	y_1	0.01	0.02	0.03	0.1	0.1
	y_2	0.05	0.1	0.05	0.07	0.2
	y_3	0.1	0.05	0.03	0.05	0.04
		x_1	x_2	x_3	x_4	x_5
		X				

Compute:

- i. The marginal distributions $p(x)$ and $p(y)$.
- ii. The conditional distributions $p(x|Y = y_1)$ and $p(y|X = x_3)$.

- 19 a) Find the extrema of $f(x,y,z) = x - y + z$ subject to $g(x,y,z) = x^2 + y^2 + z^2 = 2$. (8)

- b) Let

$$P = \begin{bmatrix} 13 & 12 & -2 \\ 12 & 17 & 6 \\ -2 & 6 & 12 \end{bmatrix}, \quad q = \begin{bmatrix} -22.0 \\ -14.5 \\ 13.0 \end{bmatrix}, \quad \text{and } r = 1.$$

Show that $x^* = (1, 1/2, -1)$ is optimal for the optimization problem

$$\begin{aligned} \min \quad & \frac{1}{2}x^T P x + q^T x + r \\ \text{s.t.} \quad & -1 \leq x_i \leq 1, \quad i = 1, 2, 3. \end{aligned} \quad (6)$$

OR

- 20 a) Derive the gradient descent training rule assuming that the target function is represented as $o_d = w_0 + w_1 x_1 + \dots + w_n x_n$. Define explicitly the cost/ error function E , assuming that a set of training examples D is provided, where each training example $d \in D$ 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 $x, y, z \geq 0$. (6)

Teaching Plan		
No	Topic	No. of Lectures
	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	Image space, null space	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	Determinant and Trace, Eigen values and Eigenvectors.	1
2.7	Cholesky Decomposition	1
2.8	Eigen decomposition and Diagonalization	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 Network	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	Axiomatic definition of Probability, Probability Space, Random variables	1
4.2	Discrete random variables (Probability Mass Function, Cumulative Distribution Function, Marginal distribution)	1
4.3	Continuous random variables (Probability Density Function, Cumulative Distribution Function, Marginal distribution)	1
4.4	Sum Rule, Product Rule, 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



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

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.

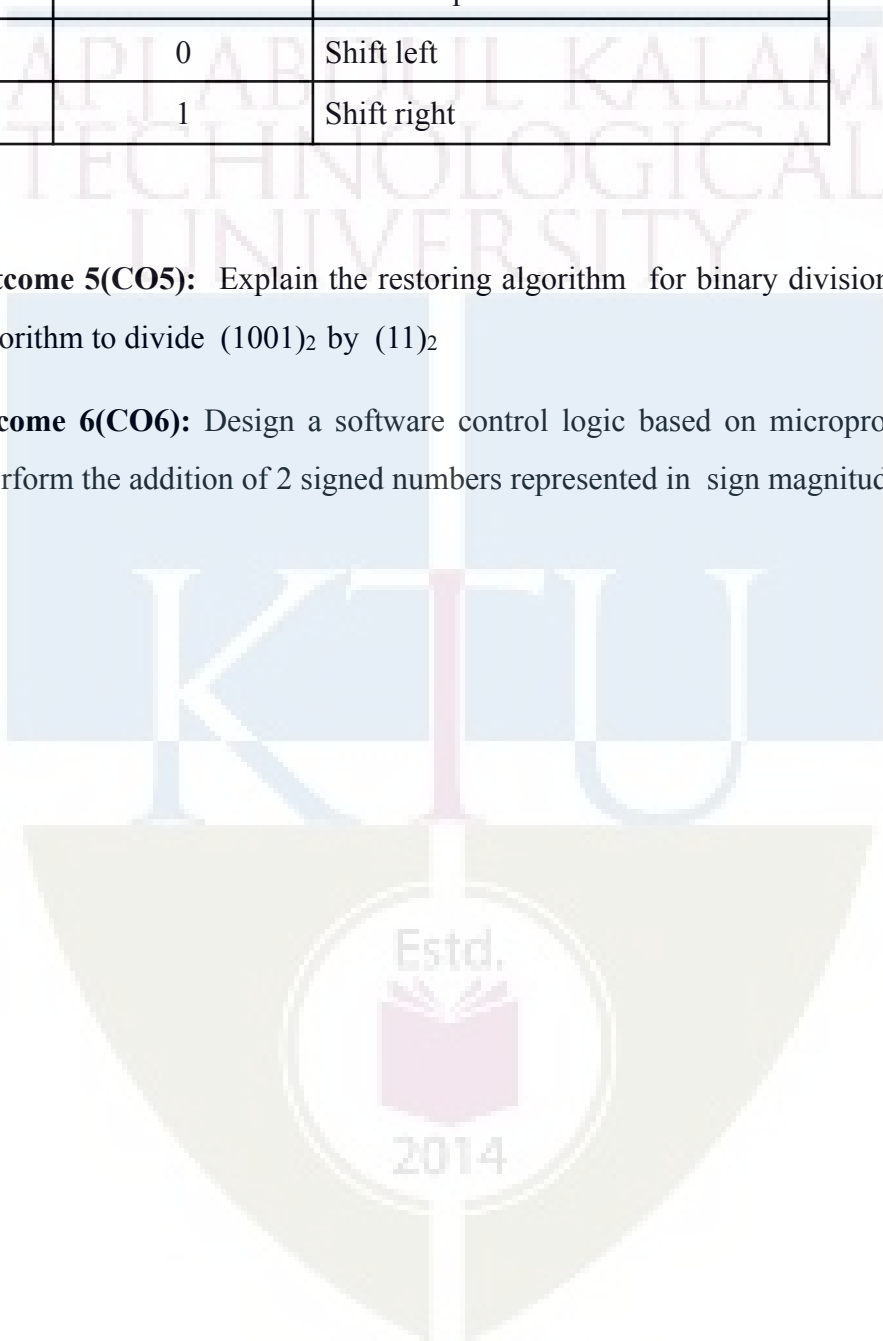
Course Outcome 3(CO3): Generate the sequence of control signals required for the execution of the instruction MOV [R1],R2 in a threebus organization.

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

THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 202

Course Name: Computer organisation and architecture

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

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

Part B

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

11.

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

(4)

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

(10)

OR

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

(14)

13. Explain various register transfer logics.

(14)

OR

14.

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

(5)

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

(9)

15.

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

(4)

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

(10)

OR

16.

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

(10)

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

(4)

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

(14)

OR

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

(14)

19.

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

(10)

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

(4)

OR

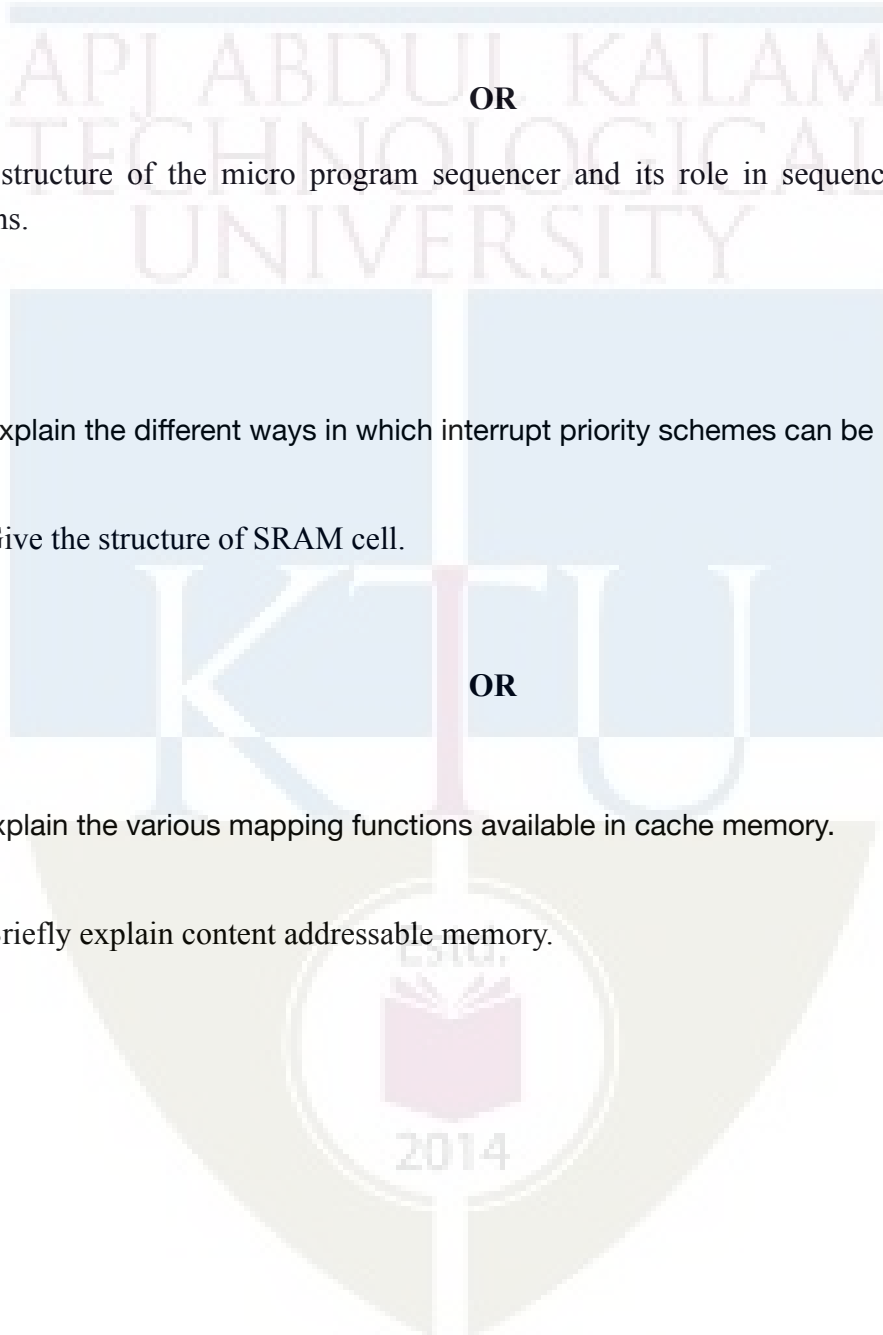
20.

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

(9)

20.(b) Briefly explain content addressable memory.

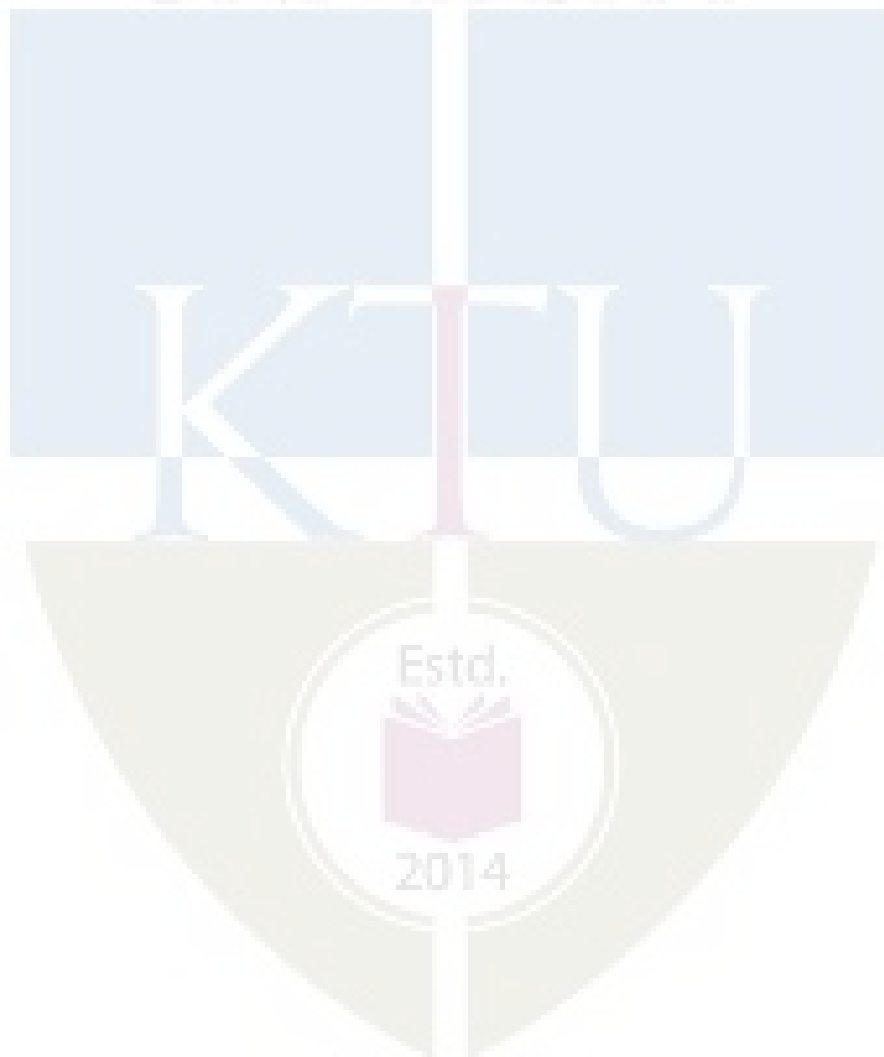
(5)



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

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

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



CST 204	DATABASE MANAGEMENT SYSTEMS	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	3	1	0		

Preamble: This course provides a clear understanding of fundamental principles of Database Management Systems (DBMS) with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS, Entity Relationship (ER) model, Relational Database principles, Relational Algebra, Structured Query Language (SQL), Physical Data Organization, Normalization and Transaction Processing Concepts. The course also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

Prerequisite: Topics covered under the course Data Structures (CST 201), Exposure to a High Level Language like C/python.

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

CO1	Summarize and exemplify fundamental nature and characteristics of database systems (Cognitive Knowledge Level: Understand)
CO2	Model real word scenarios given as informal descriptions, using Entity Relationship diagrams. (Cognitive Knowledge Level: Apply)
CO3	Model and design solutions for efficiently representing and querying data using relational model (Cognitive Knowledge Level: Analyze)
CO4	Demonstrate the features of indexing and hashing in database applications (Cognitive Knowledge Level: Apply)
CO5	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems (Cognitive Knowledge Level: Apply)
CO6	Explain various types of NoSQL databases (Cognitive Knowledge Level: Understand)

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern:

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

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

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

End Semester Examination Pattern:

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

Syllabus

Module 1: Introduction & Entity Relationship (ER) Model

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification.

ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.

Module 2: Relational Model

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema

Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

Module 3: SQL DML (Data Manipulation Language), Physical Data Organization

SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types.

Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Single level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.

Module 4: Normalization

Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.

Module 5: Transactions, Concurrency and Recovery, Recent Topics

Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions.

Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing.

Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB)

Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

Reference Books:

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018
3. Web Resource: <https://www.w3resource.com/redis/>
4. web Resource: <https://www.w3schools.in/category/mongodb/>
5. Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource : <https://www.tutorialspoint.com/arangodb/index.htm>

Sample Course Level Assessment Questions

Course Outcome1 (CO1):

1. List out any three salient features of database systems, which distinguish it from a file system.
2. Give one example each for logical and physical data independence.

Course Outcome 2(CO2):

1. What facts about the relationships between entities EMPLOYEE and PROJECT are conveyed by the following ER diagram?



1. Design an ER diagram for the following scenario:
There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team.

Course Outcome 3(CO3):

1. For the SQL query, `SELECT A, B FROM R WHERE B = 'apple' AND C = 'orange'` on the table `R(A, B, C, D)`, where `A` is a key, write any three equivalent relational algebra expressions.
2. Given the FDs $P \rightarrow Q$, $P \rightarrow R$, $QR \rightarrow S$, $Q \rightarrow T$, $QR \rightarrow U$, $PR \rightarrow U$, write the sequence of *Armstrong's Axioms* needed to arrive at the following FDs: (a) $P \rightarrow T$ (b) $PR \rightarrow S$ (c) $QR \rightarrow SU$
3. Consider a relation `PLAYER (PLAYER-NO, PLAYER-NAME, PLAYER-POSN, TEAM, TEAM-COLOR, COACH-NO, COACH-NAME, TEAM-CAPTAIN)`. Assume that `PLAYER-NO` is the *only* key of the relation and that the following dependencies hold:
 - $TEAM \rightarrow \{TEAM-COLOR, COACH-NO, TEAM-CAPTAIN\}$
 - $COACH-NO \rightarrow COACH-NAME$.
 - i. Is the relation in 2NF? If not, decompose to 2NF.
 - ii. Is the relation in 3NF? If not, decompose to 3NF.

4. In the following tables foreign keys have the same name as primary keys except DIRECTED-BY, which refers to the primary key ARTIST-ID. Consider only *single-director* movies.

MOVIES(MOVIE-ID, MNAME, GENRE, LENGTH, DIRECTED-BY)

ARTIST(ARTIST-ID, ANAME)

ACTING(ARTIST-ID, MOVIE-ID)

Write SQL expressions for the following queries:

- (a) Name(s) and director name(s) of movie(s) acted by 'Jenny'.
- (b) Names of actors who have never acted with 'Rony'
- (c) Count of movies genre-wise.
- (d) Name(s) of movies with maximum length.

Course Outcome 4(CO4):

1. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization, block size of 512 bytes and block pointer size of 5 bytes. Compute the number of block accesses needed for retrieving an employee record based on employee number if (i) No index is used (ii) Multi-level primary index is used.

Course Outcome 5(CO5):

1. Determine if the following schedule is *recoverable*. Is the schedule *cascade-less*? Justify your answer. $r1(X), r2(Z), r1(Z), r3(X), r3(Y), w1(X), c1, w3(Y), c3, r2(Y), w2(Z), w2(Y), c2$. (Note: $ri(X)/wi(X)$ means transaction T_i issues read/write on item X; ci means transaction T_i commits.)
2. Two-phase locking protocol ensures serializability. Justify.

Course Outcome 6(CO6):

1. List out any three salient features of NoSQL databases. Give example of a document in MongoDB.

Model Question paper

QPCODE

Reg No: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: CST 204

Course Name: Database Management Systems

Max.Marks:100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

- 1 List out any three salient features of a database systems.
- 2 When is multi-valued composite attribute used in ER modelling?
- 3 For the SQL query, *SELECT A, B FROM R WHERE B='apple' AND C = 'orange'* on the table R(A, B, C, D), where A is a key, write any two equivalent relational algebra expressions.
- 4 Outline the concept of *theta*-join.
- 5 How is the purpose of *where* clause is different from that of having clause?
- 6 What is the use of a trigger?
- 7 When do you say that a relation is not in 1NF?
- 8 Given the FDs $P \rightarrow Q$, $P \rightarrow R$, $QR \rightarrow S$, $Q \rightarrow T$, $QR \rightarrow U$, $PR \rightarrow U$, write the sequence of Armstrong's Axioms needed to arrive at a. $P \rightarrow T$ b. $PR \rightarrow S$
- 9 What is meant by the lost update problem?
- 10 What is meant by check pointing?

2014

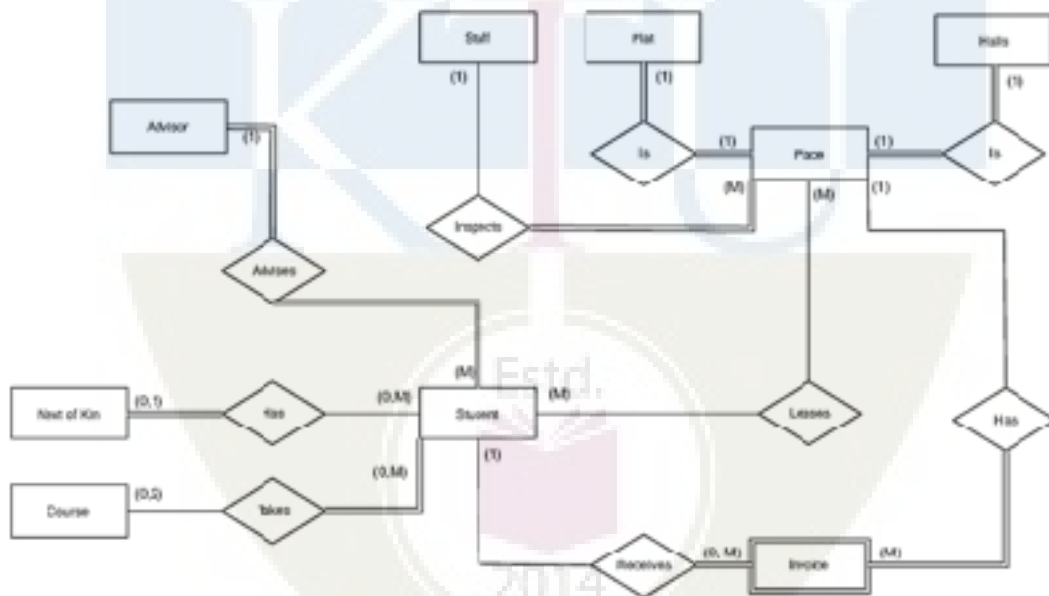
PART B

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

- 11** a. Design an ER diagram for the following scenario: There is a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs. Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses. Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team. For each match we need to keep track of the following: The date on which the game is played The final result of the match. The players participated in the match. For each player, how many goals he scored, whether or not he took yellow card, and whether or not he took red card. During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place. Each match has exactly three referees. For each referee we have an ID (unique identifier), name, DoB, years of experience. One referee is the main referee and the other two are assistant referee. (14)

OR

- 12** a. Interpret the the following ER diagram. (8)



- b. Distinguish between physical data independence and logical data independence with suitable examples. (6)

- 13 **EMPLOYEE(ENQ, NAME, ADDRESS, DOB, AGE, GENDER, SALARY, DNUM, SUPERENO) (14)**
DEPARTMENT(DNQ, DNAME, DLOCATION, DPHONE, MGRENO)
PROJECT(PNQ, PNAME, PLOCATION, PCOST, CDNO)

DNUM is a foreign key that identifies the department to which an employee belongs. MGRENO is a foreign key identifying the employee who manages the department. CDNO is a foreign key identifying the department that controls the project. SUPERENO is a foreign key identifying the supervisor of each employee.

Write relational algebra expressions for the following queries:-

- Names of female employees whose salary is more than 20000.
- Salaries of employee from 'Accounts' department
- Names of employees along with his/her supervisor's name
- For each employee return name of the employee along with his department name and the names of projects in which he/she works
- Names of employees working in all the departments

OR

- 14 a. Write SQL DDL statements for the the following (Assume suitable domain types): (10)
- Create the tables STUDENT(ROLLNO, NAME, CLASS, SEM, ADVISER), FACULTY(FID, NAME, SALARY, DEPT). Assume that ADVISER is a foreign key referring FACUTY table.
 - Delete department with name 'CS' and all employees of the department.
 - Increment salary of every faculty by 10%.
- b. Illustrate foreign key constraint with a typical example. (4)

- 15 For the relation schema below, give an expression in SQL for each of the queries (14) that follows:

employee(employee-name, street, city)
works(employee-name, company-name, salary)
company(company-name, city)
manages(employee-name, manager-name)

- Find the names, street address, and cities of residence for all employees who work for the Company 'RIL Inc.' and earn more than \$10,000.
- Find the names of all employees who live in the same cities as the companies for which they work.
- Find the names of all employees who do not work for 'KYS Inc.'. Assume that all people work for exactly one company.
- Find the names of all employees who earn more than every employee of 'SB Corporation'. Assume that all people work for at most one company.
- List out number of employees company-wise in the decreasing order of number of employees.

OR

- 16 a. Consider an EMPLOYEE file with 10000 records where each record is of size 80 bytes. The file is sorted on employee number (15 bytes long), which is the primary key. Assuming un-spanned organization and block size of 512 bytes compute the number of block accesses needed for selecting records based on employee number if, (9)
- No index is used
 - Single level primary index is used
 - Multi-level primary index is used
- Assume a block pointer size of 6 bytes.

- b. Illustrate correlated and non-correlated nested queries with real examples. (5)

- 17 a. Illustrate 3NF and BCNF with suitable real examples. (6)

- b. Given a relation $R(A_1, A_2, A_3, A_4, A_5)$ with functional dependencies $A_1 \rightarrow A_2, A_4$ and $A_4 \rightarrow A_5$, check if the decomposition $R_1(A_1, A_2, A_3), R_2(A_1, A_4), R_3(A_2, A_4, A_5)$ is lossless. (8)

OR

- 18 a. Consider the un-normalized relation $R(A, B, C, D, E, F, G)$ with the FDs $A \rightarrow B, AC \rightarrow G, AD \rightarrow EF, EF \rightarrow G, CDE \rightarrow AB$. Trace the normalization process to reach 3NF relations. (7)

b. Illustrate Lossless Join Decomposition and Dependency Preserving Decomposition with typical examples. (7)

19 a. Discuss the four ACID properties and their importance. (7)

b. Determine if the following schedule is conflict serializable. Is the schedule recoverable? Is the schedule cascade-less? Justify your answers. (7)

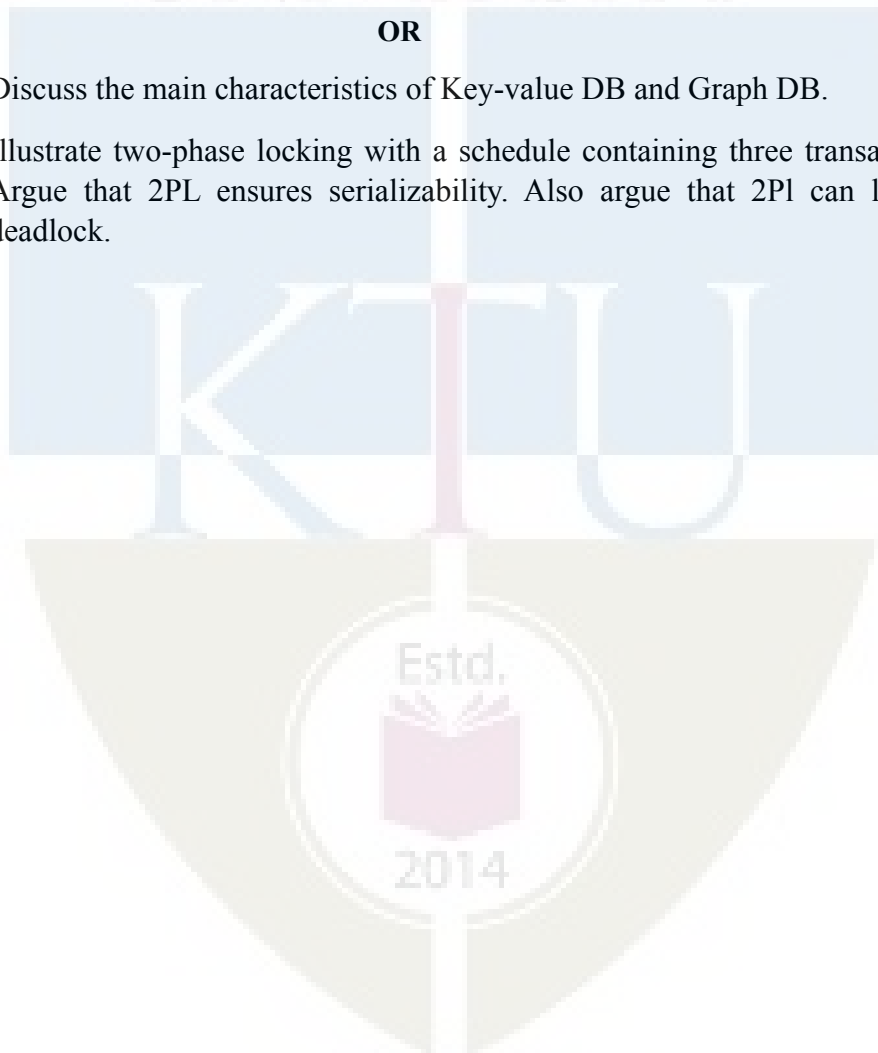
$r_1(X), r_2(Z), r_1(Z), r_3(X), r_3(Y), w_1(X), c_1, w_3(Y), c_3, r_2(Y), w_2(Z), w_2(Y), c_2$

(Note: $r_i(X)/w_i(X)$ means transaction T_i issues read/write on item X ; c_i means transaction T_i commits.)

OR

20 a. Discuss the main characteristics of Key-value DB and Graph DB. (7)

b. Illustrate two-phase locking with a schedule containing three transactions. Argue that 2PL ensures serializability. Also argue that 2PL can lead to deadlock. (7)



Teaching Plan

	Course Name	Hours (48)
	Module 1: Introduction & ER Model	8
1.1	Concept & Overview of DBMS, Characteristics of DB system, Database Users.	1
1.2	Structured, semi-structured and unstructured data. Data Models and Schema	1
1.3	Three-Schema-architecture. Database Languages	1
1.4	Database architectures and classification	1
1.5	ER model: basic concepts, entity set & attributes, notations	1
1.6	Relationships and constraints – cardinality, participation, notations	1
1.7	Weak entities, relationships of degree 3	1
1.8	ER diagram – exercises	1
	Module 2: Relational Model	7
2.1	Structure of relational Databases, Integrity Constraints	1
2.2	Synthesizing ER diagram to relational schema, Introduction to relational algebra.	1
2.3	Relational algebra: select, project, Cartesian product operations	1
2.4	Relational Algebra: join - Equi-join, Natural join	1
2.5	Query examples	1
2.6	Introduction to SQL, important data types	1
2.7	DDL, Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE	1
	Module 3: SQL DML, Physical Data Organization	11
3.1	SQL DML, SQL queries on single and multiple tables	1
3.2	Nested queries (correlated and non-correlated)	1
3.3	Aggregation and grouping	1

	Course Name	Hours (48)
3.4	Views, assertions (with examples)	1
3.5	Triggers (with examples), SQL data types	1
3.6	Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing	1
3.7	Singe level indices, numerical examples	1
3.8	Multi-level-indices, numerical examples	1
3.9	B-Trees and B+Trees (structure only, algorithms not required)	1
3.10	Extendible Hashing	1
3.11	Indexing on multiple keys – grid files	1
	Module 4: Normalization	8
4.1	Different anomalies in designing a database, The idea of normalization	1
4.2	Functional dependency, Armstrong's Axioms (proofs not required)	1
4.3	Closures and their computation, Equivalence of FDs, minimal Cover (proofs not required).	1
4.4	1NF, 2NF	1
4.5	3NF, BCNF	1
4.6	Lossless join and dependency preserving decomposition	1
4.7	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 1)	1
4.8	Algorithms for checking Lossless Join and Dependency preserving properties (Lecture 2)	1
	Module 5: Transactions, Concurrency and Recovery, Recent Topics	14
5.1	Transaction Processing Concepts: Transaction Model	1
5.2	Overview of concurrency control, Significance of concurrency Control & Recovery	1
5.3	Transaction States, System Log	1

	Course Name	Hours (48)
5.4	Desirable Properties of transactions, Serial schedules	1
5.5	Concurrent and Serializable Schedules	1
5.6	Conflict equivalence and conflict serializability	1
5.7	Recoverable and cascade-less schedules	1
5.8	Locking, Two-phase locking, strict 2PL.	1
5.9	Log-based recovery	1
5.10	Deferred database modification (serial schedule), example	1
5.11	Deferred database modification (concurrent schedule) example, check-pointing	1
5.12	Introduction to NoSQL Databases	1
5.13	Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) [detailed study not expected]	1
5.14	Main characteristics of Column-Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB) [detailed study not expected]	1



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

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

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

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

Internal Examination Pattern:

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

End Semester Examination Pattern:

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

Syllabus**Module I**

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

Module II

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

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

Module III

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

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

Module IV

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

Module V

File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods.

Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.

Text Book

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

Reference Books:

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

Sample Course Level Assessment Questions

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

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

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

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

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

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

Model Question Paper

QP CODE: _____

PAGES: ____

Reg No: _____

Name: _____

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

Course Code: CST 206

Course name : OPERATING SYSTEMS

Max Marks: 100

Duration: 3 Hours

PART-A

(Answer All Questions. Each question carries 3 marks)

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

4. How is inter process communication implemented using shared memory?
5. Describe resource allocation graph for the following.
 - a) with a deadlock
 - b) with a cycle but no deadlock.
6. What is a critical section? What requirements should be satisfied by a solution to the critical section problem?
7. Consider the reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults occur while using FCFS for the following cases.
 - a) frame=2
 - b) frame=3
8. Differentiate between internal and external fragmentations.
9. Compare sequential access and direct access methods of storage devices.
10. Define the terms (i) Disk bandwidth (ii) Seek time.

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

11. a) Explain the following structures of operating system (i) Monolithic systems (ii) Layered Systems (iii) Micro Kernel (iv) Modular approach. **(12)**
 - b) Under what circumstances would a user be better off using a time sharing system than a PC or a single user workstation? **(2)**
- OR**
12. a) What is the main advantage of the micro kernel approach to system design? How do user program and system program interact in a microkernel architecture? **(8)**
 - b) Describe the differences between symmetric and asymmetric multiprocessing? What are the advantages and disadvantages of multiprocessor systems? **(6)**
 13. a) Define process. With the help of a neat diagram explain different states of process. **(8)**
 - b) Explain how a new process can be created in Unix using fork system call. **(6)**
- OR**
14. a) Find the average waiting time and average turnaround time for the processes given in the table below using:- i) SRT scheduling algorithm ii) Priority scheduling algorithm **(9)**

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

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

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

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

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

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

OR

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

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

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

OR

18. a) With a diagram, explain how paging is done with TLB. (5)
- b) Memory partitions of sizes 100 kb, 500 kb, 200 kb, 300 kb, 600 kb are available, how would best, worst and first fit algorithms place processes of size 212 kb, 417 kb, 112 kb, 426 kb in order. Rank the algorithms in terms of how efficiently they use memory. (9)
19. a) Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. the drive currently services a request at cylinder 143, and the previous request was at cylinder 125. the queue of pending request in FIFO order is 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. Starting from the current position, what is the total distance (in cylinders) that the disk arm moves to satisfy all pending requests for each of the following algorithms
- i) FCFS ii) SSFT iii) SCAN iv) LOOK v) C-SCAN (10)
- b) What is the use of access matrix in protection mechanism? (4)

OR

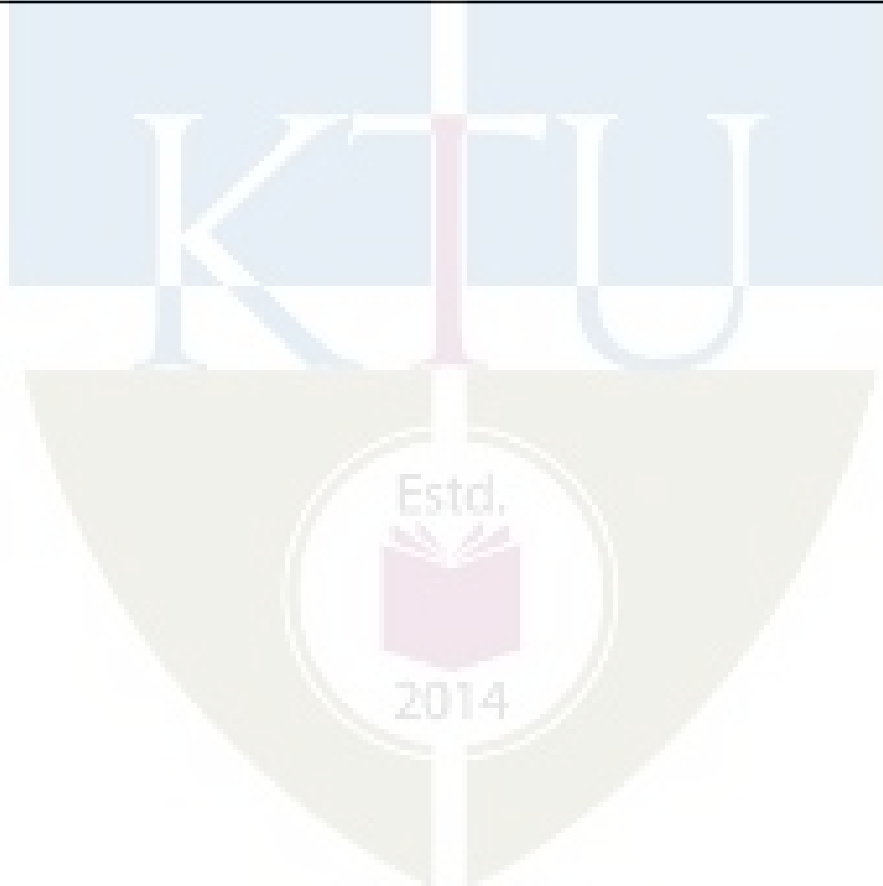
20. a) Explain the different file allocation operations with advantages and disadvantages. (8)
- b) Explain the following i) file types ii) file operation iii) file attributes (6)

Teaching Plan

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

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

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



AIL202	DATABASE MANAGEMENT SYSTEMS LAB	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2

Preamble: The Database Management Systems course is intended to impart the elementary concepts of a database management system to students and equip them to design and implement a database application based on those concepts. This course helps the learners to get practical exposure on database creation, SQL queries creation, transaction processing and NoSQL & MongoDB based operations. The course enables the students to create, manage and administer the databases, develop necessary tools for the design and development of the databases, and to understand emerging technologies to handle Big Data.

Prerequisite: A sound knowledge of the basics of relational DBMS.

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

CO#	CO
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches. (Cognitive Knowledge Level: Apply)
CO2	Construct queries using SQL for database creation, interaction, modification, and updation. (Cognitive Knowledge Level: Apply)
CO3	Design and implement triggers and cursors. (Cognitive Knowledge Level: Apply)
CO4	Implement procedures, functions, and control structures using PL/SQL. (Cognitive Knowledge Level: Apply)
CO5	Perform CRUD operations in NoSQL Databases. (Cognitive Knowledge Level: Apply)
CO6	Develop database applications using front-end tools and back-end DBMS. (Cognitive Knowledge Level: Create)

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 Schema/Logic: 30 marks, Program/Queries: 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 Schema/Logic: 30 marks, Program/Queries: 20 marks, Output: 20 marks, and Viva: 30 marks. Total 100 marks will be converted out of 75 for the End Semester Examination.

DBMS software: Oracle, MySQL, SQL Server, PostgreSQL, MongoDB.

Front end Tool: Java

Fair Lab Record:

All Students attending the DBMS 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, Schemas/Menu & Form Design, and Query questions. The left hand page should contain Queries and sample output (relations created, Form, and Menu Output) obtained for a set of input.

SYLLABUS

1. Design a database schema for an application with ER diagram from a problem description **.
2. Creation, modification, configuration, and deletion of databases using UI and SQL Commands **.
3. Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships** (with the ER diagram designed in step 1).
4. Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands)**.
5. Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)**.
6. Implementation of built-in functions in RDBMS**.
7. Implementation of various aggregate functions in SQL**.
8. Implementation of Order By, Group By & Having clause **.
9. Implementation of set operators nested queries, and join queries **.
10. Implementation of queries using temp tables.
11. Practice of SQL TCL commands like Rollback, Commit, Savepoint **.
12. Practice of SQL DCL commands for granting and revoking user privileges **.
13. Practice of SQL commands for creation of views and assertions ** .
14. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL **.
15. Creation of Procedures, Triggers and Functions**.
16. Creation of Packages **.
17. Creation of Cursors **.
18. Creation of PL/SQL blocks for exception handling **.
19. Database backup and restore using commands.
20. Query analysis using Query Plan/Show Plan.
21. Familiarization of NoSQL Databases and CRUD operations**.
22. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables**.

** mandatory

Text Books

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

References

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018

PRACTICE QUESTIONS

Design a normalised database schema for the following requirement.

The requirement: A library wants to maintain the record of books, members, book issue, book return, and fines collected for late returns, in a database. The database can be loaded with book information. Students can register with the library to be a member. Books can be issued to students with a valid library membership. A student can keep an issued book with him/her for a maximum period of two weeks from the date of issue, beyond which a fine will be charged. Fine is calculated based on the delay in days of return. For 0-7 days: Rs 10, For 7 – 30 days: Rs 100, and for days above 30 days: Rs 10 will be charged per day.

Sample Database Design

BOOK (**Book_Id**, Title, Language_Id, MRP, Publisher_Id, Published_Date, Volume, Status) // Language_Id, Publisher_Id are FK (Foreign Key)

AUTHOR(**Author_Id**, Name, Email, Phone_Number, Status)

BOOK_AUTHOR(**Book_Id**, **Author_Id**) // many-to-many relationship, both columns are **PK and FK** (Primary Key and Foreign Key)

PUBLISHER(**Publisher_id**, Name, Address)

MEMBER(**Member_Id**, Name, Branch_Code, Roll_Number, Phone_Number, Email_Id, Date_of_Join, Status)

BOOK_ISSUE(**Issue_Id**, Date_Of_Issue, Book_Id, Member_Id, Expected_Date_Of_Return, Status) // Book+Id and Member_Id are FKs

BOOK_RETURN(**Issue_Id**, Actual_Date_Of_Return, LateDays, LateFee) // Issue_Id is PK and FK

LANGUAGE(**Language_id**, Name) //Static Table for storing permanent data

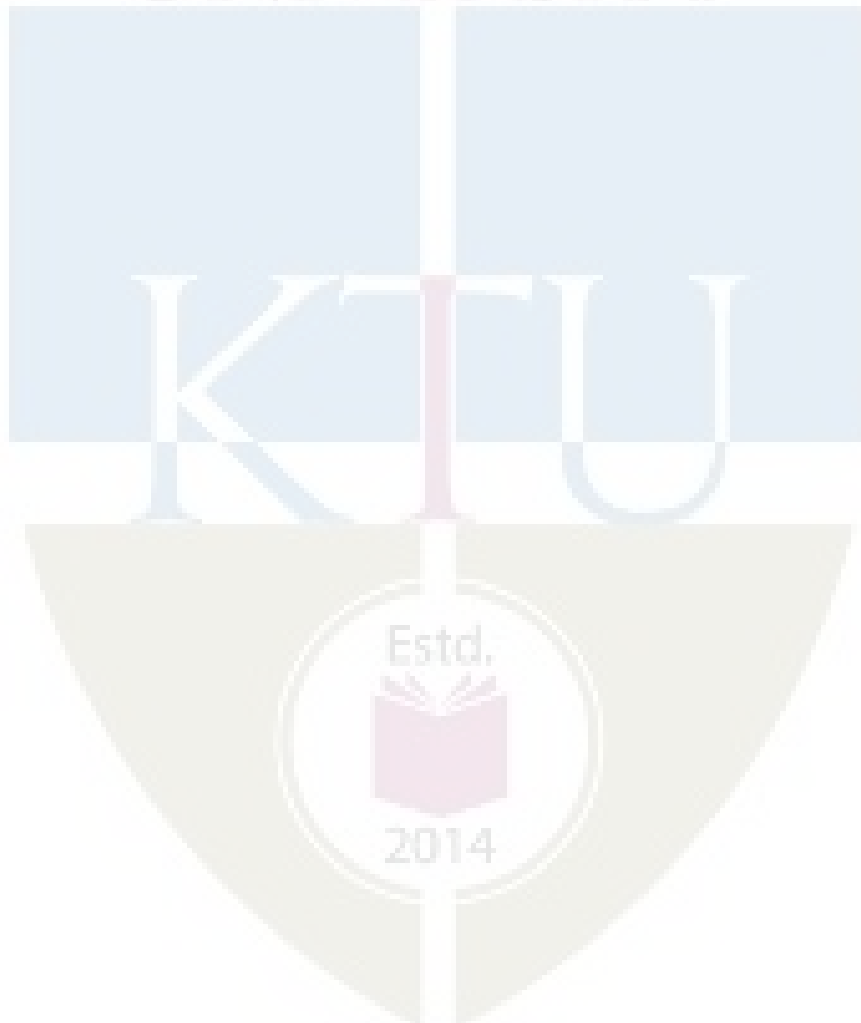
LATE_FEE_RULE(**FromDays**, **ToDays**, Amount) // Composite Key

1. Create a normalized database design with proper tables, columns, column types, and constraints
2. Create an ER diagram for the above database design.
3. Write SQL commands to
 - a. Create a database by name *Library*. Drop the database and re-create it.
 - b. Create DDL statements and create the tables and constraints (from the design) in the database created in step-a (*Library*)
Notes: [Create a script file and execute it. Create the script file in such a way that,,if the table exists, drop the tables and recreate)]
 - c. Create and execute DROP TABLE command in tables with and without FOREIGN KEY constraints.
 - d. Create and execute ALTER TABLE command in tables with data and without data.
 - e. Create and execute SQL commands to build indices on Member_Id and Book_Id on table Book_Issue.
 - f. Create and execute GRANT/REVOKE commands on tables.
 - g. Create and execute SQL commands to insert data into each of the tables designed
 - h. Learn and execute bulk import of data to tables from CSV files (insert 1000 records of books into the BOOK table from a CSV file).
 - i. Create and execute UPDATE/DELETE commands on tables. Try to update/delete rows with Primary and Foreign Keys. Try bulk updates or deletes using SQL UPDATE statement
4. Write SQLQuery to retrieve the following information
 - a. Get the number of books written by a given author
 - b. Get the list of publishers and the number of books published by each publisher
 - c. Get the names of authors who jointly wrote more than one book.
 - d. Get the list of books that are issued but not returned
 - e. Get the list of students who reads only 'Malayalam' books
 - f. Get the total fine collected for the current month and current quarter
 - g. Get the list of students who have overdue (not returned the books even on due date)
 - h. Calculate the fine (as of today) to be collected from each overdue book.
 - i. Members who joined after Jan 1 2021 but has not taken any books
5. Book return should insert an entry into the Book_Return table and also update the status in Book_Issue table as 'Returned'. Create a database *TRANSACTION* to do this operation (stored procedure).
6. Create a database view 'Available_Books', which will list out books that are currently available in the library
7. Create a database procedure to add, update and delete a book to the Library database (use parameters).
8. Use cursors and create a procedure to print Books Issue Register (page wise – 20 rows in a page)
9. Create a history table (you may use the same structure without any keys) for the MEMBER table and copy the original values of the row being updated to the history table using a TRIGGER.
10. NoSQL Exercise
 - a. Practice Mongo DB CRUD operations. Refer: <https://docs.mongodb.com/manual/crud/>
 - b. You may use a MongoDB local installation or cloud MongoDB services like MongoDB Atlas for this exercise
 - c. For documentation: Refer: <https://docs.mongodb.com/manual/introduction/>

11. Application Development Problem examples:

- 1) Inventory Control System.
- 2) Material Requirement Processing.
- 3) Hospital Management System.
- 4) Railway Reservation System.
- 5) Personal Information System.
- 6) Web Based User Identification System.
- 7) Timetable Management System.
- 8) Hotel Management System.

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CSL204	OPERATING SYSTEMS LAB	CATEGORY	L	T	P	CREDIT	YEAR OF
							INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The course aims to offer students a hands-on experience on Operating System concepts using a constructivist approach and problem-oriented learning. Operating systems are the fundamental part of every computing device to run any type of software.

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

Course Outcomes:

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

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

Mapping of course outcomes with program outcomes

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

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

Assessment Pattern:

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

Mark Distribution

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

Continuous Internal Evaluation Pattern:

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

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

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

Operating System to Use in Lab : Linux

Compiler/Software to Use in Lab : gcc

Programming Language to Use in Lab : Ansi C

Fair Lab Record:

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

SYLLABUS

OPERATING SYSTEMS LAB

* mandatory

1. Basic Linux commands
2. Shell programming
 - Command syntax
 - Write simple functions with basic tests, loops, patterns
3. System calls of Linux operating system: *
 - fork, exec, getpid, exit, wait, close, stat, opendir, readdir
4. Write programs using the I/O system calls of Linux operating system (open, read, write)
5. Implement programs for Inter Process Communication using Shared Memory *
6. Implement Semaphores*
7. Implementation of CPU scheduling algorithms. a) Round Robin b) SJF c) FCFS d) Priority *
8. Implementation of the Memory Allocation Methods for fixed partition*
 - a) First Fit b) Worst Fit c) Best Fit
9. Implement page replacement algorithms a) FIFO b) LRU c) LFU*
10. Implement the banker's algorithm for deadlock avoidance. *
11. Implementation of Deadlock detection algorithm
12. Simulate file allocation strategies.
 - b) Sequential b) Indexed c) Linked
13. Simulate disk scheduling algorithms. *
 - c) FCFS b)SCAN c) C-SCAN

OPERATING SYSTEMS LAB - PRACTICE QUESTIONS

1. Write a program to create a process in linux.
2. Write programs using the following system calls of Linux operating system:
 - fork, exec, getpid, exit, wait, close, stat, opendir, readdir
3. Write programs using the I/O system calls of Linux operating system (open, read, write)

4. Given the list of processes, their CPU burst times and arrival times, display/print the Gantt chart for FCFS and SJF. For each of the scheduling policies, compute and print the average waiting time and average turnaround time
5. Write a C program to simulate following non-preemptive CPU scheduling algorithms to find turnaround time and waiting time.
 - a) FCFS b) SJF c) Round Robin (pre-emptive) d) Priority
6. Write a C program to simulate following contiguous memory allocation techniques
 - a) Worst-fit b) Best-fit c) First-fit
7. Write a C program to simulate paging technique of memory management.
8. Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.
9. Write a C program to simulate disk scheduling algorithms a) FCFS b) SCAN c) C-SCAN
10. Write a C program to simulate page replacement algorithms a) FIFO b) LRU c) LFU
11. Write a C program to simulate producer-consumer problem using semaphores.
12. Write a program for file manipulation for display a file and directory in memory.
13. Write a program to simulate algorithm for deadlock prevention.
14. Write a C program to simulate following file allocation strategies.
 - a) Sequential b) Indexed c) Linked



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SEMESTER IV

HONOURS



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 and prime-power factorization, 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 $ax + by = c$.



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 $103x \equiv 57 \pmod{211}$.
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 $4k+1$ can be 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 $24x + 34y = 6$. (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 $135 \pmod{61}$ (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,
 $x \equiv 2 \pmod{3}$, $x \equiv 3 \pmod{5}$, $x \equiv 2 \pmod{7}$ (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 Numbers and prime-power Factorization.	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

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	Test1 (%)	Test2 (%)	
Remember	10	10	10
Understand	30	30	70
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance	10 marks
Continuous Assessment Tests (Average of Internal Tests 1 & 2)	25 marks
Continuous Assessment Assignment	15 marks

Internal Examination Pattern

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

End Semester Examination Pattern:

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

SYLLABUS

Module-1 (Introduction to bioinformatics)

Introduction to bioinformatics, Nature & Scope of Bioinformatics, animal vs plants, Eukaryote vs prokaryote, Nucleus. Chromosome, gene DNA, RNA, amino acids, and Protein, The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure, Transcription, translation.

Module-2 (Introduction to bio sequences and analysis)

Introduction to Biological Databases and data storage, NCBI, Genbank, Bio sequence formats- Database Similarity Searching, BLAST, Sequence alignment, Scoring Matrices, Multiple-Sequence Alignment, Dynamic programming

Module 3: (Introduction to Processing Nucleotides)

Tetranucleotide Frequency, Counting the Nucleotides, Writing and Verifying a Solution, Transcribing DNA into mRNA: Mutating Strings, Reading and Writing Files, Reverse Complement of DNA, String Manipulation, Iterating Over a Reversed String.

Module 4: (Processing Nucleotides GC Content and Hamming Distance)

Creating the Fibonacci Sequence, Writing, Testing, and Benchmarking Algorithms, retrieving FASTA Using Biopython, Iterating the Sequences Using a for Loop, Parsing FASTA and Analyzing Sequences, Computing GC Content, Finding the Hamming Distance, Counting Point Mutations

Module 5 (Translation of DNA and subsequence)

K-mers and Codons, Translating Codons, Translating mRNA into Protein, Finding Subsequences of DNA, Find a Motif in DNA, Finding Overlapping Patterns Using Regular Expressions, Sequence Similarity, Finding the Shortest Sequence in a FASTA File, Extracting K-mers from a Sequence, Counting Frequencies of K-mers, Finding Open Reading Frames

Text Books

1. Mount, D. W.. *Bioinformatics: Sequence and Genome Analysis*. India, CBS Publishers & Distributors, 2005.
2. Youens-Clark, Ken. *Mastering Python for Bioinformatics*. United States: O'Reilly Media, 2021.

References

1. Kelley, S.T. and Didulo, D, *Computational Biology: A Hypertextbook*. John Wiley & Sons, 2020
2. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. *Bioinformatics*. John Wiley & Sons, 2020.
3. Shaik, Noor Ahmad, et al. *Essentials of Bioinformatics, Volume I*. Springer, 2019
4. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, *Applied bioinformatics. An introduction–Springer, Verlag,*, 2008.
5. S C Rastogi, N Mendiratta and P Rastogi, *Bioinformatics: Methods and Applications*, PHI Learning Private Limited, New Delhi, 2015.
6. D E Krane and M L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education, 2006.
7. Bassi, Sebastian. *Python for Bioinformatics*. United Kingdom: CRC Press, 2017.
8. Model, Mitchell L. *Bioinformatics Programming Using Python*. United States: O'Reilly Media, 2010.
9. Antao, Tiago. *Bioinformatics with Python Cookbook*. United Kingdom: Packt Publishing, 2015. Antao, Tiago. *Bioinformatics with Python Cookbook: Learn how to Use Modern Python Bioinformatics Libraries and Applications to Do Cutting-edge Research in Computational Biology*, 2nd Edition. United Kingdom: Packt Publishing, 2018.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Compare and contrast the DNA and RNA on the basis of structure and functions.
2. Demonstrate with the help of a flow diagram the generation of protein using the transcription and translation process.

Course Outcome 2 (CO2):

1. Identify the following qualifiers for GenBank and give their definitions: [ACCN], [ALL], [AUTH], [ECNO], [FKEY], [GENE], [JOUR], [KYWD]
2. Find the sequence alignment between the following two sequences, locally and Globally
Sequence1: GATTCTATCTAACTA, Sequence2: GTTCTATTCTAAC
3. Retrieve sequence of Severe acute respiratory syndrome coronavirus 2 and use BLAST to find the similar sequences

Course Outcome 3 (CO3):

1. Write a Python program pseudocode to read the below given sequence as command line argument and print the counts for each of the bases A, C, G, and T.
Sequence: ACTGCAACGGGCAATATGTCTC
2. Write a python pseudocode to transcribe the following DNA sequence to its mRNA sequence.
Sequence: TGCAACGGGCAATATGTCTC

Course Outcome 4 (CO4)

1. Solve the problem of generating the Fibonacci sequence using Python.
2. Use a simple python program using a list to find the DNA string having the highest GC content, provided any 5 random DNA strings.

Course Outcome 5 (CO5)

1. Illustrate with the help of an example how an RNA string is getting converted to a protein string.
2. Write a python code to print the position and the number of times a subsequence is present in a given DNA string.

Model Question Paper

QP CODE:

Reg No: _____

Name: _____

PAGES : 4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

**FOURTH SEMESTER B.TECH DEGREE (HONOURS) EXAMINATION, MONTH &
YEAR**

Course Code: AIT294

Course Name: COMPUTATIONAL FUNDAMENTALS FOR BIOINFORMATICS

Max. Marks : 100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Differentiate DNA, Gene, genome and chromosome.
2. What do you mean by Gene expression?
3. Specify the functions of mRNA, tRNA and rRNA?
4. Differentiate between local and global alignment.
5. Find the reverse complement of the following DNA given in 5'-3' order?
AAAACCCGGT
6. List any 3 string manipulation construct used in processing nucleotides.
7. Illustrate how recursion is implemented using a Python pseudocode.
8. What is GC content? Give the GC content of the DNA string: "AGCTATAG".
9. Discuss the role of K-mers and codons in protein synthesis.
10. Define motif in DNA. Mention its importance in finding a conserved sequence.

(10x3=30)

Part B

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

11. (a) Discuss the central dogma of molecular biology. (7)
- (b) How is the primary transcript produced by a prokaryote different from that produced by a eukaryotic cell? (7)

OR

12. (a) Differentiate between Prokaryote and Eukaryote Cell (7)
- (b) Describe with the help of a neat diagram, the structure of DNA. (7)

13. (a) What is sequence alignment? Explain any five applications of sequence alignment in Bioinformatics? (7)
- (b) Discuss variants of BLAST with its input and output (7)

OR

14. (a) Explain the working principles of the Nucleotide BLAST with an example (7)
- (b) Differentiate primary and secondary databases in Bioinformatics. (7)

15. (a) How do you find the reverse complement of a DNA sequence? Write at least 2 different Python pseudocodes using different constructs to print the reverse complement of a given the 5'-3' end of a DNA sequence. (10)
- (b) Write a Python pseudocode to convert DNA sequence to RNA sequence by using the re.sub() regular expression construct. (4)

OR

16. (a) What is the need for 'argparse' module in Python? How can we use this module in different ways to do a tetra nucleotide frequency count? (7)
- (b) Write a Python program pseudocode to read the below given sequence as command line argument and print the counts for each of the bases A, C, G, and T. (7)
17. (a) Generate a random DNA sequence using python and find the transcribed DNA sequence of its reverse complement (7)

- (b) Write a python code using regular expressions to find the DNA sequence (7)
having the highest GC content in a DNA sequence.

OR

18. (a) Define Hamming distance. Using hamming distance, find the percentage of (7)
similarity between the sequence AAACCCGGGTTT and AACCCGGGTTTA
with one sequence in line with other.
- (b) Write a Python code using zip() function to find the hamming distance (7)
between 2 sequence. Give comments on each construct used in the code.
19. (a) Write a Python program using function and a list comprehension to translate (10)
RNA into protein. Illustrate working of the program with an example RNA
string.
- (b) Illustrate with python pseudocode to show how the str.find() function can be (4)
used to find a substring and its position in an input sequence.

OR

20. (a) Illustrate with the help of an example how an RNA string is getting converted (6)
to a protein string..
- (b) Write notes on ORF. Write a python code to find the ORF using the str.find() (8)
and str.partition() functions.



TEACHING PLAN

No	Contents	No of Lecture Hrs
Module-1 (Introduction to bioinformatics)(10 hrs)		
1.1	Introduction to bioinformatics	1
1.2	Nature & Scope of Bioinformatics	1
1.3	Animal vs plants, Eukaryote vs prokaryote	1
1.4	Nucleus. Chromosome, gene	1
1.5	DNA, RNA, and Protein	1
1.6	The Central Dogma introduction	1
1.7	Messenger RNA, tRNA, rRNA,	1
1.8	Genetic code	1
1.9	Gene Structure and Control	1
1.10	Transcription, Translation	1
Module-2 (Introduction to bio sequences and analysis) (10 hrs)		
2.1	Introduction to Biological Databases and data storage	1
2.2	NCBI, Genbank	1
2.3	NCBI, Genbank Sequence retrieval	1
2.4	Bio sequence formats	1
2.5	Database Similarity Searching, BLAST	1
2.6	BLAST Exercises	1
2.7	Sequence alignment	1
2.8	Scoring Matrices	1
2.9	Multiple-Sequence Alignment	1
2.10	Introduction to Dynamic programming in MSA	1
Module-3 (Introduction to Processing Nucleotides) (8 hrs)		
3.1	Counting the Nucleotides, Writing and Verifying a Solution	1

3.2	Transcribing DNA into mRNA	1
3.3	Iterating the Input Files	1
3.4	Mutating Strings	1
3.5	Writing and Reading Output Sequences	1
3.6	Reverse Complement of DNA	1
3.7	String Manipulation	1
3.8	Iterating Over a Reversed String	1

Module-4 (Processing Nucleotides GC Content and Hamming Distance) (8 hrs)

4.1	Creating the Fibonacci Sequence	1
4.2	Writing, Testing, and Benchmarking Algorithms	1
4.3	Retrieving FASTA Using Biopython	1
4.4	Parsing FASTA and Analysing Sequences	1
4.5	Computing GC Content	1
4.6	Finding the Hamming Distance	1
4.7	Iterating the Characters of Two Strings	1
4.8	Counting Point Mutations	1

Module-5 (Translation of DNA and subsequence) (9 hrs)

5.1	K-mers and Codons	1
5.2	Translating mRNA into Protein	1
5.3	Finding Subsequence of DNA	1
5.4	Find a Motif in DNA	1
5.5	Finding Overlapping Patterns Using Regular Expressions	1
5.6	Sequence Similarity	1
5.7	Finding the Shortest Sequence in a FASTA File , Extracting K-mers from a Sequence	1
5.8	Counting Frequencies of K-mers	1
5.9	Finding Open Reading Frames	1

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

Assessment Pattern

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Total Marks	CIE Marks	ESE Marks	ESE Duration
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Continuous Assessment Assignment	15 marks

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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 full question. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

Module – 1(Line and Circle drawing algorithms) 5

Basics of Computer Graphics and its applications. Video Display devices - Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories. Line drawing algorithms - DDA, Bresenham's algorithm. Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's algorithm.

Module - 2(Filled Area Primitives and Two dimensional transformations)

Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling. Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates.

Module - 3 (Clipping and 3D transformations)

Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. Three dimensional viewing pipeline. Basic 3D transformations.

Module - 4 (Projections and Visible Surface detection)

Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm

Module - 5 (Realism and performance)

Realism - Illumination Shading, Shadows, Texture mapping, Bump mapping, Environment mapping, Transparency, Accumulation Buffer, Back face Culling, Visibility Culling.

Text Books

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. Aditi Majumder and M.Gopi , Introduction to VISUAL COMPUTING Core Concepts in Computer Vision, Graphics, and Image Processing, 2018

References

- 1) William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001
- 2) Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019.
- 3) David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
- 4) Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, PHI, 4e, 2013

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare the working principle of raster scan systems and random scan systems.
2. How much time is spent scanning across each row of pixels during screen refresh on a raster system with resolution of 1280*1024 and a refresh rate of 60 frames per second?

Course Outcome 2 (CO2):

1. Rasterize the line with end points accepted from the user(2,3) and (5,8) using Bresenham's line drawing algorithm and implement it using any appropriate programming language. (Assignment)
2. Illustrate how the 4-connected area filling approach differs from 8- connected area filling in boundary filling algorithm and implement it using any appropriate programming language.(Assignment)

Course Outcome 3 (CO3):

1. Rotate a triangle ABC 45 degree counter clockwise about the pivot point (10,3) , where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3).
2. Implement the above transformation using any appropriate programming language with user inputs. (Assignment)

Course Outcome 4 (CO4):

1. Given a clipping window A(20,20), B(60,20), C(60,40) and D(20,40). Using Cohen Sutherland algorithm, find the visible portion of the line segment joining the points P(40,80) and Q(120,30).
2. Implement Cohen Sutherland clipping algorithm using any appropriate programming language with user inputs. (Assignment)

Course Outcome 5 (CO5):

1. Explain scan line algorithm for detecting visible surfaces in an object.

Course Outcome 6 (CO6):

1. You are rendering a black and white checkered tiled floor using a single texture mapped polygon. The view is simulating a person standing on the floor and looking at a point far away from him on the floor. (1) Artifacts at the distant end of the floor can be seen. How would you remove these artifacts? (2) How can you explain why this method works using the sampling theorem?
2. You are seeing an object which is either texture mapped, bump mapped or displacement mapped but you don't know which one. However, you have the liberty to move the light and the viewpoint of an object and see it from different angles and for different positions of the light. How will you figure out which technique was used?

Model Question Paper

QP CODE:

Reg No: _____

Name: _____

PAGES : 4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: AIT296

Course Name: Advanced Topics in Computer Graphics

Max. Marks : 100

Duration: 3 Hours

PART A

Answer All Questions. Each Question Carries 3 Marks

1. Consider a raster system with a resolution of 1024×1024 . Compute the size of the raster needed to store 4 bits per pixel? How much storage is needed if 8 bits per pixel are to be stored?
2. How 8-way symmetry of circle can be used for writing circle drawing algorithms? Write the symmetric points if (x, y) is a point on the circle with centre at origin.
3. Show that two successive reflections about either of the coordinate axes is equivalent to a single rotation about the coordinate origin.
4. Determine a sequence of basic transformations that are equivalent to the x-direction shearing matrix.

5. Find the window to viewport normalization transformation with window lower left corner at (1,1) and upper right corner at (2,6).
6. How does Cohen Sutherland algorithm determine whether a line is visible, invisible or a candidate for clipping based on the region codes assigned to the end points of the line?
7. Define the terms (i) Centre of projection (ii) Principal vanishing point
8. Differentiate between the object space and image space method for the hidden surface removal of an image.
9. Describe the steps used to convert the normal map to bump mapping.
10. One artifact of Gouraud shading is that it can miss specular highlights in the interior of the triangles. How can this be explained as an aliasing artifact?

(10x3=30
)

Part B

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

11. (a) Derive the initial decision parameter of Bresenham's line drawing algorithm and rasterize a line with endpoints (2,2) and (10,10). (8)
- (b) Draw the architecture of raster scan display systems and explain its working principle (6)

OR

12. (a) Explain the working principle of a Refresh CRT monitor with suitable diagrams. (7)
- (b) Write Midpoint circle drawing algorithm and plot a circle with radius=20 and center (50,30) using the algorithm. (7)
13. (a) Differentiate between boundary fill and flood fill algorithms. (5)
- (b) Reflect a triangle ABC about the line $3x-4y+8=0$, where the position vector of the coordinate ABC is given as A(4,1), B(5,2) and C(4,3). (9)

OR

14. (a) A diamond shaped polygon is located at P(-1,0), Q(0,-2), R(1,0) and S(0,2). Find the transformation matrix which would rotate the triangle by 90 degree counter clockwise about the point Q. Using the transformation matrix, find (7)

the coordinates of the rotated polygon.

(b) Illustrate the working principle of scan line polygon filling algorithm (7)

15. (a) Illustrate Weiler – Atherton polygon clipping algorithm. (6)

(b) Explain Cohen-Sutherland line clipping algorithm. Use the algorithm to clip line P1 (70, 20) and P2(100,10) against a window lower left hand corner (50,10) and upper right hand corner (80,40). (8)

OR

16. (a) Describe the steps required for a general 3D rotation if the rotation axis is not parallel to any one of the principal axis. The rotation axis is defined by the points P1(x1,y1,z1) and P2(x2,y2,z2). Give its composite matrix representation (6)

(b) Describe Sutherland Hodgeman polygon clipping algorithm and list out its limitations (8)

17. (a) Explain how visible surfaces can be detected using depth buffer algorithm. (7)

(b) Define parallel projection. Describe orthographic and oblique parallel projection. (7)

OR

18. (a) Illustrate the scan line method used in visible surface detection. (7)

(b) Explain the steps involved in performing perspective projections (7)

19. (a) Specify any three shading algorithms used in interactive graphics. (6)

(b) Explain the procedure of texture to object space mapping. (8)

OR

20. (a) Explain the mapping scheme in which the effects of small bumps on the surface of an object can be simulate without changing the number of primitives (8)

(b) Describe about object to screen space mapping. (6)

TEACHING PLAN

No	Contents	No of Lecture Hrs
Module – 1 (Line and Circle drawing algorithms) (10 hrs)		
1.1	Basics of Computer Graphics and applications	1
1.2	Refresh Cathode Ray Tubes	1
1.3	Random and Raster Scan Displays and systems,	1
1.4	Color CRT displays	1
1.5	Flat panel display and its categories.	1
1.6	DDA Line drawing Algorithm	1
1.7	Bresenham's line drawing algorithm	1
1.8	Midpoint Circle generation algorithm	1
1.9	Bresenham's Circle generation algorithm	1
1.10	Illustration of line and circle drawing algorithms	1
Module - 2 (Filled Area Primitives and Two dimensional transformations) (9 hrs)		
2.1	Scan line polygon filling	1
2.2	Boundary filling and flood filling	1
2.3	Basic 2D transformations-Translation	1
2.4	Basic 2D transformations- Rotation	1
2.5	Basic 2D transformations- Scaling	1
2.6	Reflection and Shearing	1
2.7	Illustration of Basic 2D Transformations	1
2.8	Composite transformations	1
2.9	Matrix representations and homogeneous coordinates	1
Module - 3 (Clipping and 3D transformations) (8 hrs)		
3.1	Window to viewport transformation	1
3.2	Cohen Sutherland Line clipping algorithm	1
3.3	Midpoint subdivision Line clipping algorithm	1
3.4	Sutherland Hodgeman Polygon clipping algorithm	1
3.5	Weiler Atherton Polygon clipping algorithm	1
3.6	Three dimensional viewing pipeline	1

3.7	Basic 3D transformation-Translation and scaling	1
3.8	Basic 3D transformation-Rotation	1
Module - 4 (Projections and Visible Surface detection) (7 hrs)		
4.1	Projections-Parallel projections	1
4.2	Projections- Perspective projections	1
4.3	Illustration of projection methods	1
4.4	Visible surface detection algorithms- Back face detection	1
4.5	Depth buffer algorithm	1
4.6	Scan line visible surface detection algorithm	1
4.7	<i>Z</i> buffer algorithm	1
Module - 5 (Realism and performance)(10 hrs)		
5.1	Illumination	1
5.2	Shading and Shadows	1
5.3	Texture mapping-Texture to object space mapping	1
5.4	Texture mapping-Object to screen space mapping and Mip Mapping	1
5.5	Bump mapping	1
5.6	Bump mapping-Illustration	1
5.7	Environment mapping and Transparency	1
5.8	Accumulation Buffer and Back face Culling	1
5.9	Visibility Culling	1
5.10	Visibility Culling	1