Paper / Subject Code: 49303 / DATA STRUCTURES

[Time: Three Hours]   **[Marks:80]**

N.B. (1)   Question No.1 is Compulsory
   (2)   Attempt any three questions out of remaining five questions
   (3)   Make suitable assumptions wherever necessary
   (4)   Figures to the right indicate full marks

1. (a) Explain ADT with an example.   (5)
   (b) Differentiate between Static and Dynamic Data Structure   (5)
   (c) Write a 'C' program to implement Binary Search using recursion   (5)
   (d) Discuss practical applications of Queues   (5)

2. (a) Write a 'C' program to implement STACK using arrays   (10)
   (b) What are the different methods of File I/O in 'C' language? What library functions are
   supported by 'C' language to do this?   (10)

3. (a) What are the advantages of Linked list over array? Write a 'C' program to implement
   Queue ADT using Linked List   (10)

   (b) Explain indexed Sequential search with a suitable example. What are the advantages and
   disadvantages of Indexed Sequential search   (10)

4. (a) Write a 'C program to create a "Singly Linked List" ADT. The ADT should support
   the following: (10)

   (i) Creating a Linked List
   (ii) Inserting a node after a specific node
   (iii) Deleting a node
   (iv) Displaying the list

   (b) Explain the method of Huffman Encoding. Apply Huffman encoding method for the
   sentence "MAHARASHTRA". Give Huffman code for each symbol.   (10)

5. (a) Write a 'C' program to create Binary Search Tree. Show BST for the following
   Input: 10,5,14,22,17,1,8   (10)

   (b) What is the use of hashing? Show hash table entries for the given dataset using Linear
   Probing and Quadratic Probing: 12,45,67,88,27,78,20,62,36,55.   (10)

6. Write Short notes on (any two)   (20)
   (a) Threaded Binary Tree
   (b) Explain BFS algorithm with example
   (c) Doubly Linked list.

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Total Marks: 80   **Time Duration: 3Hr**

N.B.:1) Question no.1 is compulsory.   **Maximum**
    2) Attempt any three questions from Q.2to Q.6.   **Marks**
    3) Figures to the right indicate full marks.

Q1. a) Find the Laplace transform of $\cos 2t \sin t\, e^{-t}$.   **[5]**

b) Find the half-range sine series for $f(x) = x(\pi - x)$ in $(0, \pi)$.   **[5]**

c) Show that the function $f(z) = ze^z$ is analytic and find $f'(z)$ in terms of z.   **[5]**

b) Prove that $\nabla\left\{\nabla.\frac{\bar{r}}{r}\right\} = -\frac{2}{r^3}\bar{r}$.   **[5]**

Q2. a) Find the inverse Z-transform of $F(z) = \frac{z}{(z-1)(z-2)}$ $|z| > 2$.   **[6]**

b) Find the analytic function whose real part is $\frac{\sin 2x}{\cosh 2y + \cos 2x}$.   **[6]**

c) Obtain Fourier series for the function $f(x) = \begin{cases} 1 + \frac{2x}{\pi} & , -\pi \le x \le 0 \\ 1 - \frac{2x}{\pi} & , 0 \le x \le \pi \end{cases}$,   **[8]**

deduce that $\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots$

Q3. a) Find $L^{-1}\left[\frac{1}{s^2(s+a)^2}\right]$ using convolution theorem.   **[6]**

b) Show that the set of functions $\cos nx$, $n = 1, 2, 3 \ldots$ is orthogonal on $[0, 2\pi]$.   **[6]**

c) Using Green's theorem evaluate $\int_c \left(\frac{1}{y}dx + \frac{1}{x}dy\right)$ where C is the boundary of the   **[8]**

region defined by $x = 1, x = 4, y = 1$ and $y = \sqrt{x}$.

Q4. a) Find Laplace transform of $f(t) = k\frac{t}{T}$ for $0 < t < T$ and $f(t) = f(t + T)$.   **[6]**

b) Show that $\bar{f} = (x^2 + xy^2)i + (y^2 + x^2y)$ j is irrotational and find its scalar potential.   **[6]**

c) Find half – range cosine series for $f(x) = x$, $0 < x < 2$. Using Parseval's identity   **[8]**
deduce that

i) $\frac{\pi^4}{96} = \frac{1}{1^4} + \frac{1}{3^4} - \frac{1}{5^4} + \cdots$

ii) $\frac{\pi^4}{90} = \frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \cdots$

Q5.a) Use divergence theorem to show that $\iint_S \nabla r^2 \overline{ds} = 6v$ where S is any closed surface   **[6]**
enclosing a volume V.

b) Find the Z-transform of $f(k) = k\alpha^k$, $k \ge 0$.   **[6]**

c) i) Find $L^{-1}\left[\frac{(s+2)^2}{(s^2+4s+8)^2}\right]$ **[8]**

ii) Find $L^{-1}[2\tanh^{-1}s]$

Q6.a) Solve using Laplace transform   **[6]**
$(D^2 - 3D + 2)y = 4e^{2t}$, with $y(0) = -3, y'(0) = 5$.

b) Find the bilinear transformation which maps the points 1, -i, 2 on z-plane onto 0, 2, -i   **[6]**
respectively of w-plane.

c) Express the function $f(x) = \begin{cases} \sin x & , 0 < x \le \pi \\ 0 & x < 0, x > \pi \end{cases}$ as Fourier integral and deduce   **[8]**

that $\int_0^\infty \frac{\cos\left(\frac{w\pi}{2}\right)}{1 - w^2}\, dw = \frac{\pi}{2}$.

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(3 Hours)   Marks : 80

Note: **Q. 1** is **compulsory**.

Attempt any **THREE** questions from **Q. 2 to Q. 6**

Q. 1 **a** Differentiate between method overloading and overriding.   **[5]**

  b Illustrate with an example use of arraycopy() method.   **[5]**

  c Discuss the limitations of String class in JAVA. Differentiate between Sting and   **[5]**
       StringBuffer class.

  d Write a program to calculate GCD of two numbers. Take input from command   **[5]**
       line arguments. (GCD: Greatest Common Divisor)

Q. 2 **a** Explain Inheritance. Discuss different types of Inheritance in JAVA. Why JAVA   **[10]**
       does not support Multiple Inheritance?

  b What is multithreading? Explain different ways to create thread in JAVA. Write a   **[10]**
       program to display 1 to 10 numbers by creating a thread.

Q. 3 **a** Differentiate between application program and Applet. Explain applet lifecycle   **[10]**
       with neat diagram.

  b Explain the steps to create package in JAVA by adding class or an interface.   **[10]**
       Write a program to create package MYPACK to add Employee class and display
       Employee details: Employee_ID, Employee_Name and Employee_Salary.

Q. 4 **a** Explain exception handling mechanism with the help of **try**, **catch**, **throw**, **throws**   **[10]**
       and **finally**.

  b Differentiate between interface and abstract class.   **[5]**

  c Why JAVA is platform Independent? Explain JVM.   **[5]**

Q. 5 **a** Write a program to create class Product with Product ID, Product Name, Quantity   **[10]**
       and Price. Also write methods to take input for product details, to display product
       details and to sort product details in ascending order of their price. Write a program
       to read and display sorted list of 10 products.

  b Differentiate between Array and Vector. Explain any five methods of Vector class.   **[10]**

Q. 6 **a** Explain use of super keyword in JAVA.   **[5]**

  b Discuss Final keyword with respect to variable, method and class in JAVA.   **[5]**

  c Explain logical operators in JAVA.   **[5]**

 **d** What is constructor? Explain different types of constructor.   **[5]**

(3 hours)   **Total Marks: 80**

N.B.
1. **Question No 1 is compulsory**
2. **Solve any three question out of remaining five questions**
3. **Assumption made should be clearly stated**
4. **Figure to the right indicates full marks**

1 (a) Prove by mathemathical induction that $11^{n+2} + 12^{2n+1}$ is divisible by 133.   **5**

  (b) Show that if a relation on set A is transitive an irreflexive, then it is asymmetric.   **5**

  (c) Function $f(x) = (4x + 3)/(5x - 2)$. Find f^{-1} **5**

  (d) What is the total number of vertices in a full binary tree with 20 leaves?   **5**

2. (a) Let $f(x) = x + 2$, $g(x) = x - 2$ and $h(x) = 3x$ for all $x \in R$. (R is the set of real   **8**
number). Find i) $f \circ g \circ h$ ii) $h \circ g \circ f$ iii) $f \circ f \circ f$

  (b) Let R be a relation on the set of integers Z defined by aRb if and only if   **8**
$a \equiv m(mod\ 5)$. Prove that R is an equivalence relation. Find Z/R.

  (c) Is it possible to draw a graph with 5 vertices of degree 1,1, 2, 2, 4   **4**

3 (a) Let $A = \{1, 2, 3, 4\}$ and $R = \{(1,2), (2,3), (3, 4), (2, 1)\}$. Find the transitive closure using   **6**
Warshall's algorithm.

  (b) Consider the lattices $L1 = \{1, 2, 4\}$, $L2 = \{1, 3, 9\}$ under divisibility. Draw the lattice $L1 \times$ **6**
$L2$.

  (c) Solve the recurrence relation $a_n = -3(a_{n-1} + a_{n-2}) - a_{n-3}$ with $a_0 = 5$, $a_1 = -9$ and   **8**
$a_2 = 15$

4 (a) Show that a group G is abelian if and only if $(ab)^2 = a^2b^2$ for all $a, b \in G$ **6**

  (b) Prove that the set $G = \{1, 2, 3, 4, 5, 6\}$ is an abelian group under multiplication modulo 7.   **6**

  (c) Find the generating function for the following series   **8**
i) $\{0, 1, 2, 3, 4, \dots\dots\dots\dots\dots\dots\}$
ii) $\{1, 2, 3, 4,\ 5, \dots\dots\dots\dots\dots\dots.\}$
iii) $\{2, 2, 2, 2, 2, \dots\dots\dots\dots\dots\dots.\}$
iv) $\{0, 0, 0, 1, 1, 1, 1\ \dots\dots\dots\dots\dots\dots.\}$

5 (a)   **8**

Let $H = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ be parity check matrix.

Decode the following words relative to maximum likelyhood decoding function.
i) 011001   ii) 101011   iii) 111010   iv) 110110

(b) Determine the Eulerian and Hamiltonian path/circuit, if any, in the following graphs. **6**
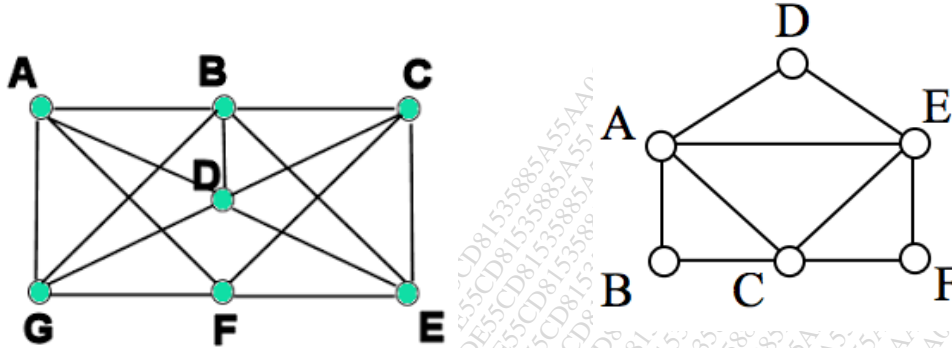
(c) Let G be the set of real numbers and let Let G be the set of real numbers and let **6**
$a * b = ab/2$. Showthat $(G,*)$ is a abelian group.

6 (a) Determine whether following graphs are isomorphic **8**
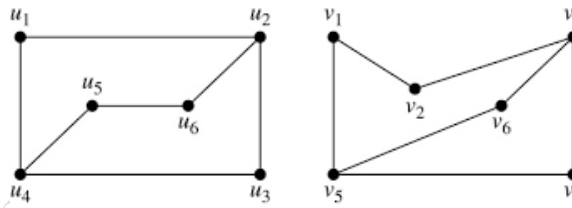
(b) Use the laws of logic to determine the following expression as tautology or contradiction. **6**
$$[p \wedge (p \Rightarrow q)] \Rightarrow q$$

(c) Draw the Hasse Diagram of the following: **6**

a) D₄₈   **b) D₁₀₅**   **c) D₇₂**

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Time: 3 Hours   **Marks: 80**

N.B. (1) Question No. 1 is compulsory

    (2)Assume suitable data if necessary

    (3)Attempt any three questions from remaining questions

1   Attempt any 5

    (a) Convert $(216.24)_{10}$ into octal, binary and hexadecimal, and base 4.   (4)

    (b) Perform $(76)_{10} - (33)_{10}$ in BCD using 10's complement method   (4)

    (c) Explain Glitch problem.   (4)

    (d) State De Morgan's theorem. Prove NAND is Universal gate.   (4)

    (e) Encode the data bits 110010001 using Hamming code.   (4)

    (f) Explain SOP and POS and solve the following using K-Map

         $F(A,B,C,D)=\sum m(1,5,6,7,10,11,13)+d(2,4)$ (4)

    (g) Explain parity generator/checker.   (4)

2 (a) Simplify following function using Quine McCluskey method and realize circuit

    using basic gates. $F(A,B,C,D) = \pi M (2,7,8,9,10,12)$ (10)

  (b) Explain and Design a BCD adder using 4 bit binary adders.   (10)

3 (a) Implement 16:1 Mux using 8:1 Mux.   (5)

  (b) Explain lockout condition. How can it be avoided.   (5)

  (c) Design a 2 bit magnitude comparator.   (10)

4 (a) Compare different logic families with respect to fan in, fan out, speed,

    propogation delay and power dissipation.   (10)

  (b) Explain 4 bit bidirectional shift register.   (10)

5 (a) Design mod 10 asynchronous counter using T flipflop   (10)

  (b) Convert SR flipflop to JK flipflop and T flipflop.   (10)

6 Write short note on (any four):-   (20)

  (a) ALU

  (b) 3 bit Up/Down Asynchronous Counter

  (c) Priority Encoder

  (d) 4-bit Universal shift register

  (e) VHDL

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(3 Hours)   **[Total Marks : 80]**

N.B. : 1. Question **ONE** is **Compulsory.**
   2. Solve any **THREE** out of remaining.
   3. **Draw** neat and **clean** Diagrams.
   4. Assume suitable **data** if required

Q.1.   Attempt the following
   a) Explain the concept of virtual ground in op-amp   5
   b) Explain block diagram of PCM   5
   c) Compare FET and BJT   5
   d) What is ZCD?   5

Q.2.   A. Explain the construction and working of n-channel JFET with help of   10
         characteristic curves.
   B. Explain op-amp as integrator   10

Q.3.   A. List down various parameters of op-amp with their practical values and ideal values   10
         for IC741.
   B. Explain working of PLL as frequency as frequency multiplier with diagram.   10

Q.4.   A. Explain Superheterodyne Receiver along with waveforms at each stage .   10
   B. What are power amplifiers .what are the types of power amplifiers .Explain
      class C power amplifiers.   10

Q.5.   A. Derive the equations for Zi, Zo, Av for common source configuration using 10
         voltage divider network
   B. Discuss Delta Modulation and Adaptive Delta Modulation

Q.6. Write short note: 20
   a) TDM-PCM System
   b) Generation of FM
   c) Comparators.
   d) op-amp as summing amplifier

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