

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA**End Semester Examination 2019****IInd Semester B.Sc. Computer Science Honours****Core Course IV****Full Marks: 50****Time: 2 hours****Section-A (Answer any 20 questions)** **$20 \times 1 = 20$**

1. Define infinite set with example.
2. Why recurrence relation is useful?
3. What is closed walk?
4. How many elements in $A \times B$ and $B \times A$ are common if 3 elements are common to A and B?
5. What is spanning tree?
6. What is chromatic number of graph?
7. Write Inclusion-Exclusion principle for two sets.
8. Give the statement of Harmonic series.
9. What does $O(1)$ complexity means?
10. The function $\frac{2}{1-2x} + \frac{1}{1-x}$ generates the sequence $\{a_n\}$ where a_n equal to ____.
11. Let R and S be two equivalence relations on a set consider the following assertions.
 - a) $R \cup S$ is an equivalence relation.
 - b) $R \cap S$ is an equivalence relation.
 Then which of the following is true.
 - i) only (a)
 - ii) both (a) and (b)
 - iii) only (b)
 - iv) none of above.
12. How many minimum friends you must have to guarantee that at least five of them will have birthdays in the same month?
13. There are 10 lamps in a hall. Each one of them can be switched on independently. The number of ways in which the hall can be illuminated is ____.
14. Give the asymptotic upper bound of n^2+7n+3 .
15. What is the Cartesian product of $(A \times B \times C)$ where $A=\{0, 1\}$, $B = \{1, 2\}$, $C = \{0, 1, 2\}$.
16. State the generating function for $(1+z)^n$.
17. Give the recurrence relation for Fibonacci series.
18. Give an example of Hamiltonian path.
19. What is the complexity of searching an element from a set of n element using binary search algorithm?
20. What is the number of edges present in a complete graph having n vertices?
21. Translate the following statement into mathematical logic “some real numbers are rational.”
22. State the graph coloring problem.
23. What is tautology?
24. What is the remainder when 4^{119} is divided by 9?

Section-B (Answer any 3 questions) **$3 \times 10 = 30$**

1. a) Give an example of function from N to N that
 - i) One-to-one but not onto.
 - ii) Onto but not one-to-one.

- iii) Both onto and one-to-one.
 iv) Neither onto nor one-to-one.
 b) how many five digit numbers can be formed using 0 to 9, if each number starts with 59, for example 59124, 59729 etc. and no digits appears more than once.
 c) State the application of graph coloring.

$$4 + 4 + 2 = 10$$

2. a) Prove that the following proportion is Tautology

$$[(p \vee q) \wedge (p \rightarrow r) \wedge (q \rightarrow r)] \rightarrow r.$$

- b) Determine the generating function of the sequence $\{n^2\}$, $n \geq 1$.
 c) Let $H = \{n \in \mathbb{N} : \sin n\pi = 0\}$. Prove that $H = \mathbb{N}$.

$$5 + 2 + 3 = 10$$

3. a) Use the method of generating function to solve the recurrence relation

$$a_n = 4a_{(n-1)} + 3n2^n; n \geq 1, \text{ given that } a_0 = 4.$$

- b) If we select 10 points in the interior of an equilateral triangle of side 1, show that there must be at-least two points whose distance apart is less than $1/3$.
 c) A house has 4 doors and 10 windows. In how many ways can a burglar rob the house by entering through a window and exiting through a door.
 d) How many numbers are there between 100 and 1000 such that at least one of their digits is 3?

$$4 + 2 + 2 + 2 = 10$$

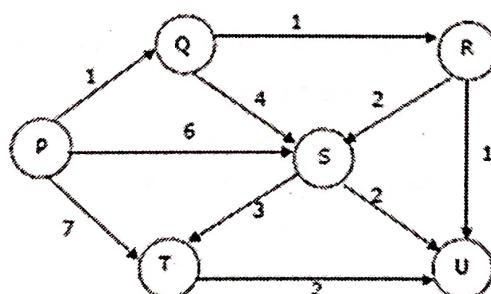
4. a) Find the value of S for the following geometric series:

$$S = \sum_{j=0}^3 2(4)^j$$

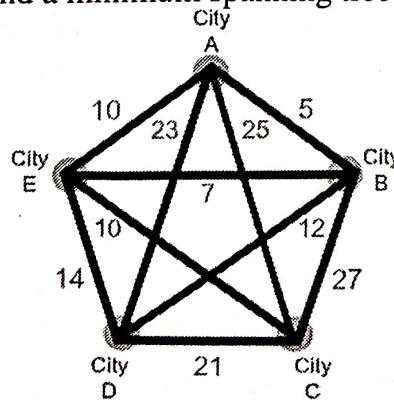
- b) State and explain the Konigsberg bridge problem with proper diagrams.
 c) What is a Propositional variable and logical expression?
 d) What is a planer graph?

$$4 + 3 + 2 + 1 = 10$$

5. a) Find the shortest paths using Dijkstra algorithm with starting node P for the following graph. Explain it and draw proper diagrams.



- b) Explain if Dijksta algorith can be used in case of negative weighted graphs?
 c) Use Prim's algorithm to find a minimum spanning tree of the following graph:



$$5 + 2 + 3 = 10$$

RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA

END SEMESTER EXAMINATION 2022

SEMESTER II

B.Sc. COMPUTER SCIENCE HONOURS

Core Course IV

Full Marks: 50

Time: 2 hours

Answer any five (5) questions from the following taking at least one Question from each group :

$$5 \times 10 = 50$$

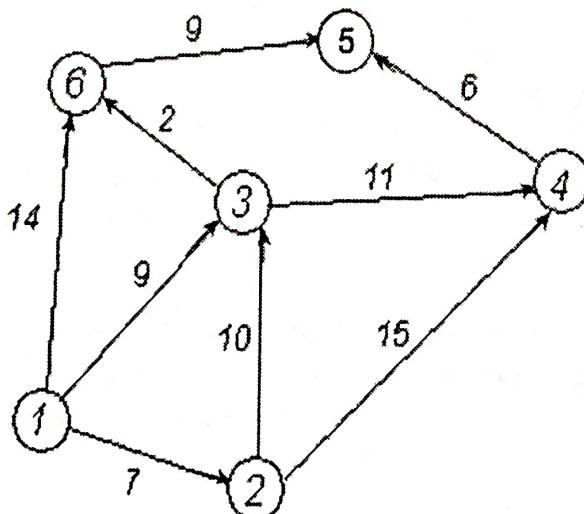
Group-A

1. Define following terms:
 - i) Indegree and Outdegree.
 - ii) Pseudo simple graph.
 - iii) Weakly connected graph.
 - iv) Sub graph.

[$2\frac{1}{2} \times 4 = 10$]
2. i) "Bubble sort is the example of polynomial time algorithm"- justify.
ii) Graphically compare between Algorithm complexity vs Growth of input for $O(1)$, $O(\log n)$, $O(n)$, $O(n^2)$.
iii) Write "R" code to plot a full graph with 5 vertices of blue color.

[2 + 4 + 4]
3. i) The Contra-positive of "If you do your homework, you will not be punished" is "If you are punished, you did not do your homework"- Is it true? Justify your answer.
ii) Briefly explain the term 'modus ponens'.
iii) Use De Morgan's Laws to express the negations "Sachin has a smart phone and he has a smart TV" and "Sourav will go to the summit or Rahul will go to the summit".

[2 + 4 + 4]
4. i) Find the shortest paths using Dijkstra algorithm with starting node P for the following graph.



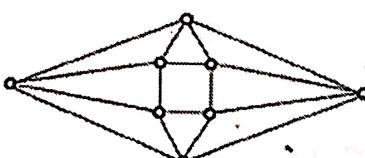
- ii) Why asymptotic notations are useful?
- iii) Define depth of a tree.
- iv) Define Floor and ceiling function.

[5 + 2 + 1 + 2]

5. i) Prove that $(P \rightarrow Q) \wedge (Q \rightarrow R) \rightarrow (P \rightarrow R)$ is tautology.
 ii) How many 5-digits telephone numbers can be constructed using the digits 0 to 9 if each number starts with 67, for example 67125 etc., and no digit appears more than once?
 iii) Give an example of Hamiltonian Circuit.

[4 + 4 + 2]

Group-B

6. a) Use the method of generating function to solve the recurrence relation
 $a_n = 4a_{n-1} + 3n2^n; n \geq 1$, given that $a_0 = 4$.
 b) Find all the equivalence relation on the set $A = \{1, 2, 3\}$.
 c) Let $x \in \mathbb{R}$ and $n \in \mathbb{N}$. Then $\lfloor x + n \rfloor = \lfloor x \rfloor + n$, where $\lfloor x \rfloor$ denotes floor function.
- [4 + 3 + 3]
7. a) Solve the recurrence relation $a_{n+2} - 6a_{n+1} + 9a_n = 2^n + 7 \cdot 3^n, n \geq 0$, given that $a_0 = 1, a_1 = 4$.
 b) Find the number of integers between 1 and 250 both inclusive that are not divisible by any of the integers 2, 3, 5 and 7.
 c) Find the number of symmetric relations on a set of three elements.
- [4 + 4 + 2]
8. a) The number of virus affected file in a system is 100 initially, and this increased by 250% every three hours. Use a recurrence relation to determine the number of virus affected file in the system after one day.
 b) Prove that the sum of degrees of all nodes in a graph is twice the number of edges.
 c) What is the minimum number of colors required to color the following graph, such that no two adjacent vertices are assigned the same color? Also show how that can be done.
- 
- d) If $A \subset B$, then what is $A \cap B$?

[4 + 2 + 3 + 1]

**RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA**

END SEMESTER EXAMINATION 2022

SEMESTER III

B.Sc. COMPUTER SCIENCE HONOURS

Core Course V

Full Marks: 50

Time: 2 hours

N. B.:

- Draw diagrams whenever necessary.
- Numbers to right indicate marks.

Answer any five (5) questions from the following:

$5 \times 10 = 50$

1. What do you understand by data structure? Let there is an integer 2D array of size 4x5. Assuming each integer takes 4 bytes of memory and the base address is 1018, consider the values are stored in row major ordering, with proper diagrammed explanation find out address of the element A[2][4]. Which one is better and why: recursive version or non-recursive version of a function? Linked list is not a non-linear data structure-Explain it with example. $2 + 4 + 2 + 2$
2. What are the advantages and disadvantages of using a linked list over an array? How will you represent the polynomial $7x^6 + 5x^3 - 2x + 10$ using linked list? Write an algorithm/function to reverse the direction of links of a given singly linked list. Write an algorithm/function to delete an element from the beginning of a doubly linked list. $2 + 2 + 4 + 2$
3. Explain the overflow condition of a deque (implemented using array). Write a C function to insert a new element at the beginning of a deque, considering that the deque has been implemented using array. Explain how to use a deque as stack. $3 + 5 + 2$
4. Write down the basic properties of a recursive function. Write a C program to print the resultant matrix where you need to use the following formula to compute each element of the resultant matrix.
$$f(x,y) = 4x \min\{A(x,y), A(x,y+1), A(x+1,y+1), A(x+1,y)\}$$
Here A is the input matrix and $f(x,y)$ is the element of the resultant matrix. If values are not available then treat them as zeros.
Write down C functions to check queue full and to display the circular queue elements using array. $2 + 5 + 3$
5. What is the main advantage of selection sort over bubble sort? Write a C program to sort the elements of a single linked list.

Which one will be efficient to implement binary search: linked list or array? Justify your answer with example(s). 1 + 5 + 4

6. Explain binary search tree with the help of an example? Write an algorithm/function for searching a given element in a binary search tree, if the element is not present, your algorithm/function should insert it in the tree so that it remains a binary search tree. What is the advantage of storing elements in binary search tree? (3 + 5) + 2
7. Write a function to find the minimum value of a binary search tree(BST). Insert the following data into an empty BST - 40, 25, 70, 22, 35, 60, 80, 90, 10, 30. Delete the following data from the BST: 30, 80, 40. Show all the steps. What is balance factor of a binary tree? 3 + 5 + 2
8. What is the precondition of performing binary search in an array? Write an algorithm/function to search an element in an array using binary search method. Write an algorithm/function to search and insert an element in a hashed table where collisions are resolved by linear probing with open addressing. What is the drawback of this algorithm function? (1 + 4) + (4 + 1)

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA
End Semester Examination 2019
IIIrd Semester B.Sc. Computer Science Honours
Core Course V

Full Marks: 50**Time: 2 hours****Answer 5 out of 9 questions.** **$5 \times 10 = 50$ Marks**

1. Define linear and non-linear data structures.

Write an algorithm to convert an Infix Expression to an equivalent Postfix Expression.

Convert the following Arithmetic Infix Expression into its equivalent Postfix form:

$$(F + G) * C - ((A + B) - (D - E)) \quad (2+6+2)$$

2. What are Advantages and Disadvantages of using a Linked List over an Array?

How will you represent the polynomial $4x^3 - 10x^2 + 3$ using a Linked List?

Write an algorithm to delete an element from the beginning of a Doubly Linked List.

Write an algorithm to concatenate two existing circular lists. (2+2+2+4)

3. Write a program to implement Singly Linked List using templates. Also design functions for insertion, deletion and search of a number. (4+2+2+2)

4. What is a Priority Queue? What operations does it support? Explain in detail Heap Data Structure that is used to implement Priority Queue covering MinHeap. (2+2+6)

5. What is Recursion? Explain internal stack implementation using recursive factorial function. Explain linear, binary, and multiple recursions. (2+3+5)

6. What is a tree traversal? Write preorder, inorder, and post-order tree traversal algorithms for a Binary Tree, with illustrations. (1+3+3+3)

7. What is the precondition of performing binary search in an array? Write a non-recursive algorithm to search an element in an array using binary search method. What is the time complexity of it? What is the advantage of using binary search method over linear search method?

What is the best case time complexity of an insertion sort algorithm? When does it occur?

$(1+4+1+2) + (1+1)$

8. How does an AVL tree differ from a Binary Search Tree?

Construct an AVL Tree by inserting the following set of nodes:

B, W, M, T, R, J, D, S, Q, K, V, P

State at each step balanced or unbalanced, if unbalanced, rotation type.

What is the maximum height of an AVL Tree with n number of nodes? (2+6+2)

9. What is Hash Data Structure? Explain in detail methods followed in Hash Collision Handling. (3+7)

**RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA**

MID SEMESTER EXAMINATION 2023

SEMESTER II

B.Sc. COMPUTER SCIENCE HONOURS

Core Course IV

Full Marks: 25

Time: 1 hour

Group-A

Answer any three (3) questions from the following:

$3 \times 5 = 15$

1. (a) Define Propositional Logic.
(b) Give examples of Inverse and Converse. (2+3)
2. Prove $(A \vee B) \wedge [(\neg A) \wedge (\neg B)]$ is a contradiction. (5)
3. (i) What do you mean by adjacent vertices?
(ii) Give examples of strongly connected graph and weakly connected graph. (2+3)
4. (i) "Binary search algorithm is $O(\log n)$ " - Is it true? Justify your answer.
(ii) Write "R" code to plot a cycle graph with 6 vertices of blue color. (2+3)
5. (i) Draw and explain Arbitrarily Traceable Graph.
(ii) What do you mean by Deletion and Fusion? (2+3)

Group-B

Answer any two (2) questions from the following:

$2 \times 5 = 10$

6. Using the generating function to solve the recurrence relation $a_n = 4a_{n-1} + 3n2^n$, $n \geq 1$ with $a_0 = 4$
7. Solve the recurrence relation $a_n = 4a_{n-1} - 4a_{n-2} + 3n + 2^n$; $a_0 = 4$, $a_1 = 1$
8. Find the formula for the general term F_n of the Fibonacci sequence 0,1,1,2,3,5,8,13,....

RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA
MID SEMESTER EXAMINATION 2023
SEMESTER III
B.Sc. COMPUTER SCIENCE HONOURS
Core Course V

Full Marks: 25**Time: 1 hour****N. B.:**

- Draw diagrams whenever necessary.
- Numbers to right indicate marks.

Answer any five (5) questions from the following: **$5 \times 5 = 25$**

1. What is the purpose of data structure? Compare between array and linked list. What is self-referential structure? Explain it with an example. 1+2+2
2. A two dimension 6×7 array “arr” having the starting index as $\text{arr}[0][0]$ with the base address as 1020 and size of each element is 2 Bytes of memory then find the address of $\text{arr}[5][4]$ using column major ordering showing all the steps. Let there is an array of 57 elements with starting index as 2177 having the base address as 2310 then find the address of the element at index 2222 considering memory size of each element is 4 bytes. 3+2
3. Write C function(s) to insert a node before a specific position in a single linked list, also define the node structure. Consider the starting pointer of the linked list is not global. 5
4. What are the advantages of circular doubly linked list over doubly linked list? Is it possible to create two dimensional linked lists? Justify your answer with proper node structure and description. 2+3
5. Write a C program to reverse an inputted string with the help of a stack created using linked list. 5
6. How to check the overflow and underflow condition of a stack using array? Write function(s) in C to delete a node from the end of a double circular linked list, also define the node structure of the linked list. Consider the starting point as not global. 2+3
7. Consider a stack (size=16) in which $\text{TOP}=2$. Elements at present moment are – 22, 34. Now perform the following. Show all steps using diagrams. (a) Push(17), (b) Push(54), (c) Pop(), (d) Pop(), (e) Pop(), (f) Pop(), (g) Peek(), (h) Pop(), (i) Add (98), (j) Push(56), (k) Add (874), (l) Add(623), (m) Peek(). 5
8. Convert the following infix expression to postfix expression using stack showing all the steps:

$$(m-r)/p*a^f-(c+f)^k^j$$
 5

RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA
MID SEMESTER EXAMINATION 2023
SEMESTER IV
B.Sc. COMPUTER SCIENCE HONOURS
Core Course VIII

Full Marks: 25**Time: 1 hour****N. B.:**

- Draw diagrams whenever necessary.
- Numbers to right indicate marks.

Answer any five (5) questions from the following: **$5 \times 5 = 25$**

1. What is the need of algorithm? How an algorithm can be validated? How many types of time complexities are there explain about those? 1+1+(1+2)
2. Write down the differences between algorithm and program. Why efficiency of an algorithm is important and how to measure them. 3+2
3. What do you mean by Big Ω ? Find out the lose upper bound of the recursive algorithm of the n^{th} Fibonacci number (no need to write the algorithm). 3+2
4. Using substitution method find the upper, lower and tight (if any) bound of $T(n)=4T(n/2)+n$, show the total procedure. 5
5. Write down the iterative algorithm of Insertion sort and deduce the worst case complexity. 2+3
6. In merge sort if the division is not from the middle rather it is after the 1st element will it increase the complexity? Justify your answer. Using recursive tree method, deduce the complexity of the recurrence relation of the merge sort algorithm. 3+2
7. Write down the Quick Sort algorithm. Discuss whether selecting pivot at the middle or at random position except the beginning or end will improve the complexity of the quick sort algorithm? 3+2
8. Write the algorithm to perform iterative Binary search on an unsorted list. Find out the $T(n)$ of it and analyse its time complexity. 3+2

RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA
END SEMESTER EXAMINATION 2023
SEMESTER II
B.Sc. COMPUTER SCIENCE HONOURS

Core Course IV

Full Marks: 50

Time: 2 hours

N. B.:

- Draw diagrams whenever necessary.
- Numbers to right indicate marks.

Answer any five (5) questions from the following:

5×10=50

1. Define following terms [Any five(5)]:
 i) Multi graph and non-multi graph.
 ii) Co-tree.
 iii) Strongly connected graph.
 iv) K-regular graph.
 v) Rooted Tree
 vi) Properties of graph coloring. [2×5=10]
2. a) Use mathematical induction to show that $1 + \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} + \dots + \frac{1}{\sqrt{n}} > \sqrt{n}$, for $n \geq 2$.
 b) If $f, g, h: \mathbb{R} \rightarrow \mathbb{R}$ are defined by $f(x) = x^3 - 4x$, $g(x) = \frac{1}{x^2+1}$ and $h(x) = x^4$ then find $((fog)oh)(x)$ and $(fo(goh))(x)$. Also check if they are equal. [5+5]
3. a) In a group of 38 people, at least how many must have been born in the same month?
 b) Determine the following relation R are reflexive, symmetric, transitive relations or not on \mathbb{Z} .
 aRb iff $ab \geq 0$.
 c) Find explicit formula for the general term of the sequence 1, 1, 2, 3, 5, 8, 13, ... [3+3+4]
4. i) Give a comparative graphical representation of Algorithm complexity vs Growth of input for $O(1)$, $O(n)$ and $O(n^2)$.
 ii) Write "R" code to plot a ring graph with 10 vertices with black color.
 iii) Find out the value of S, where

$$S = \sum_{k=4}^5 (2 + 3k) \quad [3+3+4]$$
5. i) Define chromatic number of a graph and explain its applications.
 ii) Prove that a simple graph with n vertices and k components has at most $n - k$ edges.
 iii) Let G be a simple graph with 6 vertices and edges. Suppose that h is a graph obtained from G by adding an isolated vertex (i.e., a vertex with no edges).

Determine whether G and H are isomorphic. If they are, provide an isomorphism between the two graphs. If they are not, explain why not.

[3+3+(2+2)]

6. i) Suppose you have a graph with 8 vertices, 13 edges, and a maximum degree of 4. What is the minimum number of colors required to color the vertices of this graph such that no two adjacent vertices have the same color?
 - ii) A school district is planning a transportation system for students. Each bus can hold 50 students, and each bus costs \$500 to operate per day. The school district has a total of 1000 students. Write a recurrence relation that models the minimum daily cost of transporting all students to school, assuming that all buses must be filled to capacity.
 - iii) What is the relationship between the number of edges in a graph and the number of edges in a spanning tree of that graph?
 - iv) State the number of entries we need to store for an undirected graph represented as adjacency matrix. [3+4+2+1]
7. i) Four persons P1,P2,P3,P4 who arrive late for a dinner party find that only one chair at each of five tables T1,T2,T3,T4,T5 is vacant. P1 will not sit at T1 or T2, P2 will not sit at T2, P3 will not sit at T3 or T4 and P4 will not sit at T4 or T5. Find the number of ways they can occupy the vacant chairs.
 - ii) Solve the recurrence relation $a_{n+2}-8a_{n+1}+16a_n = 8(5^n)+6(4^n)$ where, $n \geq 0$ and $a_0=12, a_1=5$.
 - iii) What are the advantages and disadvantages of using an adjacency matrix vs. an adjacency list to represent a graph? [3+5+2]
8. i) What is modus ponens? Explain with truth table.
 - ii) Prove that $(A \vee B) \wedge (\neg A)$ is contingency.
 - iii) What do you mean by universal Quantifier? [(1+2)+3+4]

**RAMAKRISHNA MISSION
VIVEKANANDA CENTENARY COLLEGE, RAHARA, KOLKATA
END SEMESTER EXAMINATION 2023
SEMESTER III
B.Sc. COMPUTER SCIENCE HONOURS**

Core Course V

Full Marks: 50

Time: 2 hours

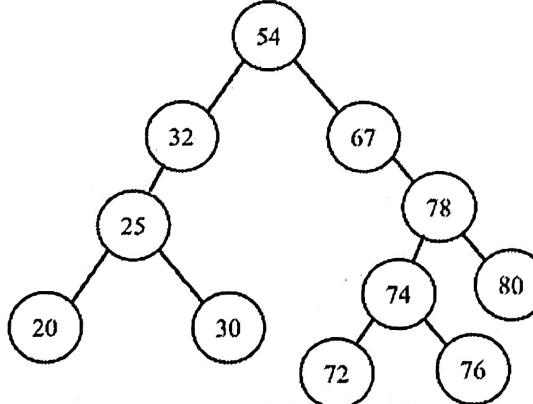
N.B.:

- Draw diagrams whenever necessary.
- Numbers to right indicate marks.

Answer any five (5) questions from the following:

$5 \times 10 = 50$

1. A two dimension 4x8 array “arr” having the starting index as arr[0][0] with the base address as 2710 and size of each element is 4 Bytes of memory then find the address of arr[2][6] using column major ordering showing all the steps. Write C function(s) to delete a node from any position of a doubly linked list (define node structure). Write down a code segment to create a 4D array of 4x3x2x6 size and store auto generated data into it. 3+3+4
2. What are the properties of recursive function? Write down the recursive post-order traversal function of a binary search tree. Use the function and do the post-order traversal of the following BST (showing all the steps of internal stack). 2+3+5



3. Define a full and complete binary tree? Post-order traversal of a given binary search tree T produces following sequence of keys: 3, 5, 7, 9, 4, 17, 16, 20, 18, 15, 14. Find out the in-order traversal of T and construct the BST. Create an AVL search tree from the given set of values- 34,12,27,56,38,46,23,50,89,40,76 2+3+5
4. What are the Characteristics of a Good Hash Function? Write an algorithm to search and insert an element in a hashed table where collisions are resolved by Separate Chaining. Discuss the advantages of using a Threaded binary tree. 2+5+3
5. What do you mean by a Priority Queue? Write an algorithm to extract an element from a priority queue. Why bubble sort algorithm is suitable for small number of records? What is the advantage of using binary search method over linear search method? (2+4)+2+2

6. What is the role of a stack to implement a Method/Procedure Call? Convert the following arithmetic infix expression into its equivalent Prefix Form:

$$(F + G) * C - ((A + B) - (D - E)).$$

What is the advantage of using a Circular Queue over a Queue?

2+5+3

7. Write a C program to sort a single linked list using selection sort to arrange all elements in ascending order. Which one out of these will be beneficial as data structure design: Implementation of binary search using linked list or using array? Justify your answer with example(s). What is the utility of starting pointer in a linked list?

5+4+1

8. Write a function using C to find the maximum of a binary search tree. Insert the following data into an empty BST – 42, 87, 11, 32, 98, 65, 81, 23, 73. Then delete the following- 87, 32, 65. Show all the steps. Why insertion sort is better than selection sort as both having same time complexity of $O(n^2)$?

3+5+2

