

SEAL

R/A/S/M/EXAM.
2021

120098

TECHNICAL PAPER
(Computer Science / Application)

Time : 3 hours]

[Full Marks : 200

PART—I

(Marks : 40)

Notes : (i) Answer **all** questions.

(ii) Each question carries **2** marks.

1. Give two differences between HDD and SSD storage.
2. The main memory address of a computer consists of 10 bits. How many addressable memory locations are there in the memory?
3. Some types of memory are : main memory, secondary memory, cache memory. Order them in the increasing order of their access speed.
4. Convert the following infix expression to a prefix expression :

$$(X - Y) + (W / Z) * T$$

5. Suppose, *best-fit* is used for dynamic memory allocation and there are n blocks (nodes) of free space in the available list. What is the minimum number of blocks that will be examined in search for a free block for allocation?
6. Suppose, *first-fit* is used for dynamic memory allocation and there are n blocks (nodes) of free space in the available list. What is the minimum number of blocks that will be examined in search for a free block for allocation?

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7. What is the number of edges in a spanning tree of a connected graph with n nodes?
8. What is the number of nodes in a full binary tree of height k ? Assume that a binary tree consisting of only one node is of height 0.
9. Assume a linked list representation, in which a node is represented by a structure consisting of three fields : data, flink and blink, where flink and blink are pointers to the next and previous node respectively. Let n be the node pointed to by p and assume that there are many nodes before and after n . Which is the node pointed to by the following?
- $p \rightarrow \text{flink} \rightarrow \text{blink} \rightarrow \text{flink} \rightarrow \text{blink}$
10. With respect to asymptotic notations of an algorithm, which of the following is true?
- $n^3 + 4n^2 + 2 = \underline{\hspace{2cm}}$.
- (i) $\theta(n)$
- (ii) $O(n^2)$
- (iii) $O(1)$
- (iv) $O(n^3)$
11. The maximum number of edges that a connected undirected graph of n vertices is given by a function $f(n)$, where $f(n) = \underline{\hspace{2cm}}$.
12. State the difference between white box and black box software testing.
13. What is the difference between a compiler and an interpreter?
14. In the UNIX Operating System, which method is used to handle deadlocks?

15. Under which condition is the existence of a cycle in the resource allocation graph, a necessary and sufficient condition for the existence of a deadlock?
16. Which is the page replacement algorithm that suffers from Belady's Anomaly?
17. Draw the truth table for the following Boolean expression :

$$\bar{X}Y + YZ$$

18. With the help of a diagram, illustrate implementation of the following Boolean expression using NAND gates :

$$\bar{X}Y$$

19. Give the SQL syntax for creating a relational table.
20. What is a foreign key in a relational table?

PART—II

(Marks : 160)

- Notes :** (i) Answer **all** questions.
(ii) Each question carries **20** marks.

21. Explain the following Object-Oriented Programming Concepts with the help of an example each : 4×5=20
- (a) Abstract data type
 - (b) Data encapsulation
 - (c) Operator overloading
 - (d) Multiple inheritance
 - (e) Virtual function
22. (a) Explain the *wait* (also known as *P*) and *signal* (also known as *V*) atomic functions of a *semaphore*. What is the difference between a counting semaphore and a binary semaphore? 3+2=5

(b) Three processes are used to print the first 300 positive integers. Process P_1 prints 1 to 100, process P_2 prints from 101 to 200 and process P_3 prints from 201 to 300 in the ascending order. Show how semaphores can be used to synchronize them so that the 300 integers are printed in the ascending order. Give the structures of the three processes.

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23. Assume that you have been given the task for designing a road network in a district consisting of 5 villages such that every village is connected to every other village in the district. You wish to minimize the cost of building the network. The cost of building a road between each pair of villages is represented by the following cost matrix. An entry at row m and column n denotes the cost of building a road from village m to village n :

0	4	6	5	10
4	0	4	12	11
6	4	0	3	2
5	12	3	0	1
10	11	2	1	0

What graph algorithm will you use to solve this problem? Apply the algorithm on this problem instance and generate the minimum-cost road network. Show each iteration graphically.

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24. (a) Consider the following algorithm :

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```

NewAlgo(A, n, s)
//A[1..n] is an array of n integers; n is even; s is an integer
begin
    var1=0; //var1 is an integer
    for k=1 to n do
        if A[k] < s then
            var1=var1+1;
            if var1==n/2 then
                return 1;
            endif
        endif
    endfor
    return 0;
end

```

When does the algorithm, *NewAlgo* return 1? When does it return 0? What are the worst case and the best case data for the algorithm? Analyze the above algorithm and give its running time with the help of asymptotic notations.

- (b) Show the difference between DFS (depth first search) and BFS (breadth first search) graph algorithms using an example graph consisting of 4 vertices and 5 edges. Show each step graphically. 5

25. (a) In an institute, several courses are offered. Each course is handled by one or more faculty members. Each faculty member can handle one or more courses. A student can enrol in several courses. A course may be taken by several students. A student is assigned one faculty member as a mentor. A faculty member can be a mentor for several students. Draw an E-R (Entity-Relationship) diagram depicting the above scenario. 10

- (b) Consider the following relation : 10

A	B	C
10	Betty	Itanagar
10	Bobby	Aizawl
11	Rose	Itanagar
12	Lily	Kohima
13	Betty	Itanagar
14	Lily	Kohima

Determine which of the following dependencies may hold in the above relation. If the dependency cannot hold, explain why and show the tuples that cause violation :

(i) $A \rightarrow B$, (ii) $B \rightarrow C$, (iii) $C \rightarrow B$, (iv) $B \rightarrow A$, (v) $C \rightarrow A$.

26. (a) Illustrate with the help of a diagram the encoding of the bit stream, 0001110101 using the following encoding schemes (Assume the line is initially in the low state wherever applicable) : 5

- (i) Manchester encoding
(ii) Differential Manchester encoding

- (b) Write short notes on the following with the help of appropriate diagrams : 15

- (i) Any three contention-based MAC (Medium Access Control) protocols.
(ii) Any two contention-free MAC (Medium Access Control) protocols.

- 27.** (a) Explain the function of the following units of a CPU : 10
- (i) An index register
 - (ii) Memory Address Register (MAR)
 - (iii) Memory Data Register (MDR)
 - (iv) Program Counter (PC)
- (b) Explain four types of addressing modes which are usually provided in a microprocessor with the help of suitable examples. 10
- 28.** A directed graph can be represented by an adjacency matrix or adjacency list. Using any one representation, write a program in C, C++ or Java which— 20
- (i) accepts a directed graph as input;
 - (ii) contains a function that calculates the in-degree (i. e., no. of incoming edges) of a vertex;
 - (iii) contains a function that calculates the out-degree (i. e., no. of outgoing edges) of a vertex;
 - (iv) prints the vertices in the non-descending order of their in-degree;
 - (v) prints the vertices in the non-ascending order of their out-degree.