

... and zero vectors is linearly independent. (2)
field F , and let A be the following 3×3 matrix over F : $A =$
...istic polynomial $f_A(x) =$

Roll No.:

Name :



Indian Institute of Information Technology, Design and Manufacturing, Kancheeppuram
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Course Code: CS1004
Batch: CS20B1/CS21B1/CS21B2
Date of Examination: 15.07.2022
Duration: 3 hours

Course Title: Data Structures and Algorithms
Category: Core
Instructor: Dr. Ram Prasad Padhy, Dr. Jaishree Mayank
Maximum Marks: 50

Instructions to students:

- This question paper contains *four(4)* pages. All questions are compulsory.
- All parts of a question should be written on the same place on the answer sheet.
- All the answers should be written on the provided answer sheets only. **DO NOT WRITE ANYTHING ON THE QUESTION PAPER. DO NOT SUBMIT THE QUESTION PAPER.**

1. Answer the following questions. No explanation required. (0.5 x 6 = 3)
 - (a) What are the data structures needed for BFS and DFS traversals of a graph?
 - (b) What is the number of edges in a complete graph of 7 nodes? $n-1$
 - (c) What is the complexity of extracting the root from a binary heap?
 - (d) If you go for an efficient algorithm for searching an element in a sorted array of 234 elements, what is the number of comparisons/steps required in the worst case?
 - (e) What do you mean by asymptotic complexity of an algorithm?
 - (f) What is the number of NULL links (wasted pointers) and useful links (not NULL) in a complete binary tree of 512 nodes.
2. Answer the following MCQ questions. (0.5 x 6 = 3)
 - (a) What is the maximum number of edges in an acyclic undirected graph with n vertices?
(i) $n-1$
(ii) n
(iii) $n+1$
(iv) $2n-1$
(v) None of the options
 - (b) Which of the following statements is/are TRUE for an undirected graph?
P: Number of odd degree vertices is even
Q: Sum of degrees of all vertices is even
(i) P only
(ii) Q only
(iii) Both P and Q
(iv) Neither P and Q
(v) None of the options
 - (c) Consider a node X in a binary Tree. Given that X has two children, let Y be the inorder predecessor of X . Which of the following is true about Y ?

PTO...

- (a) If A is square symmetric matrix then prove that its eigenvalues are orthogonal.
 (b) Prove that orthogonal set of non-zero vectors is linearly independent.

- (i) Y has no right child
 (ii) Y has no left child
 (iii) Y has both the children
 (iv) Y is a leaf node
 (v) None of the options
- (d) Let G be a graph with n vertices and m edges. What is the tightest upper bound of the running time of the Depth First Search (DFS) algorithm on G ? Assume that the graph is represented using adjacency matrix.
- (i) $O(n)$
 (ii) $O(m)$
 (iii) $O(n^2)$
 (iv) $O(nm)$
 (v) None of the options
- (e) Consider the following sequence of operations on an empty stack - Push(54), push(52), push(53), push(55), pop(), T=pop(); Consider the following sequence of operations on an empty queue - enqueue(21), enqueue(25), enqueue(28), enqueue(32), dequeue(), F=dequeue(); The value of (T+F) is
- (i) 79
 (ii) 80
 (iii) 76
 (iv) 74
 (v) None of the options
- (f) Initially, a max-heap has five elements. The level-order traversal of the heap is as follows: 30, 28, 25, 23, 22. Two new elements '27' and '20' are inserted in the heap in that order. The level-order traversal of the heap after the insertion of the element is:
- (i) 30, 28, 25, 23, 22, 27, 20
 (ii) 30, 28, 27, 20, 23, 22, 25
 (iii) 30, 28, 27, 23, 22, 20, 25
 (iv) 30, 28, 27, 23, 22, 25, 20
 (v) None of the options

3. Answer the following questions. Explain briefly if necessary.

(1 x 6 = 6)

- (a) How many structurally unique binary search trees are possible that store 3 distinct values? Explain by taking an example.
- (b) Explain the double hashing method in hash data structure.
- (c) If the sequence of operations - push(x), push(y), pop, push(x), push(y), pop, pop, pop, push(y), pop are performed on a stack, write the sequence of popped out elements.
- (d) Following is C like pseudo code of a function that takes a number as an argument, and uses a stack S to do processing. What does the following function do in general?

```
void fun(int n)
{
    Stack S; // Say it creates an empty stack S
    while (n > 0)
    {
        push(&S, n%2);
        n = n/2;
    }
    while (!isEmpty(&S))
        printf("%d ", pop(&S));
}
```

$$\frac{12}{2} = 5 \text{ } 10$$

$$n = \frac{5}{2} = 2$$

$$\frac{2}{2} = 1$$

$$1 = \frac{1}{2}$$

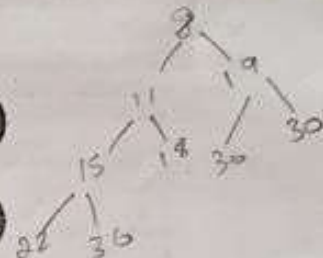
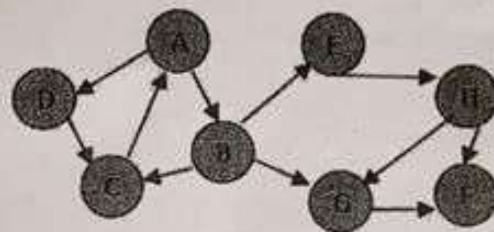
$$\frac{1/2}{2} = \frac{1}{4}$$

1
0
0

orthogonal set of non-zero vectors is ...
 be elements of a field F , and let A be the following 3×3 matrix over F : $A =$
 Find the characteristic polynomial for A . Prove that characteristic polynomial

(3)

- Find the infix and prefix expressions
- Compute the final value for the expression if $A=7, B=3, C=4, D=5, E=8, F=2, G=2, H=3$.
- (b) A binary tree has 10 nodes. The preorder and inorder traversals of the tree are shown below. Draw the tree. Perform the postorder traversal.
 Preorder: JCBADFEIGH
 Inorder: ABCEDFJGHIH
- (c) What is the total number of nodes in a full binary tree of height h ? Prove it by method of induction. NB: A tree with only one node has a height of 1.
- (d) Write the Algorithm/pseudo-code for level order traversal of a binary tree. What is the complexity of the proposed algorithm and why? 3x
- (e) For the given graph, perform the BFS and DFS traversals. Starting node is A. Show the steps of the traversal using the required data structures. 3x



- (f) Create a min-heap with the given elements (as given in the order): 18, 15, 36, 22, 11, 30, 19, 8, 22, 36. After creation of the heap, extract the root node and create the resultant min-heap.
6. Answer the following questions.

- (a) Consider the fruit names as given in the order: Dates, Mango, Guava, Apple, Orange, Sapota, Watermelon, Peach, Lychee, Kiwi, Grapes, Mulberry, Pomegranate, Gooseberry, Coconut, Apricot. (5 x 2 = 10)
- Create a binary search tree (BST) using the fruit names as given in the order. Indexing should be done based on the alphabetical ordering. What is the height of the BST. (1.5)
 - Use the same data to create a height balanced AVL tree. At each step, explain the type of rotation used. What is the height of the AVL tree? (3.5)
- NB: A binary tree with only one node has a height of 1.

- (b) Consider the animal and bird names as given in the order: Dog, Rabbit, Parrot, Cow, Duck, Goat, Crab, Deer, Chinkara, Lion, Crow, Peacock, Crocodile, Dove, Goose, Wolf, Cat, Pigeon. (5 x 2 = 10)
- Insert the keys to a 3-way B-tree. Indexing should be done based on the alphabetical ordering. What is the height of the B-tree. (2.5)
 - Delete the items from the above constructed B-Tree as given in the order: Dog, Cow, Deer, Chinkara, Pigeon, Crocodile, Goose, Rabbit. What is the height of the B-tree after deleting the given items. (2.5)
- NB: A B-tree with only one node has a height of 1.

End of Question Paper