Unique Paper Code: 32341301
Name of the Course: B.Sc. (H) Computer Science
Name of the paper: Data Structures
Semester: III
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Duration: 3 Hours Maximum Marks: 75

Instructions for Candidate

Attempt any four questions. All questions carry equal marks.

1 a) Consider a playing machine which emits a random numbered play-card each time it is pressed. The player has to keep the cards coming out of the machine in his hand in such a manner that they are always in order. Suggest a scheme that player should follow to keep the cards always arranged. Depict your scheme pictorially on 7 cards emitted by playing machine in order <12,10,15,18,1,46,33>. Analyze the total number of comparisons player has to do.

b) A sorted array A containing n unique elements is rotated k times (k is not known) i.e. <1, 5, 10, 12, 16, 19, 30> becomes <16, 19, 30, 1, 5, 10, 12>.Write a function that finds minimum element from the rotated array A. Your function should take logarithmic time. Justify the running time of your function.

2 a) 64 random integers in the range [1, 1000] are arranged to form a square matrix. These integers are divided into two sets such that integers belonging to lower triangular part of the matrix are stored in matrix 'A' and rest all are stored in matrix 'B' without disturbing their arrangement. How many integers will be there in matrix 'A' and matrix 'B' respectively? All the non-zero integers of matrix 'A' and matrix 'B' are now to be arranged in linear order with all the integers of matrix 'A' followed by integers of matrix 'B'. What will be the size of resulting array? The integers, while being arranged in the linear array are picked in column wise manner. What will be the location of integer at 3^{rd} row, 4^{th} column in the linear array, considering the location of the first element to be 200? Derive a conversion formula and justify your answer.

b) A magician showed a trick to store some 30 numbers in the range [1000, 9999] in a crate of size 20, with the possibility of more than one number to be placed at same position. The 20 positions in crate are numbered from 0 to 19. The magician decides where to put the number based on the middle two digits of the number. When asked to pick up any number, he goes directly to that position. Devise the trick used by magician and find out where the following numbers would have been stored 1206, 7822, 6467, 8990, 1211, 4444, 6701, 5468, 7345 and 8210.

3 a) Two printers are attached to a print server. Following strategies are used by the print server to handle incoming printing requests:

- The server allocates a new printing request to the printer having less number of pending printing jobs.
- As the time taken by different jobs is different, from time to time, server re-evaluates the pending jobs of both the printers. In order to balance the load and increase the efficiency in job completion, the server can remove some of the jobs (one by one) from the end of one printer and allocates them to the other printer.

There is no limitation on the number of printing requests that can be allocated to any printer at any given time. Which data-structure would be most suitable to manage printing jobs at each printer in this scenario? Write complete class definition for this data structure with data members, necessary constructors and complete function definitions for adding and removing printing requests at a printer.

b) A Robot is to be created such that when it is shown some data arranged in a Binary tree form, can judge whether the shown tree is Binary Search Tree or not. Write this function for this Robot.

4 Consider a calculating device that does not recognize parenthesis in expressions. The device can evaluate only those expressions in which an operator appears after its operands. To correctly evaluate the following expression using this device, suggest a data structure to convert it into a parenthesis free suitable notation. Depict steps of conversion for the following expression: `((3*(2+9/2-3^2))/3)-7`.

Show the evaluation result of the generated expression applying one operator at a time.

Give complete class definition of this data structure.

5. Following numbers <1, 2, 3, 6, 9, 12, 15, 17> are to be stored in a Binary Search Tree in sequence one by one. Show the BST after each insertion and calculate the number of comparisons to search the value '17'.

Now construct a BST again for the same values in a manner such that the number of comparisons for searching any key is not more than 3 at any given time. Show the tree after each insertion. Delete following values <6,3,2,1> one by one from the generated tree such that the height of the resultant tree does not increase. Show the tree after each deletion.

6. a) A memory block can store maximum 4 values and minimum 2 values in ascending order and give way to 5 more such blocks for creating hierarchical data storage. However, the top block of this hierarchical data storage is allowed to have minimum 1 value. Considering these restrictions, store the following elements in a way such that the search time is logarithmic. Show the data structure after each insertion.

<50,17,76,9,23,54,14,19,72,12,67,100,11,25,7,8,52,53,51>

Then, delete values "8" and "23" one by one. Show the data structure after each deletion.

b) Trace the output of following function 'func1' on the given linked list, when the function is invoked as 'func1 (head->next);' such that head is pointing to 2.

Linked List - 2->4->6->8->5->1->12->11

```
void func1(class Node* p, bool a=true)
{
    if (p == NULL)
       return;
    if (a == true)
        cout << p->data << " ";
    func1(p->next, !a);
}
```