

This question paper contains 4 printed pages.

6125

Your Roll No

MCA / II Sem.

J

Paper— MCA-201 : DATA STRUCTURES AND FILE PROCESSING

(Admissions of 2009 and onwards)

Time · 2 hours

Maximum Marks : 50

*(Write your Roll No. on the top immediately
on receipt of this question paper.)*

*Attempt all questions. All parts of a question must be answered together.
Marks are indicated against each question.*

1. (3 marks)

- a. What is the worst-case runtime complexity of the following operation in big-O notation in terms of n? Explain your answer

```
String s1 = some String;
```

```
System.out.println (s1 indexOf('a'));
```

- b. What is the best-case runtime complexity of the following operation in big-O notation in terms of n? Explain your answer.

```
String s1 = some String;
```

```
String s2 = some OtherString;
```

```
System.out.println(s1.equals(s2));
```

- c. What is the runtime complexity of the following code fragments in big-O notation as functions of n? Explain your answer.

```
int sum = 0;  
for (int i = 1; i <= n, i++)  
    for (int j = 1; j <= n; j+=2)  
        sum += (i + j);
```

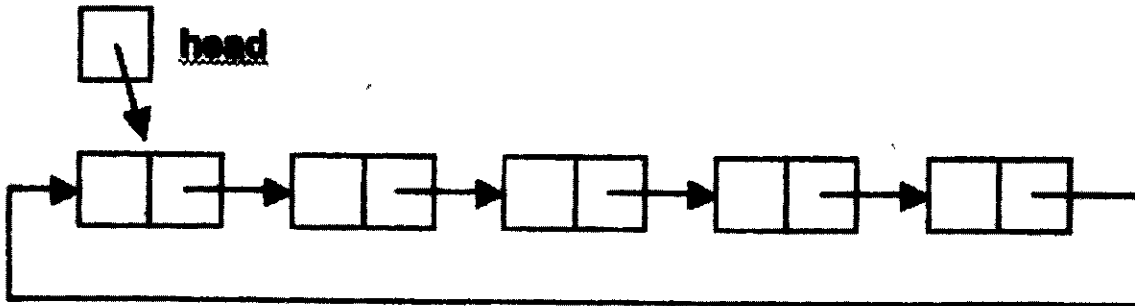
2. (3 marks)

(a) What is the purpose of abstract data types? Define the data type `Date` as abstract datatype with `get`, `set` and `compare` operations.

(b) What are the similarities and differences between Java interfaces and abstract classes?

3. (3 marks)

(a) Given that a list is implemented as a circularly singly-linked list. There is one reference to the head of the list. The last node of the list has a next reference that points back to the head of the list.



- (i) Give a node structure for nodes of the above list and write an algorithm / method for adding a new entry into the list so that the insert operation is always $O(1)$, regardless of the length of the list. What happens if the list is empty?
- (ii) Write an algorithm that will print all elements of the above circular linked list.

4. (3 marks)

Suppose list is implemented using doubly linked list data structure. What are the advantages and disadvantages of this implementation as compared to singly linked list? Give a node structure for a node of a doubly linked list and show the generic implementation of doubly linked list in java. Include only one method which will print the contents of the last element in the list.

5. (3 marks)

(a) Give an array implementation of stack. Include only `push`, `pop` and `isEmpty()` methods.

(b) Write an algorithm to determine if a string containing mathematical expression is nested correctly. For example, the expression $((3+4)*(6-2))$ is nested properly but the expression $(3+6)*(2*2)$ is not nested properly.

6. (3 marks)

Given a queue of strings, it is required to reverse the queue. Write a method/algorithm reverse (Queue q), to reverse the queue q, using a stack. You may assume array implementations of queue and stack. You just need to use operations of queue and stack. Don't write code for these operations.

7. (2 marks)

What do you understand by Collections in java? Draw collections hierarchy with at least two classes and two interfaces.

8. (3 marks)

What is the Iterative interface in java? What methods are included in this interface? Give java implementation of these methods.

9. (5 marks)

Given the following recursive method: Draw a recursion tree showing all recursive calls that are made when computing $f(5)$, and using your tree, compute $f(5)$.

```
public static int f ( int n )
{
    if (n < 2)
        return n;
    else
        if (n % 2 == 0)
            return f(n-2) + f(n/2);
        else
            return f(n-1) + f(n-2) + f(n-3),
}

```

Show the runtime stack of the call tree when $f(5)$ is called.

Convert it to iterative method and explain whether iterative method or recursive method is more efficient and why?

10. (3+1+2+2=8 marks)

(a) Explain what is a Huffman tree. Where and when is it used? Given that there are five characters with the frequency of their usage as follows: A-35%, B-25%,

C-20%, D-15%, and E-5%. Draw the Huffman tree for the above set of characters and give the Huffman code for each character. Given any bit string, show how you will decode it to convert it character string.

- (b) Define what is a binary search tree and give a node structure for a node of binary search tree
- (c) Write methods / algorithms to search data in the given binary search tree, and to insert data into the given binary search tree. Your methods / algorithms should be recursive.
- (d) What is a full binary tree? What is the number of nodes in full binary tree of height h in terms of h . Explain your answer. What is the order of complexity of insertion in a full binary search tree?

11. (3+3=6 marks)

(a) Give linked implementation of Binary Search Tree in Java. Write a method for the BinarySearchTree class that returns the minimum element in the binary search tree using recursion.

(b) A binary tree has the preorder traversal T S V U M B A and the inorder tree traversal is S V T B M U A. What is the postorder traversal?

12. (3 marks)

What is a heap? For the following list of numbers, construct a max-heap (i.e. root containing largest element). 10, 12, 1, 14, 6, 5, 15, 3, 9, 18.

Why array or array list is appropriate for implementing heap but not for implementing a binary search tree? Explain with example.

13. (1+1+3= 5 marks)

(a) What is the complexity of searching a key value in a hash table with n keys? Explain your answer.

(b) What are the characteristics of a good hash function?

(c) Given the following list of numbers 11, 23, 89, 26, 72, 73, 33, 44, 14, and 12, prepare a hash table using an appropriate hashing function. Show the structure of the hash table when collisions are handled using linear probing. Show the hash table for the same list of numbers, using chaining for handling collisions. Explain which method is better for handling collisions and why?