

AMIETE – CS/IT (NEW SCHEME)

Time: 3 Hours

JUNE 2012

Max. Marks: 100

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.
- The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.
- Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.
- Any required data not explicitly given, may be suitably assumed and stated.

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. Θ notation, which is used for finding the complexity of an algorithm is asymptotic

- (A) lower bound (B) upper bound
(C) tight bound (D) None of above

b. Linked lists are not suitable data structures for which one of the following problems:

- (A) Insertion sort (B) Binary search
(C) Radix sort (D) Polynomial manipulation

c. Which of the following algorithm design techniques is used in the quicksort algorithm

- (A) Dynamic programming (B) Backtracking
(C) Divide and conquer (D) Greedy method

d. The algorithm which always makes a choice that looks best at the moment is

- (A) Greedy Algorithm (B) Dynamic programming
(C) Random algorithm (D) None of these

e. For merging two sorted lists of sizes m and n into a sorted list of size $m + n$, we require comparisons of

- (A) $O(m)$ (B) $O(n)$
(C) $O(m + n)$ (D) $O(\log m + \log n)$

Code: AC64/AT64 Subject: DESIGN & ANALYSIS OF ALGORITHMS

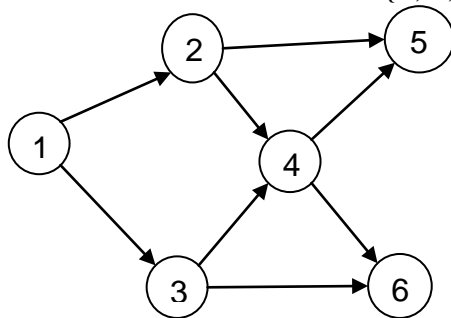
f. Consider an undirected graph G . Let a breadth-first traversal of G be done starting from a node r . Let $d(r, u)$ and $d(r, v)$ be the lengths of the shortest paths from r to u and v respectively in G . If u is visited before v during the breadth-first traversal, which of the following statement is correct?

- (A) $d(r, u) < d(r, v)$ (B) $d(r, u) > d(r, v)$
 (C) $d(r, u) \leq d(r, v)$ (D) None of these

g. A binary max heap containing n numbers, the smallest element can be found in time

- (A) $O(n)$ (B) $O(\log n)$
 (C) $O(\log \log n)$ (D) $O(1)$

h. Consider the DAG with $V = \{1, 2, 3, 4, 5, 6\}$



Which of the following is NOT a topological ordering?

- (A) 1 2 3 4 5 6 (B) 1 3 2 4 5 6
 (C) 1 3 2 4 6 5 (D) 3 2 4 1 6 5

i. The most efficient (in terms of time complexity) algorithms for finding the shortest path from a node S to every other node in an unweighted and undirected graph is

- (A) Dijkstra's algorithm starting from S
 (B) Warshall's algorithm
 (C) Performing DFS starting from S
 (D) Performing BFS starting from S

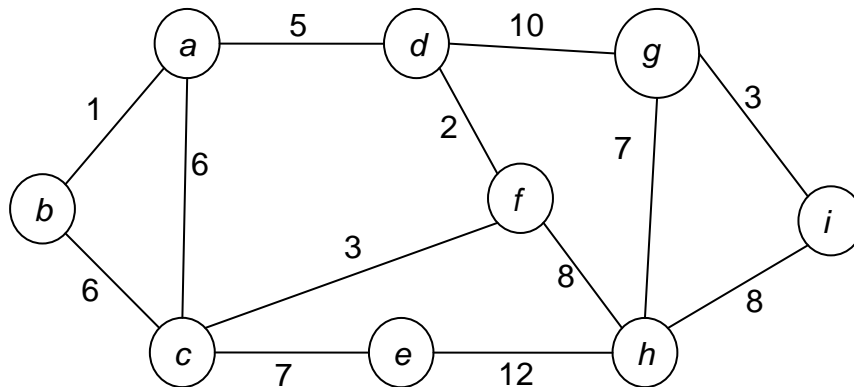
j. Which of the following is NP complete problem

- (A) Circuit-satisfiability (B) 3-CNF satisfiability
 (C) Clique (D) All of these

**Answer any FIVE Questions out of EIGHT Questions.
 Each question carries 16 marks.**

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- Q.2** a. Define an algorithm. What is the difference between an algorithm and a program? (8)
- b. State master theorem and find the tight asymptotic bound of the following recurrence $T(n) = 2T\left(\frac{n}{2}\right) + n$ (8)
- Q.3** a. Define Fibonacci number and prove that the Fibonacci numbers grow exponentially. (10)
- b. Explain Big Oh and Little Oh Notation. What is the complexity of the following code (in terms of Big Oh)? (6)
- ```
int counter=0;
for(i=0; i<n; i++)
 for(j=0; j<n*n; j++)
 counter++;
```
- Q.4** a. Randomized quicksort is an extension of quicksort where the pivot is chosen randomly. What is the worst case complexity of sorting  $n$  elements using randomized quicksort? Justify your answer. (8)
- b. Write an algorithm to multiply two large integers (assume the size of the integer is more than 100 decimal digits). (8)
- Q.5** a. Explain topological sort with an example. Write its algorithm. Explain any one of its application. (8)
- b. What graph traversal algorithm uses a queue to keep track of vertices which need to be processed? Write a modular algorithm for the same. (8)
- Q.6** a. A  $d$ -ary heap is like a binary heap, but instead of 2 children, nodes have  $d$  children.
- (i) How would you represent a  $d$ -ary heap in an array?
- (ii) What is the height of a  $d$ -ary heap of  $n$  elements in terms of  $n$  and  $d$ ? (10)
- b. Suppose that you are given a uni-modal array  $a$ , that is there is some position  $i$  such that the finite  $i$  elements are sorted in ascending order and the elements from  $i$  onwards are sorted in descending order (thus  $a[i]$  is the maximum element). If the position  $i$  is also given to you, how you would search efficiently for a key  $X$  in this array, what kind of running time your strategy offer? (6)
- Q.7** a. Tabulate the differences between Dynamic Programming and Divide and Conquer techniques. (8)
- b. For the undirected graph given below, write the sequence of edges visited during the execution of Prim's algorithm to construct a Minimum Spanning Tree. (8)



- Q.8** a. Consider a B-tree with degree  $m$ . i.e. the number of children  $c$ , of any internal node (except the root) is such that  $m \leq c \leq 2m - 1$ . Derive the maximum and minimum number of records in the leaf nodes for such a B-tree with height  $h$  ( $h \geq 1$ ). (Assume that the root of a tree is at height 0). **(10)**
- b. Explain truncation errors and round-off errors in numerical algorithms. Give an example for each. **(6)**
- Q.9** a. Give an example for each of the following and give its complexity:-  
 (i) Backtracking.  
 (ii) Branch and bound **(8)**
- b. Discuss an algorithm for solving non-linear equations. Give its time complexity. **(8)**