Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M. TECH-ME(CSE)/SE/SEM-1/PGCSE-104A/PGSE-104/2011-12

2011
ADVANCED ALGORITHMS

Time Allotted : 3 Hours   *Full Marks* : 70

*The figures in the margin indicate full marks.*

Candidates are required to give their answers in their own words as far as practicable.

Q. No. 1 is compulsory and any *five* from the rest.

1. Critically comment on the correctness for any *two* of the following statements :

    a) All NP Complete problems are NP-Hard as well, but the reverse is not true.

    b) The worst complexity of an algorithm is more critical than its best case or average case complexities.

    c) Problems with overlapping sub-problems may be solved by using either of the divide and conquer or the dynamic programming approaches. 2×5

2. a) Write a polynomial time non-deterministic algorithm to sort a list of *n* numbers.

    b) What is a decision problem ? How is it different from an optimization problem ? Explain with a suitable example.

    c) Define and compare between *N* and NP class of problems.

    d) State the condition under which a problem P1 reduces to another problem P2. $3 + 4 + 3 + 2$

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3. a) How do you compare dynamic programming with the greedy approach ?

   b) Write a recursive algorithm that solves the matrix parenthesis problem in $O\left(n^3\right)$ run time complexity for a chain of matrix of length n.

   c) Compare the merits and demerits of the algorithm proposed above with a dynamic programming solution of the same run time complexity.   4 + 5 + 3

4. a) Write an algorithm to solve the n-queen's problem by the method of backtracking.

   b) Explain the steps of your algorithm by generating an appropriate tree structure for $n = 4$.   7 + 5

5. Give tight big-O bounds for $T (n)$ for each of the following recurrence relations.

   Assume $T (1) = 1$

   a) $T (n) = T (n/2) + 1$

   b) $T (n) = 2T (n/2) + \log n$

   c) $T (n) = 2T (n/2) + n$ 3 × 4

6. a) Write an algorithm to describe topological sort on a direct acyclic graph.

   b) Describe an algorithm for finding strongly connected components of a directed graph.   6 + 6
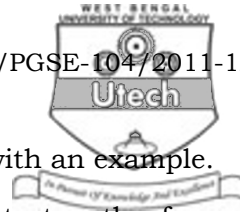
7. a) What is square of a graph ? Explain with an example.

   b) Write an algorithm to find the shortest paths from a single source to all other nodes in a graph.

   c) Estimate the run-time complexity of your algorithm.

   3 + 6 + 3

8. a) Define minimal spanning tree for a graph.

   b) Suggest a suitable representation of an undirected, weighted graph for finding minimal spanning tree by using Kruskal's algorithm. [You need not write the algorithm]. Explain the advantage of using the suggested representation for Kruskal's algorithm.

   c) You are given a set of boxes to be packed into a bin. All the boxes have the same width and breadth (the same as the width and breadth of the bins). However, the boxes have different heights. The heights are given in a list $H = (h_1, ..., hn)$. The goal is to pack the boxes in bins using as few bins as possible. Suggest a greedy algorithm for this problem.

   d) Estimate the run-time complexity of your algorithm.

   1 + 3 + 5 + 3