

**MCA (Revised)**  
**Term-End Examination**  
**June, 2007**

**MCS-031 : DESIGN AND ANALYSIS OF  
ALGORITHMS**

Time : 3 hours

Maximum Marks : 100

---

**Note :** Question number 1 is **compulsory**. Attempt any **three** questions from the rest. All algorithms should be written nearer to C/C++ language. Parts of the same question should be attempted together.

---

---

1. (a) (i) What is the difference between  $\Omega$ -notation and  $w$ -notation ? Is  $n^2 + 4 = w(n^2)$  ? 4
- (ii) Give an analysis of merge-sort. For simplicity, assume that the number of elements i.e.,  $n$  is an exact power of two. 6
- (b) (i). In a quick sort algorithm, describe the situations when a given pair of elements will be compared to each other and when they will not be compared to each other. 5

- (ii) Describe whether best first search algorithm belongs to the branch of heuristic algorithms. What are the trade-offs in using best first search as compared to depth first search ? 5
- (c) What is optimal substructure property of a dynamic programming problem ? 5
- (d) (i) Describe the difference between a Deterministic Finite Automata and Non-Deterministic Finite Automata. In general, which one is expected to have less number of states ? 5
- (ii) What is the additional capability of PushDown Automata as compared to Finite Automata ? Can a PDA (PushDown Automata) be used to describe regular as well as non-regular languages ? 5
- (e) What is an NP-complete problem ? Is it necessary that every NP-complete problem must also be a NP-hard problem ? Justify. 5
2. (a) Write a recursive algorithm to compute the binomial coefficient according to the definition : 5

$$\binom{n}{k} = \begin{cases} 1 & ; k = 0 \text{ or } k = n \\ \binom{n-1}{k-1} + \binom{n-1}{k} & ; \text{otherwise} \end{cases}$$

- (b) Describe the white path property of depth first search. 5
- (c) What are the limitations of Strassen's Algorithm for matrix multiplication ? 5
- (d) Consider the following set of activities (I), their starting times ( $S_i$ ) and finishing times ( $F_i$ ), where

$$I = \langle i_1, i_2, i_3, i_4, i_5, i_6, i_7, i_8, i_9 \rangle$$

$$S_i = \langle 1, 3, 0, 5, 3, 5, 6, 8, 8 \rangle$$

$$F_i = \langle 4, 5, 6, 7, 8, 9, 10, 11, 12 \rangle$$

(For example, in the above set, the activity  $i_2$  starts at time 3 and finishes at time 5). Moreover, the activities are arranged in the monotonically increasing order of finishing times.

Assuming that only one activity can be scheduled at a time (i.e., no new activity can start before the finishing time of current activity), find the set of activities that will be selected/scheduled by a greedy activity selector whereas the job of a greedy activity selector is to schedule several competing activities that require exclusive use of a common resource i.e., it selects the maximum number of mutually exclusive activities. 5

3. (a) (i) Write the general algorithm for alpha-beta procedure. How does alpha-beta procedure improve the minimax-procedure ? 8
- (ii) Describe whether or not breadth first search algorithm always finds the shortest path to a selected vertex from the starting vertex. 3
- (b) Show how greedy approach is useful to find the solution to fractional knapsack problem. 4
- (c) What is the complexity of quicksort algorithm if the input is completely sorted in ascending order or in descending order ? 5
4. (a) Design a turing machine over the alphabet  $\Sigma = \{a, b, \#\}$  that scans to right until two consecutive a's and then halts. ( $\#$  represents a blank square on the tape) 7
- (b) In quicksort, average case is closer to best case than worst case — comment. 3
- (c) Design a non-deterministic finite automata (NFA) representing the language over alphabet  $\Sigma = \{a, b\}$  in which all valid strings have bb or bab as substring. 5
- (d) Consider the CFG : 5
- $$S \rightarrow SS \mid XaXaX \mid \Lambda$$
- $$X \rightarrow bX \mid \Lambda$$
- What is the language generated by this CFG ?

5. (a) Give an analysis of Best First Search algorithm. 5

(b) An undirected graph is given below in the form of a weighted matrix. (The graph has five nodes A, B, C, D and E) :

	A	B	C	D	E
A	0	15	10	3	7
B	15	0	2	0	5
C	10	2	0	2	0
D	3	0	2	0	6
E	7	5	0	6	0

where weight 0 means – no edge, otherwise any +ve value represents the cost of the edge.

(i) Draw the corresponding weighted, undirected graph. 3

(ii) Find the minimum spanning tree using Kruskal's algorithm. 7

(c) What is the benefit of preconditioning a problem space ? Explain using an example. 5

