M.E Software Engg. 1st Sem Examination, 2010
Algorithms & Data Structures

Time: Three hours | Full Marks: 100

Answer any FIVE questions.

1) (4 X 2) +4+ (5+3)

a) Prove that the following equalities are correct or incorrect:
   i) $\Sigma^{n}_{i=0} i^2 = \theta(n^3)$
   ii) $10n^3 + 15n^4 + 100n^2 2^n = O(100n^2 2^n)$
   iii) $n^2 \log n = \theta(n^2)$
   iv) $n^3 2^n + 6n^2 3^n = O(n^3 2^n)$

b) Write down the Master Theorem.

c) Draw the recursion tree for $T(n) = 4T(\lfloor n/2 \rfloor) + c.n$, where c is a constant, and provide a tight asymptotic bound on its solution. Verify your bound by the substitution method.

2) 7+5+8

a) Implement a stack using singly linked list L, the operations PUSH and POP should still take O (1) time.

b) Write an algorithm to evaluate prefix expression with operators + and X.

c) A dequeue (double-ended queue) is a list from which elements can be inserted or deleted at either end. Develop array implementation for a dequeue.

3) (5+5)+5+5

a) Consider the following 4-digit employee numbers: 9614, 5882, 6713, 4409 and 1825. Find the 2-digit hash address of each number using (i) the division method, with m=97; and (ii) the folding method.

b) Write a function MID (KEY, HASH) which uses the mid-square method to find the 2 digit hash address HASH of a 4-digit employee number key.

c) Explain double hashing technique with example.

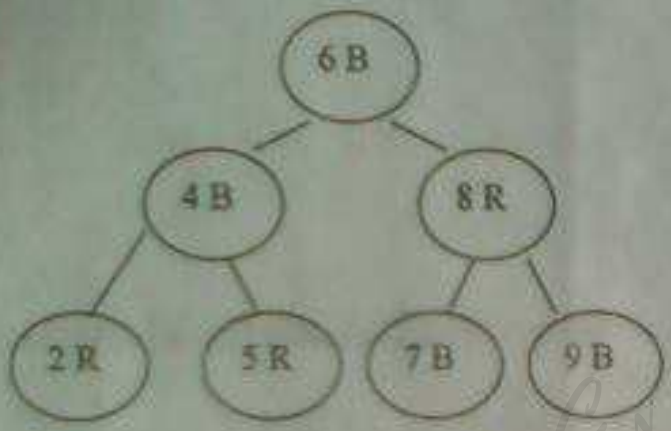
4) 3+5+7+5

a) Show that the maximum number of nodes in a binary tree of height h is $2^{h+1} - 1$

b) Construct an AVL tree with following keys: 24, 1618, 2346, 271, 3141, 1414, 1732, 1729, 8351 and 9999.

c) Write an insertion function for Red-Black Tree.

d) Remove 9, 8 and 7 from the following Red- Black tree. Show all the intermediate steps. (B = Black node and R=Red node)



5) 4+4+12

a) Sort the array 170, 45, 75, 90, 2, 24, 802, 66, 19 and 551 using radix sort.

b) Write an algorithm of counting sort.

c) Show the B-trees of order 4 that result after successively inserting the keys A-Z into an initially empty tree. Delete A, B, E, I, O, P, Q and U.

6) 10+6+4

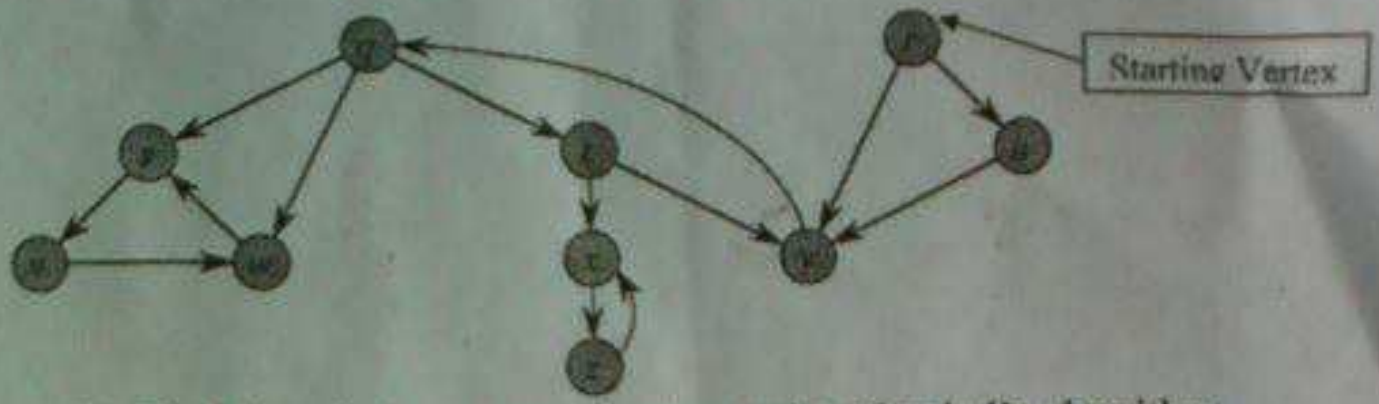
a) Find the optimal parenthesization of a matrix chain whose sequence of dimensions is <10, 80, 20, 70, 60, 75 and 50>.

b) What is the solution generated by Job Sequencing algorithm when n=7, (p1, p2, p3, p4, p5, p6, p7) = (30, 20, 5, 25, 10, 35, 15) and (d1, d2, d3, d4, d5, d6, d7) = (2, 2, 4, 3, 4, 2, 3). Where n= no of jobs, p= profit and d= deadline.

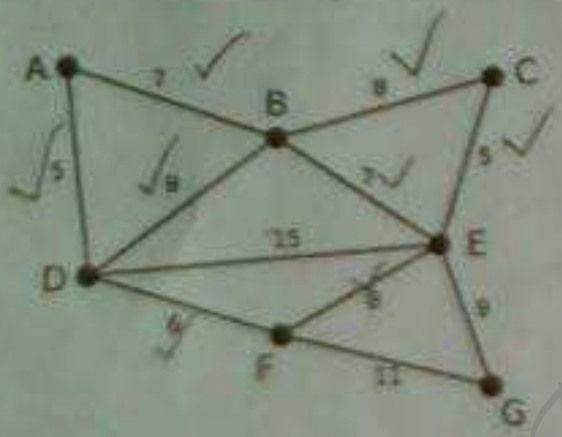
c) Prove that in case sum of all the weights is $\leq m$, the $x_i = 1$, $1 \leq i \leq n$ is an optimal solution.

7) 6+5+6+3

a) Show how depth-first search works on the following graph, considering the vertices in alphabetical order.



b) Find the minimum spanning tree using Kruskal's algorithm.



c) Write down the Dijkstra's algorithm. (If you are mentioning any procedure then explain/write that procedure)

d) Write the recursive definition of weight and predecessor in the Floyd-Warshall algorithm.

(5+5)+10

8)

a) Short note: Reductions, Encodings.

b) "The clique problem is NP-complete." – Prove it.