MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

THIRD YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (COMPUTER SCIENCE & TECHNOLOGY), BSC (WITH IT), BSC (ACTURIAL SCIENCE) WITH IT, BSC (STATISTICS) WITH IT, BSC (BIOMEDICAL SCIENCES) WITH IT, B.ED (SPECIAL NEEDS EDUCATION) WITH IT, B.ED (ARTS) WITH IT AND B.ED (SCIENCE) WITH IT

SCS 301: DATA STRUCTURES AND ALGORITHMS

Date: 3rd December, 2010 *Time: 2.00 – 4.00 p.m.*

INSTRUCTIONS:

- Answer QUESTION ONE and any other TWO questions.
- Electronic calculators may be used.

Question One (Compulsory, 30 marks)

(a) Consider the sequence 1, 4, 16, 64, ...

(i) express the sequence as a recurrence relation (3 marks)

(ii) solve the recurrence relation (5 marks)

(iii)find the 9^{th} term of the sequence (2 mark)

(b) The running time of an algorithm is given by $T(n) = 9T(n/3) + n$. Determine the efficiency class of this algorithm. (3 marks)

(c) (i) Show the steps of converting the following infix expression into its postfix equivalent using a stack. Show the contents of the output as well as the stack after each step using the format shown below:
(A-B)+(C-D*E) (5 marks)

Step	Character read from infix	Infix parsed so far	Stack Content	Output (postfix)
1.				

(ii) If A=9 B=4, C=7, D=2, E=3, show how starts can be used to evaluate the postfix expression obtained above. Use the format shown below (4 marks)

Step	Character read from postfix	Postfix parsed so far	Stack Content	Output (postfix)
1.				

(d) consider the following pseudo code

```
int i,j,min,minat;
for(i=0;i<(length-1);i++)
{
        minat=i;
        min=array[i];
        for(j=i+1;j<(length);j++)
        {
                if(min>array[j])
                {
                        minat=j;
                        min=array[j];
                }
        }
        int temp=array[i] ;
        array[i]=array[minat];  //swap
        array[minat]=temp;
}
```

(i) Use the following list to demonstrate the function of the algorithm
2, 9, 8 5, 7. (3 marks)

(ii) Determine the efficiency class of the algorithm (5 marks)

Question 2 (20 marks)

a) Give two examples of applications of Minimum Spanning Trees (MST). (4 marks)

b) Use Kruskal's algorithm to compute the minimum spanning tree of Fig Q2(b) show each step of the construction of the MST (16 marks)

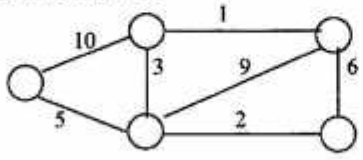

Figure Q 2

Question Three (20 marks)

(a) (i) Show [a + (b+ c)] * [(d – e) / (f + g – h)] on a binary tree (3 marks)

(ii). carryout preorder and post order traversals on the binary tree (2 marks)

(b) Show the contents of the new list after every pass of sorting the following list (into ascending order) using the bubble sort method: 77, 33, 44, 11, 88, 22. (5 marks)

(c) Consider the algorithm below:

```
Algorthm X(A,p,q,r)
1 if p <r  then
2.      q ← (r + p)/2
3       X(A, p, q )
4       X(A,q+1,r)
5        Y(A, p, q, r)

Y(A, p, q, r)
6 n1←q-p+1
7 n2←r-q
8 create arrays L[1...N1+1] and R[1...N2+1]
9 for i←1 to N1 do
10      L[i] ← A[p+i-1]
11      for j ← 1 to n2 do
12              R[j] ← A[q+j]
13              L[N1+1] ← ∞
14              R[N2+1] ← ∞
15 i ← 1
16 j ← 1
17 for k ←  p to r do
18      if L[i] ≤ R[j] then
19              A[k] ← L[i]
20              i ← i+1
21      else A[k] ← R[j]
22              j ← j+1
```

(i). Using the list below, show how the algorithm above would proceed:

5, 4, 6, 1, 3, 2, 6 (6 marks)

(ii). Determine the efficiency class of the algorithm in the worst case. (4 marks)

Question Four (20 marks)

(a) Use the bottom-up heap construction algorithm to construct a heap for the list: 1,8, 6, 5, 3, 7, 4 (5 marks)

(b) Study the BST below and use it to answer the questions that follow

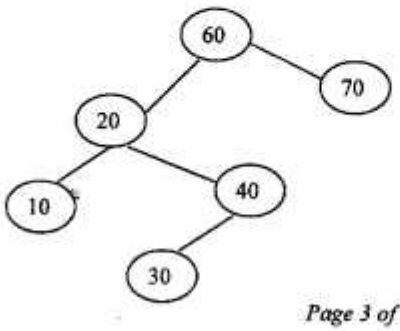

Figure Q 4(a)

(i) Redraw the BST above to show the results of inserting the nodes 80, 71, 79, 38, 15, and 25 in that order. (2 marks)

(ii) What are the **inorder**, **preorder** and **postorder** traversals of the BST after (i) above (3 marks)

(c) Using Dijkstra's algorithm, determine the single-source shortest paths to the vertices of the graph below from vertex *a*. (8 marks)

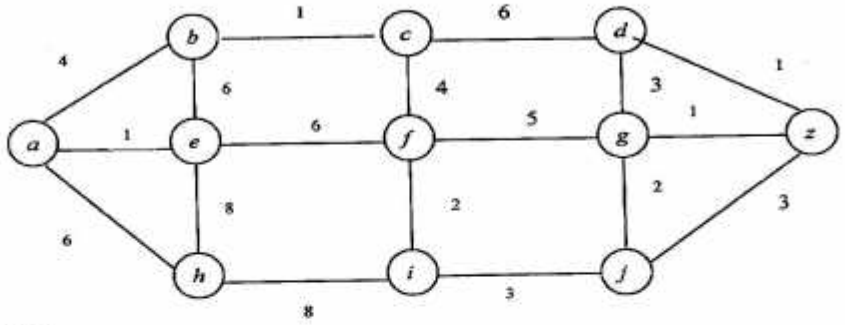

Figure Q 4(b)

(i) Find the length of the shortest path to *z* from *a* (1 marks)

(ii) Find the length of the shortest path from *a* to *z* through *c* (1 marks)

Question Five (20 marks)

a) Show that the equation for computing the minimum cost of multiplying a chain of matrices is given by

$$m[i,j] = \begin{cases} 0 & \text{if } i=j \\ \min\limits_{i \le k < j} \{ m[i,k] + m[k+1,j] + P_{i-1} P_k P_j \} & \text{if } i<j \end{cases}$$

(6 marks)

b) Use the formula in (a) above to compute m[i,j] for the following matrices.

$A_1 = 6 \times 3$
$A_2 = 3 \times 7$
$A_3 = 7 \times 4$
$A_4 = 4 \times 6$

Do not compute S [i,j]. Show all your work in the calculation for m[i,j] (14 marks)