

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF APPLIED SCIENCES
COMPUTER SCIENCE DEPARTMENT
MAY EXAMINATIONS 2011

SUBJECT: DATA STRUCTURES AND ALGORITHMS
CODE: SCS2103

INSTRUCTION TO CANDIDATES

This question paper consists of five (5) questions. Answer any four (4) questions.
Each question carries 25 marks.

Time: 3 hours

QUESTION ONE

- a) An Algorithm is defined as an ordered set of unambiguous, executable steps, defining a terminating process in problem solving. Explain the meaning of the following as used in this definition:
- i) Ordered set of unambiguous steps [3]
 - ii) Executable steps [3]
 - iii) Terminating process [3]
- b) With the aid of examples, explain the following types of algorithms
- i) Backtracking algorithms [5]
 - ii) Recursive algorithms [5]
- c) List any three properties of algorithms. [3]
- d) Give reasons why it is important to analyse algorithms. [3]

QUESTION TWO

- a) Explain how the efficiency of an algorithm is measured. [5]
- b) Describe the following as they are used in algorithms performance:
- i) Worst case [3]
 - ii) Best case [3]
 - iii) Upper Bounds [3]
- c) Evaluate the Greedy algorithm. [5]

d) Given a sequence data structure M, as shown in the figure 2.1 below.

M



Figure 2.1: Sequence data structure.

The operations **Add**, **Set** and **Remove** are carried out on **M**. Draw the resultant **M** for each of the following:

- i) **Add(2,X,M)** [2]
- ii) **Set(3,Y,M)** [2]
- iii) **Remove(A,M)** [2]

QUESTION THREE

a) Describe these coding methods:

- i) Fixed-length code [3]
- ii) Huffman code [3]
- iii)

b) The table below shows the character data file that we wish to store. The file contains only five characters with corresponding character bits allocation and frequencies.

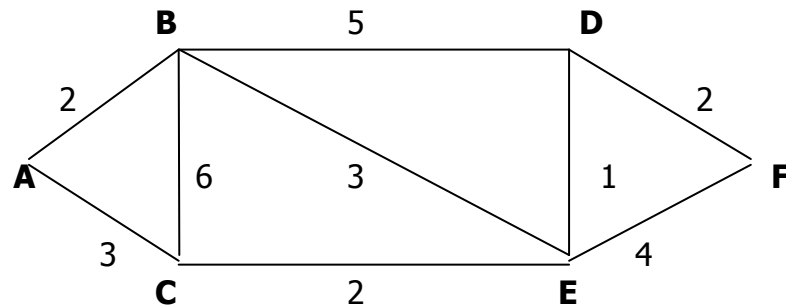
	p	q	r	s	t
Frequency	55 000	14 000	13 000	15 000	9 000
Fixed length	000	0001	010	011	100
Variable length	0	101	100	111	1101

- i) Calculate the space in bits that is required to store the file using
 - a) Fixed length code [4]
 - b) Prefix code [4]
 - ii) Express the space saved as a percentage [2]
- c) Given the set {a, b, c} with the following codes: {a = 00, b = 01, c = 10} Encode the letters
- i) aab [1]
 - ii) abc [1]
 - iii) aabbcc [1]

- d) Describe an array data structure and give a class declaration for such a structure. [6]

QUESTION FOUR

- a) Let $X = \{a/20, b/15, c/5, d/15, e/65\}$ be the alphabet and its frequency distribution.
- i) Using this distribution obtain the Huffman tree. [8]
 - ii) Explain why Huffman codes are optimal. [4]
- b) Using Prim's algorithm with explanations in each step, find the minimum spanning tree in the following weighted graph. A, B, C, D, E and F are vertices and 1, 2, 3, 4, 5 and 6 are weights. [7]



- c) Evaluate Dijkstra's algorithms. [6]

QUESTION FIVE

The code in Figure 5 is that of a stack data structure.

```
Class Stack {  
  
    Public:  
    Stack( ) (tos=0);  
    Stack( );  
        bool push (int Val);  
        bool top(int &Val);  
        bool pop( );  
  
    Private:  
        Class Node {  
  
        Public:  
        Node*nextNode;  
        Int value;  
        };  
        Node * tos;  
        };  
        int main:  
  
    Stack;
```

Figure 5

a) Draw a symbolic representation of the stack data structure after the following sequence of member function calls in Figure 5.1 [8]

```
s.stack(5)  
s.stack(17)  
s.stack(35)  
s.pop( )  
s.push(33)  
s.push(34)  
s.pop( )  
s.pop( )
```

Figure 5.1 : Function calls

- b) Explain the advantage of implementing a stack using a dynamic memory allocation as opposed to a static memory allocation. [5]
- c) Describe a queue data structure and give a class declaration for such a structure. [8]
- d) List four applications of the Queue data structure. [4]

END OF QUESTION PAPER

