



AFRICA NAZARENE UNIVERSITY

CENTRE: NAIROBI
DEPARTMENT: COMPUTER SCIENCE
UNIT TITLE: DATA STRUCTURES AND ALGORITHMS
UNIT CODE: CSC 202
LECTURER: J. OBUHUMA
TRIMESTER: 3RD TRIMESTER 2015/2016
DATE: 2ND AUGUST 2016
TIME: 5.30 PM – 7.30 PM

Instructions:

1. Answer **Question One (Compulsory)** and any other **TWO** Questions.
2. Write all your answers in the answer booklet provided
3. **DO NOT** write on the question paper
4. Time allowed: Two Hours

QUESTION ONE [Compulsory - 30 Marks]

a) Consider the following algorithm:

```
algorithm fun1 (x <integer>)
  if (x < 5)
    return (3 * x)
  else
    return (2 * fun1 (x - 5) + 7)
  end if
end fun1
```

What would be returned if fun1 is called as;

i) fun1 (4)

[1 Marks]

ii) fun1 (10)

[1 Marks]

b) Describe the running time of the following pseudocode in Big-O notation in terms of the variable n.

i) First pseudocode

```
sum ← 0
for i ← 0 to 4 do
  for j ← 0 to (n-1) do
    sum ← sum + 1;
```

[4 Marks]

ii) First pseudocode

```
sum ← 0
for i ← 0 to (n * n) do
  sum ← sum + 5;
```

[4 Marks]

c) Explain two advantages of using a linked list to implement a stack as opposed to the use of an array. [4 Marks]

d) Illustrate the contents of the stack at each level with the following operations push (7), push (10), push (35), IsEmpty (), pop (), top (), push (2), push (4), pop (), pop () [5 Marks]

e) Prove that $f(n) = 2210 + 30n^5 \log(n) + 2n^2 + 10n$ is $O(n^5 \log(n))$ using the "big-O". [5 Marks]

f) Consider the Insertion Sort:

i) Write the insertion sort pseudocode. [3 Marks]

ii) What is the complexity of insertion sort in big-O notation? Explain your answer. [3 Marks]

QUESTION TWO [15 Marks]

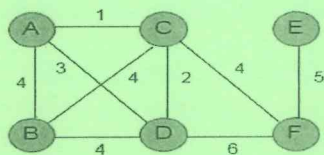
a) Given the following inorder and preorder traversal reconstruct a binary tree

Inorder sequence D, G, B, H, E, A, F, I, C

Preorder sequence A, B, D, G, E, H, C, F, I

[10 Marks]

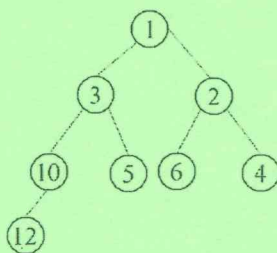
- b) Use the Prim's algorithms to generate the minimal spanning tree for the following graph. Show all the steps involved.



[5 Marks]

QUESTION THREE [15 Marks]

- a) Consider the following heap. Perform operation deleteMin(). Show all the intermediate trees. [10 Marks]



- b) Prove that if $f_1(n) = (g_1(n))$ and $f_2(n) = (g_2(n))$, then $f_1(n) \times f_2(n) = (g_1(n) \times g_2(n))$. [5 Marks]

QUESTION FOUR [15 Marks]

- a) Sort the following sequence of keys using merge sort.
66, 77, 11, 88, 99, 22, 33, 44, 55 [5 Marks]
- b) What is the asymptotic running time for a merge sort on n numbers with d digits each? [2 Marks]
- c) What is quick sort? Sort the following array using quick sort method.
24 56 47 35 10 90 82 31 [8 Marks]

QUESTION FIVE [15 Marks]

- a) Explain Dijkstra's algorithm for finding the shortest path in a given graph. [5 Marks]
- b) Find the shortest path from A to Z using Dijkstra's Algorithm. [10 Marks]

