(Knowledge for Development)

KIBABII UNIVERSITY COLLEGE

A CONSTITUENT COLLEGE OF

MASINDE MULIRO UNIVERSITY OF

SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS

2014/2015 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BSC INFORMATION TECHNOLOGY

COURSE CODE: **BIT 222**

COURSE TITLE: **DATA STRUCTURES & ALGORITHMS**

DATE: 29TH APRIL, 2015 **TIME:** 8.00AM - 10.00AM

INSTRUCTIONS TO CANDIDATES

Answer Question One in Section A and Any other TWO (2) Questions in Section B

TIME: 2 Hours

QUESTION 1 (COMPULSORY) [30 MARKS]

a) In an array implementation of a binary tree, the root of the tree is in position 0. For each node n, give the position of n's left child and n's right child. **[3 marks]**

b) Here is an array with exactly 15 elements:

```
1   2   3   4   5   6   7   8   9   10   11   12   13   14   15
```

i. Suppose that we are doing a sequential search for an element. Write any elements that will be found by examining/comparing two or fewer numbers from the array**.[2 marks]**

ii. Suppose that we are doing a binary search for an element. Write any elements that will be found by examining two or fewer numbers from the array. **[3 marks]**

c) If the characters 'D', 'C', 'B', 'A' are placed in a queue (in that order), and then removed one at a time, in what order will they be removed? **[1 mark]**

d) Convert each time formula to the best possible big-O notation. Do not include any spurious constants in your big-O answer. **[4 marks]**

Time Formula	**Big-O**
$f(n)=10n$	.
$f(n)=2n^2$	.
$f(n)=3\log_2 n$	.
$f(n)=2n^2 + 10n$	.

e) Given an array containing the digits **5 3 9 5**, show how the order of the digits changes during each step of [i] insertion sort, [ii] selection sort,[iii] mergesort, and [iv] bubble sort. Show the array after each swap, except in insertion sort. For insertion sort, show the array after each insertion. **[7 marks]**

f) Briefly define the following terms **[3marks]**

i) Big -O (big oh)
ii) Big -Ω (big omega)
iii) Big -Θ.(big theta)

g) What is the importance of the stopping case in recursive methods? **[1 marks]**

h) Outline any two implementation strategies for binary trees **[2 marks]**

i) Briefly describe the following data structures. **[4 marks]**

i. Stack
ii. Queue
iii. Linked list
iv. Hash table

QUESTION 2 (20 marks)

Question 5

Here is an INCORRECT pseudo code for the algorithm which is supposed to determine whether a sequence of parentheses is balanced:

```
declare a character stack

while ( more input is available)

{

   read a character

   if ( the character is a '(' )

      push it on the stack

   else if ( the character is a ')' and the stack is not empty )

      pop a character off the stack

   else

      print "unbalanced" and exit

 }

 print "balanced"
```

a) What will be the output of the above algorithm for each of the following unbalanced sequences? **[8marks**]

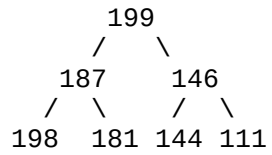
i. (((()
ii. ())(()
iii. (()()))
iv. (()))()

b) Write the correct algorithm so that it outputs unbalanced only if the sequence is unbalanced. **[6 marks]**

c) Suppose that p, q, and r are all references to nodes in a linked list with 15 nodes. The variable p refers to the first node, q refers to the 8th node, and r refers to the last node. Write a few lines of code that will make a new copy of the list. Your code should set THREE new variables called x, y, and z so that: x refers to the first node of the copy, y refers to the 8th node of the copy, and z refers to the last node of the copy. **[6 marks]**

QUESTION 3 (20 marks)

a) State with reasons whether the following binary tree is a heap structure or not:
[2marks]



b) Draw an expression tree for the expression (90 + 40) * 50 + (40 - (60 - 30)).
[4 marks]

c) Give the output of the three traversal orders of the generated expression tree. **[6 marks]**

d) Draw the binary search tree that results from adding the following integers (134, 145, 13, 187, 165, 132, 11, 112, 117). **[4 marks]**

   i. List the leaf nodes of the tree. [2 marks]

e) What problem does binary search tree suffer from? **[2 marks]**

Question 4

a) Distinguish between a table and a record. [2 marks]

b) What is a dictionary in the context of data structures? [2 marks]

c) Distinguish between open addressing and closed addressing in hash tables. [2 marks]

d) Suppose that an open-address hash table has a capacity of 900 and it contains 100 elements. What is the table's load factor? **[1 marks]**

e) Define the following as relates to hash tables:
   i. Perfect hashing function [1 mark]

f) Briefly describe one algorithm that is used for resolving collisions in a hash table. [4 marks]

g) Draw a hash table with open addressing and a size of 13. Use the hash function "k%13". Insert the keys: 39, 5, 29, 20, 0, 26, 35, 47 and 18 into your table (in that order). [5 marks]

h) State the strategy used to resolve any collisions. [2 marks]

i) What is the load factor of the hash table? [1 mark]

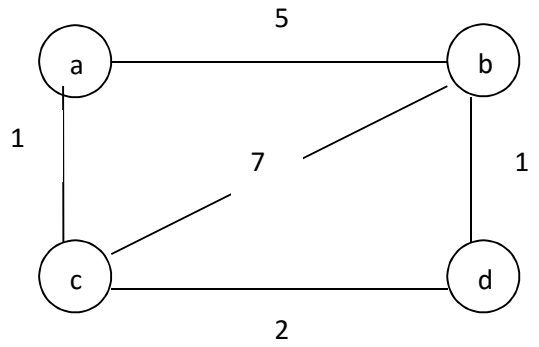
Question 5 — 20 marks

a) Draw the directed graph that is represented by the following: [4 marks]
Vertices: 1, 2, 3, 4, 5, 6, 7
Edges: (1, 2), (1, 4), (2, 3), (2, 4), (3, 7), (4, 7), (4, 6), (5, 6), (5, 7), (6, 7)

b) Outline two principal methods for representing graphs for computer algorithms [4 **marks]**

c) If a graph is sparse which representation will you use and why? [2 marks]

d) Consider the weighted graph given below:



Represent the weighted graph using the two representation methods described in part (b) above. **[4 marks]**

e) Define the following terms **[2 marks]**
   i. Spanning tree
   ii. Minimum spanning tree

f) Let *A* be the adjacency matrix of an undirected graph. Explain what property of the matrix: **[4 marks]**
   i. indicates that the graph is complete.
   ii. the graph has a loop, i.e., an edge connecting a vertex to itself.
   iii. the graph has an isolated vertex, i.e., a vertex with no edges incident to it.