(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 COMPUTER SCIENCE

COURSE CODE: CSC 224

COURSE TITLE: DATA STRUCTURES

DATE: 29TH APRIL, 2015   **TIME**: 800AM-10.00AM

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

TIME: 2 Hours

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no question is missing.

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. **[2 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) What is the load factor and how does it affect table size? **[2 marks]**

d) What is a collision in a hash table? **[1 mark]**

    The situation where two elements or keys map to the same location in the table is called a collision.

e) Why is sorting important? **[1 marks]**

f) 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]**

g) What are the steps to inserting a new item at the head of a linked list? Use one short English sentence for each step. **[2 marks]**

h) 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. **[6 marks]**

i) Draw the directed graph that corresponds to this adjacency matrix: **[3 marks]**

```
          0        1        2        3

0   |   true    false    true     false   |

1   |   true    false    false    false   |

2   |   false   false    false    true    |

3   |   true    false    true     false   |
```

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

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

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

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

QUESTION 2   **(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:
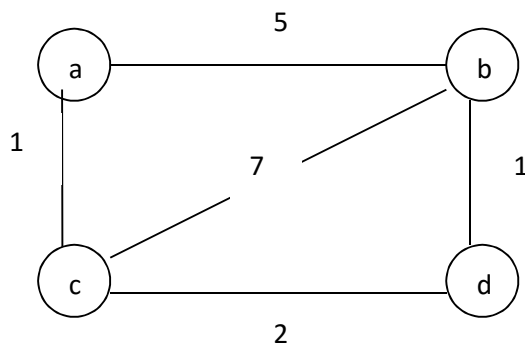


Represent the weighted graph using the two representation methods described in part (b)
above.   **[4 marks]**

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.

QUESTION 3   **(20 marks)**

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

```
        199
       /   \
     187    146
    /  \    /  \
  198  181 144 111
```
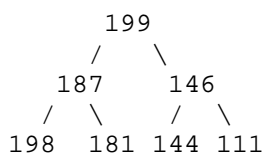
b) Draw an expression tree for the expression (90 + 40) * 50 + (40 - (60 - 30)).
                                                                           [4 marks]
c) Give the output of the three traversal orders of the generated expression tree. **[6 marks]**
d) Draw the binary search tree that results 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%11". Insert the keys: 33, 5, 29, 20, 0, 22, 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
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.

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]**