(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY REGULAR EXAMINATIONS 2023/2024 ACADEMIC YEAR

FIRST/SECOND YEAR 2ND SEMESTER EXAMINATIONS

BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY, COMPUTER SCIENCE, KNOWLEDGE MANAGEMENT AND EDUCATION

COURSE CODE: BCS 225/BIT 122
COURSE TITLE: DATA STRUCTURES AND ALGORITHM

DATE: MONDAY 15TH APRIL, 2024 **TIME:** 8:00AM - 10:00AM

INSTRUCTIONS TO CANDIDATES

Answer Question **ONE (1)** and Any **OTHER 2** questions
Ensure your answers/ideas are clearly expressed
All your answers must be clearly numbered
Write in ink. Rough work can be done (in answer booklet) in pencil and will not be marked. Cross out any rough work.
Calculators, phones, tablets, computers not allowed

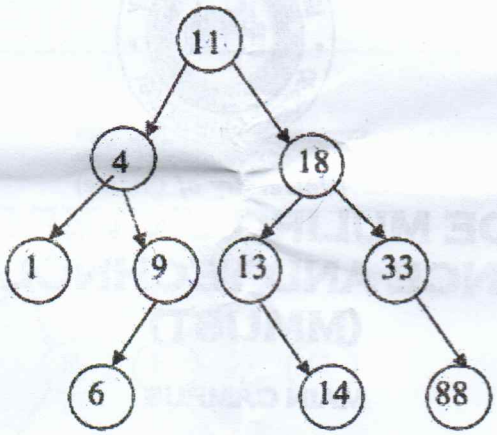
TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE **COMPULSORY** **[30 MARKS]**

a) The height of a tree consisting of a single node is 0.What is the minimum and maximum number of nodes in an AVL tree of height 6? [4 Marks]

b) Given the binary search tree shown below. Draw what the tree would look like after deleting the value 11. [4 Marks]



c) For each of the functions f(N) given below, calculate the worst case time complexity represented in Big Oh notation [6 Marks]

i) $f(N) = N^{1/2} + \log^3 N$

ii) $f(N) = 100 \log N + N^{1/4}$

iii) $f(N) = N^2 \log N^2 + 2N \log^2 N$

d) Draw the binary min heap that results from inserting the integers: 7, 5, 6, 3, 8, 1 in that order into an initially empty binary min heap [4 Marks]

e) Using a stack, solve the following in order equation. Note the value of x is 14 [4 Marks]

```
30%6*x^(4*2)/19-5+2^(3*(70-x)%6))
```

f) Write two functions to differentiate bubble sort and insertion sort [6 Marks]

g) Draw a graph for time complexity vs input size for: [2 Marks]

i) O(n)
ii) $O(n^2)$
iii) O (nlogn)
iv) O (logn)

QUESTION TWO **[15 MARKS]**

a) Describe the worst case running time of the following pseudocode functions in Big-Oh notation in terms of the variable n. show all your steps for each [6 Mark

i) [2 Marks]

```
void silly(int n) {
for (int i = 0; i < n; ++i) {
 j = n; while (j > 0) { System.out.println("j = " + j);
j = j - 2;
 }
 }
 }
```

ii) [2 Marks]

```
void silly(int n, int x, int y) {
for (int k = n; k > 0; k--)
 if (x < y + n) {
for (int i = 0; i < n; ++i)
for (int j = 0; j < i; ++j)
System.out.println("y = " + y);
} else {
System.out.println("x = " + x);
}
}
```

iii) [2 Marks]

```
void silly(int n) {
for (int i = 0; i < n; ++i) {
for (int j = 0; j < n; ++j)
System.out.println("j = " + j);
 for (int k = 0; k < i; ++k) {
System.out.println("k = " + k);
for (int m = 0; m < 100; ++m)
System.out.println("m = " + m);
}
 }
 }
```

iv) [2 Marks]

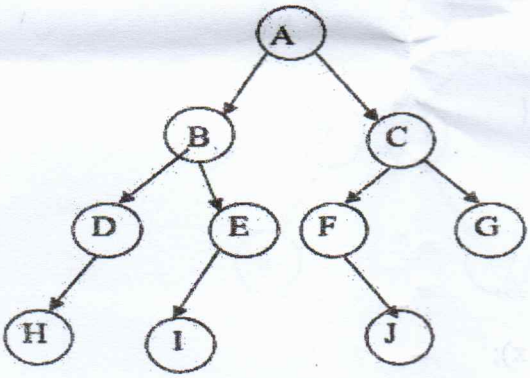
```
int silly(int n, int m) {
if (m < 2) return m;
 if (n < 1) return n;
 else if (n < 10)
return silly(n/m, m);
else return silly(n - 1, m);
}
```

b) Construct an expression tree for the following expression [3 Marks]
(a(+b^c/d^3) + e+1*2%f)*g).

c) What will be the outputs when you apply polished and reverse polished notations to the tree constructed in b)? [4 Marks]

QUESTION THREE **[15 MARKS]**

a) [8 Marks]



Write the traversals of the three shown above for

i) Pre Order [2 Marks]

ii) Post Order [2 Marks]

iii) In Order [2 Marks]

b) What is the depth of node F in the tree shown in a)? [2 Marks]

c) Is it AVL balanced? explain [2 Marks]

d) Write an algorithm to different between heap sort and merge sort [4 Marks]

e) Showing all steps, what is the time complexity of the code in d) [1 Marks]

QUESTION FOUR **[15 MARKS]**

a) Given the a random stack , using your appropriate programming language, write a code that will determine which value in the stack is the smallest and move that value to the top of the stack while leaving the remainder of the stack in its original order [10 Marks]

b) Write a code to show how pop from a Stack implemented with linked list works. Calculate the worst case time complexity of this code [5 Marks]

QUESTION 5 **[15 MARKS]**

a) Write an algorithm (not code) to differentiate between the following

i) Circular queues and priority queues . [4 marks]

ii) Circularly linked list and doubly linked list [4 Marks]

iii) Implementation of stack using linked list and array . [4 Marks]

b) When implementing a circular queue, what will you prefer between a linked list and an array . [3 Marks]