NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF SOFTWARE ENGINEERING

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE	
QUALIFICATION CODE: 07BCMS	**LEVEL:** 7
COURSE: DATA STRUCTURES AND ALGORITHMS 2	**COURSE CODE:** DSA711S
DATE: JUNE 2024	**PAPER:** THEORY
DURATION: 2 HOURS	**MARKS:** 90

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**MR S. TJIRASO**
MODERATOR:	**MRS P. DOLIAN**

INSTRUCTIONS
1. Answer ALL the questions. 2. Read all the questions carefully before answering. 3. Number the answers clearly

THIS QUESTION PAPER CONSISTS OF 10 PAGES
(Including this front page)

PERMISSIBLE MATERIALS

1. NON-PRGRAMMABLE CALCULATOR

SECTION A: Multiple Choice Questions **[40 Marks]**

- Answer all the questions in the provided booklet.
- The section consists of 8 problems.

Problem A1

Which **one** is the worst case time complexity of the function; $\mathbf{f(n) = 9n^3 - 10000n^3 + n^2 + n^4}$? **[2 Marks]**

A. O(n),
B. $O(n^2)$
C. $O(n^4)$
D. $O(n^{12})$
E. $O(n^3)$

Problem A2

Consider the function; $\mathbf{f(n) = 10n^3 - 10n^3 + n^2}$. **2 Marks]**

Statement A: The function **f(n)** has polynomial time complexity.
Statement B: The function **f(n)** has linear time complexity.

A. Statement A is true, and Statement B is false.
B. Statement A is false, and statement B is true.
C. Both Statement A and Statement B are true.
D. Both Statement A and Statement B are false.

Problem A3

Consider the function; $\mathbf{f(n) = 100 + 9n^3}$**?** **[2 Marks]**

Statement A: The function **f(n)** has linear time complexity.
Statement B: The function **f(n)** has Quadratic time complexity.

A. Statement A is true, and Statement B is false.
B. Statement A is false, and statement B is true.
C. Both Statement A and Statement B are true.
D. Both Statement A and Statement B are false.

Problem A4

Consider the program snippet below. **[2 Marks]**

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

Statement A: The program has $O(n^4)$ time complexity.
Statement B: The program has $O(n^3)$ time complexity

A. Statement A is true, and Statement B is false.
B. Statement A is false, and statement B is true.
C. Both Statement A and Statement B are true.
D. Both Statement A and Statement B are false.

Problem A5

..... is not an example of a recursive problem. **[2 Marks]**

A. Problem with more than one (1) base cases
B. Problem without a base case
C. Finding the length of a string
D. Finding the n^{th} Fibonacci number

Problem A6

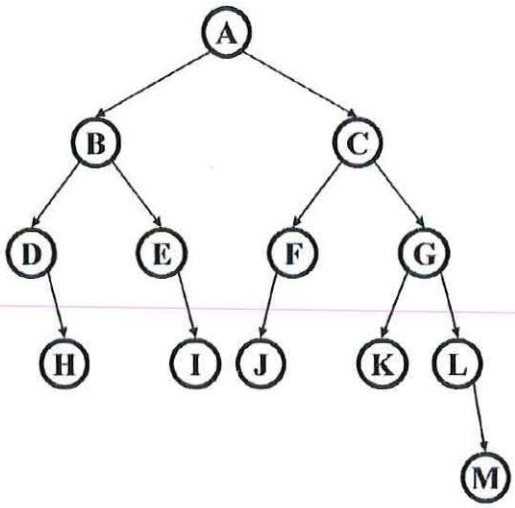
Given the code snippet below. What will happen when the code is executed? **[2 Marks]**

```
void recurse(){
        recurse();
}

main(){
recurse();

}
```

A. program will successfully execute but no output will be generated
B. Infinite loop will be generated
C. Program will generate an error
D. program will successfully execute but no output will be generated

Problem A7

Study the binary search tree below and answer the questions that follow;



a). What node is the successor of node A? **[2 Marks]**

A. B
B. C
C. F
D. M
E. G
F. L
G. None of the above

b). what node is the successor of node F? **[2 Marks]**

A. J
B. C
C. K
D. E
E. G
F. I
G. None of the above

c). what node is the predecessor of node A? **[2 Marks]**

A. J
B. K
C. B
D. M
E. G
F. L
G. None of the above

d). what is the height of the tree? **[2 Marks]**

A. 2
B. 1

C. 4
D. 8
E. 3
F. 5
G. None of the above

e). is the tree an AVL tree? **[2 Marks]**

A. No
B. Yes

f). if we remove only node **H**, is the result an AVL tree? **[2 Marks]**

A. No
B. Yes

g). If we remove only node **J**, is the result an AVL tree? **[2 Marks]**

A. No
B. Yes

h). If we remove only node **K**, is the result an AVL tree? **[2 Marks]**

A. No
B. Yes

i). If we remove only node **M**, is the result an AVL tree? **[2 Marks]**

A. No
B. Yes

Problem A8

Study the news headline from the Namibia Newspaper below and answer the questions.

mines and energy minister tom alweendo says local companies should play a part in shaping the new oil regulating policy that will guide the industry. He was speaking at the ongoing Namibian Local Content Conference yesterday at Lüderitz, where he also urged local businesses to take full advantage of the emerging oil and gas sector to accrue maximum financial benefits.

NOTE: Consider only the text in **bold**, including spaces to answer all the questions in problem A8.

a). Which type of data compression algorithm will be the most appropriate to compress this news article? **[2 Marks]**

A. Lossy methods
B. Lossless compression
C. None of the above

b). what is the total number of bits needed to store the bolded headline of this article before compression? Include spaces in the bolded text. Assuming 8-bit ASCII encoding is used. **[2 Marks]**

A. 2
B. 1200
C. 512
D. 8
E. 1184
F. 5
G. None of the above

c). How many unique characters are in the text? **[2 Marks]**

A. 24
B. 19
C. 512
D. 8
E. 158
F. 12
G. None of the above

d). what is the code word or encoded string of the bolded text after compression using run length encoding? Use underscore (_) for space. **[4 Marks]**

A. 2
B. m04i12n11e12s05_24a11d05r05g05y05t09o07l10w03c13p05h05u04
C. 512
D. m04i10n11e12s05_24a11d05r08g05y05t09o07l10w03c13p05h05u04
E.m01i01n01e01s01_01a01n01d01_01e01n01e01r01g01y01_01m01i01n01i01s01t01e01r01_01t01o01m01_01a01l01w01e03n01d01o01_01s01a01y01s01_01l01o01c01a01l01-01c01o01m01p01a01n01i01e01s01_01s01h01o01u01l01d01_01p01l01a01y01_01a01_01p01a01r01t01_01i01n01_01s01h01a01p01i01n01g01_01t01h01e01_01n01e01w01_01o01i01l01_01r01e01g01u01l01a01t01i01n01g01_01p01o01l01i01c01y01_01t01h01a01t01_01w01i01l01l01_01g01u01i01d01e01_01t01h01e01_01i01n01d01u01s01t01r01y01
F. 5
G. None of the above

SECTION B: True and False Questions **[10 Marks]**

- Answer all the questions in the provided booklet.
- The section consists of 5 questions.

Problem B1
A doubly-linked list is a linear data structure. **[2 Marks]**

Problem B2
It is sensible to discuss depth-first and breadth-first searches in linear data structures. **[2 marks]**

Problem B3
A Stack follows a LIFO (last-in-first-out) rule. **[2 marks]**

Problem B4
Push and pop operations are associated with Binary Search Tree data structure. **[2 marks]**

Problem B5
Big-O and Big-Θ (Big-Theta) are both asymptotic notations. **[2 marks]**

SECTION C: Structured questions **[40 Marks]**

- Answer all the questions in the provided booklet.
- The section consists of 4 questions.

Problem C1

What is the worst case time complexity for the function **f(n)** below using " big-Oh" notation?
You must choose your answer from the following list. The list is not in any particular order and any item in the list could be the answer for 0, 1, or more than 1 question.

$O(n)$, $O(n^2)$;$O(2^n)$, $O(n^{1/2})$, $O(n^{1/4})$, $O(n^3)$, $O(n^4)$, $O(n^5)$, $O(n^6)$, $O(n^7)$, $O(n^8)$, $O(n^9)$,
$O(\log^3 n)$, $O(n^2 \log n)$, $O(\log^8 n)$, $O(\log^4 n)$, $O(n \log^3 n)$, $O(\log^2 n)$, $O(\log n)$, $O(1)$;$O(n^3 \log n)$,
$O(n^n)$, $O(n \log \log n)$, $O(n \log^2 n)$, $O(\log \log n)$, $O(n \log n)$

a. $f(n) = 9n^3 - 8n^3 + n^2$ **[2 marks]**

b. $f(n) = 9n^3 - 9n^3 + n^2$ **[2 marks]**

c. $f(n) = 100 + 9n$ **[2 marks]**

Problem C2

Describe the worst case running time of the following code in " big-Oh" notation in terms of the variable **n**. You should give the tightest bound possible. You must choose your answer from the following list. **[2 marks]**

$O(n)$, $O(n^2)$;$O(2^n)$, $O(n^{1/2})$, $O(n^{1/4})$, $O(n^3)$, $O(n^4)$, $O(n^5)$, $O(n^6)$, $O(n^7)$, $O(n^8)$, $O(n^9)$,
$O(\log^3 n)$, $O(n^2 \log n)$, $O(\log^8 n)$, $O(\log^4 n)$, $O(n \log^3 n)$, $O(\log^2 n)$, $O(\log n)$, $O(1)$;$O(n^3 \log n)$,
$O(n^n)$, $O(n \log \log n)$, $O(n \log^2 n)$, $O(\log \log n)$, $O(n \log n)$

```
(a) void myFunction(int n) {
        for(int i=0; i < n; i++) {
            for(int j=0; j < n; j++) {
                for(int k=0; k < 100; k++) {
                 for(int m=0; m < 10; m++) {
                     System.out.println(" DSA711S");
        }}}}
}
```

(b)
```
void myFunction(int n) {
        for(int i=0; i < n; i++) {
            for(int j=0; j < n; j++) {
                for(int k=0; k < n; k++) {
                    System.out.println(" DSA711S");
        }}}
}
```

Problem C3

Consider a hash table with separate chaining, M = 10 positions with integer keys, and a hash function h(x) = x mod M.

Starting from an empty table, show the resulting table after inserting the keys 41, 12, 98, 183, 483, 74, 722, 3313, 30, 5001, 4202, 465, 18181, 199, 999 and 1267. **[10 marks]**

Problem C4

Huffman Coding is a technique of compressing data to reduce its size without losing any of the details. Some of the benefits of compressing data are that it can be transmitted faster over the network and can reduce "data" costs for mobile subscribers for example. Huffman Coding is one of many examples of binary tree applications.

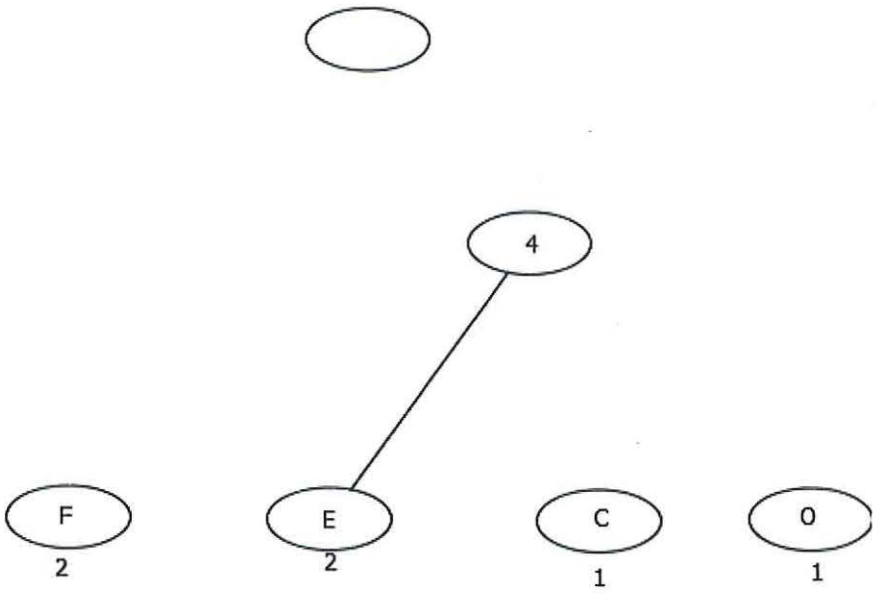
Suppose the following string is to be sent over a network

C	O	F	F	E	E

Task:

a) What is the total size of the string as it is (in bits) or before compression, assuming 8-bit ASCII encoding is used? **[2 marks]**

b) Apply Huffman Coding on the string and determine the Huffman tree, by completing the tree below. The first few steps are done for you. **[4 marks]**



c) Determine the code and code length of each character. **[8 marks]**

Character	**C**	**O**	**F**	**E**
Frequency	1	1	2	2
Code				
Code Length				

d) Compute the size of the encoded string? **[4 marks]**

e) Provide the encoded string or code word? **[4 marks]**

********** End of Exam**********