(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

END OF SEMESTER EXAMINATIONS
YEAR TWO SEMESTER ONE EXAMINATIONS

FOR THE DEGREE OF
BACHELOR OF SCIENCE COMPUTER SCIENCE

COURSE CODE   :   CSC 225

COURSE TITLE   :   DATA STRUCTURES

DATE: 18/04/2023   TIME: 9.00AM-11AM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTIONS ONE AND ANY OTHER TWO.

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. [4 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]

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, and [iii] bubble sort. [6 marks]

i) Outline any two implementation strategies for binary trees [4 marks]

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

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

QUESTION 2   (20 marks)

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? [12 marks]

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

2

b) Write the correct algorithm so that it outputs unbalanced only if the sequence is unbalanced and hence translate the algorithm into a static method. Write the method main to test your method.   [8 marks]

(20 marks)

QUESTION 3

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

```
        199
       /    \
     187    146
     / \    / \
   198 181 144 111
```
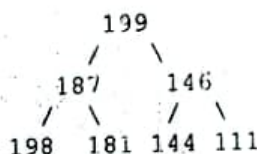
b) Draw an expression tree for the expression (90 + 40) * 50 + (40 - (60 - 30)).
   [4 marks]

c) Generate the postfix expression from the expression tree in question (b) above and evaluate the expression
   [4 marks]

d) Give the output of the three traversal orders of the generated expression tree. [3 marks]

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

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

## Question 4   (20 marks)

a) What is a hash table?   [2 marks]

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

c) Briefly describe any three collision resolution algorithms for hash tables highlighting any disadvantages that may exist.
   [6 marks]

d) A parking lot has 31 visitor spaces, numbered from 0 to 30. Visitors are assigned parking spaces using the hashing function $h(k) = k \bmod 31$, where k is the number formed from the first three digits on a visitor's license plate.

   i.   Which spaces are assigned by the hashing function to cars that have these first three digits on their license plates: 317, 918, 007, 100, 111, and 310?
        [7 marks]

   ii. Describe a procedure visitors should follow to find a free parking space, when the space they are assigned is occupied.
        [3 marks]

Question 5   (20 marks)

a) Consider the tree shown below the table that follows: [6 marks]
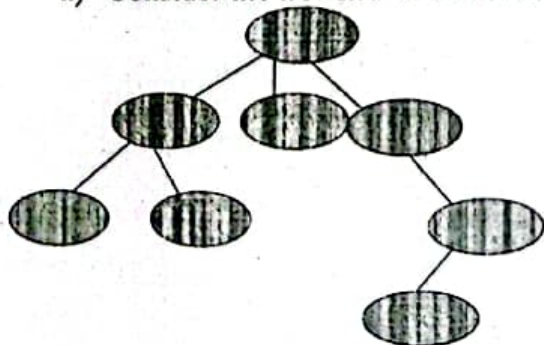
NODE	DEPTH	HEIGHT	LEVEL
A			
B			
C			
F			
H			

b) Write the Java code to represent the class Node used to represent a binary tree. The data part of the node should hold elements of type Object. Include in your class, a no-parameter constructor with appropriate initialization. **[7 marks]**

c) Design a tree class that uses the node class above. Include in your tree class a reference to the root, a no-argument constructor, insert method which inserts a given method into the tree, and traverse method which traverses the tree starting from the root. **[7 marks]**