BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF COMPUTER SCIENCE

BSc HONS DEGREE IN COMPUTER SCIENCE

DATA STRUCTURES AND ALGORITHMS – CS213/CSH114/NWE113/SWE113

2 HOURS 30 MINUTES

INSTRUCTION TO CANDIDATES

Answer **all** questions.
Total marks are **100**.

Question 1

a. Describe the role of algorithms in computer science. **[4]**

b. Discuss the factors that you would consider when choosing or selecting an algorithm to use from among several alternative algorithms. **[6]**

Question 2

a. Describe the characteristics of an algorithm? **[4]**

b. Suppose the nodes of a doubly linked list structure are defined as follows:

```
struct node
{
int item;
        struct node * next;
        struct node * prev;
        };
```

Write a function concat which concatenates two given lists (the first node of the second list will follow the last node of the first list) and returns the new list.

Note that concat does not create new nodes; it just rearranges the links of some existing notes. Assume that the pointers all refer to the head of their respective list.

struct node * concat(struct node * list1, struct node * list2) **[10]**

c. Suppose the nodes of a linked list structure are defined as follows:

```
struct node
      {
      int value;
struct node * next;
      };
```

Define a function length which takes a pointer to the start of the linked list (of nodes) and returns the number of items that are in the list.

For instance, if list is the list (3, 9, 5, 6) then length(list) returns 4. **[6]**

Question 3

Consider the following list of words

apple, tree, car, dog, yellow, frog, gun, harp

a. Sort in alphabetical order using

i. Insertion sort. Show your work. **[5]**

ii. Bubble sort. How many complete passes are necessary for the bubble sort to ensure the list is sorted? Show your work. **[5]**

iii. Merge sort. Show your work. **[5]**

b. Consider an initially empty binary search tree (BST). Place each of the above words into the BST in the order given above. (Use alphabetical order to make your comparisons). Draw the completed binary search tree **[5]**

Question 4

a. For the following binary tree

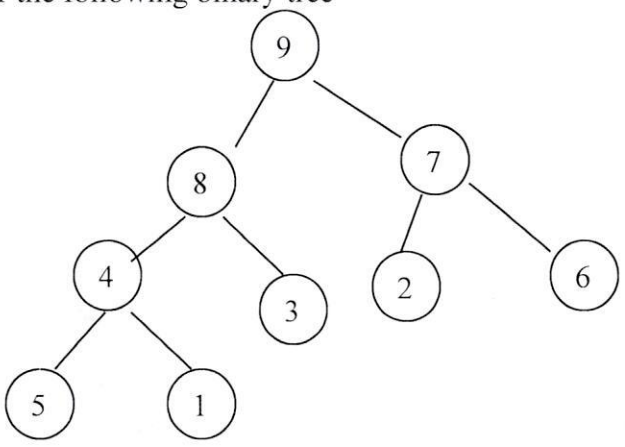

Figure 1. Binary Tree

i. What is the depth of this tree [1]

ii. Is the tree a **complete binary tree**? Why [2]

iii. Is the tree a **full binary tree**? Why [2]

iv. Is the tree a **binary search tree**? Why? [2]

v. List the node numbers for traversing the tree using **Preorder, Inorder and Postorder** traversal method. [9]

b. Draw the binary expression tree corresponding to the expression

(- x – y * z) + (a + b + c / d * e) [4]

Question 5

a. Describe the basic steps of the divide and conquer approach to algorithm design [4]

b. A **graph** $G = (V, E)$ is an ordered pair of finite sets V and E. The elements of V are called vertices and the elements of E are called edges.

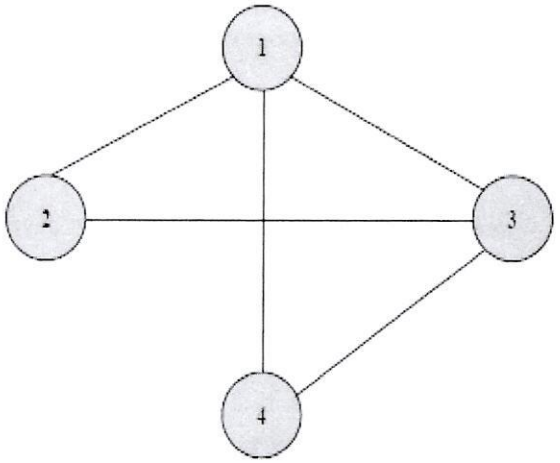

Figure 2. Graph G

Using the set notation, specify the above graph G. [2]

c. Draw all possible spanning trees of the above graph G. [6]

d. Musariwa's initial release of an application Windbag 2018 had a few bugs. So, President and CEO Gill Bates has decided to release a patch. In addition to fixing all the bugs in the initial release, the patch also has improvements for a variety of operations.

Bates has stated publicly that the way the new code is able to execute more quickly is through the use of a data structure that supports the push and pop operations and a third operation called findMin, which returns (without removing) the smallest element in the data structure.

Explain how the data structure might be organized and how each of the **three** operations (push, pop, findMin) work. **[8]**

Question 6

Use the Dijikstra algorithm to determine the distance from Norton to Ruwa.

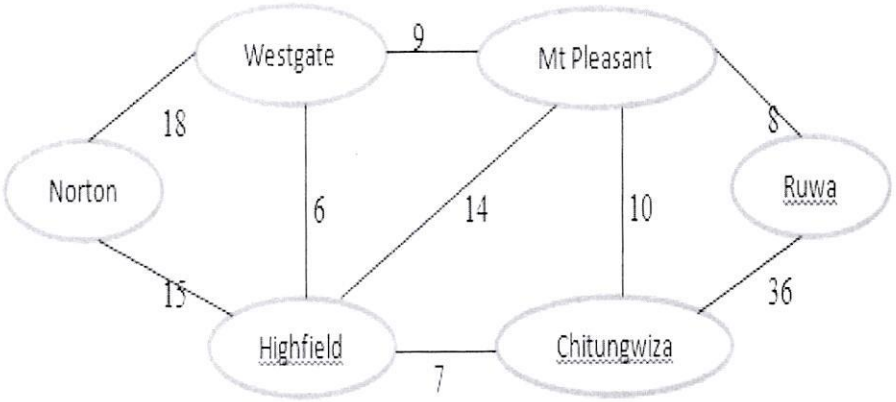

Figure 3. Map

[10]

**** END OF EXAM****