

January 2020

Softwarica College of IT and E-Commerce

210CT

Programming, Algorithms and Data Structures

Instructions to candidates:

Time allowed: 2 Hours

Answer: **All** questions

You must **hand** in this question paper at the end of the examination.

Question 1

Total for Question 1: 25 Marks

- a) Use pseudocode to describe a function that takes a number as input and returns the sum of its digits.

Input: an integer *n* read from the keyboard, for example $n = 561283$

Output: digit sum *sum* = 25

For solving this task, **do not** use any predefined functions that would make this task trivial, such as sum or map in Python. (10 marks)

- b) Show an implementation of the algorithm designed in the language of your choice. You will not be penalised for small syntactical errors. (10 marks)

- c) Implement an algorithm in the language of choice that checks whether an element occurs in a list **recursively**.

Input: a list *L* read from the keyboard, for example $L = [2, 6, 1, 9, 7, 3]$

an element *e*, for example $e = 9$ Output: True or False – in this case True

For solving this task, you can use any predefined functions in the language of your choice, however their name and number/location of arguments must be accurate.

Continue

Question 2

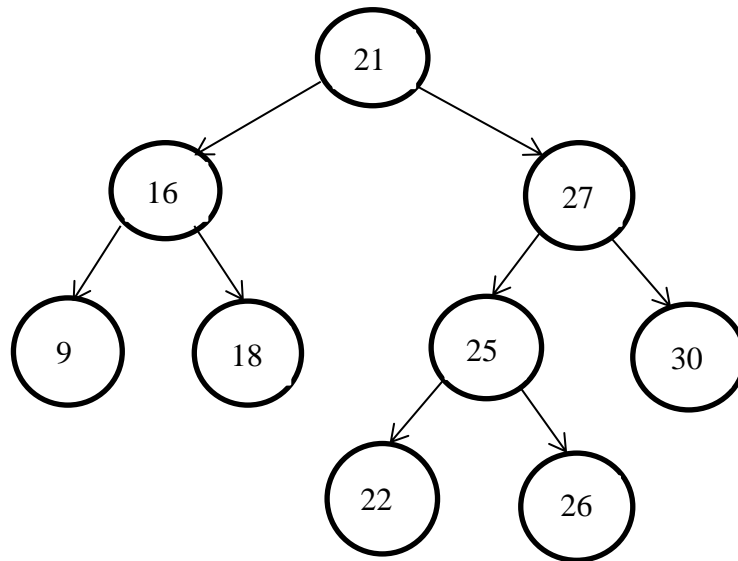
Total for Question 2: 25 Marks

- a) Implement Bubble Sort in the language of your choice. (10 marks)
- b) Use the big-O notation to describe the run-time performance of the algorithm implemented for the previous sub-question, relative to input size. (5 marks)
- c) Use pseudocode to describe the Quick Sort algorithm. (5 marks)
- d) Use the big-O notation to describe the run-time performance of the algorithm implemented for the previous sub-question, relative to input size. (5 marks)

Question 3

Total for Question 3: 25 Marks

- a) Give an example of a specific tree data structure you have studied and explain its characteristics. (2 marks)
- b) Write the pseudocode for searching a target value in a binary search tree recursively. Assume the following structure of a tree object: left, right and value as attributes.
Input: a tree object *t* and integer key of the node to be searched for, target
Output: True or False. (5 marks)
- c) Draw the binary search tree resulting from the insertion of the numbers 10, 5, 25, 27, 3, 7, 21 and 1. (3 marks)
- d) Given the binary search tree below, give the pseudocode for the three different traversal methods: pre-order, in-order and post-order. Also, specify the order in which the nodes in the tree are visited according to all three methods. (9 marks)



- e) Consider the operation of **inserting** an element in a binary search tree. Use the big-O notation to describe the run-time performance of the operation both for the average **and** worst case scenarios. Describe and exemplify the two particular scenarios. (6 marks)

Question 4

Total for Question 4: 25 Marks

- a) What type of graph is **Graph 1**? Circle the right choice based on the four criteria. (4 marks)

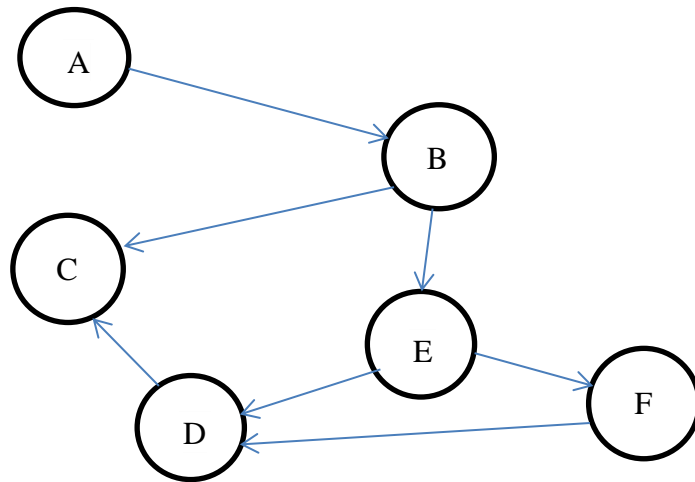
directed **or** undirected

connected **or** unconnected

weighted **or** unweighted

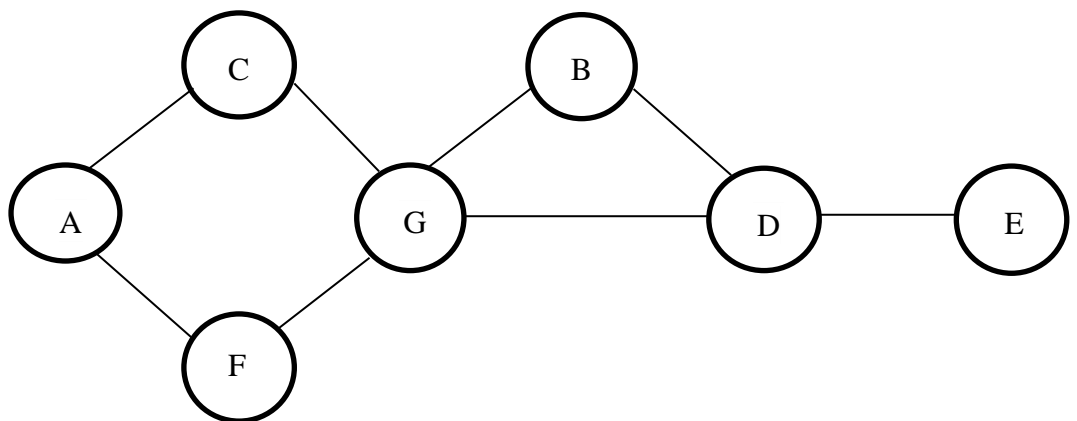
cyclic **or** acyclic

Graph 1



- b) Given **Graph 1**, state the degrees for all vertices (total degree, indegree and outdegree)? (6 marks)
- c) Write a complete adjacency matrix representation of **Graph 1**. (5 marks)
- d) Given **Graph 2**, describe how Depth First Search (DFS) is performed and state the order in which the nodes will be visited, beginning with C. Assume that visited nodes will be remembered and not visited again, and that nodes are selected based on an alphabetical order. (10 marks)

Graph 2



End