

NAME:

VSV Student ID:

ALGORITHMICS UNIT 3

SAC 1: Abstract Data Types (Weeks 1 to 5)

Outcome 1

Date of Completion: 18-22 March 2024

Reading Time: 5 minutes

Writing time: 55 minutes

TOTAL (60 minutes)

QUESTION AND ANSWER BOOK

<i>Type</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
Short/Extended Response	10	10	40
Total			40

Materials supplied

- Question and answer book of 8 pages

Materials permitted

- Pens/Stationary and one Scientific Calculator permitted.

No Reference material permitted.

Instructions

- Write your **name** in the space provided above on this page.
- All written responses must be in English, point form is preferred.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the test room.

1. Explain two differences between a list and a set.

(2 marks)

2. The following operations are carried out on a stack.

ENQUEUE (myStack, "Yellow")

ENQUEUE (myStack, "Green")

ENQUEUE (myStack, "Red")

DEQUEUE (myStack)

ENQUEUE (myStack, "Blue")

(a) Write down the current contents of the stack.

(1 mark)

(b) Write down the signature for the PEEK operation on a stack.

(2 marks)

3. Louise wants to model a friendship network, which has the following properties:

- A can like B, but this does not mean that B likes A.
- Each 'like' is given a strength rating between 1 and 5, where 1 is the weakest and 5 is the strongest.
- Each person's age and income also needs to be stored.

4. Explain how to model this situation using ADTs.

(3 marks)

(b) Write down the signature for an operation to add a new person to the friendship network.

(2 marks)

4. Vehicles are loaded onto a ferry one at a time. They are loaded into one of five lanes, each with a fixed capacity. They are unloaded through the same door, i.e. the last car to be loaded into a particular lane is the first one to be unloaded.

(a) Explain a combination of ADTs which could be used to model this problem.

(2 marks)

(b) Write the signature for the operation `loadVehicle`, using a string to represent the registration plate of the vehicle.

(2 marks)

(c) Vehicles must be loaded in the order in which they arrive, however it is desired that cars with young children are unloaded first. Explain how you would achieve this, and whether or not it could guarantee that all such cars are unloaded first.

(2 marks)

5.
(a) Clearly define a tree.

(1 mark)

(b) Explain why there exists one and only one path between any two vertices in a tree.

(3 marks)

6. Consider the following boolean statement

$[(A' \text{ and } B) \text{ or } (A \text{ and } B')]$ and $[(B \text{ and } C') \text{ or } (B' \text{ and } C)]$

For which set(s) of boolean values of A, B and C is the statement true?

A	B	C
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

(2 marks)

7. The following pseudocode is written to add numbers from a list to a queue, and then print them in the order they were added.

```
Algorithm printListQ(myList):  
    myQ = empty queue  
    for each item in myList:  
        myQ.enqueue(item)  
    for each item in myQ:  
        item = myQ.pop()  
        print(item)
```

Explain the fault in this pseudocode, and how to correct it.

(1 mark)

8. Bill is creating a database to record company employees. He needs to record the following information about them:

first_name
last_name
address
age
salary
job_title

He suggests the following combination of ADTs.

Dictionary: {key = first_name, value = employee_details}

where employee_details is a Dictionary: {
 "last name": last_name,
 "address": address,
 "age": age,
 "salary": salary,
 "job title": job_title}

(a) Identify two problems with this combination of data structures.

(2 marks)

(b) Suggest a better way to store this information.

(2 marks)

9.

(a) Outline the graph colouring problem.

(1 mark)

(b) A factory produces a wide range of items using different machines. For some items there exists only one machine which can produce them. For some items only certain workers are able to produce them. Each machine and worker can only produce one item at a time.

The table below shows four of the items the factory produces.

Item name	Worker	Machine
Florp	Kappa	GizmoTron 3000
Snazzle	Epsilon	GizmoTron 3000
Jibbet	Epsilon	TechnoFizzatron
Gizmizzle	Kappa	Quirk-O-Matic

(b) Illustrate this information in a graph where edges indicate conflicts, so that you could apply the graph colouring problem. (Do not attempt to solve the graph colouring problem.)

(2 marks)

(c) With reference to your graph and the graph colouring problem, state two items which can be produced at the same time, and explain how your graph shows this.

(2 marks)

10. A project manager wants to keep track of tasks which need to be completed. Some tasks must be completed before other tasks, and each task requires a particular amount of time to complete.

Task	Time to complete	Must be completed after
A	5	-
B	10	A
C	5	A, B
D	3	B
E	2	C, D

(a) Shahril suggests using a priority queue, giving each task a priority so that tasks are completed only after their prerequisites have been completed.

With reference to the data above, explain whether or not this is the best way to store the data.

(2 marks)

(b) Epi suggests using a directed graph, so that each directed arrow leads to a task from its prerequisite. The time required for each task should be stored as edge weights.

(i) Draw the directed graph for the above tasks.

(3 marks)

(ii) Explain an alternative method for recording the time required for each task, and a potential advantage this could bring.

(2 marks)

END OF TEST