

**NAME:****VSV Student ID:****VCE ALGORITHMICS (HESS) UNIT 3****SAC Abstract Data Types (Part A)****Outcome 1****Date of Completion: 20-24<sup>th</sup> March 2023****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/<br>Extended<br>Response | 4                          | 4                                         | 40                     |
| Total                          |                            |                                           | 40                     |

**Materials supplied**

- Question/answer booklet of **8 pages**

**Materials permitted**

- Pens/Stationary and one Scientific Calculator permitted.

**No Reference material permitted.****Instructions**

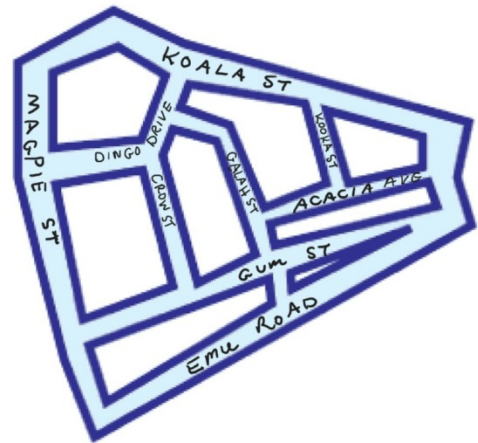
- Write your **name** in the space provided above on this page.
- All written responses must be in English, point form is preferred.

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

### Question 1 (10 marks)

Here is an aerial map of some suburban streets.

The council town planner needs to store the spatial information and non-spatial information related to the streets in a computer system that will be used for managing council services and for future urban planning.



- a) Describe how the spatial information and the following related details can be represented using the graph and other Abstract Data Type(s) for the following: (5 marks)

i. Streets

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ii. Intersections

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iii. Intersection (x,y) coordinates

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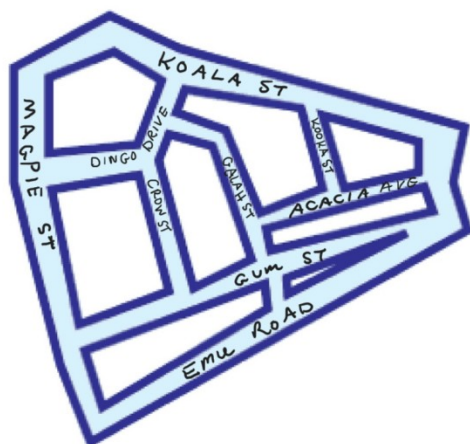
iv. Street names

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v. Distances between intersections

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### Question 1 (continued)



- b) Give a detailed example of the Abstract Data Type model you have described in part a. for the given urban street map in the vicinity of Koala St (diagrams do not have to be to scale). (5 marks)

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## Question 2 (9 marks)

Many coding languages have built in elementary data types such as integer, real and Boolean. Many coding languages also have some built in structured data types such as array, list and set which are implementations of abstract data types used in pseudocode to define algorithms.

- a) Describe the main features of the **array** abstract data type, and describe what distinguishes it from the **list** and the **set**. (3 marks)

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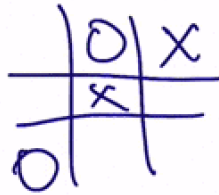
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Consider the following information representing a state of play in a game of tic-tac-toe.



- b) Show the operations required to create a **one dimensional** array data structure to hold the state of play of the tic-tac-toe game and show the operations to capture the information in the data structure. (2 marks)

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## Question 2 (continued)

- c) Describe the main features of the list abstract data type, and describe what distinguishes it from the array and the set. (2 marks)

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- d) Complete the Description and the Return Value results columns of operations in the empty cells in the following table which has list operations. (2 marks)

| List operation       | Description | Example           | List contents before | Return Value or updates list after |
|----------------------|-------------|-------------------|----------------------|------------------------------------|
| <b>isEmpty(list)</b> |             | myList.isEmpty()  | [2,3,7,1]            |                                    |
| <b>append(item)</b>  |             | myList.append(33) | [2,4,6]              |                                    |
| <b>remove(item)</b>  |             | myList.remove(13) | [4,13,6,8,13]        |                                    |

**Question 3 (7 marks)**

Consider a table of activities A, B, C, D, E, F, G and H and activity duration, where some activities have predecessor activities.

| Activity Name | Predecessor Activity | Duration (days) |
|---------------|----------------------|-----------------|
| A             | -                    | 3               |
| B             | A                    | 4               |
| C             | A                    | 2               |
| D             | B                    | 5               |
| E             | C                    | 1               |
| F             | C                    | 2               |
| G             | D,E                  | 4               |
| H             | F,G                  | 3               |

- a) Should the activity names be stored as a set, list or an array? Justify your selection. (1 mark)

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- b) Using stack, queue or priority queue create a model of the information shown in the table above. Describe your model and how the ADTs are used to control the ordering of activities. (3 marks)

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- c) Using different ADTs to part a) and b) create a new model of the activities and dependencies. Describe and show the appearance your choice of ADT(s) depicting the activities shown below. (3 marks)

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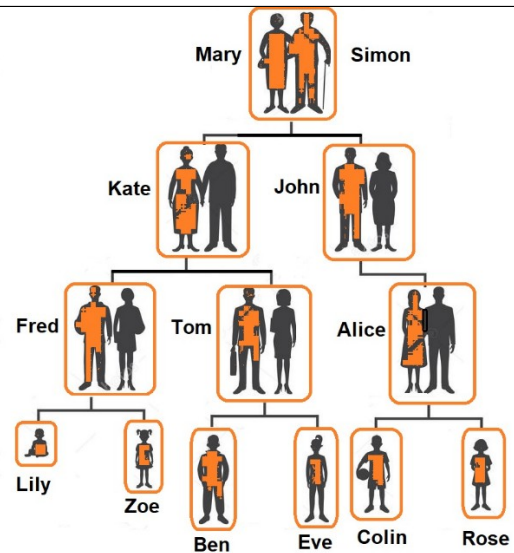
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#### Question 4 (15 marks)

The descendants of Mary and Simon are represented by a graph, with their

- children Kate and John,
- grandchildren Fred, Tom and Alice and
- great-grandchildren, Lily, Zoe, Ben, Eve, Colin, Rose



- a) What operations according to the data signature of the graph ADT are required to build the graph model for Mary and Simon's family tree? (2 marks)

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- b) What operations according to the data signature of the graph ADT are required to add new descendants to Mary and Simon's family tree? (2 marks)

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- c) What are the properties,  $|V|$ ,  $|E|$  and characteristics of the Mary and Simon's family graph? (2 marks)

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**Question 4** (continued)

- d) What is the degree of the starting node shown in the graph in the diagram? In terms of graph terminology describe the characteristics of the nodes in the family graph. (2 marks)

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- e) What is the **diameter** of the graph shown in the diagram? (2 marks)

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- f) If a node of degree higher than 1 is removed from the graph in the diagram describe the characteristics of the result. What are the characteristics of the result when a node of degree 1 is removed? (2 marks)

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- g) A bridge is an edge that if removed would make a connected graph disconnected. Provide an argument for why every edge in the diagram of Mary and Simon's family graph shown is a bridge. (3 marks)

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**END OF TEST**