

**PRIFYSGOL CYMRU; UNIVERSITY OF WALES**

**M.Sc. AND DIPLOMA EXAMINATIONS**

**May/June 2002**

**SWANSEA**

**Computer Science**

**CS M11 Data Structures**

**Attempt 2 questions out of 3**

**Time allowed: 2 hours**

**Students are permitted to use the dictionaries provided by the University**

**Students are NOT permitted to use calculators**

**CS\_M11**  
**DATA STRUCTURES**  
**Summer 2002**  
*(Attempt 2 questions out of 3)*

**Question 1**

- a. Define the concept of a **stack** in terms of the operations that can be performed on it. Include in your answer details of all the arguments required for each operation, and the results of each operation.

**[4 marks]**

- b. Define the concept of a **queue** in terms of the operations that can be performed on it. Include in your answer details of all the arguments required for each operation, and the results of each operation.

**[4 marks]**

- c. Using a Delphi-like language which includes the concept of an array, but not pointer variables show how you could implement a stack, and a queue. Discuss any alternative implementation strategies that might be available to you.

**[6 marks]**

- d. Consider a language similar to Delphi that does not include the concept of an array, but does include the concept of a list with the following functions and operators defined:-

<code>head</code>	- a function which, given a list, returns the first item
<code>tail</code>	- a function which, given a list, returns the rest of the list with the first item removed
<code>empty</code>	- a function which, when applied to a list, returns true if the list is empty, and false otherwise
<code>mklist</code>	- a function which, given an item, returns a list consisting solely of that item
<code>++</code>	- an operator which joins two lists together

Declaring a variable to be a '`list of integer`' will create an empty list which can contain only integers.

Using this language show how you could implement a stack, and a queue.

**[7 marks]**

- e. Discuss the advantages and disadvantages of the two languages you have used above.

**[4 marks]**

## Question 2

- a. Distinguish between the concepts of **static data storage** and **dynamic data storage** as used in a language like Delphi. Discuss how these two types of data storage can be managed.

In particular for dynamic storage your answer should include a discussion of the ways in which a programmer can manage his or her memory requirements, and the ways in which the system might be expected to manage the memory requirements. Clearly indicate the advantages and disadvantages of each approach you discuss.

[10 marks]

- b. **Hash tables**, **Index Tables**, and **Trees** can all be used to store large amounts of data and avoid the need for a linear search for all the data when an item needs to be retrieved. Discuss the implementation of each method. Clearly indicate where alternative implementation strategies are possible. What are the relative merits of each method, and what characteristics of the data would influence your choice of method?

[15 marks]

## Question 3

- a. Define the terms **graph**, **directed graph**, and **acyclic graph**. Give the usual operations that can be performed on a graph.

[7 marks]

- b. In what sense can both **trees** and **lists** be considered as examples of **graphs**? Outline how a graph can be implemented in a Delphi/Pascal-like language using (i) pointers, and (ii) arrays. What are the advantages and disadvantages of each approach to implementing graphs?

[7 marks]

- c. It is required to implement a program to simulate the behaviour of traffic through a series of junctions. It is therefore necessary to define data structures to represent the roads and junctions and the traffic on them. The main problem under investigation is the fact that queues at some junctions are preventing traffic flowing through other junctions. Solutions suggested include road modifications to allow more vehicles to queue at certain points. Discuss what sorts of data structures (defined in terms of operations required on them) you would consider for implementing this system. What additional information might you require in order to decide between alternative data structures?

**Briefly** outline how the data structures you consider would allow the simulation of various solutions to the traffic problems.

[11 marks]