PRIFYSGOL CYMRU; UNIVERSITY OF WALES

M.Sc. AND DIPLOMA EXAMINATIONS

JANUARY 2003

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
(Attempt 2 questions out of 3)

Question 1

a. Define the concepts of a **graph**, and a **binary tree** in terms of the operations that can be performed on them. Include in your answer details of all the arguments required for each operation, and the results of each operation. In what sense can a **binary tree** be considered to be a form of **graph**? Indicate how the operations you have defined for a **binary tree** could be implemented in terms of **graph** operations.

[12 marks]

b. Define the concepts of a **list**, a **stack**, and a **queue** in terms of the operations that can be performed on them. Include in your answer details of all the arguments required for each operation, and the results of each operation. How can **stack**s and **queue**s be viewed as special forms of **list**s? Indicate how the operations you have defined for a **list** can be used to implement the operations required for **stack**s and **queue**s.

[13 marks]

Question 2

a. Distinguish between the concepts of **static data storage** and **dynamic data storage** as used in a language like Delphi. Briefly explain how the concept of a stack can be applied in the management of both types of storage.

[5 marks]

b. Explain what you understand by the following:
reference counting, and
mark and release garbage collection algorithm.

Explain the advantages and disadvantages of using reference counting and a mark and release garbage collection algorithm. What other variations are possible? You do not need to give full algorithms, just briefly indicate the options available.
Why might you use a binary **buddy system of memory allocation**? What alternative approaches are there to managing memory allocation requests for records of differing sizes?

[7 marks]

c. Give outline descriptions (in pseudo-code) of how you could implement the following in the context of dynamic storage management:

i) Reference counting **[5 marks]**
ii) A mark and release garbage collection algorithm **[3 marks]**
iii) A binary buddy system of memory allocation **[5 marks]**

Question 3

a. Explain what you understand by the terms **hash function**, **collision**, **and clustering** in the context of a **hash table**. What are the advantages and disadvantages of using a **hash table** as opposed to other data structures (such as trees or sorted arrays) for storing information? What conditions have to be met to ensure that a **hash table** operates efficiently?

[7 marks]

b. Given the following declarations, and (complete) functions:-

```
const maxentries = 101;
type indexrange = 1..maxentries;
     hashrange = 1..(maxentries div 2);
     closedentry = record key : {what};
                          data : (ever}
                   end;
     openentry = record key : {what};
                        data : {ever};
                        next : ^openentry
                 end;
     closedtable = array[indexrange] of closedentry;
     opentable = array[indexrange] of openentry;

function firsthash(key : {what}):indexrange;
.....
function secondhash((key : {what}):hashrange;
.....
```

Briefly define procedures/functions to implement **collision resolution** in a Delphi style language for

i) A **hash table** implemented using **chaining**, and

ii) A **closed hash table** without chaining.

Why might the `firsthash` and `secondhash` functions be defined to return a different range of values?

[12 marks]

c. Discuss the relationship between **hash tables**, **index tables**, and **trees** when used to store data. How might they be combined?

[6 marks]