UNIVERSITY OF BIRMINGHAM

School of Computer Science

First Year – MSc Computer Science

06 21921

Fundamentals: Data Structures

Summer Examinations 2013

Time Allowed: 1:30 hours

[Answer THREE Questions out of four]

No Calculator

[Answer THREE Questions out of four]

1. (a) Define the following four notions –

data, **information**, **abstraction**, **abstract data type.** [10%]

(b) Give **two** possible levels of abstraction, each with a minimum of **two attributes**, for the following:

(i) bus station
(ii) your DVD collection
(iii) a Data Structures module for an MSc degree.

[18%]

(c) Describe **three** features necessary in a programming language to support data abstraction. [6%]

2. (a) Outline the abstract data type referred to as an **Index List**. [4%]

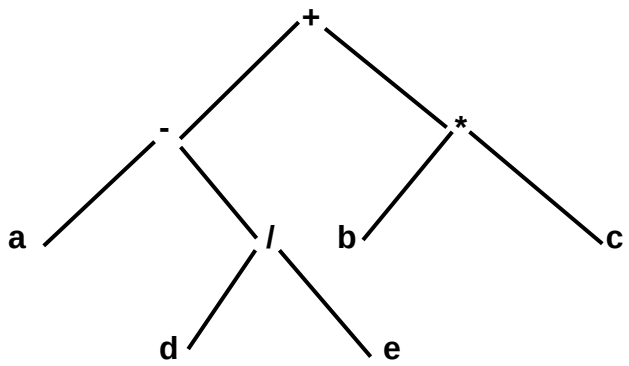
(b) Briefly define **three** distinct classes of an Index List data type. [12%]

(c) A large city hospital needs to produce its Staff Handbook in order of seniority of staff i.e. grouped by title in each Department, in the order Head of Department, Senior Consultants, Consultants, Surgeons, Resident Doctors, Matrons, Sisters, Nurses, auxiliaries, administrators, secretaries and clerks In the current computer system, the hospital already records the job title of each member of staff and the department in which they work.

Describe, using diagrams and/or a suitable notation, how an Index List may be used to solve the above requirements. [18%]

3. (a) A **Binary Tree** (BST) abstract data type can also be represented by a **Sequential Enumerated List** ADT (created by traversing the BST). Explain the properties that permit the generation of such a list from a BST. [6%]

(b) Construct a **Sequential Enumerated List** representation for the following Binary Tree:



[8%]

(c) Give **one** advantage and **one** disadvantage of a Sequential Enumerated List representation for a Binary Tree. [6%]

(d) A binary tree T has **eight** nodes. The symmetric order and pre-order traversals of T yield the following sequence of nodes:

Symmetric order traversal: C B D A F E H G
Pre-order traversal: A B C D E F G H

From the above traversals, draw the tree T and indicate briefly your approach to its construction. [14%]

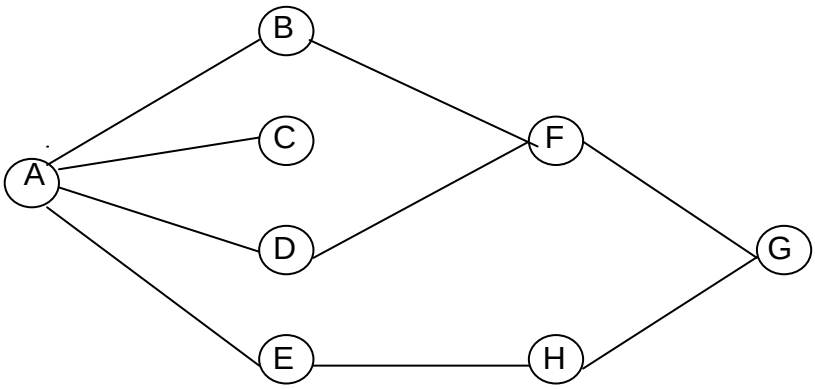
4. (a) Define the Abstract Data Type known as a **graph** and briefly describe **<u>two</u>** possible representations for such a data type. [6%]

(b) Outlined below is an algorithm for a **<u>depth first traversal</u>** (DFT) of a graph data type. Present an overview of how the algorithm works.

```
ALGORITHM DFT(s)
(* assumes the vector visited(n) corresponds to the n vertices of the
graph, each initialised to zero*)
BEGIN
   visited(s) set to 1
    FOR each vertex w adjacent to s DO
       IF visited(w) = 0
          THEN
               Add edge (s,w) to edge sequence
               DFT(w)
       ENDIF
END
```

[7%]

(c) Consider the algorithm in part (b) above and the following graph -



Starting at node A show two distinct sequences generated using the depth first traversal.

How could the algorithm and graph representation be changed so that only **<u>one</u>** unique sequence is generated? [10%]

(d) Using the definition of a graph **cycle** modify the depth-first algorithm given above to detect the presence of a cycle. Demonstrate its use by applying it to the graph shown in part c) above. [10%]