1. A binary search can be used to locate a data item in a sorted array. It does this by comparing the middle item of a list with the required input value. If the input is equal to the middle item the search stops, otherwise the half of the list which cannot contain the item is ignored by reassigning the current value for the top or bottom of the list.

For example, using the following:

```
newtype FRUITARRAY string array [1..7]
declare FRUIT is FRUITARRAY
declare BOTTOM, TOP, MIDDLE integer
declare INPUT_VALUE string
```

and initially:

```
BOTTOM = 1
TOP = 7
```

with

FRUIT	Apple	Banana	Grape	Grapefruit	Kiwi	Orange	Pear
	[1]	[2]	[3]	[4]	[5]	[6]	[7]

Then `MIDDLE = (TOP+BOTTOM) div 2 = 4.`

Since the item at location 4 (Grapefruit) is **not** equal to the input value (Kiwi) the search does not stop. Also, because Grapefruit is less than Kiwi, the input value cannot be in the lower half of the list, so `BOTTOM` is reassigned to `MIDDLE+1` and the search continues.

(a) Trace the remainder of the binary search, using a suitable layout. *[4 marks]*

(b) Construct the algorithm fragment to perform this binary search.
(Remember to give an error message if the item is not found or output 'Found' if item is located.) *[16 marks]*

(c) The binary search can be expressed as a recursive routine.

A call to such a routine could be `BSEARCH(FRUIT,BOTTOM,TOP).`

Construct the recursive algorithm that would carry out this call. No loop is used, instead the routine is used recursively with suitable parameters. *[10 marks]*

This question requires the use of the Case Study.

2. (a) State the type of network required to link the hospitals. *[1 mark]*

(b) (i) One method to collect data during the analysis stage is interviewing current users. State **two** other suitable methods of collecting data. *[2 marks]*

(ii) Outline **one** advantage of **each** of the three methods of collecting data. *[3 marks]*

(c) Outline **three** tasks, other than collecting data, that the systems analyst may have carried out whilst investigating the original system. *[6 marks]*

(d) Outline how a patient's data record can be sent from one hospital to another. *[2 marks]*

(e) Identify **two** security measures that are required to protect data records from physical hazards or unauthorised access. *[2 marks]*

(f) (i) Explain why the codes used in the shared file for drugs may be different to the ones previously used in a particular hospital. *[2 marks]*

(ii) Describe **one** problem that may occur as a result. *[2 marks]*

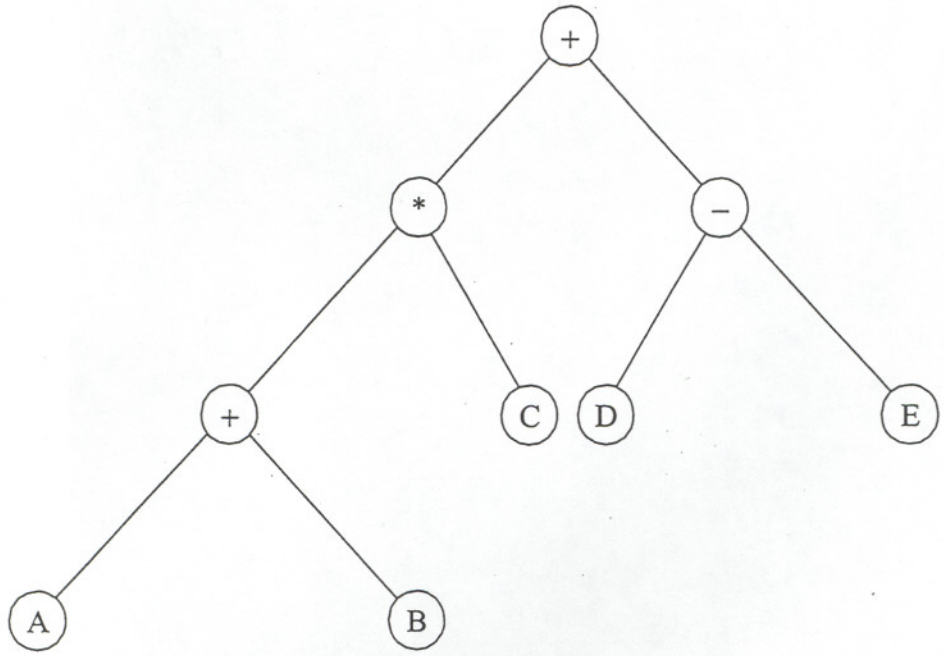
(g) The amount of money spent on the analysis and the new computer system for stock control would have been enough to extend facilities at one of the hospitals to allow 15 more beds.
Discuss whether the money was well spent. *[4 marks]*

(h) There are several different electronic communication systems between the hospitals. Explain why a van is needed to drive between the hospitals. *[2 marks]*

(i) One particular circuit within the monitoring system has inputs for heart rate (H) and respiration (R), where 1 indicates suitable input, and 0 indicates a problem. An output of a red heart shape (S) is displayed if there is a problem with the patient being monitored, where 1 indicates that the red heart shape is displayed. Deduce the truth table for this circuit, and identify its equivalent logic gate. *[4 marks]*

3. A tree can be used to store data relating to mathematical expressions.

For example,



There are three common methods of traversing a tree:

I. traverse left subtree, right subtree, root;

II. traverse root, left subtree, right subtree;

III. traverse left subtree, root, right subtree.

(a) Apply these three methods of traversal to the above tree and identify which result corresponds to post-order (Reverse Polish Notation). *[7 marks]*

A typical node in the tree is represented by the following data structure:

```
newtype NODE record
                VALUE character
                LEFT pointer → NODE
                RIGHT pointer → NODE
            endrecord
```

(b) (i) Explain why this is a dynamic data structure. *[2 marks]*

(ii) Construct the algorithm for the recursive procedure, `TRAVERSE`, to perform traversal I. *[6 marks]*

4. Two possible file organisations are *partially-indexed* and *fully-indexed*.

(a) For **one** of the file organisations given above, list the steps required to search for a record in the file.

(You may assume that the record being searched for is actually in the file, so no error conditions are required.) *[5 marks]*

(b) For **each** of the given file organisations, explain how to display the file in key value order. *[5 marks]*

(c) Describe why the retrieval of a record from a partially-indexed file is generally faster than when using a fully-indexed file. *[2 marks]*

(d) Suggest **one** reason why a fully-indexed file may be used for the drug file in the Case Study. *[3 marks]*

5. An advertisement for a new personal computer states that it has the following features:

- 128 MB RAM;
- 8 GB Hard disk;
- 256 kB Cache memory;
- 400 MHz Processor;
- 2 Serial and 2 Parallel Ports.

(a) State the function or purpose of **each** of the above features (RAM, Hard disk *etc.*). *[5 marks]*

(b) The values stated for each feature are higher than earlier machines. Explain why these higher values make this personal computer more useful than earlier machines. *[10 marks]*