Computer Science Department

1997 Examinations

D0a - MSc Basic Paper 1

Answer ALL questions

The use of Electronic Calculators is not permitted in this examination.

Q1 Answer parts a) **and** b) and **either** part c) **or** part d)

a) Study the function `mystery` below:

```
void mystery(int* a, int* b, int c){
    for (int i = 0; i < c; i++){
        int x = 0;
        for (int j = 0; j < c; j++){
            if (a[j] < a[i]){
                x += 1;
            }
        }
        b[x] = a[i];
    }
}
```

i) The following code snippet shows the declaration of two arrays and a call of the function `mystery`. What do the two arrays contain after the call to `mystery`?

```
int p[4];
p[0] = 3; p[1] = 2; p[2] = 0; p[3] = 1;
int q[4];
q[0] = 2; q[1] = 4; q[2] = 1; q[3] = 5;

mystery(p,q,4);
```

[3 marks]

ii) What do you think the purpose of the function is? There are certain kinds of parameters for which the function does not work correctly: describe these cases.

[3 marks]

iii) Write a function prototype for the function, renaming the function and its parameters with meaningful names. Put as many `'const'` modifiers for the parameters as is allowed. Write a short comment to go with the function prototype.

[3 marks]

[Question 1 continued over page]

[Question 1 continued]

b) Write a function `count_occurences' that takes two strings, and returns the number of times that the second string is contained in the first. For example, the call:

```
count_occurences("stop all the clocks", "all");
```

returns the value 1, and the call:

```
count_occurences("ababa","aba");
```

returns the value 2.

Minor errors in C++ syntax will not be penalised.

[8 marks]

Answer either question c) or question d)

c) *This is an alternative to question d)*

Novice programmers often find it hard to decide how to break up a program into functions. Suggest some guidelines to use in determining whether a piece of code should be made into a function.

[7 marks]

d) *This is an alternative to question c)*

Using global variables often seems convenient when trying to get code working in limited time. Why is the use of global variables seen as a bad thing despite this apparent convenience?

[7 marks]

Q.2 Answer any **two** of parts a) b) and c)

a) A computer has a colour "*bit-mapped*" display which is accessed directly across the bus. Describe the main components and operation of such a system. Your answer should explain the role of *pixels* and *video RAM* but should not concern itself with electrical details nor the physical operation of the Cathode Ray Tube (CRT).

[12 marks]

b) i) What is the meaning of "*relative addressing*" and what advantages does it confer?

[5 marks]

ii) Explain how relative addressing may be implemented as a special case of *indexed addressing*.

[3 marks]

iii) The M68000 processor employs "relative branch" instructions in which the offset is calculated from the address of the 16-bit word immediately following the op-code. In the program fragment below, given that `loop` and `end` correspond to addresses `0x40003000` and `0x40003014` respectively and that the 16-bit opcode for `bra` is `0x6000` what would be the encoding of the `bra` instruction below expressed in hexadecimal notation?

```
loop: ...
      ...
 end: bra loop
```

[4 marks]

[Question 2 continued overleaf]

[Question 2 continued]

c) *In this question you are asked to write a small program. This should be written in a representative assembly language. You will not be marked on the accuracy of your use of any particular language, however, you must restrict yourself to typical assembly language constructs and must make clear the meaning of any novel notations you introduce.*

A character string is stored as a byte-array of ASCII codes starting at location `0x40002000`. The string is terminated by a zero byte. Write an assembly language program to search the array for a character whose ASCII code is stored in register `D3`. The program should terminate with `1` stored in register `D0` if the character is present, `0` otherwise.

Q3. Answer any **two** of parts a) b) and c)

a) i) Explain the meaning of the following sentence: “The magnetic disc drive has 4 *surfaces*, 1000 *tracks* per surface and 50 *sectors* per track”.

[3 marks]

ii) The disc in i) has an average seek time of 10 ms and rotates at 6000 r.p.m. Estimate the average rotational latency and explain why it is beneficial to store all the data from a file in a single *cylinder*.

[4 marks]

iii) Briefly explain how a cache can be used to improve the performance of a disc system. What precautions are necessary when operating a cache with a removable disc system (such as a floppy disc drive)?

[5 marks]

[Question 3 continued overleaf]

[Question 3 continued]

b) i) Explain the following Operating Systems terms; *process*, *pre-emption*, *time-slice*.

[6 marks]

ii) Multiple processes running on a multi-processed, pre-emptive operating system all access a single resource. The code for each process includes the code fragment below which is intended to ensure that just one process may access the resource at any time. In this code `sleep()` is a system call which asks the operating system to suspend the current process until some other process executes a `wakeup()` system call.

```
while (flag == 0) {
     sleep();
}
flag = 1;
access_shared_resource();
flag = 0;
wakeup();
```

Explain why this code does not perform as intended.

[6 marks]

c) i) Define *virtual memory* and briefly outline how *paging* may be used to implement it. Your answer should make reference to the *page table*, *the memory management unit* (*MMU*) and *page faults*.

[6 marks]

ii) A MMU typically has a small amount of memory which operates as a *cache*. Explain how such a cache may improve the performance of the memory management system.

[3 marks]

iii) A paged *virtual memory* system offers a *32-bit address space* and uses 2048-byte pages. How many virtual pages would there be (expressed as a power of 2) and how many bits would be allocated to the page addresses?

[3 marks]

Q.4 Answer **either** part a) **or** part b) from **each** of the three sections A, B and C.

Section A: Answer either part a) or part b)

a) Consider the following specification of what a person should do on a Sunday.

If it is sunny then depending on whether it is humid or not, go swimming or, alternatively, sit in the garden.
If it is not sunny then do the following. If it is raining then, if it is windy then stay at home, otherwise go for a walk. Finally, if it is not raining then go shopping.

A decision tree is a tree representation of a decision table. Draw the decision tree for the above specification and briefly explain your notation. When is a decision tree a better representation than a decision table ?

[8 marks]

b) Assume that a student is a specialisation of a person, and is always taking at most one course. A person may have zero or more children. All persons have a name, an address, and are uniquely identified by their social security number. Students have, in addition, a unique student number and a provisional grade. All courses have a unique course title and a course director. A course director is also a specialisation of a person, and every director has a salary.
Draw an ERD to model the above scenario and briefly explain your notation.

[8 marks]

[Question 4 continued overleaf]

[Question 4 continued]

Section B: Answer either part a) or part b)

a) Evaluation methods

There is a number of methods available for conducing HCI evaluations. Briefly describe ANY TWO of the following methods and discuss the advantages and disadvantages associated them

(i) analytic evaluation;
(ii) HCI expert reports;
(iii) user reports;
(iv) observational evaluation.

[8 marks]

b) Physical context for human-computer interaction

Computers are operated in a variety of physical contexts (e.g. outdoors; in vehicles; in offices; in factories). Describe the main contextual factors that should be considered in the design and configuration of the user interface and workspace for ONE of the following:

(i) a computer-based voice-mail system in a large company with open-plan offices;
(ii) a hand-held computerised navigation aid for walkers and climbers.

[8 marks]

[Question 4 continued overleaf]

[Question 4 continued]

Section C: Answer either part a) or part b)

a) Briefly outline the major team structures, software lifecycle and system development process models and then briefly discuss the relationships between the various structures and process models.

[8 marks]

b) Briefly describe the Soft Systems Method (SSM). What are the aims and goals of applying the method?

[8 marks]

 END OF PAPER