



University  
of Glasgow

**Monday, 16th May 2011  
2.00pm – 4.00pm  
(Duration: 2 hours)**

**DEGREES OF MSci, MEng, BEng, BSc, MA and MA (Social Sciences)**

## **COMPUTING SCIENCE 1Q**

**(Answer all 4 questions.)**

**This examination paper is worth a total of 100 marks**

**(Use SEPARATE ANSWER BOOKS for sections A, B and C)**

**You must not leave the examination room within the first hour or the last half-hour of the examination.**

## Section A – Human Computer Interaction

1. (a) What is iterative design? Use a diagram in your answer. [5]
- (b) Prototyping can be split into low fidelity and high fidelity approaches. Explain and compare these approaches. In your answer, give at least one example of each approach. [9]
- (c) You have been asked to evaluate the interface to a new mobile phone application for runners and joggers, used with the phone strapped to the arm and earphones providing output. The interface will allow a user to use the phone's touch screen to enter commands in the form of gestures, and the phone will then give the required information to the runner. For example, a runner might gesture a '?' on the screen, and phone will give basic statistics such as the length of the run so far and average speed.
- Choose an evaluation technique and describe how you would use it to assess the effectiveness of the application, and what potential problems or dangers you might face in running your evaluation. [11]

## Section B – Information Management

2. (a) Draw an Entity-Relationship diagram for the following scenario, indicate clearly all primary keys and the cardinality and totality of all relationships.

Academic staff have unique identification numbers, a surname and title. Students have a unique matric number, a surname and firstname. All students have an academic staff member as their advisor. Some academic staff advise several students and some academic staff advise no students. Some students work in a shop and some work in a pub. Several students may work in the same shop, but not in the same pub. Pubs and shops may be close to each other, in which case the distance between them is recorded. Each member of academic staff buys food from a single shop, but they don't necessarily all shop at the same venue.

[11]

- (b) Assume there is a relational database that implements part of the scenario above, with three tables as follows:

Student = (Surname:Text, Firstname:Text, Matricno:Text, Worksh:Text)

Staff = (Surname:Text, Fname:Text, Staff-id:Text, Title:Text, Shopping: Text)

Shop = (Name:Text)

Assume that underlined attributes are primary keys and Worksh and Shopping are foreign keys referring to the Name attribute of Shop.

- (i) Write an SQL query that returns the surnames of academic staff who buy their food at "Tesco".

[2]

- (ii) Write an SQL query that returns the firstnames and surnames of students who work in a shop where Dr Gay buys his food.

[4]

(c) Given the following sets:  $A=\{1,3,7,9\}$ ,  $B = \{1,4,6\}$ ,  $C=\{7,9\}$

give the following. Assume that  $\wp$  is the powerset operator.

(i)  $|B|$

(ii)  $\wp(B)$

(iii)  $|\wp(C)|$

(iv)  $B \times C$

(v)  $A \cup B$

(vi)  $A \cap C$

(vii)  $A - C$

(viii) Which of the following are true

a.  $C \subseteq A$

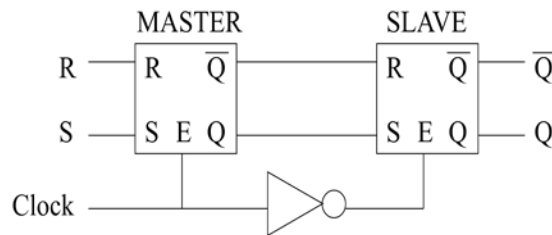
b.  $C \subseteq B$

c.  $\langle 1,6 \rangle \in A \times B$

[8]

## Section C: Systems (Section C includes questions 3 and 4)

3. (a) Modern digital computers are based on the use of binary arithmetic. Give two reasons why the binary system of representing numbers is used. [2]
- (b) Given a decimal number  $D$  explain how to determine how many binary digits  $N$  are required to represent  $D$ . Illustrate your answer by explaining how many bits are needed to represent 257 [2]
- (c) The following circuit schematic implements a Set-Reset flop, explain the operation of this circuit.



- (d) The two's complement representation for negative binary numbers was devised to allow ordinary binary arithmetic operations to work correctly when performing calculations involving both positive and negative binary numbers. Explain how to compute the two's complement of a 3 bit binary word, stating the range of positive and negative values that can be represented using only a 3 bit word. [4]
- (e) You are required to design a circuit which will perform the two's complement operation you defined in question (d) on an input 3 bit word  $xyz$ , and output a 3 bit word  $abc$  containing the results of this operation.
- Draw a truth table which shows  $a, b, c$  as functions of  $x, y, z$ . [4]
  - Draw a Karnaugh map for each of  $a, b, c$ . [3]
  - Use the Karnaugh maps to work out formulae for  $a, b$  and  $c$  in terms of  $x, y$  and  $z$ , and simplify these as far as you can. [3]
  - Consider the truth table you constructed for the two's complement operation you defined in (d) applied to a 3 bit word. What anomaly do you notice and why is this so? [2]
  - Draw a circuit schematic that given an input  $xyz$  representing a 3 bit word, implements the equations you derived in section (iv) above to produce a 3bit output word  $abc$ . [3]

**4. (a)**

- (i) Explain what is a compiler, what it does and suggest two circumstances that would instead require a cross-compiler to be used.

[4]

- (ii) A C compiler is available, running on an X86 computer, that translates C source statements into machine codes that can execute on an ARM architecture machine and this compiler has also been coded in C. Explain how to migrate this C compiler to execute on an ARM architecture machine.

[2]

- (iii) Considering your answers to questions (i) & (ii) above, explain why it is a good idea to implement a compiler in the same language that it is intended to compile.

[4]

- (b) Currently many Internet Service Providers are offering increasingly higher bandwidth products. Write a brief report explaining why such claimed raw bandwidth does not always translate into proportionally increased network access speeds for the home computer user.

[15]