



University
of Glasgow

Wednesday 1 May 2013
2.00 pm – 4.00 pm
(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.

THE USE OF CALCULATORS IS NOT PERMITTED IN THIS EXAMINATION

INSTRUCTIONS TO INVIGILATORS

Please collect all exam question papers and exam answer scripts and retain for school to collect. Candidates must not remove exam question papers.

Section A: Information Management

1. (a)

(i) What is a database management system (DBMS)? [1]

(ii) What are the four key functions of a database management system (DBMS)? [4]

(iii) Why is it important for a database management system to control concurrent access to a database? [2]

(b)

(i) Please describe briefly with examples what is meant by each of the following terms in the context of Entity Relationship models:

- Entity
- Relationship
- Attribute

[3]

(ii) Using Entity-Relationship Modeling illustrate the following:

- Books have a title, author and unique ISBN number.
- Libraries have a location and Institution code (INST-ID).
- Libraries contain many books and any book can belong to one or more libraries.

[5]

(c)

- (i) S is the set { e, f } and T is the set { 4, 5, 7 }.

Write down the Cartesian product $S \times T$.

[1]

- (ii) If $U = \text{Footballers}$, P stands for 'Spanish' and Q stands for 'plays in the English Premier League', give the set builder notation for the set of all footballers who are Spanish AND play in the English Premier League.

[1]

- (iii) List the powerset for the following set: { 1,2,4 }

[1]

- (iv) List the elements in the relation R from $A = \{1,2,6\}$ to $B = \{1,5\}$ where $\langle x,y \rangle \in R$ if and only if $x \geq y$.

[1]

(d)

- (i) What is SQL and what is it used for?

[2]

- (ii) Employee and Department are two tables in a relational database.

Employee (Name, NI-Number, Email, Phone-No, Works_In)
Department (Name, Code, Building)

The attribute **Works_In** is a foreign key in Employee relating to the primary key **Code** in Department.

Express the SQL required to extract the names of all the employees of the "Accounts" department.

[4]

Section B: Human Computer Interaction

2. (a)

- (i) Within the context of HCI, what is meant by the user's mental model?

[2]

- (ii) Briefly describe both Norman's concept of the Gulf of Evaluation and the Gulf of Execution, and how these relate to the notion of the user's mental model.

[4]

(b)

- (i) Within the iterative design cycle for the development of interactive systems, a key stage is determining requirements. Define, with an example for each, both *functional* and *non-functional* requirements.

[4]

- (ii) Prototyping can be a good iterative design tool when developing an interactive product. Prototyping is often split into *low fidelity* and *high fidelity* approaches. Explain low and high fidelity approaches to prototyping and use examples to compare their advantages and disadvantages.

[4]

- (c) A client has asked your company 'Spaghetti Code Design' to help them create a new smartphone app that would allow people to track their health and fitness on the phone.

A previous team have already carried out requirements capture. They have specified that the app should allow users to log when they visit the gym, how long they exercise for, and what type of exercise they do. The users surveyed also wanted the GPS functionality of the phone to allow them to track their running routes. Some people said they wanted graphs and images of their fitness levels and progress to motivate them to keep going.

The client said that they want the app to be functional and usable but also that they want to know that they are providing a rich user experience. They have two prototype apps to try out but want you to evaluate these properly with potential users before they decide which one to take forward to full development.

Write a short technical report detailing how you would propose to evaluate the mobile phone 'fitness' app. Include details of the methods you would use and the data you would gather to demonstrate both the usability and user experience of the product.

[11]

Section C: Systems

3. (a) Describe how to compute the 2s complement representation for a negative binary number and list what advantages the 2s complement representation has over the sign-magnitude representation for negative binary integers. [3]
- (b) With the aid of a diagram describe the main components of a basic computer and their interconnection. [4]
- (c) Explain, by giving examples, the concept of *parity* when describing a binary number comprising a fixed number of bits, e.g. 4 bits, and suggest where the concept of parity checking might be useful in computer systems. [3]
- (d) You are required to design an encryption circuit which, given an input xyz representing a 3 bit binary number n , produces a pseudo-random output abc mapped from the following list: 101, 011, 000, 110, 001, 100, 111, 010. For example, if the input is 110 ($x = 1, y = 1, z = 0$), representing $n = 6$, then the output is 111, representing 7. If the input is 000 then the output is 101.
- (i) Draw a truth table which shows a, b, c as functions of x, y, z . [3]
- (ii) Draw a Karnaugh map for each of a, b, c . [3]
- (iii) Use the Karnaugh maps to work out formulae for a, b and c in terms of x, y and z . [3]
- (iv) Draw a diagram of the circuit which calculates a, b and c from x, y and z . [3]
- (v) Explain how to implement the circuit in part (iv) such that the random mapping could potentially be updated rather than being fixed and draw an outline circuit to support your explanation. [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]

- (b) Explain, the difference between multi-tasking and parallel processing and how these concepts relate to each other.

[5]

- (c) Explain the concept of *interrupts* and how these are used within operating systems, for example to implement multi-tasking.

[4]

- (d) Explain why there isn't a central database which stores the IP address for each domain name in the internet, and briefly describe how this information is actually stored and accessed.

[6]

- (e) “Cloud”-based computing is becoming popular where storage servers contain a user’s data, which is then accessible via the Internet. Give two potential advantages and two potential disadvantages of the cloud-based approach.

[4]