University of Glasgow

May 2015

(Duration: 2 hours)

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

COMPUTING SCIENCE 1Q

ANSWER ALL 4 QUESTIONS

(Use separate answer books for section A and B and C)

This examination paper is worth a total of 100 marks

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 – Human Computer Interaction

1. **a)** In the context of interactive systems design, explain the following terms:

(i) Containment hierarchy

[2]

(ii) Field studies

[2]

(iii) The serif hypothesis

[2]

(iv) Distributed cognition

[2]

(v) Low fidelity prototype

[2]

b) Event-driven programming is a better paradigm for interactive systems design than command-driven programming. Why?

[4]

c) Trainline.com is a web site that gives train timetable information and sells train tickets. It wishes to improve its web site, so as to better serve the train travellers' needs and interests, and to increase its revenues, by using A/B testing. Explain what A/B testing is, and describe how you could use it to achieve Trainline's aims.

[11]

Section B – Information Management

2. **(a)** Provide short descriptions of any **three** of the following terms. Use examples and/or diagrams to illustrate your answers.

(i) The union set operator (provide an example of usage and a Venn diagram).

(ii) The difference between conceptual and implementation models for a database.

(iii) Weak entities in an ER diagram

(iv) A many-to-many relationship in an ER diagram.

(v) The degree and cardinality of a relation.

(vi) A foreign key in the context of a relational database

(vii) The projection and selection operations in relational algebra

[9]

b) A dental practice keeps data on its dentists and patients. A patient has a unique code and name, and may be a dependent of another patient. Each dentist also has a unique code, a name and a status (part-time or full-time). Each patient must be registered with a single dentist. An appointment is when a single patient meets a dentist at a given date & time (not necessarily the patient's own registered dentist). Appointments also have durations and appointment types (checkup, operation).

Draw an ER diagram that could be used in the development of a database to support the dental practice.

[7]

c) Assume a relational database with two tables, as follows:

Staff(NI_Num, Firstname, Surname, PartTime, Dept)

Department(DeptNo, Name, Building)

Building(BuildingId, StreetNum, StreetAddress, City)

where Staff.Dept is a foreign key reference to Department.DeptNo and Department.Building is a foreign key reference to Buidling.BuildingId.

(i) Write a relational algebra expression to find the surnames of all staff who work in department 5.

[1]

(ii) Write the SQL query to find the names of the departments based in Glasgow city.

[2]

(iii) Write the SQL query to find how many part time staff work in each department number.

[2]

d) Given the following sets:

$A = \{1,4,5\}$ $B = \{a,e\}$

give the following sets. Assume that $\square$ is the Cartesian product.

(i) $|A|$

(ii) $A \square B$

(iii) $A \cup B$

(iv) $\{<x,y> \mid x \in A \bigwedge y \in A \bigwedge x<y\}$

[4]

Section C – Systems

3. **(a)** Convert 1101 1010 to a decimal number, assuming binary representation.

[2]

(b) Convert 1101 1010 to a decimal number, assuming two's complement representation.

[3]

(c) Translate the following program fragment into assembly language for Sigma16. You may assume that the variables have been declared with data statements; just write the instructions needed.

```
if x<y
   then  a = a + 3
   else  b = a - b
```

[10]

(d) Suppose `x` is an array containing `n` integers, where `n` is an integer variable in memory. There is another integer variable `const`. Write a loop in Sigma16 assembly language that adds `const` to every element of the array. You may assume that the variables `n` and `const`, and the array `x` have been declared; just write the necessary instructions.

[10]

4. **(a)** Define the behavior of a multiplexer (the mux1 circuit), given control input c and data inputs a and b. Give a circuit that implements a multiplexer using logic gates.

[4]

(b) State what the behavior of a delay flip flop (dff) is. Explain what would happen in a synchronous circuit containing delay flip flops if the clock runs too fast.

[5]

(c) Define the term *process*. Explain the difference between *non-preemptive* process scheduling and *preemptive* process scheduling. Give two advantages of preemptive process scheduling.

[8]

(d) State the primary function of the TCP protocol and the IP protocol. Describe two kinds of transmission error that TCP can detect and correct.

[8]