University of Glasgow

Friday, 5 May 2017
2.00 pm – 4.00 pm am
(Duration: 2 hours)

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

Computing Science 1Q

(Answer All Questions)

This examination paper is worth a total of 100 marks

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

The use of a calculator 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 25 Marks

1. (a) Provide descriptions of any THREE of the following terms. You MUST use examples and/or diagrams to illustrate your answers.

[9]

(i) The grouping SQL design pattern.

(ii) The Relational Algebra ⋈ operation.

(iii) The degree and cardinality of a relation.

(iv) A foreign key and its role in a relational database.

(v) A NATURAL JOIN in SQL

(b) An advertising agency has many staff (with unique staff#, forename & surname), which can be either designers or account managers. Each member of staff also has a line manager. Each account manager is entitled to an annual bonus.

Each of the agency's client companies (with a name, and an address consisting of street, city and postcode) must be assigned to an account manager. When a client company requests an advertising campaign, they specify a maximum budget, and the agency assigns designers to the project. Clients only run one campaign per month, but designers can work on many campaigns.

Draw the ER diagram that describes this scenario. You may assume that the names of client companies are unique.

[7]

(c) Employee, Office & Building are three tables in a relational database.

Employee (EmployeeName, NI-Number, Email, Phone-No, OfficeBuilding, OfficeNumber)
Office (Building, RoomNumber, Capacity)
Building(Name, Address, PostCode)

The attributes OfficeBuilding, OfficeNumber in the Employee relation are foreign key references to the primary key of the Office table; Building is a foreign key reference to the primary key of the Building table.

(i) Express in **relational algebra** a query to obtain the names of all employees working in the SAWB building.

[1]

(ii) Express in SQL a query to obtain the full address (name, room number, building name, address, postcode) of the employee named "Jim Harkness".

[3]

(iii) Assuming that each telephone number corresponds to one telephone, express in SQL a query to provide a list with the number of phones in each office of the "SAWB building", along with the capacity of the room. Your query should return the following attributes: building name, room number, number of telephones, and room capacity.

[3]

(d)

(i) If S = {x,y} and T = {0,2,7}, list the elements of the Cartesian product of the two sets S and T.

[1]

(ii) Express as a Venn diagram the intersection of sets A and B.

[1]

Section B – Human Computer Interaction 25 marks

2. (a) This question is about *quantitative evaluation techniques*. You have recently completed an evaluation of a student record management system that allows users to input and manage student records. You have collected a dataset that includes the task times for entering data into the system for twenty participants.

(i) You selected your participants from a pool of administrators who are likely to use the system. What is this kind of selection called?

[2]

(ii) What type of quantitative data have you collected?

[2]

(iii) Your analysis shows that the data is normally distributed. With respect to the mean and standard deviation, what does this say about your data?

[4]

(b) This question is about implementing user interfaces.

(i) Being able to control interfaces is crucial for successful interaction. What is required to enable control, and why is this important?

[4]

(ii) Continuous actions by a user need to be translated into discrete actions. How can this be achieved?

[2]

(iii) Give an example of an interface that translates continuous action into discrete action, including the actions performed by a user, the signal that is generated, and how the signal is analysed.

[5]

(c) This question is about qualitative evaluation techniques.

(i) How would you complete a semi-structured interview as part of a user study?

[2]

(ii) Describe how you would analyse the results of a semi-structured interview using qualitative analysis techniques.

[4]

Section C – Systems 50 Marks

3. (a) Convert 1001 0110 to a decimal number, assuming binary representation.

[2]

(b) Convert 1001 0110 to a decimal number, assuming two's complement representation.

[3]

(c) Translate the statement `a = b + x[i]` into Sigma16 assembly language, assuming that `a`, `b`, and `i` are integer variables and `x` is an array. You do not need to write data statements to define the variables or the array.

[4]

(d) Show the sequence of steps performed by the processor as it executes the instruction `load R2,x[R1]`.

[4]

(e) There is an array named `x` that contains `n` integers, where `n` is an integer variable in memory. Write a Sigma16 assembly language program that calculates the sum of the positive elements of the array (i.e. the elements that are greater than 0) and stores this sum in the variable `SumPos`. The program should define `n = 6` and define the initial elements of the array as 6, -9, 7, 4, -1, 2. After the program runs the variable `SumPos` should have the value 19. The program must work correctly for any nonnegative `n` and initial array elements.

[12]

4. **(a)** Give the circuit design for a multiplexer (the mux1 circuit). You may give either a diagram or an equation describing the circuit. The circuit takes inputs `c`, `x`, `y` and produces output `z`, where `z = (if c=0 then x else y)`. Use Boolean algebra to show that if `c=1` then `z=y`.

[5]

(b) Explain why the speed of a synchronous circuit depends on the longest path through logic gates. Describe how a suitable clock speed for the circuit is determined, and explain what can happen if the clock speed is too fast.

[5]

(c) Define the terms *interrupt* and *process*. Describe how the operating system uses interrupts to implement concurrent processes.

[5]

(d) Define the terms *circuit switching* and *packet switching*, and state which technique is used in the Internet. Give two advantages of using packet switching.

[5]

(e) Give two services provided by the TCP protocol in the Internet, and describe how TCP recovers from errors. Explain what the IP protocol does.

[5]