University of Glasgow

Friday 4 May 2018
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 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) Controlled concurrent access.

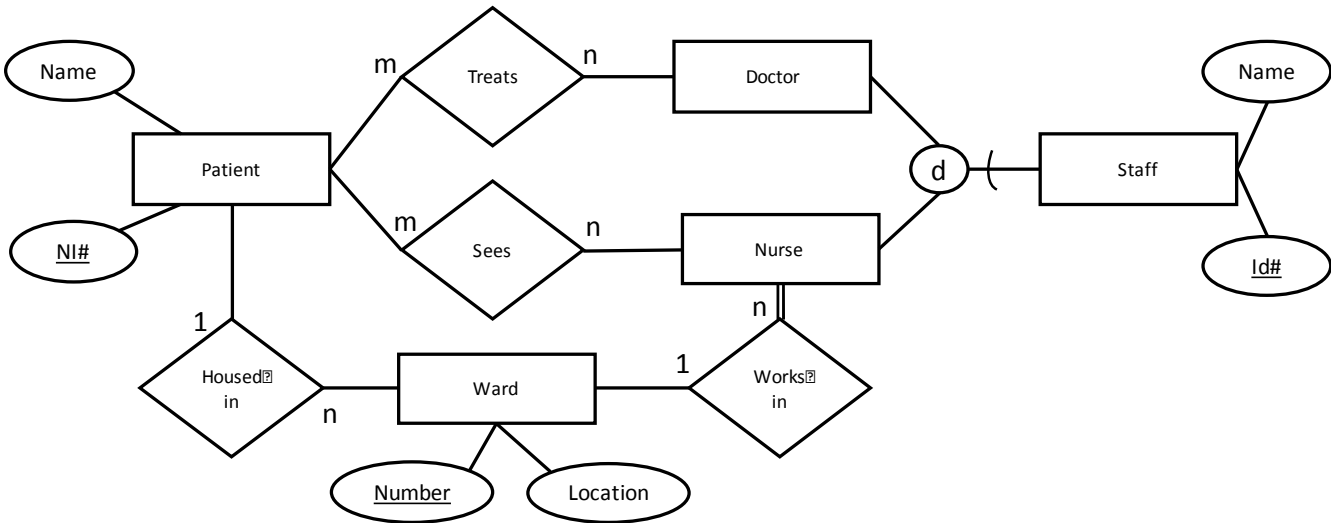
(ii) The Relational Algebra ⋈ operation.

(iii) The cardinality of a relationship in an ER diagram.

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

(v) Weak entities in an ER diagram, and how they are mapped into a relation schema.

(b) Consider the undernoted ER diagram for a hospital.



Define the corresponding relational schema for this ER diagram, stating for each relation the attributes, and the primary key(s). You must also clearly state which attributes are foreign keys, and to which relations & attributes they refer, and if any are mandatory.

[7]

(c)

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

```
Customer = (Name, Customer_No, Flight_Booked)

Flight = (Flight_Code, Destination, Date, Cost)
```

where the `Flight_Booked` attribute in `Customer` is a foreign key referring to the `Flight_Code` attribute of `Flight`.

(ii) Write an SQL query that will return the Name of all Customers that are booked on the Flight DB123 to Las Vegas.

[3]

(iii) Write an SQL query that will return how many customers were on each of the flights from London to Glasgow on 3/10/2017?

[4]

(d)

(i) Consider relations S & T with the follow schema: S(A,B) T(B,C) If S = {<a,1>, <b,2> } and T = { <2,x>} list the elements of the natural join of the two relations S and T.

[1]

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

[1]

Section B – Human Computer Interaction 25 Marks

2. This question is about quantitative and qualitative evaluation techniques for user studies.

(a) Give an example of a quantitative metric you could use to evaluate the usability of a data entry task using a graphical database interface.

[2]

(b) For your chosen example, what data would you collect?

[4]

(c) Describe what is meant by the usability heuristic "help users recognize, diagnose, and recover from errors" and give an example of this in the context of a graphical database interface.

[4]

(d) How would you run a heuristic evaluation to understand the usability problems in a graphical database interface?

[4]

(e) Your evaluation of the graphical database interface includes rating scale questions about users' experience with the interface. What metrics would you use to describe this data?

[2]

(f) Describe how you would complete a structured interview.

[2]

(g) Give two examples of ways that bias can be introduced during data collection and/or analysis during user evaluations.

[4]

(h) Describe what is meant by informed consent and discuss why this is important for ethical user evaluation.

[3]

Section C – Systems 50 Marks

3. **(a)** Convert 1010 0010 to a decimal number, assuming binary representation.

[2]

(b) Convert 1010 0010 to a decimal number, assuming two's complement representation.

[3]

(c) Translate the statement `a := b - c*d` into Sigma16 assembly language, assuming that a, b, c, d are signed integer variables. You do not need to write a complete program, and you don't need to write data statements for the variables. Just translate this one statement.

[5]

(d) Translate the following high level language program fragment into low level language. The variables sum, i and n are signed integers, and x is an array of signed integers containing n elements. You do not need to define the variables or array, just translate the program code. (The low level language contains assignment statements, goto statements, and statements of the form if b then goto label, where b is a Boolean expression.)

```
sum := 0
i := 0
while i < n && x[i] > 0 do
   sum := sum + x[i]
   i := i + 1
```

[5]

(e) Translate the program in part (d) into a complete program in Sigma16 assembly language. Use data statements to define the following initial values: n = 4, x[0] = 7, x[1] = 2, x[2] = 0, x[3] = 5. What is the value of sum when the program terminates?

[10]

4. **(a)** Give the truth tables for the following logic gates: and2, or2, xor2.

[3]

(b) Design a circuit that takes two inputs a and b, and produces one output x, which is 1 if the two inputs have the same value, as shown in the truth table. Implement the circuit using any of the standard logic gates (inv, and2, or2, xor2). You may specify the circuit using any of the following notations (just use one): a schematic diagram, Boolean algebra, or Hydra notation.

a	b	x
0	0	1
0	1	0
1	0	0
1	1	1

[3]

(c) Explain the purpose of the clock in a synchronous circuit. Describe how a suitable clock speed for the circuit is determined.

[4]

(d) The following program determines the sum of the elements and the number of elements in a linked list, given a pointer p to the head of the list. Each node is a record consisting of two words: the first word "value" is an integer, and the second word "next" is a pointer to the rest of the list. The last node in the list has nil in the next field (nil is represented by 0). Translate the program to Sigma16 assembly language. You don't need to write out the low level language version, and you don't need to define the variables or the linked list.

```
; given p = pointer to list
length := 0
sum := 0
while p /= nil do
   length := length + 1
   sum := sum + (*p).value
   p := (*p).next
```

[10]

(e) State what the processor does when an interrupt occurs**.** Give two advantages of using interrupts to catch errors (such as overflow or division by zero) rather than using instructions to test explicitly for the error.

[5]