A LEVEL COMPUTER SCIENCE

COMPONENT 2

Computer Architecture, Data, Communication and Applications

SPECIMEN PAPER

2 hours 45 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a 16 page answer book.

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the separate answer book provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question; you are advised to divide your time accordingly.

The total number of marks is 100.

You are reminded of the need for good English and orderly, clear presentation in your answers.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

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Answer all questions

1. (a) In a certain computer, integers are stored using sign and magnitude representation and 16 binary digits. The left hand bit is set to zero for a positive number.

Find the integer represented by the binary number 1000000000001001   [1]

(b) In another computer, integers are stored using two's complement representation. Explain, using an example, how the two's complement of a binary number is derived.   [2]

(c) In another computer, real numbers are stored in floating point form using 20 bits as shown below:

Mantissa	Exponent
(16 bits in two's complement form. The binary point in the mantissa is immediately after the left bit.)	(4 bits in two's complement form)

Convert the number 22.75 to this floating point form.   [2]

(d) Evaluate the benefits and drawbacks of floating point form compared with integer form.   [2]

2. (a) Explain the sequence of operations which will occur during the fetch phase of the fetch execute cycle, making clear the role of the PC (program counter), the MAR (memory address register) and the MDR (memory data register).   [3]

(b) A simple computer has a number of 16 bit registers. Its assembly language set includes the following:

LOAD R,X   loads register R with the contents of address X
STOR R,X   stores contents of register R in address X
XORR R1,R2   executes a bit-wise XOR operation on the contents of
                       register R1 and R2, storing the results in register R1

Explain what the following fragment of code does, by showing the content of registers and addresses at each step. Make clear the contents of register 1 when the fragment has finished execution.

Assume that the address d1 initially contains 1001 0110 1110 1100
Assume that the address d2 initially contains 1110 1011 1010 0011

LOAD 1,d1
LOAD 2,d2
XORR 1,2
STOR 1,d3
XORR 1,2   [4]

3. *(a)* Explain the term foreign key as used in a relational database system. [2]

(b) If a database is already in second normal form, describe the step necessary to ensure that it is in third normal form. [1]

(c) Two tables have already been created in a database using SQL commands.

They are:

STUDENTS

StuNum	StuName	DateBirth	TutNum
12675	Brown	02-Nov-96	307
13670	Abbakari	01-Jun-95	378
13777	Walker	23-Oct-95	307
14156	Pang	29-Feb-96	307
14238	Hartford	18-Jan-95	378

TUTORS

TutNum	TutName	RoomNum
307	Harris	106
345	Lester	113
378	Suleiman	113

(i) Write an SQL command to output the names and tutor numbers of all the students. [1]

(ii) Write an SQL command to output the names of students who have the tutor with number 378. [1]

(iii) Write an SQL command to change the tutor number of all those students whose tutor number is currently 378. Their new tutor number should be 345. [2]

(iv) Write an SQL command to output the names of all students who have the same tutor as student 13777. [2]

(v) Write an SQL command to output the names of all the students and their tutors' names. [2]

(vi) Write an SQL command to create a new table PHONES to contain the telephone number for each room (Assume there is only one telephone per room) [2]

(vii) Write an SQL command to enter the following data into the table you have created in part (vi): room 106 should have telephone number 625 and room 113 should have telephone number 670. [2]

(viii) Write an SQL command which will output the names of the students and their dates of birth in descending age order. [2]

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4. *(a)* Access to computer files may be sequential or indexed sequential.

Compare these two types of access. [5]

(b) Computer files may also allow direct (random) access.

(i) A certain random access file system uses a hashing algorithm. The key field in this case is an integer in the range 001 to 999. The hashing algorithm operates by:

- squaring the key field, resulting in a six digit number with zeroes added to the left if necessary
- taking the middle two digits of these six digits

Calculate the output of this hashing algorithm for a key field of value 123 [1]

Calculate the output of this hashing algorithm for a key field of value 223 [1]

(ii) Another hashing algorithm operates on the same data by:

- squaring the key field, resulting in a six digit number with zeroes added to the left if necessary
- taking the right hand two digits of these six digits

Calculate the output of this hashing algorithm for a key field of value 123 [1]

Calculate the output of this hashing algorithm for a key field of value 223 [1]

(iii) Discuss these two hashing algorithms [2]

5.   The following algorithm fragment is not suitable for parallel processing:

………..
set a = b * c
set d = a * e
set f = a + d
………..

Write an algorithm fragment which is suitable for parallel processing, to gain both marks, your fragment should demonstrate at least three calculations which can be carried out in parallel.   [2]

6.   *(a)*   Define simplex, half duplex and full duplex data transmission.   [3]

       (b)   Explain what is meant by a data collision on a network. Describe what should happen when this occurs.   [3]

7.   *(a)*   (i)   Calculate the effect of carrying out an arithmetic shift left by two places on the eight-bit positive integer 00001111 and state the effect of this operation on the number.   [2]

               (ii)   If an arithmetic shift left by two places was carried out on an eight-bit register containing the positive integer 01001111, a problem would arise. Describe the problem and how it can be rectified.   [2]

       (b)   Explain, using an example, why hexadecimal notation is often used to represent binary numbers.   [2]

8. *(a)* An estate agent has branches in many towns. It uses a distributed database. Describe why the estate agent might wish to use a distributed database and describe one difficulty that the estate agent will experience in using a distributed database. State what is actually distributed in a distributed database. [3]

    (b) Explain the term Big Data. [1]

    (c) A supermarket chain uses data mining techniques on data gathered from its customer loyalty card scheme. Explain what is meant by data mining in this instance and evaluate the benefits of this system to the supermarket. [4]

9. *(a)* Compare two different types of real-time operating system, giving an example of an application which would use this type of operating system, in each case. [6]

    (b) Describe the functions carried out by a multiprogramming system. [4]

    (c) A multiprogramming operating system is carrying out a low priority task. During the execution of the low priority task a high priority interrupt is generated immediately followed by a medium priority interrupt.

    Explain how the operating system would deal with this situation. [4]

10. *England and World Carriers* employs a number of drivers for its vehicles. Each driver is based at just one depot (for instance Avonmouth or Sheffield) and each depot has a full address, telephone number and a supervisor. Each driver has an ID number, name and home address, and is based at just one depot. Each vehicle has a registration number, make and model, and is also based at just one depot. Each supervisor (who may be the supervisor for more than one depot) has an ID number and a home address.

    A database is required by *England and World Carriers* to store the data required.

    (a) Design an entity-relationship diagram to illustrate the above situation. [3]

    (b) Design a database for the above situation in third normal form. [6]

11. When designing a major computer-based control system in a large safety critical system, the designers need to consider both operational and safety issues. There is a particular concern over possible malicious attacks on the computer system.

    Discuss the general issues related to safety critical control systems of this type and discuss approaches that can be adopted to ensure system security.

    You should draw on your knowledge, skills and understanding from a number of areas across your Computer Science course when answering this question. [13]

End of Paper