GCE A LEVEL

A500U20-1

TUESDAY, 13 OCTOBER 2020 – AFTERNOON

COMPUTER SCIENCE – A level component 2
Computer Architecture, Data, Communication and Applications

2 hours 45 minutes

ADDITIONAL MATERIALS

A WJEC pink 16-page answer booklet.

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the separate answer booklet 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 available is 100.

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

Answer all questions.

1. A supermarket with a number of checkout terminals uses a computerised stock control system to monitor the quantities of products in stock and identify items which need to be reordered.

    (a) The supermarket's system uses real time transaction processing. Explain how the stock control system would operate. [4]

    (b) Only one terminal/checkout can update a stock record at a time. Identify the potential problem if customers purchase items with the same stock code at different checkouts at the same time and describe a possible solution to this problem. [3]

2. A theatre uses a database to record customer bookings. Example records are shown in the table:

Booking ID	Production	Performance	Seats	CustomerName
1001	Les Miserables	18 August, 7.00pm	C12, C13	John Edwards
1002	The Lion King	22 August, 7.00pm	D06, D07, D08	John Edwards
1003	Les Miserables	18 August, 2.00pm	G22	Kim Wong

This database is not in normal form and problems occur when searching the data.

A customer can make many bookings and can specify which seats are required. Many performances of a production can occur.

    (a) Produce an entity-relationship diagram for the theatre booking database in third normal form. [4]

    (b) Design a structure for the theatre booking database clearly identifying all primary and foreign key fields required. [4]

3. The temperature of a tank of liquid in a factory should not exceed 65 °C. A microprocessor receives readings from an electronic thermometer in the tank and activates a warning light if the temperature is too high.

An assembly language program is required to operate the warning light, using the algorithm:

LOOP continuously

    INPUT temperature

    SUBTRACT **65** from temperature

    IF the result is more than zero THEN

        OUTPUT numeric value **1** to activate the warning light

    ELSE

        OUTPUT numeric value **0** to deactivate the warning light

END LOOP

The assembly language used by the microprocessor has an instruction set which includes the following commands:

Assembly Language Command	Description
IN	Input a temperature from the thermometer and store in the accumulator
OUT X	Output a numeric value X to the warning light
ADD Y	Add the numeric value Y to the accumulator, leaving the result in the accumulator
SUB Y	Subtract the numeric value Y from the accumulator, leaving the result in the accumulator
JPOS LABEL	Jump to LABEL if the contents of the accumulator are greater than zero
JNEG LABEL	Jump to LABEL if the contents of the accumulator are less than zero
JMP LABEL	Jump unconditionally to LABEL

Using the algorithm and the instruction set write a program to control the warning system. You may not need to use every command in the instruction set. [6]

4. A running club keeps member records in a database:

Member

MemberID	Name	Address	MemberClass
44	Nisha Patel	11 Manor Close, Ashby	Senior
67	Sally Hughes	7 Church Street, Ashby	Senior
82	Illtud Green	Sea View, Shore Road, Westwick	Junior
106	Rachel King	4 Harbour Terrace, Westwick	Senior

Members' times are recorded during weekly training sessions:

Result

MemberID	Date	Minutes	Seconds
44	08 Apr 20	16	40
82	08 Apr 20	18	10
44	15 Apr 20	16	30
67	15 Apr 20	19	25

(a) Write an SQL command to output the Name and Address only for all Senior members. [2]

(b) Write an SQL command to output the MemberID of all members who have completed the course in less than 17 minutes. [2]

(c) Write an SQL command to output the Name for all members who trained on 15 April 2020. [2]

(d) Write an SQL command to record that, on 15 April 2020, member 106 recorded a time of 17 minutes 20 seconds. [2]

(e) Another table is required to record data for membership fees. Write an SQL command to create a new table Payment to contain the following fields: [2]

Field name	Example data entry
PaymentID:	10
MemberID:	82
PaymentDue:	24.60
Paid:	TRUE

5. A series of nodes are connected in a network:
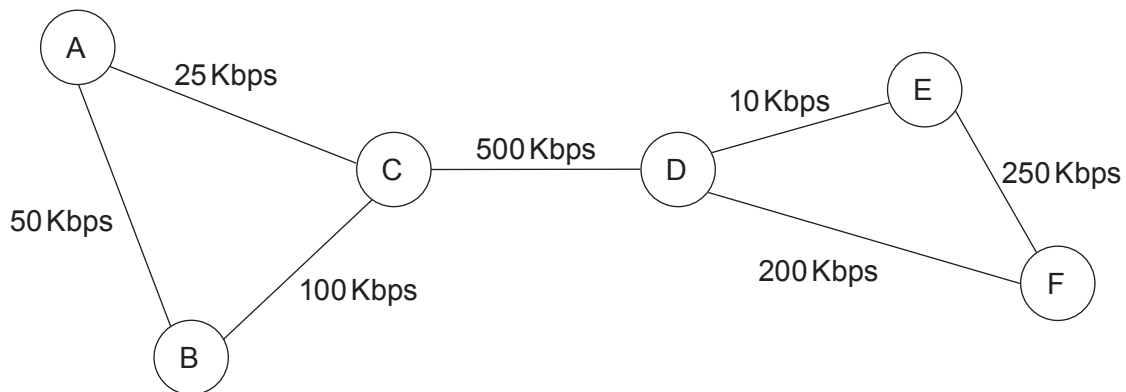
(a) A cost for routing data packets between nodes is calculated by dividing 1Mbps by the transmission speed of the link. For example:

$$\text{cost for the link A to B} = \frac{1\text{Mbps}}{50\text{Kbps}} = \frac{1\,000\,000}{50\,000} = 20$$

Packets are transmitted between source and destination by the route which has the lowest total cost.

(i) Calculate the costs for each of the remaining 6 links in the network. [2]

(ii) State the route which packets would take from node A to node F. [1]

(b) Multiplexors are installed at nodes on certain networks.

Describe the need for multiplexing. [2]

6. *(a)* Describe the following methods of data transmission, giving an example of where each is used.

(i) parallel transmission. [2]

(ii) serial transmission. [2]

(b) (i) Explain how collisions might occur in a bus network and how these collisions are dealt with. [4]

(ii) Explain why collisions are not a problem in ring networks. [2]

7. *(a)* In a certain computer system, real numbers are stored in floating point form using two's complementation as shown below.

Mantissa	Exponent
12 bits in two's complement form. The binary point in the mantissa is immediately after the leftmost bit.	8 bits in two's complement form

Determine the floating point representation of the number 231.625_{10} [4]

(b) Explain the effects amending the number of bits allocated to the mantissa or exponent will have on the floating point form used in part *(a)*. [2]

8. A film company uses computer generated images (CGI) for a science fiction film.

(a) Explain why powerful computers are required to produce CGI for films. [2]

(b) To produce the computer generated image for each frame of the film takes 20 minutes on a single processor computer.

The film company decides to produce the images by parallel processing, using a computer with 6 processors.

10 % of the total processing time is taken up in collecting data from the previous frame of the film, which must be carried out serially. The remainder of the processing can then take place in parallel, with each processor working on a different area of the image.

Calculate the time taken to produce **one** frame of the film using the parallel processing system with 6 processors. [2]

9. Describe a data processing system which makes use of a master file and transaction file to produce utility bills. [8]

10. A factory uses a direct access file with a separate overflow area to store stock records for the current year. The number of records to be stored will not exceed 1 000.

Each record has a key field made up from a five digit code followed by the year number (20).

For example: 3561220   6834520   7012120

It is proposed to use the hashing algorithm: key field MOD 1000

    (a) Calculate the location of a stock record with a key field = 3561220 [1]

    (b) Explain why this hashing algorithm is unsuitable. [3]

    (c) Describe a more suitable hashing algorithm for the direct access file. [2]

11. *(a)* Discuss the advantages and disadvantages of symmetric (single key) and asymmetric (double key) encryption methods and explain a situation where each encryption method would be the most suitable. [8]

    (b) Double key encryption uses three numeric values: e, d and n where:
        e is the encryption key
        d is the decryption key.
        n is used during both encryption and decryption.

      (i) Encryption is carried out using the formula:
        (original data)^e MOD n = (encrypted data)

        Use the key values e=3, n=30 to encrypt the numeric value 8. [2]

      (ii) Decryption is carried out using a similar formula:
        (encrypted data)^d MOD n = (original data)

        Use the key values d=7, n=30 to decrypt the result calculated in part (i) [2]

12. Explain, giving an example of each, what is meant by the concepts of Big Data, data mining and predictive analytics. [9]

13. Describe the purpose of an operating system in a personal computer. [9]

END OF PAPER