GCE A LEVEL

1500U40-1

S23-1500U40-1

MONDAY, 19 JUNE 2023 – MORNING

COMPUTER SCIENCE – A2 unit 4

Computer Architecture, Data, Communication and Applications

2 hours

1500U401
01

ADDITIONAL MATERIALS

A WJEC pink 16-page answer booklet.

A calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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.

Assessment will take into account the quality of written communication used in your answers.

Answer **all** questions.

1. Giving an example for each, describe why the following applications might be preferred over keyboard entry:

(a) creating a text document by voice recognition. [2]

(b) controlling an electronic device by voice input. [2]

(c) managing a security system by voice print recognition. [2]

2. (a) A series of calculations must be carried out to complete a process:

Task 1: $a = bx + cy$

Task 2: $d = ex + f^2$

Task 3: $g = hy – d$

Explain why these tasks are **not** suitable for parallel processing. [2]

(b) A computer model is to be used to predict economic forecasts for an industrialised country. The model involves many complex calculations. It is estimated that it will take 16 hours to run on a single processor computer.

80% of the algorithm can be carried out in parallel. The remaining parts of the algorithm must be carried out serially.

Determine the time taken to run the parallel processing elements of the economic forecast model on a parallel processing system using 8 processors. [2]

3. In a food factory, packages are filled as they travel along a conveyor belt. The packages are weighed and any underweight packages are rejected.

A control program for the weighing system is to be written in assembly language. The minimum acceptable weight is stored in memory location **R**. The required algorithm is:

```
LOOP continuously
    input package weight
    subtract the value stored in location R from the input weight
    IF the remainder is zero or greater THEN
        output value 1
    ELSE
        output value 2
    ENDIF
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 weight to the accumulator
OUT X	Output a numeric value X
ADD Y	Add the numeric value in location Y to the accumulator, leaving the result in the accumulator
SUB Y	Subtract the numeric value in location Y from the accumulator, leaving the result in the accumulator
JNG LABEL	Jump to LABEL if the contents of the accumulator are less than zero
JMP LABEL	Jump unconditionally to LABEL

Using the algorithm and instruction set, write a program in assembly language to control the weighing system. [6]

4. Giving an example for each, explain what is meant by batch processing and real time transaction processing. [8]

5. (a) Giving an example for each, describe the format of sign and magnitude and two's complement when representing negative binary integers. [4]

(b) A certain computer uses this floating point representation:

Mantissa	**Exponent**
10 bits in two's complement form. The binary point in the mantissa is immediately after the leftmost bit.	6 bits in two's complement form.

Find the base-10 (denary) number represented by the floating point value:

0110010101 000110 [2]

6. Describe the process and effects of carrying out arithmetic shifts on a two's complement negative binary number. [4]

7. The owner of a shop requires a program to store stock records. Each stock item has a three-digit identification code in the range 000 to 999. The number of different stock items held by the shop is currently 95.

A programmer considers two different methods of storing the stock records:

- A direct access file with 100 storage locations. The location for each item is calculated using the hash function: identificationCode MOD 100.
- A sequential access file with 1000 storage locations. The stock record is stored at the location corresponding to its identification code, so product 715 will be stored at location 715.

Explain the advantages and disadvantages of these two methods. [6]

8. Describe the three basic states of a process in a multi-tasking computer. [6]

9. Improved worker safety is a benefit of automation.

(a) Describe **two** *other* benefits and **two** drawbacks of automating a manufacturing process. [4]

(b) Explain, giving an example of each type of system, the main purpose of:

- a safety related control system
- a safety critical control system.

[4]

10. A kitchen equipment shop uses a database to record information about products and orders. Two tables with example records are shown:

Product

ProductID	Description	Model	Price
108	Cooker	Ultrachef	342.80
112	Dishwasher	Speedclean	291.50
134	Freezer	IceKing	188.80
196	Cooker	MasterKitchen	405.60

Order

OrderID	Customer	ProductID	OrderDate	Delivered
6291	R. Kelling	108	23 Mar 2020	True
7821	G. Hambleton	112	07 Apr 2020	False
9215	P. Yang	108	19 May 2020	False
9851	S. West	196	22 May 2020	True

(a) Write an SQL command to list only the description and price for each Product record where the price is less than 300. [2]

(b) Write an SQL command to list the customer and order date for all orders with a product description 'Cooker'. [3]

(c) Write an SQL command to add the following record to the Product table:

A refrigerator with the model name 'Coolstore 2000'. This has been allocated Product ID 288 and has a price of 150.60. [2]

11. A large company has many departments, each of which has different responsibilities. When a major project is carried out, employees from the departments need to work together.

(a) The company currently uses a single flat file to store all details of the projects. They have discovered that the data structure has several shortcomings.
Describe **two** disadvantages for the company of using a flat file to store its data. [4]

(b) The company has decided to develop a relational database to store details of the projects. Each project will have a title and a project budget. Project teams will be made up of employees from various departments. Each time an employee joins the company they will be allocated to the department that matches their skills. An employee may be a member of more than one project team.

Design a database system in third normal form for this situation. [5]

12. (a) Explain what is meant by a distributed system and describe what will be distributed in the system. [2]

(b) A car manufacturer has a number of dealerships across the UK. Car owners take their cars for servicing each year to a convenient dealership. Records are kept of servicing, any faults found, and replacement parts fitted.

Explain the advantages to the company of implementing a distributed database system across its dealerships compared with using a single centralised database. [4]

13. (a) Explain the advantages and disadvantages of single key (symmetric) encryption compared with double key (asymmetric) encryption, giving an example, for each method, of a situation where that method would be the most suitable. [6]

(b) Text is stored in 8-bit binary ASCII format, with numeric codes representing each character:

A = 65_{10} $0100\ 0001_2$

B = 66_{10} $0100\ 0010_2$

C = 67_{10} $0100\ 0011_2$

The text is encrypted using a sequential XOR method:

- The first character is encrypted by XOR with the key value $0110\ 1010_2$
- The second character is encrypted by XOR with the encrypted value of the first character
- The third character is encrypted by XOR with the encrypted value of the second character

Using this algorithm, encrypt the word CAB. [3]

14. (a) Identify **two** hardware devices required to make a wireless connection to a network. [2]

(b) State **two** protocols used for wireless digital communication. [2]

(c) Describe **one** disadvantage of using a public wireless network. [2]

15. Information and advice on medical and health issues are readily available to the public through the internet, including online expert systems. Discuss the possible effects of using the internet for this purpose on health professionals and the wider community. [9]

END OF PAPER

BLANK PAGE