Oxford Cambridge and RSA

Wednesday 11 June 2025 – Morning

A Level Computer Science

H446/01 Computer systems

Time allowed: 2 hours 30 minutes

You can use:
- a ruler (cm/mm)
- an HB pencil

Do not use:
- a calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.

INFORMATION
- The total mark for this paper is **140**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

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DO NOT WRITE ON THIS PAGE

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1 Charlie is about to study a computer games design course at university. He needs to purchase a computer to allow him to design and edit the graphics in his games, including video files.

(a) Charlie's computer contains a data bus, an address bus and a control bus.

State the purpose of each of these three buses.

Data bus .....

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Address bus .....

.....

Control bus .....

.....

[3]

(b) Charlie will need to use input **and** output devices when designing and editing his computer games.

(i) State **one** input device **and one** output device that Charlie could use **and** give an example use of each.

Input device

Device name .....

.....

Example use .....

.....

Output device

Device name .....

.....

Example use .....

.....

[4]

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(ii) Charlie will need to store a large collection of files containing high definition images and high definition videos that he will use during his course.

State a type of secondary storage device that Charlie could use and give a reason why.

Type of storage .....

.....

Reason.....

.....

[2]

(c) In addition to the Central Processing Unit (CPU), Charlie will purchase a Graphical Processing Unit (GPU) that will be used to process and display the graphics in his games.

(i) Tick (✓) **one** box on each row to indicate if each statement is referring to a CPU **or** a GPU.

Statement	CPU	GPU
Suited to performing simple operations in parallel on larger data sets		
Suited to performing complex operations on smaller data sets		

[2]

(ii) State **two** benefits of using a GPU to process and display the graphics in computer games.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

(d) Charlie will require an operating system that will allow him to have several applications open at the same time.

(i) State which type of operating system Charlie will need to install.

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..... **[1]**

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(ii) An operating system that Charlie is thinking about installing uses a multi-level feedback queue.

Describe how a multi-level feedback queue works.

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..... **[3]**

(iii) An operating system manages and installs device drivers.

Explain why hardware devices require a device driver.

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..... **[2]**

(e) Once Charlie has installed an operating system he will need to install utility software.

State **two** utilities that Charlie could install and state the purpose of each.

Utility 1 .....

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Purpose .....

.....

Utility 2 .....

.....

Purpose .....

.....

[4]

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2 OCR Consultants is designing a computer for a large company.

(a) OCR Consultants is designing the architecture of the CPU.

(i) Compare **two** differences between the Von Neumann architecture and the Harvard architecture.

Difference 1 .....

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Difference 2 .....

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[4]

(ii) OCR Consultants is considering using pipelining.

State **two** benefits of using pipelining.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

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(iii) OCR Consultants can base the CPU around a RISC architecture or a CISC architecture.

Compare **two** differences between a RISC architecture and a CISC architecture.

Difference 1 .....

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Difference 2 .....

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[4]

(iv) Describe a benefit of making the CPU a multicore CPU.

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..... **[2]**

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(b)* The employees of the large company work remotely from home and use large databases that store a lot of sensitive data. They need to be able to use the databases to search and sort data quickly.

OCR Consultants is considering two approaches:

- **thin client approach** – this is where the database is stored virtually on a remote server. All of the data processing is also completed on a remote server on virtual machines. The employees' computers are only used to capture the data input and display the results from the virtual machines
- **thick client approach** – this is where most of the processing is done on the employees' computer using specialised software to access the remote database.

Discuss the benefits and drawbacks of each of these approaches.

You should include the following in your answer:

- what is meant by virtual machines and virtual storage
- the benefits and drawbacks of a thin client and thick client approach described in the question
- a conclusion justifying which approach would be most suitable for this scenario. **[9]**

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3

(a)

(i) Convert the denary number **189** into an 8-bit binary number.

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..... **[1]**

(ii) Convert the denary number **189** into a hexadecimal value.

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..... **[1]**

(iii) Convert the hexadecimal value **E4** into a denary number.

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..... **[1]**

(b) Explain the effect that a right shift of **three** places will have on a positive binary number.

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..... **[2]**

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(c) Show the subtraction of these **two** floating point binary numbers.

Both numbers are stored in a normalised floating point format, using 6 bits for the mantissa and 4 for exponent.

You should show your result in the same format.

Show your working out.

011010 0011 – 010010 0010

Working space .....

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Final 6-bit **mantissa** .....

Final 4-bit **exponen**t .....

[6]

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(d)

(i) Show the result of applying a bitwise **AND** mask of 1010 1110 to the byte 1010 0011.

Byte	**1010 0011**
AND Mask	**1010 1110**
Result	

[2]

(ii) State the purpose of the bitwise **AND** mask.

.....

..... **[1]**

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4 Kofi is a software engineer and has been asked to write some code using the Little Man Computer (LMC) instruction set.

(a) State the LMC command that would be used for each description given in the table.

Description	LMC Command
Load the value stored in the memory address into the accumulator	
Branch without checking the value in the accumulator	
Store the value from the accumulator into a memory address	
Branch if zero is in the accumulator	
Branch if zero or a positive number is in the accumulator	

[3]

(b) Kofi has been asked to write a program that inputs **two** numbers and then outputs the largest of the two numbers.

Write the code for this program using the LMC instruction set.

You can assume that the two numbers will always be different.

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..... **[4]**

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(c)* Kofi is working on a number of projects. These include:

- **project 1** – Writing a mobile phone app to look at the news
- **project 2** – Writing software to send temperature readings from an embedded heat sensor to other devices
- **project 3** – Writing an image editing application for a desktop computer
- **project 4** – Writing software to calculate the results of a physics experiment that produces terabytes of data
- **project 5** – Writing a new device driver for a new piece of hardware.

Discuss which of these projects should be written in a high level programming language and which should be written in a low level language.

You should include the following in your answer:
- what is meant by high level programming language and low level language
- which projects are suitable for high level and which are suitable for low level languages
- a conclusion that justifies why these different languages are needed. **[12]**

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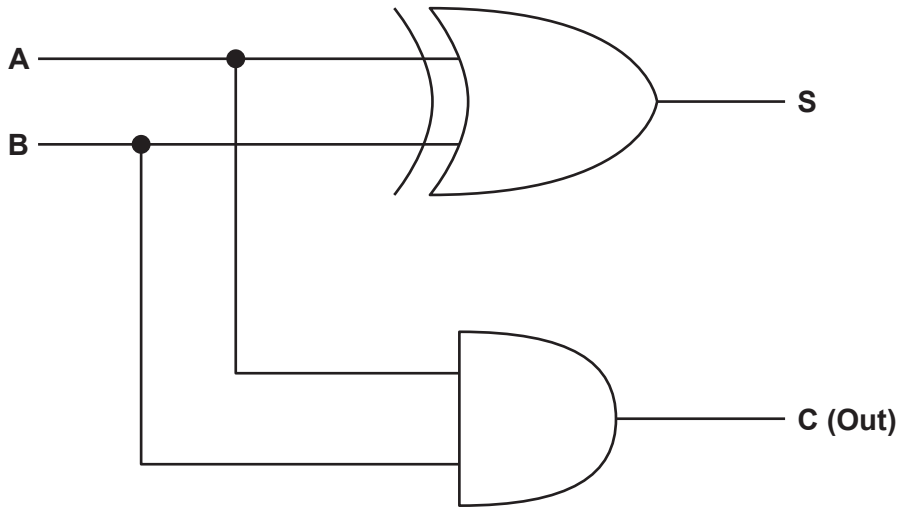
5 This diagram shows the logic circuit for a **half** adder.



(a) Complete the truth table for this half adder circuit.

A	B	S	C (Out)
0	0		
0	1		
1	0		
1	1		

[4]

(b) Describe the difference between a half adder circuit and a full adder circuit.

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..... **[2]**

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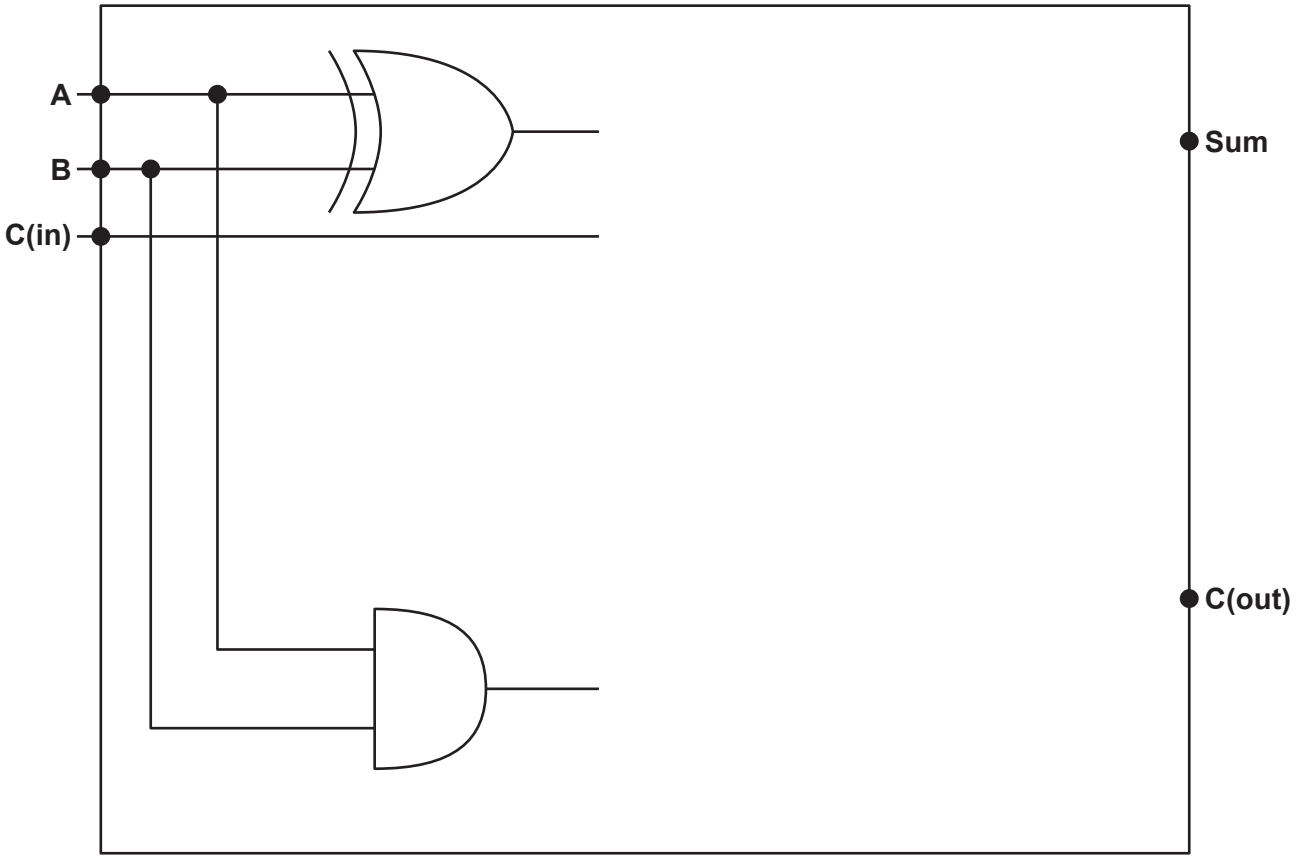
(c) The diagram below shows a partially completed logic circuit for a **full** adder.

The full adder circuit contains **three** inputs:
- **A** – represents the first input
- **B** – represents the second input
- **C(in)** – represents the carry bit from the previous stage of the addition.

The full adder circuit contains **two** outputs:
- **Sum** – represents the result of adding the three inputs **A**, **B** and **C(in)**
- **C(out)** – represents the carry that is passed to the next stage of the addition.

Complete the logic circuit to represent a full adder.



[4]

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(d) This Karnaugh map represents a different logic circuit.

CD \ AB	**00**	**01**	**11**	**10**
00	0	1	1	1
01	0	1	1	0
11	0	0	0	0
10	0	0	1	1

Use this Karnaugh map to find the simplified expression for this circuit.

You should annotate the Karnaugh map to show the groups that you have used to find the simplified expression.

Write your simplified expression here.

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..... **[4]**

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6 DCC Software is a company that creates a wide range of software products for home computers. Its products include image, video and sound editing software.

(a) DCC Software makes significant use of software libraries.

Explain the benefits of using software libraries to create software.

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..... **[4]**

(b) Once DCC Software has written a piece of software, they use translators to translate the programming code.

(i) The table shows different stages of code compilation labelled **A**, **B**, **C** and **D**.

A	Lexical analysis
B	Syntax analysis
C	Code generation
D	Code optimisation

In each box write the letter of the stage that matches each description.

Converts the high level code into low level instructions ☐

Examines the code and improves the efficiency of it without affecting the functionality ☐

Removes comments and whitespace and then converts the high level code into tokens ☐

Identifies syntax errors and creates an abstract syntax tree ☐

[4]

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(ii) DCC Software is considering the benefits of both an interpreter and a compiler.

State **two** benefits of using an interpreter.

Benefit 1 .....

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Benefit 2 .....

.....

[2]

(iii) State **two** benefits of using a compiler.

Benefit 1 .....

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Benefit 2 .....

.....

[2]

(c) DCC software uses a database table called `TblSoftware` to store details about all of their products.

ProductID	Name	Type	Price
DCC01	DCCPhotos	Image	£129.99
DCC02	DCCDraw	Image	£119.99
DCC03	DCCAnimate	Image	£99.99
DCC04	DCCMovie	Video	£189.99
DCC05	DCCEffects	Video	£99.99
DCC06	DCCAudio	Sound	£119.99

TblSoftware

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(i) Write an SQL statement to insert this new product into `TblSoftware`:

ProductID:	DCC07
Name:	DCCCast
Type:	Sound
Price:	£89.99

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..... **[3]**

(ii) Write an SQL statement to return the `Name` of products that have a `Price` that is less than the `Price` of the product with the `Name` "DCCDraw".

You should use a nested SELECT statement in your answer.

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..... **[5]**

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7*

(a) OCR Photo is a free website designed to use Artificial Intelligence (AI) to generate unique photographs from a text description given by the user.

The AI learns by searching the internet randomly for millions of photographs and then matching these to a textual description of the photograph. The photographs include people, property, landscapes and objects.

Discuss the legal and moral implications of this approach and what OCR Photo should consider.

You should include the following in your answer:

- what is meant by AI
- the legal and moral implications of the learning approach described in the question
- a conclusion justifying if OCR Photo should use this approach or not. **[9]**

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(b) OCR Photo uses run length encoding to compress the generated photographs.

A black and white photograph is encoded using **B** for the colour black and **W** for the colour white. The encoded sequence is:

```
W4B1W4
W3B3W3
W2B5W2
W1B7W1
```

Use the grid to show the result of using run length encoding to decompress this sequence.

[4]

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8 Orla is developing a program that will allow candidates to complete quizzes for a range of subjects. Each quiz has **three** questions and each one is multiple choice with **three** possible answers.

(a) Orla is considering using a flat file database to store data about candidates, and the subjects and quizzes they sit.

Explain the limitations of using flat file databases.

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..... **[4]**

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(b) Due to the limitations of flat file databases, Orla decides to create a relational database containing these **four** tables:

- `TblCandidate` – Stores data about the candidates
- `TblSubject` – Stores data about the subject
- `TblQuiz` – Stores the questions for each individual quiz and the answers
- `TblResponse` – Stores the candidate's responses for a given quiz.

The fields in each table are shown here. **PK** indicates the primary keys and **FK** indicates the foreign keys that are used.

TblCandidate
CandidateID(PK)
CandidateName
eMail
PhoneNumber

TblSubject
SubjectID(PK)
SubjectName
Description

TblQuiz
QuizID(PK)
Q1Text
Q1Answer
Q2Text
Q2Answer
Q3Text
Q3Answer
SubjectID(FK)

TblResponse
ResponseID(PK)
Date
Q1Response
Q2Response
Q3Response
Score
QuizID(FK)
CandidateID(FK)

Complete an Entity Relationship Diagram (ERD) to show the relationships between these **four** tables.

TblCandidate

TblSubject

TblResponse

TblQuiz

[3]

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(c) In order to determine what tables were required, Orla used database normalisation.

(i) State **two** requirements for a database to be in Second Normal Form (2NF).

1 .....

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2 .....

.....

[2]

(ii) State **two** requirements for a database to be in Third Normal Form (3NF).

1 .....

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2 .....

.....

[2]

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(d) Orla wants a web based version of the quiz. She develops a function called `checkAnswers` to calculate the score of each quiz on the client side using JavaScript.

Next to each candidate answer is an empty HTML element. When the user presses submit, the function, `checkAnswers`, will check if each answer is correct. If so, it will add the word "Correct" into the empty HTML element.

The function, `checkAnswers` takes **three** parameters:

- `responses` – an array of the IDs of the HTML elements that contains the user's responses.
- `feedbacks` – an array of the IDs of the HTML elements that the text "Correct" is to be written to if the candidate gets the question right. The array will be the same length as `responses`.
- `answers` – an array of the correct answer for each of the questions. The array will be the same length as `responses`.

The function returns the final score out of three for the quiz. It loops through each question to calculate if the candidate got it correct and processes it appropriately if they did.

Complete the function `checkAnswers`, using pseudocode or program code.

```
function checkAnswers(responses, feedbacks, ……)
{
    var …… = 0;
    for(var qCount = 0; qCount < responses.length; qCount++)
    {
        response = document.getElementById(responses[qCount]).innerHTML;
        answer = answers[……];
        feedbackElement = document.getElementById(feedbacks[qCount]);
        if (response == answer)
        {
            score = ……
            feedbackElement.innerHTML = "Correct";
        }
    }
    …… score;
}
```

[5]

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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