2024L219A1EL

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2024

Computer Science

Sections A & B

Higher Level

Wednesday 22 May Morning 9:30 - 11:00

130 marks

Examination Number

Date of Birth / /

For example, 3rd February 2005 is entered as 03 02 05

For Examiner use only								
Section	**Question**	**Mark**	**Section**	**Question**	**Mark**	**Section**	**Question**	**Mark**
A	1		A	7		B	13	
	2			8			14	
	3			9			15	
	4			10		**Section B Total:**		
	5			11		C	16	
	6			12		**Section C Total:**		
Section A Total:						**Total:**		

The 2024 examination papers were adjusted to compensate for disruptions to learning due to COVID-19. This examination paper does not necessarily reflect the same structure and format as the examination papers of past or subsequent years.

Instructions

There are **three** sections in this examination. Section A and B appear in this booklet. Section C is in a separate booklet that will be provided for the computer-based element.

Section A	Short Answer Questions	Attempt any **nine** questions All questions carry equal marks	54 marks
Section B	Long Questions	Attempt any **two** questions All questions carry equal marks	76 marks
Section C	Programming	Answer **all** question parts	80 marks

Calculators may **not** be used during this section of the examination.

The superintendent will give you a copy of page 78 (Logic gates) of the *Formulae and Tables* booklet on request. You are **not** allowed to bring your own copy into the examination.

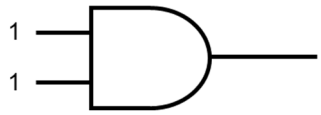
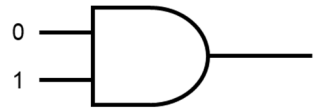
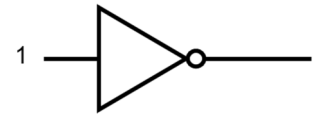
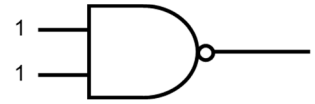
Write your answers for Section A and Section B in the spaces provided in this booklet. There is space for extra work at the end of the booklet. Label any such extra work clearly with the question number and part.

Section A — Short Answer Questions — 54 marks

Answer any **nine** questions.

Question 1

Logic gates have one or more inputs and a single output. For each logic gate in Column A in the table below enter the output, either 0 or 1, in Column B.

Column A Logic gate with input(s)	Column B Output (0 or 1)
	
	
	
	
	
	

Question 2

What is the output displayed by the following Python code?

```
1  number = 27
2  while number < 39:
3      print(number, end=" ")
4      number = number + 3
```

Question 3

Express the decimal number **121** as an 8-bit binary number.

Answer:

Question 4

Figure 1 shows a row of black and white discs with their position numbers shown under each square. There are only two ways to move a disc:

1. Move into an empty square one position to the left or right, for example 1 → 2 means move the disc from square 1 to square 2.
2. Jump in either direction over a single adjacent disc into an empty space immediately beyond, for example 3 → 1 means move the disc from square 3 to square 1, jumping over a disc in square 2.

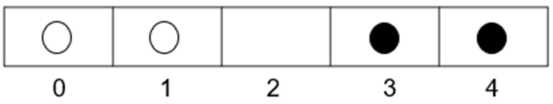


Figure 1 (start state)

Write a sequence of steps, or an algorithm, that swaps all the white discs with the black discs so that the row looks like that shown in **Figure 2**. You can only move a single disc in each step.

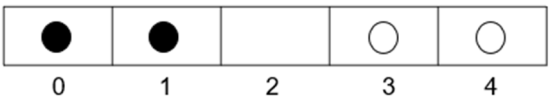


Figure 2 (end state)

Question 5

The history of computer hardware is marked by significant milestones that have driven advancements in computing capabilities. Six key milestones between the 1930s and the 1980s are shown in **Figure 3** below.

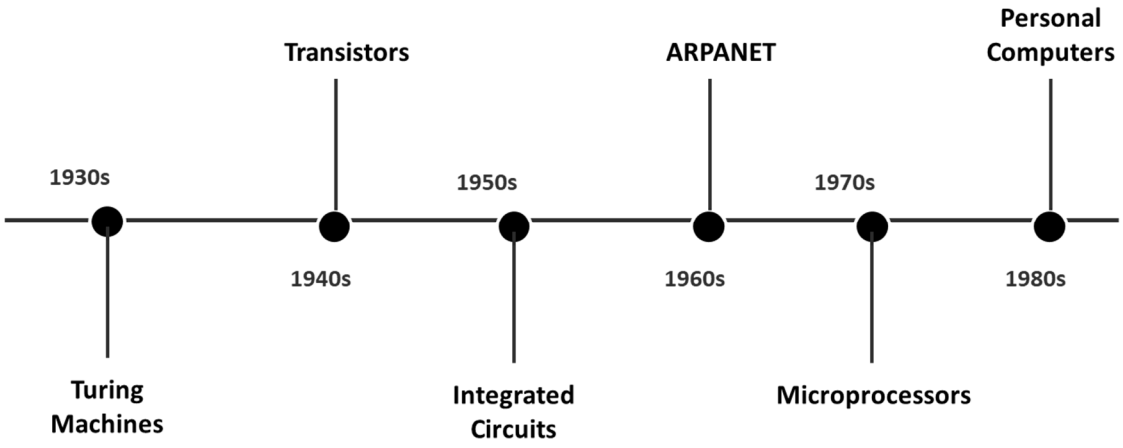


Figure 3

Choose **one** of the milestones from **Figure 3** and explain its significance.

Milestone:
Significance:

Question 6

Consider a social networking mobile application designed for teenagers. Provide **one** example of a unit test case and **one** example of a system test case that might be carried out during the development process.

Unit test case:
System test case:

Question 7

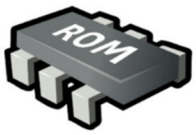
Computing technologies continue to evolve at a rapid pace. Some of the current emerging trends include:

- Quantum Computing
- Edge Computing
- Internet of Things (IoT)
- Biometric Authentication and
- Blockchain Technology

Pick any **one** of the above and briefly describe **one** potential advantage and **one** potential disadvantage it might have on society in the future.

Emerging trend:
Potential advantage:
Potential disadvantage:

Question 8



RAM and ROM are two types of primary memory used to store data. Provide **one** example of data that might be stored in RAM and **one** example of data that might be stored in ROM.

Data in RAM:
Data in ROM:

Question 9

A leap year is a year that contains an additional day making it 366 days long instead of the usual 365 days. The Python function `is_leap_year`, shown below can be used to determine whether a year (denoted by the parameter `y`) is a leap year or not.

```
1  def is_leap_year(y):
2      if (y % 400 == 0) or ((y % 4 == 0) and (y % 100 != 0)):
3          return True
4      else:
5          return False
```

Use the code to describe the **two** rules for determining whether a year is a leap year.

Rule 1:
Rule 2:

Question 10

Many fast-food restaurants have begun using interactive kiosks that allow customers to order food without having to go to a cashier. These kiosks have menu-driven interfaces.

Name **two** principles of universal design and explain how these principles could be met in the design of such systems.

Universal design principle 1:
Explain:
Universal design principle 2:
Explain:

Question 11

(a) Apply the algorithm shown in pseudo code below to the row of shapes shown in **Figure 4** and illustrate your answer in the boxes provided.

```
problem_solved ← FALSE
LOOP until problem_solved IS TRUE
   square ← find the leftmost square
   triangle ← find the rightmost triangle
   IF position of square IS GREATER THAN position of triangle
      problem solved ← TRUE
   ELSE
      swap(square, triangle)
```

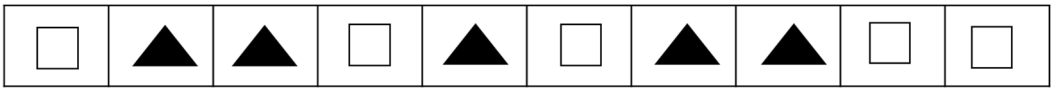


Figure 4

Step 1:

Step 2:

(b) The algorithm described in **part (a)** provides a general solution to the problem it solves. Explain what is meant by the phrase 'a general solution'.

Question 12

Figure 5

(a) Explain the meaning of the quote, shown in **Figure 5** above, in relation to online applications.

(b) Provide **one** implication that the quote could have for your use of online applications.

There is no examination material on this page

Section B	Long Questions	76 marks

Answer any **two** questions.

Question 13

(a) The term artificial intelligence (AI) was first used in 1955 by among others, American computer scientist John McCarthy who had an Irish father from Co. Kerry. Since then, other related terms such as narrow AI, artificial general intelligence (AGI) and generative AI have emerged.

(i) What is meant by the term 'artificial intelligence'?

(ii) Distinguish between narrow AI and artificial general intelligence (AGI).

(iii) ChatGPT and Gemini are examples of generative AI applications. Explain the term 'generative AI'.

(iv) Name **two** types of output that can be produced by generative AI.

1.

2.

This question continues on the next page.

(b) Computer vision is a field of AI that uses machine learning techniques to develop models capable of identifying objects in an image.

Study the image shown in **Figure 5** and answer the questions that follow.

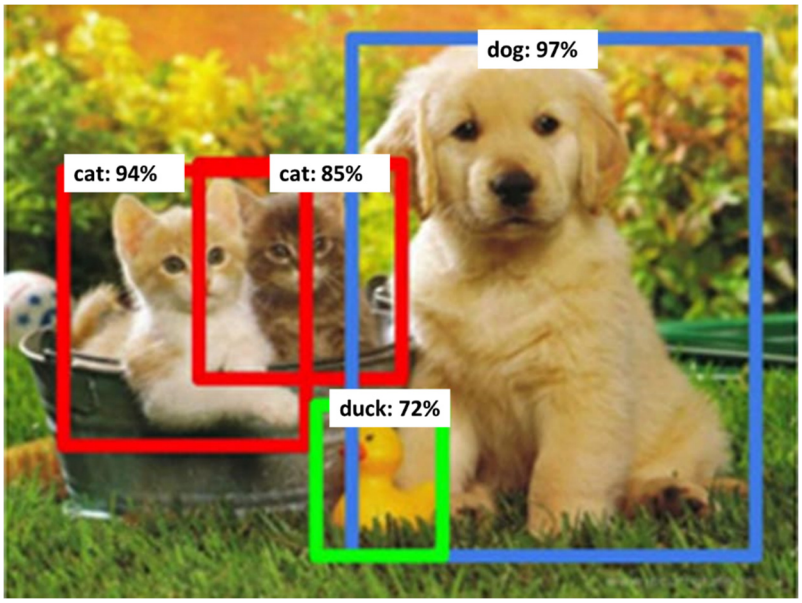


Figure 5

(i) In relation to computer vision, what do the percentages shown in **Figure 5** represent?

(ii) Suggest **two** applications for this type of technology and describe how each application could benefit society.

Application 1:
Benefit:
Application 2:
Benefit:

(iii) Read the **two** example scenarios below and for each one, state whether it could use machine learning AI. Justify each answer.

Scenario 1: An online streaming service that recommends films based on users' viewing habits.

State:
Justify:

Scenario 2: An automated lawnmower that uses sensors to navigate an outdoor space and avoid obstacles while cutting the grass.

State:
Justify:

(iv) In recent years many instances of bias have been identified in computer vision applications. Explain **one** method that could be used to reduce bias in these applications.

This question continues on the next page.

(c) In 2023 an open letter published by the Future of Life Institute requested all AI labs to immediately pause for at least six months the training of very powerful AI systems. Interestingly, while the letter was signed by many well-known academics and industry leaders, there were many notable individuals and companies who did not publicly declare their support.

Discuss the reasons for some people supporting the initiative to pause training and others not supporting the initiative.

Question 14

(a) The flowchart, shown in **Figure 6** below, describes an algorithm that reads two values, swaps them, and then displays their new values.

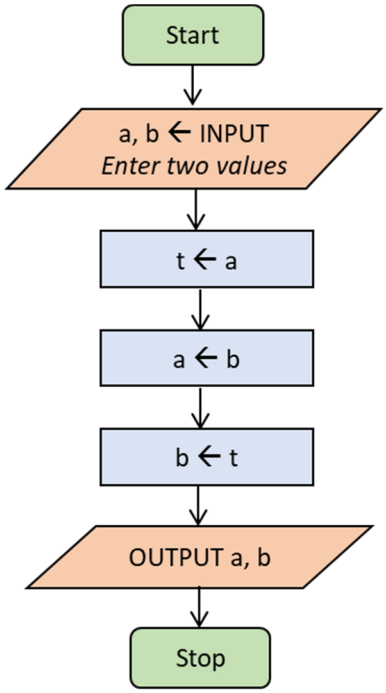


Figure 6

(i) State the names of the **two** input variables.

Input variable 1:
Input variable 2:

(ii) Explain the purpose of the variable t.

(iii) Flowcharts are commonly used in the design process to describe algorithms. State **one** advantage and **one** disadvantage of using flowcharts.

Advantage:
Disadvantage:

This question continues on the next page.

(b) The Python code below shows an implementation of the bubble sort algorithm.

```
1  values = [50, 70, 30, 60, 20]
2
3  for i in range(len(values)):
4      for j in range(len(values)-1):
5          if values[j] > values[j+1]:
6              t = values[j+1]
7              values[j+1] = values[j]
8              values[j] = t
9
10 print("OUTPUT:", values)
```

(i) State the data type of the variable, `values`.

(ii) What is the index of the element 70?

(iii) What does the Python expression `len(values)` return?

(iv) What does the slice expression `values[2:4]` return?

(v) Explain why the expression `values[5]` would generate a runtime error.

(vi) State **one** advantage and **one** disadvantage of sorting a data set.

Advantage:
Disadvantage:

(c) The algorithm takes five passes to complete the bubble sort of the integers in `values`.

(i) Apply the bubble sort algorithm to sort `values`. Show the contents of `values` after each of the five passes.

Initial state of `values`:	50	70	30	60	20
After pass 1:					
After pass 2:					
After pass 3:					
After pass 4:					
After pass 5:					

(ii) The bubble sort algorithm has O(n^2) best and worst case time complexity. Explain what this means in terms of the number of compare operations performed.

(iii) Suggest **one** possible improvement that could be made to the algorithm that would reduce either the number of comparisons or the number of swaps required to complete the sort.

Question 15

(a) Alex wants to keep track of her collection of Dr. Seuss books in a database. So far, she has managed to design a single table called BOOKS and enter the records shown below.

book_id	title	year	cost	author	author_dob	on_loan
1	The Cat in the Hat	1957	6.95	Dr. Seuss	02/03/1904	Yes
2	Green Eggs and Ham	1960	8.95	Dr. Seuss	March 2, 1904	Y
3	Horton Hears a Who!	1954	€10	Doc Seus	02/03/1904	N
4	How the Grinch Stole Christmas!	1957	9.95	Dr. Seuss	03/02/1904	No

(i) Explain the **two** terms, 'database' and 'record'.

Database:
Record:

(ii) Suggest which field would be a good choice for the primary key for the BOOKS table. Justify your answer.

Primary key:
Justify:

(iii) Identify any **two** data inconsistencies in the data shown in the BOOKS table.

1.
2.

(iv) Assuming all data inconsistencies are fixed, enter the names of **three** fields from the BOOKS table in Column B that correspond to the data types shown in Column A.

Column A Data Type	Column B Field Name
Boolean	
String	
Real	

(b) Alex has decided to build a relational database that could be used by a library and has created two new tables called MEMBERS and LOANS. The MEMBERS table is used to store the library members and LOANS will be used to keep track of the books that are taken out on loan.

Alex is working out her design on paper and has inserted some data into both tables as shown in **Figure 7** below. For example, the first row of data in the LOANS table records the fact that Chloe borrowed *Green Eggs and Ham* on 20th May 2024.

(i) Use the information provided below to fill in the **six** empty cells with the correct values.

- Amy borrowed *How the Grinch Stole Christmas!* on 1st May 2024.
- Bill borrowed *The Cat in the Hat* on 18th May 2024.
- Chloe borrowed *Horton Hears a Who!* 7 days ago.

member_id	member_name
1	Amy
2	
3	Chloe

MEMBERS

member_id	book_id	date_borrowed
3	2	20/05/2024
	4	01/05/24
2	1	

LOANS

Figure 7

(ii) Identify and explain the use of **one** foreign key from the design shown in **Figure 7**.

Foreign key:
Explanation:

This question continues on the next page.

(iii) Explain how the design shown in **Figure 7** removes the need for the `on_loan` field from the BOOKS table.

(iv) Relational databases reduce the amount of data redundancy. Explain the term 'data redundancy'.

(c) Alex is planning to use the database for a data analytics project. A data analytics project can be carried out in stages starting with a hypothesis.

(i) Suggest **two** possible hypotheses Alex could use her data analytics project to test.

1.
2.

(ii) Another stage in a typical analytics project is data cleaning. Name and describe **two** types of data errors that can be removed using data cleaning.

Data error type 1:
Description:
Data error type 2:
Description:

Space for extra work.

Indicate clearly the number and part of the question(s) you are answering.

Space for extra work.

Indicate clearly the number and part of the question(s) you are answering.

Space for extra work.

Indicate clearly the number and part of the question(s) you are answering.

Acknowledgements

Images
Image 1 on Page 6: https://technologyicalword.wordpress.com/emerging-technologies-in-computer-science/
Image 2 on Page 6: https://fossbytes.com/difference-between-ram-and-rom-memory/
Image on Page 7: https://www.forbes.com/sites/edrensi/2018/07/11/mcdonalds-says-goodbye-cashiers-hello-kiosks/
Image on Page 9: https://tech.co/digital-marketing/social-media-trends
Image on Page 11: https://thebulletin.org/2023/08/convergence-artificial-intelligence-and-the-new-and-old-weapons-of-mass-destruction/
Image on Page 12: https://www.meathspca.com/get-involved.html

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