L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 SECOND SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	I
DATE:	31st August 2026
TIME:	9:00 a.m. to 12:05 p.m.

Directions to Candidates

- Answer **ALL** questions.
- Good English and orderly presentation are important.
- All answers are to be written on the booklet provided.
- The use of flowchart templates is permitted but calculators may **NOT** be used.

1. Produce the truth table for the following logic expression: $Y = (A \cdot B) \oplus (C + D)$ (5)

(Total: 5 marks)

2. Binary number systems are used by computers to represent and manipulate data. Two's complement is commonly used to represent signed integers, allowing arithmetic operations such as subtraction to be performed efficiently within fixed-size registers.

   a. State the range of values that can be represented by an 8-bit register using two's complement, including the minimum and maximum values. (2)
   b. Show how the calculation (30 - 12) is carried out using 8-bit two's complement. Show all your working in binary. (2)
   c. State **ONE** limitation of using sign and magnitude representation for binary numbers. (1)

(Total: 5 marks)

3. A student is learning how assembly language programs are structured and how instructions are executed within a processor.

   a. Distinguish between an instruction and a pseudo-directive in assembly language. (1)
   b. Explain the purpose of **TWO** general-purpose registers in assembly programs. (2)
   c. Consider the following instruction:

```
MOV AX, [BX]
```

      i. Identify the addressing mode used in this instruction. (1)
      ii. Explain how the operand is obtained during execution. (1)

(Total: 5 marks)

Please turn the page.

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4. Consider an 8-bit register AX. A program requires that bits 1, 3 and 5 must all be set to 1 before execution can continue. This condition must be checked carefully before the program proceeds to the next stage.
   Two students wrote the following programs:

   Program 1:

```
AND AX, #00101010     ; Apply bitwise AND with 00101010
CMP AX, #00101010     ; Check if AX equals 00101010
JMP NEXT              ; Jump to NEXT unconditionally
```

   Program 2:

```
OR  AX, #00101010     ; Apply bitwise OR with 00101010
CMP AX, #00101010     ; Check if AX equals 00101010
JMP NEXT              ; Jump to NEXT unconditionally
```

   a. Identify which program will correctly verify the required condition. (1)
   b. Explain why the program you identified in part (a) correctly checks the required condition, while the other does not. Your answer should describe how `AND AX, #00101010` and `OR AX, #00101010` affect bits 1, 3 and 5 of `AX` before the comparison. (4)

(Total: 5 marks)

5. A company wants to send a large training video of 1.2 GB across its network.

   a. Explain the difference between a digital signature and a digital certificate, and their roles in secure data transfer. (2)
   b. The video is transmitted in 8 minutes.
      i. How would you calculate the bit rate of the link in bits per second? No need to calculate the final numerical value. (2)
      ii. Suggest a protocol for transferring the video file efficiently over the network. (1)

(Total: 5 marks)

6. Staff members at the office presently connect to the central server through its IP address. However, the IT department wants employees to use a more user-friendly name.

   a. Explain what network service or system allows employees to access the file server using server.xyz.mt instead of the IP address. (2)
   b. The network uses unshielded twisted pair cables, and transmission errors are reported.
      i. Name **ONE** type of interference which may cause these errors. (1)
      ii. Suggest **TWO** alternative network media or cable types that could reduce these errors, and briefly explain why **each** is better. (2)

(Total: 5 marks)

7. During the development of a new system, different methods are used to gather information and understand user needs.

    a. Describe the use of interviews and questionnaires in system requirements elicitation. For **each** method, state **ONE** advantage and **ONE** disadvantage. (4)
    b. Explain why it is important to fully understand user requirements before moving to later stages of the software development lifecycle (SDLC). (1)

(Total: 5 marks)

8. Maintenance is an essential phase of the system life cycle that occurs after the system has been implemented.

    a. Describe the difference between corrective maintenance and adaptive maintenance, and give **ONE** example of **each**. (3)
    b. Explain the role of documentation in supporting system maintenance. (2)

(Total: 5 marks)

9. A company is planning to implement a database system to manage its data more efficiently and securely.

    a. Identify and briefly explain **TWO** components of a database management system (DBMS). (2)
    b. Give **ONE** advantage of using a relational database instead of a traditional file system.(1)
    c. State **TWO** characteristics of a relation (table) in a relational database. (2)

(Total: 5 marks)

10. A library wants to design a database to store information about members and the books they borrow. The following attributes are required: *member_id*, *member_name*, *book_id*, *book_title* and *borrow_date*.

    a. Design the database table(s) that would store this data efficiently. (2)
    b. Identify the primary key(s) and any foreign key(s) that would be used. (1)
    c. Explain why it may be necessary to split the data into more than one table. (2)

(Total: 5 marks)

11. A teacher is explaining the differences between various types of Read-Only Memory (ROM), including ROM, Electrically Erasable Programmable Read-Only Memory (EEPROM), and other related technologies, to a group of secondary students.

    a. Differentiate between ROM and EEPROM by describing **TWO** key differences between them. (2)
    b. Give **ONE** scenario where ROM is typically used and **ONE** scenario where EEPROM is more appropriate. (2)
    c. Name **TWO** other types of ROM apart from ROM and EEPROM. (1)

(Total: 5 marks)

Please turn the page.

12. A small company is installing new digital devices that must communicate reliably with a central computer system. The company plans to connect keyboards, and storage devices using USB ports.

    a. Explain why USB ports are suitable for connecting a wide range of peripherals to the computer. (1)
    b. Describe the role of Flash RAM in USB storage devices. (1)

    The devices will transmit data to the computer using serial transmission.

    c. Define serial transmission. (1)
    d. State **ONE** advantage and **ONE** disadvantage of using it. (2)

(Total: 5 marks)

13. An organisation uses computers for different tasks, including payroll processing and managing time-sensitive operations. The IT manager uses a batch operating system (OS) for payroll processing.

    a. What is a batch OS? (1)
    b. Which type of OS would be ideal to handle the time sensitive operations? Justify your answer. (2)
    c. Mention and describe **TWO** other types of OS apart from batch and the type identified in part (b). (2)

(Total: 5 marks)

14. A company stores different types of files on its system, including large project archives. One of the project archive files grows in size every week as new data is added. The IT administrator must decide which file allocation method is most suitable for storing this growing file.

    a. Mention and describe **THREE** types of file allocation methods. (3)
    b. Out of the three methods mentioned, specify which one is the most suitable for the described scenario. Justify your answer. (2)

(Total: 5 marks)

15. A group of computing students is learning about language translators and how high-level programs are converted into machine code. They have already studied compilers and are now exploring other translation methods.

    a. Mention and describe **TWO** other types of language translators. (2)
    b. Explain **ONE** difference between a compiler and **each** of the two translators mentioned in part (a). (2)
    c. Give **ONE** scenario where one of the translators mentioned would be more suitable than a compiler. (1)

(Total: 5 marks)

16. A student is writing commands for a robot that places items into boxes in a factory in preparation for shipping. The system uses a formal language designed for movement instructions. The student must ensure that each statement is both syntactically and semantically correct.

    a. Explain the difference between syntax and semantics. (2)
    b. Describe **ONE** problem that might occur if a robot command is syntactically correct but semantically unclear. (1)
    c. Consider the following rules for the robot command language:

    A valid command has the form:

    <action> <object>

    where:`<action>` may be `pick`, `place`, or `seal`

    `<object>` may be `item` or `lid`

    Consider the following sequence:

    ```
    seal box
    place item
    ```

    Determine whether this sequence is syntactically correct, semantically correct, or both. Provide reasons for your answer. (2)

(Total: 5 marks)

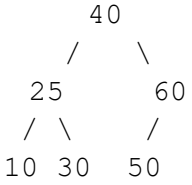
17. A programmer is designing a simple Java class called `Product` to store information about items in a shop. Write this class by carrying out the following tasks:

    a. Declare a private instance variable of type `double` named `price`. (1)
    b. Write **TWO** methods, both named `setPrice`:
        i. one that accepts an int; (1)
        ii. one that accepts a double. (1)
    c. Write a getter method named `getPrice` that returns the value of the `private` variable `price`. (1)
    d. What is the object-oriented technique called when two methods have the same name but different parameter types, as shown in part (b)? (1)

(Total: 5 marks)

Please turn the page.

18. A telecommunication company stores employee ID numbers in a binary tree to allow efficient searching and organised retrieval of data. The current structure of the binary tree is shown below:



a. Mention and describe **THREE** types of binary tree traversal methods. (3)
b. Choose **TWO** of the traversal methods mentioned in part (a), and for each method chosen write the sequence of node values produced when it is applied to the binary tree above. (2)

(Total: 5 marks)

19. A school keeps a linear list of student ID numbers in an array called `students`, along with a variable `count` that stores how many IDs are currently in the list. The list is currently stored as follows:

```
students[0] ← 1023
students[1] ← 1045
students[2] ← 1078
students[3] ← 1102
count ← 4
```

In pseudocode, do the tasks below on the list above:
a. Add a new student ID (1150) to the end of the linear list. (2)
b. Delete the student ID stored at position 1 in the linear list. (2)
c. Explain why these operations cannot be implemented in the same way for linked lists. (1)

(Total: 5 marks)

20. A small shop needs a simple Java program to calculate the adjusted cost of an item. Write a Java program that carries out this task by following the steps below:

a. Declare a variable called `rate` with an initial value of 2.0. (1)
b. Read a double quantity from the user. (1)
c. Post-increment the `rate` variable. (1)
d. Use a shortcut assignment operator to multiply the quantity entered by the user by the updated `rate` variable. (1)
e. Output the resulting value. (1)

(Total: 5 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 SECOND SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	II
DATE:	1st September 2026
TIME:	9:00 a.m. to 12:05 p.m.

Directions to Candidates

· Answer **any FIVE** questions.
· Good English and orderly presentation are important.
· All answers are to be written on the booklet provided.
· The use of flowchart templates is permitted but calculators may **NOT** be used.

1. A digital logic circuit for a smart home security system is being designed. The system uses four input sensors:

   Motion Sensor (A)
   Door Sensor (B)
   Window Sensor (C)
   Night Mode Switch (D)

   It produces three outputs: Alarm (X): Activates when intrusion is detected
   Lights (Y): Turns on security lights
   Notification (Z): Sends alert to homeowner

   The behaviour of the system is defined by the following truth table:

A	B	C	D	X	Y	Z
0	0	0	0	0	0	0
0	0	0	1	1	1	0
0	0	1	0	0	0	0
0	0	1	1	1	1	1
0	1	0	0	0	0	0
0	1	0	1	1	1	1
0	1	1	0	1	0	0
0	1	1	1	1	1	1
1	0	0	0	0	0	0
1	0	0	1	1	1	0
1	0	1	0	0	0	0
1	0	1	1	1	1	1
1	1	0	0	0	0	0
1	1	0	1	1	1	1
1	1	1	0	1	0	0
1	1	1	1	1	1	1

Questions continue on the next page.

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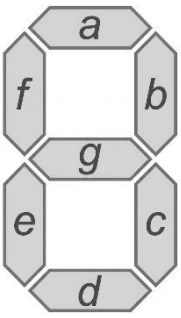
a. Construct separate Karnaugh maps for **each** output variable (X, Y and Z). Clearly label rows and columns. (6)
b. Using the Karnaugh maps, derive simplified Boolean expressions for **each** output. Show your grouping. (6)
c. Design a combinational logic circuit using your simplified expressions. (3)

The system also includes a 7-segment display to show alert levels from 0 to 9, where inputs A, B, C and D represent a binary-coded number. The segments required for each digit (0–9) follow the standard 7-segment display format.



d. Using Karnaugh maps, derive simplified Boolean expressions for outputs a, b and c only. Use don't care (X) conditions for unused input combinations. (5)

(Total: 20 marks)

2. Assembly language is a low-level programming language that provides a way to write instructions closely related to machine code. It allows direct control over hardware through the use of registers, instructions and memory addressing.

a. Describe the general format of an assembly language instruction, naming **each** of its parts and explaining the role of **each**. (3)

Consider the following program segment:

```
MOV AX, #000AH  ; Move 000AH into AX
MOV BX, #0002H  ; Move 0002H into BX
MOV CX, #0001H  ; Move 0001H into CX
ADD AX, BX      ; Add BX to AX, result in AX
SUB AX, CX      ; Subtract CX from AX, result in AX
DEC BX          ; Decrement BX by one
ADD AX, BX      ; Add BX to AX, result in AX
```

b. Trace the execution of the program and state the contents of registers AX and BX after **each** instruction. (6)
c. Identify the addressing mode used in **each** of the following instructions:
   i. `MOV AX, #0005H  ; Move 0005H into AX` (1)
   ii. `MOV AX, BX  ; Copy contents of BX into AX` (1)
   iii. `MOV AX, 0900H  ; Move contents of address 0900H into AX` (1)
   iv. `MOV AX, [BX]  ; Move contents of address held in BX into AX` (1)
   v. `MOV AX, [BX+SI] ; Move contents of address BX + SI into AX` (1)
d. Explain what is meant by symbolic addressing and state **ONE** advantage of using it in assembly programs. (2)
e. Describe **THREE** stages involved in the assembly process. (3)
f. Name and describe **ONE** type of assembler. (1)

(Total: 20 marks)

3. A smart city is implementing a new network infrastructure to support traffic management systems, public WiFi, security surveillance cameras and communication between emergency services. The network must handle large volumes of data efficiently and reliably.

   a. Define point-to-point communication. (1)
   b. Differentiate between simplex and full-duplex communication, giving **ONE** example of **each** from the scenario. (2)
   c. Explain what is meant by bit rate and baud rate, and describe **ONE** main difference between them. (2)
   d. Describe how time division multiplexing (TDM) operates in a network environment and compare it with frequency division multiplexing, stating **ONE** advantage of **each**. (3)
   e. Define an IP address and distinguish between public and private IP addresses. (2)
   f. Explain **ONE** limitation of IPv4 and how IPv6 addresses this issue. (2)
   g. Explain the purpose of the OSI model and describe any **TWO** of its layers. (3)
   h. Compare bus topology and mesh topology, giving **ONE** advantage of **each**. (3)
   i. Explain the role of a router in a network and describe why encryption is important in this smart city network. (2)

(Total: 20 marks)

4. A retail company is upgrading its data storage system from a traditional file-based system to a modern database management system (DBMS). The new system will handle product details, customer information and sales transactions.

   a. The IT manager warns that moving to a DBMS also carries drawbacks. Describe **TWO** disadvantages of using a database system compared to the existing file-based system. (2)
   b. The new system must allow staff to look up sales by `SaleID`, but also to search products by `ProductName`. Explain the purpose of a primary key and a secondary key, referring to this scenario. (2)
   c. Compare the hierarchical database model and the relational database model, and state **ONE** characteristic of **each**. (2)
   d. Explain the purpose of the following components of a DBMS:
      i. Data Manipulation Language (DML); (1)
      ii. Data Description Language (DDL). (1)
   e. Describe the **THREE** levels of the database schema. (2)
   f. The following table is used in the system:
      `SALES (SaleID, ProductName, CustomerName, ProductPrice, Quantity)`
      i. Identify **TWO** problems with this table structure. (2)
      ii. Explain how data redundancy can be reduced in this system. (1)
   g. Describe the purpose of Entity-Relationship (E-R) diagrams in database design. (1)
   h. Explain what is meant by cardinality in an E-R diagram. (1)
   i. State **ONE** responsibility of a database administrator related to security. (1)
   j. Without writing SQL, describe in words what the following queries would return:
      i.
```
SELECT ProductName
FROM Products
WHERE ProductPrice > 50
ORDER BY ProductName;
```
(2)
      ii.
```
SELECT CustomerName, SUM(Quantity)
FROM Sales
GROUP BY CustomerName
HAVING SUM(Quantity) > 10;
```
(2)

(Total: 20 marks)

Please turn the page.

5. This question focuses on the internal organisation and operation of a CPU within a typical computer system. A key element of the CPU is its set of registers, which are used to temporarily store data and control information during processing.

   a. Briefly describe the function of **each** of the following registers:
      i. MDR/MBR;
      ii. MAR;
      iii. CIR. (3)
   b. Mention **THREE** general-purpose registers and explain how **each** one is used during program execution. (3)
   c. Draw a labelled diagram of the CPU model, using the Von Neumann architecture, clearly showing its **THREE** main components (including the registers) and any other necessary components related to it. (4)
   d. Explain the role of the other **TWO** CPU components drawn in your diagram in part (c), apart from the registers. (2)
   e. Using the CPU components identified in part (c), list the steps involved in the Fetch–Decode–Execute cycle. Make direct reference to the role of the System Bus (Data Bus, Address Bus and Control Bus) and the registers used at each stage. (6)
   f. A program may include several subroutines that the CPU must call and return from correctly. Explain the structure and purpose of the stack in managing subroutine calls. (2)

   (Total: 20 marks)

6. An insurance company stores sensitive customer and financial data on a central file server. Employees frequently edit files and access shared folders, but the company has recently faced issues such as unauthorised access, accidental file changes, and data loss due to hardware failure.

   a. Describe **TWO** operating system (OS) file-management facilities that support the editing of file contents. (2)

   One technique the company is considering to prevent unauthorised access is the use of a User ID and password.

   b. Explain how a User ID and password help prevent unauthorised file access. (1)
   c. State **TWO** limitations associated with relying solely on a User ID and password for access control. (2)

   Another security measure used by the company is the implementation of file access rights.

   d. What are file access rights? (1)
   e. Mention and describe **THREE** types of file access rights. (3)
   f. Describe how incorrect file access rights can lead to security vulnerabilities. (1)
   g. Explain what allocated privileges are and describe how they differ from ordinary access rights. (2)
   h. Give **TWO** examples of allocated privileges which might be used by this insurance company. (2)
   i. Apart from access rights and allocated privileges, files are also controlled through various attributes. Define file attributes. (1)
   j. Mention and describe **TWO** examples of file attributes. (2)
   k. Despite access controls, files can still be lost or corrupted if hardware failure occurs. Explain how hardware failure affects file integrity, and describe **TWO** preventive measures the insurance company can implement to reduce this risk. (3)

   (Total: 20 marks)

7. A software engineer is documenting the syntax of a simple input language for a small embedded system which accepts the following commands:

run A
run B
stop

The engineer decides to describe the syntax using Backus-Naur Form (BNF).

a. What is BNF and why is it appropriate for the engineer to use it to describe the syntax of this language? (2)

The BNF grammar written by the engineer to describe the syntax is the following:

```
<command>      ::= <run-command> | <stop-command>
<run-command>  ::= run <variable>
<variable>     ::= "A" | "B" | "C"
<stop-command> ::= "stop"
```

b. Identify **TWO** mistakes in the BNF grammar above and rewrite the relevant rules correctly. (4)
c. Using the corrected grammar from part (b), determine whether **each** of the following commands is syntactically valid i.e. *run A*, *run B* and *stop*. Show your working. (6)
d. The engineer notes that even a syntactically valid command may not be meaningful. What term describes the meaning of a language, as opposed to its form? Give a concrete example of this, not necessarily limited to the example above. (2)
e. Draw syntax diagrams for the following **TWO** BNF rules:
   i. <run-command> ::= "run" <variable> (3)
   ii. <command> ::= <run-command> | <stop-command> (3)

(Total: 20 marks)

8. A software developer is building a data-retrieval system that must search customer records stored in either unsorted lists or lists arranged in ascending order. The engineer must choose between using a sequential search or a binary search.

a. Differentiate between a sequential and a binary search. (2)
b. State **ONE** advantage and **ONE** disadvantage of each search method mentioned in part (a). (4)
c. Write, in pseudocode, an algorithm that performs a sequential search for an item with customer ID 4405 in an unsorted list. (4)
d. State the conditions that must be satisfied before a binary search algorithm can be used. (2)
e. Write, in pseudocode, an algorithm that performs a binary search for an item with customer ID 4405 in an ordered list. (6)
f. Explain how the performance of a binary search changes as the number of data items increases. (2)

(Total: 20 marks)