L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2018 FIRST SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	I
DATE:	14th May 2018
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.

SECTION A

1. Consider the TWO classes:

```
public class MyClass {
   private int myVariable = 1;
   public void myMethod() {
         System.out.println("Hello");
   }
}

public class Main {
   public static void main(String[] args) {
         MyClass myClass = new MyClass();
         myClass.myMethod();
         myClass.myVar;
   }
}
```

   a. Will the statement myClass.myMethod() result in a compilation error? Explain. (2)
   b. Will the statement myClass.myVar; result in a compilation error? Explain. (2)
   c. How would you modify MyClass to ensure that the Main class compiles correctly? (1)

(Total: 5 marks)

2. a. What is the purpose of the "try-catch" block in Java programming? (2)
   b. Name **THREE** data structures. (3)

(Total: 5 marks)

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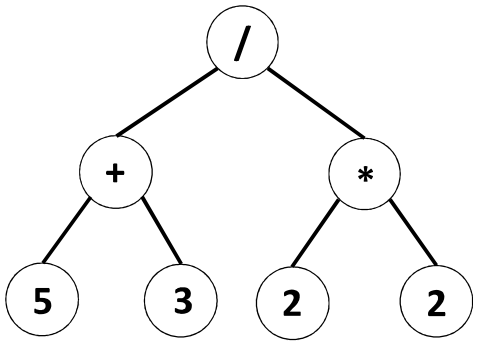
SECTION B

3. a. Briefly describe what is meant by bandwidth and baud rate. (2)
   b. What do HTML, ISDN and ADSL stand for? (3)
   (Total: 5 marks)

4. a. What does the structure of a datagram consist of? (2)
   b. Briefly describe **THREE** layers of the OSI model (3)
   (Total: 5 marks)

5. a. Traverse the tree shown below to determine an arithmetical statement in Reverse Polish Notation(RPN). (2)



   b. Briefly explain what assemblers, compilers and interpreters are. (3)
   (Total: 5 marks)

6. a. Name and briefly describe **THREE** types of operating systems. (3)
   b. Briefly describe the function of the interrupt mask register. (2)
   (Total: 5 marks)

7. a. Mention **THREE** techniques of file organisation using blocks. (3)
   b. What is memory fragmentation, and which technique is used to recover from it? (2)
   (Total: 5 marks)

8. A book shop hires you as their consultant to replace their current manual system with a computerised system.
   a. Describe the first step that you would take in order to achieve the upgraded system. (1)
   b. One of the new features that the bookshop would like to provide to their customers is an online search facility using the book title. Draw the flowchart that would be required to achieve this feature using linear search. Assume that you have access to a list of all the book titles currently in stock. (4)
   (Total: 5 marks)

9. a. Mention **TWO** reasons why a business would want to develop a new system. (2)
   b. Describe **THREE** testing strategies used in the system life cycle. (3)
   (Total: 5 marks)

10. a. Briefly discuss the parallel and pilot change-over techniques. (2)
    b. Documentation is one best practice to ensure efficient system maintenance. Name and briefly describe another such best practice. (2)
    c. What is meant by pseudo-code? (1)

(Total: 5 marks)

11. a. Name and describe **TWO** stages of the compilation process. (4)
    b. What is meant by the term semantics? (1)

(Total: 5 marks)

12. a. Mention **TWO** responsibilities of a database administrator. (2)
    b. Mention **THREE** advantages of databases over traditional file systems. (3)

(Total: 5 marks)

13. Consider the following Student table:

surname	name	student_id	school_name	town
Meilak	George	2897	ABC	Sliema
Schembri	Anthony	3454	PQR	Attard
Abela	Maria	1230	PQR	Zebbug
Farrugia	Susanne	0789	XYZ	Siggiewi
Vella	Ethan	2213	ABC	Mellieha
Said	Laura	1511	LMN	Valletta

    a. What is the result of the SQL query:

```
SELECT name, surname
FROM Student
Where school_name = 'ABC'
ORDER BY surname
```

(2)

    b. What is the result of the SQL query:

```
SELECT school_name
FROM Student
HAVING student_id > 2000
```

(2)

    c. Out of the existing fields in the table, which one is suitable as the primary key? (1)

(Total: 5 marks)

Questions continue on next page

14. a. Given the following array of numbers: [3, 5, 11, 16, 17, 25, 50], explain how binary search would be used to determine the location of number 17. (2)
    b. Mention **ONE** important condition needed to ensure the success of the binary search algorithm. (1)
    c. Draw a tree representing the binary search performed in part (a) of this question. (2)

(Total: 5 marks)

15. a. Convert the hexadecimal number $3E_{16}$ to decimal. (2)
    b. Convert the decimal number 183_{10} to binary. (2)
    c. Convert the binary number 10100101_2 to hexadecimal. (1)

(Total: 5 marks)

16. a. List the different components of a floating-point number representation and describe them briefly. (2)
    b. Convert the decimal number -11.5_{10} into the described floating-point representation with a 10-bit mantissa. (3)

(Total: 5 marks)

17. Using Karnaugh maps, determine minimised expressions for F and G. X indicates a don't care condition.

A	B	C	F	G
0	0	0	1	X
0	0	1	X	0
0	1	0	X	X
0	1	1	0	1
1	0	0	0	X
1	0	1	X	X
1	1	0	1	1
1	1	1	X	0

(Total: 5 marks)

18. A memory component has a data bus that is 16 bits wide and an address bus that is 12 bits wide.
    a. What is the number of 16-bit words that can be accessed? (2)
    b. What is is the capacity of the device in kilobits, where 1 kilobit is 2^{10} bits? (2)
    c. What is the capacity of the device in kilobytes, where 1 kilobyte is 2^{10} bytes? (1)

(Total: 5 marks)

19. Distinguish between a microprocessor with a RISC instruction set and a microprocessor with a CISC instruction set. Your answer must include at least **ONE** example of each, and at least **ONE** advantage of each. **(Total: 5 marks)**

20. Find the value inside the register ax at the end of the following assembly language program. Show your working.

```
        mov ax, 3    ; set ax = 3
        mov cx, 0    ; set cx = 0
        mov dx, 0    ; set dx = 0
loop:   cmp cx, ax   ; compare cx with ax
        jge ready    ; jump to ready if cx >= ax
        inc cx       ; increment cx by 1
        add dx, cx   ; set dx = dx + cx
        jmp loop     ; jump to loop
ready:  mov ax, dx   ; set ax = dx
```

(Total: 5 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2018 FIRST SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	II
DATE:	15th May 2018
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. A full adder has **THREE** inputs and **TWO** outputs. List the inputs and outputs of the full adder. (2)

   b. Draw a truth table of the outputs of the full adder in terms of the inputs. (3)

   c. Using Karnaugh maps, determine minimised expressions for each of the two outputs. (6)

   d. For only one of the two outputs, draw a diagram showing how it can be implemented using logic gates. You should use only NAND gates and, optionally, NOT gates. (4)

   e. i. Write down the binary representation of the decimal number 36 using an eight-bit two's-complement representation. (2)

   ii. Write down the binary representation of the decimal number −2.25 using an eight-bit two's-complement fixed-point representation with four integer bits and four fractional bits. (3)

(Total: 20 marks)

2. a. Using Boolean algebra:

   i. Show that $(A + B + C)(A + \bar{B} + \bar{C}) = A + B\bar{C} + \bar{B}C$ (3)

   ii. Show that $(\bar{A} + B + \bar{C})(\bar{A} + \bar{B} + C) = \bar{A} + BC + \bar{B}\bar{C}$ (3)

   iii. Hence, show that

   $$(A + B + C)(A + \bar{B} + \bar{C})(\bar{A} + B + \bar{C})(\bar{A} + \bar{B} + C) = ABC + A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}\bar{B}C$$ (3)

   b. Using a suitable diagram, show how the main components of a computer system are connected together. (4)

   c. Direct memory access (DMA) can be used to improve the performance of a computer system. Describe DMA and explain how it improves the performance. (4)

   d. Is DMA used to access main memory, or to access cache memory, or to access both main and cache memory? Give reasons for your answer. (3)

(Total: 20 marks)

3. a. What is a page fault, and how does the operating system recover from it? (4)

   b. Define the notion of deadlock. Discuss how it can be avoided, and how it may be detected should it occur. (9)

   c. Distinguish between a logical address and a physical address. (4)

   d. Name and describe **ONE** scheduling technique used by an operating system. (3)

(Total: 20 marks)

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4. In the assembly program below, ax is a 16-bit register, and `al` is the eight-bit lowest significance byte of `ax`.

```
        jmp start       ;jump to program start
func:   cmp ax, 65      ; compare ax with 65
        jl same         ; jump to same if ax < 65
        cmp ax, 78      ; compare ax with 78
        jl up           ; jump to up if ax < 78
        cmp ax, 91      ; compare ax with 91
        jl down         ; jump to down if ax < 91
same:   ret             ; return from function
up:     add ax, 13      ; set ax = ax + 13
        ret             ; return from function
down:   sub ax, 13      ; set ax = ax - 13
        ret             ; return from function

start:  mov ax, 0       ; set ax = 0

        mov al, [1000H] ; read from address 1000H into al
        call func       ; call function func
        mov [1000H], al ; write al into address 1000H

        mov al, [1001H] ; read from address 1001H into al
        call func       ; call function func
        mov [1001H], al ; write al into address 1001H

        mov al, [1002H] ; read from address 1002H into al
        call func       ; call function func
        mov [1002H], al ; write al into address 1002H

        mov al, [1003H] ; read from address 1003H into al
        call func       ; call function func
        mov [1003H], al ; write al into address 1003H
finish:                 ; program has finished
```

Before the program starts, the four memory locations starting at hexadecimal address 1000 are as shown below. The values are shown in decimal.

Memory Location	1000H	1001H	1002H	1003H
Value	85	82	76	33

a. Determine the ASCII characters represented by the bytes at hexadecimal addresses 1000, 1001 and 1002 before the program starts. The character 'A' has ASCII code 65. (2)

b. Determine the contents of the four memory locations shown when the program reaches finish. (8)

c. Determine the ASCII characters represented by the bytes at hexadecimal addresses 1000, 1001 and 1002 after the program finishes. (2)

d. From the program above, list all:
   i. data transfer instruction mnemonics;
   ii. arithmetic instruction mnemonics; and
   iii. transfer instruction mnemonics (from instructions that can change the flow of control). (3)

e. Name the addressing modes used for the underlined operands in these instructions from the program above:
   i. mov al, **[1000H]** ; read from address 1000H into al
   ii. cmp ax, **91** ; compare ax with 91 (2)

f. An assembler is required to convert an assembly language program into machine code for a very simple microcontroller that has a limited instruction set. What type of assembler is typically used for this kind of task? Give reasons for your answer. (3)

(Total: 20 marks)

5. a. Name and describe **TWO** types of transmission media which make use of cabling. (6)

b. Each machine on a network is allocated an IP address to allow it to communicate with other machines. Discuss how a website URL entered by a user is converted to an IP address. (4)

c. Mention **ONE** benefit and **ONE** drawback for each of the Bus, Ring and Star network topologies. (6)

d. E-commerce and e-learning are two important applications of the Internet. Discuss **ONE** other application. (4)

(Total: 20 marks)

6. a. Distinguish between a terminal symbol and a non-terminal symbol? (4)

b. Evaluate the RPN expression: 3 5 + 9 7 - * using a stack, showing all stages of your working. (8)

c. Discuss **THREE** similarities between natural and formal languages. (6)

d. What is meant by just-in-time compilation? (2)

(Total: 20 marks)

7. a. Discuss **FOUR** feasibility aspects to consider when performing systems analysis and design. (8)

b. What is meant by an "off-the-shelf" solution? Mention **ONE** advantage and **ONE** disadvantage of this solution when compared to a purpose-built solution. (4)

c. Compare and contrast the Spiral model and the Waterfall model. (8)

(Total: 20 marks)

8. Consider the following three Java classes:

```
public class Vehicle {
    public String colour;
    public Vehicle(String colour) {
        this.colour = colour;
    }
    public void drive() {
        System.out.println("Drive");
    }
}

public class Car extends Vehicle {
    public Car(String colour) {
        super(colour);
    }
    public void drive() {
        System.out.println("Vroom");
    }
}

public class Motorcycle extends Vehicle {
    public Motorcycle() {
        super("Black");
    }
    public void driveMotorCycle() {
        System.out.println("Vroom Vroom");
    }
}
```

a. Write code which creates an instance of the `Car` class with a colour of your choice. (2)
b. What would the output be if you called the drive method on your `Car` class instance? Briefly discuss how you arrived at your answer. (2)
c. What would the output be if you called the drive method from an instance of the `Motorcycle` class? Briefly discuss how you arrived at your answer. (2)
d. Draw a UML class diagram for the `Vehicle`, `Car` and `Motorcycle` classes. (6)
e. Discuss **ONE** change that you would make to the `Vehicle` class in order to improve security. (1)
f. Following the change in part (e), which OOP principle is now exploited? (1)
g. How would you save data generated by a Java application, so that it may be used when the application is executed again? (1)
h. Suppose you were to create several instances of the `Motorcycle` and `Car` classes, and would like to store them in a single data structure. Give an example of a suitable data structure, and explain which data type you would use for it and why. (5)

(Total: 20 marks)