L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2019 SECOND SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	I
DATE:	2nd September 2019
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 following code which computes the factorial of an integer:

```
public static int factorial(int number) {
   if (number == 1 || number == 0) {
     return 1;
   } else {
     return factorial(number-1)*number;
   }
}
```

   a. What is the value returned by calling `factorial(4)` ? Show your working. (4)
   b. What programming technique is being used in this code? (1)

(Total: 5 marks)

2. Consider the method:

```
public int doCalculation(int num1) {
   return num1*num1;
}
```

   a. Overload the method shown above to take a second parameter of type `int`, and return the sum of the two parameters. (2)
   b. In part (a), overloading was performed by adding a second parameter. Mention **ONE** other way in which overloading can be performed. (1)
   c. Override the method shown in part (a) to first print out the result of the multiplication, and then return the answer. There is no need to produce the code for the subclass containing the overriding method. (2)

(Total: 5 marks)

SECTION B

3. a. What are the following protocols used for?
   i. HTTP (1)
   ii. FTP (1)
   iii. POP3 (1)
   b. What is the arrangement of the various elements on a computer network called? Give **ONE** example of such an arrangement. (2)

   (Total: 5 marks)

4. Data can be transmitted via either a wired or a wireless medium.
   a. Which medium would provide greatest reliability and reduced transmission errors due to noise, and why? (2)
   b. Give an example of an IP address. (1)
   c. Distinguish between a peer-to-peer and a broadcast network. (2)

   (Total: 5 marks)

5. a. What is meant by partitioning? Which entity in a computer system performs this task? (2)
   b. What is DMA, and how is it associated with interrupt handling? (3)

   (Total: 5 marks)

6. a. What does it mean for a process to be in a suspended state? (2)
   b. Mention **TWO** other states that a process can be in. (2)
   c. What is the term used for the situation when two processes wait for each other to finish, and therefore neither ever does? (1)

   (Total: 5 marks)

7. a. Mention **THREE** techniques that can be used to understand the problem which needs to be solved in systems analysis and design. (3)
   b. Mention **TWO** hardware aspects which need to be considered when designing a new system. (2)

   (Total: 5 marks)

8. Consider the following pseudocode:

```
int[] myArray = new int[5, 6, 3, 2, 1]
For each element in myArray, print out the element.
```

   a. Sketch a flowchart which represents the above pseudocode. (3)
   b. Mention **TWO** algorithm representation forms other than pseudocode and flowcharts. (2)

   (Total: 5 marks)

9. a. Discuss **TWO** advantages and **TWO** disadvantages of off-the-shelf solutions. (4)
   b. Code documentation is one best software development practice. Mention another best practice. (1)

   (Total: 5 marks)

10. a. Mention **ONE** instance where you would use:
    i. an interpreter; (1)
    ii. an assembler; (1)
    iii. a compiler. (1)
    b. What is the difference between a lexeme and a token? (2)

(Total: 5 marks)

11. a. Briefly describe the purposes of the following components of a database management system:
    i. data dictionary; (1)
    ii. data manipulation language; (1)
    iii. data description language. (1)
    b. Mention **TWO** reasons why it is desirable to normalise a database up to the Third Normal Form. (2)

(Total: 5 marks)

12. Consider the following Student table:

Surname	Name	Town	Time of Registration	Course
Camilleri	Matthew	Zurrieq	21072019105433	Engineering
Borg	James	Sliema	21072019113701	IT
Galea	Nadine	Marsa	22072019091023	Architecture
Borg	Antoinette	Zebbug	22072019091513	Medicine
Zammit	Angela	Mgarr	22072019092345	IT

    a. Which attribute would you select as the primary key, and why? (2)
    b. Mention **THREE** types of database models. (3)

(Total: 5 marks)

13. Consider the array of numbers [7, 9, 3, 8, 6]:

    a. Explain how linear search would be used to locate the number 8. (2)
    b. Explain how binary search would be used to locate the number 6. (2)
    c. What is the purpose of serialisation for a data structure such as an Array List? (1)

(Total: 5 marks)

14. a. Use the Big-"O" notation to indicate the computational complexity for the following sorting algorithms in the best case that the array is already sorted:
    i. insertion sort; (1)
    ii. selection sort; (1)
    iii. bubble sort. (1)
    b. Distinguish between a linked list and a double linked list. (2)

(Total: 5 marks)

15. a. Distinguish between syntax and semantics. (2)
    b. What is a syntax diagram? (1)
    c. Draw a syntax diagram to represent an if-then-else statement in a high level language. (2)

(Total: 5 marks)

16. a. Using Boolean algebra, show that:

$$A + \overline{A}B = A + B$$

(2)

    b. Hence, show that

$$A + \overline{A}B + \overline{B}C = A + B + C$$

(3)

(Total: 5 marks)

17. Convert the following hexadecimal numbers to decimal. The numbers use a two's-complement fixed-point representation with eight integer bits and eight fractional bits.
    a. 3B40 (2)
    b. A4C0 (3)

(Total: 5 marks)

18. a. Describe the following types of CPU registers, giving **ONE** example of each:
        i. data registers; (1)
        ii. index registers; (1)
        iii. stack registers. (1)
    b. The status register, also called the flag register, contains a number of flags. Name and describe any **TWO** of the flags. (2)

(Total: 5 marks)

19. Determine the contents of the register `ax` in hexadecimal after the following assembly code is executed. The registers `ax`, `cx` and `dx` are 16-bit registers. Show your working.

```
mov ax, 00ffh   ;initialize ax to hexadecimal 00ff
mov dx, 0180h   ;initialize dx to hexadecimal 0180
mov cx, 0001h   ;initialize cx to hexadecimal 0001
not cx          ;set cx to logic NOT cx
add cx, 1       ;set cx to cx + 1
xor cx, ax      ;set cx to logic cx XOR ax
and cx, dx      ;set cx to logic cx AND dx
xor ax, cx      ;set ax to logic ax XOR cx
```

(Total: 5 marks)

20. Using a Karnaugh map, find a minimised expression for the following truth table, where X indicates a don't care condition.

A	B	C	D	F
0	0	0	0	1
0	0	0	1	0
0	0	1	0	X
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	X
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(Total: 5 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2019 SECOND SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	II
DATE:	3rd September 2019
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 very small computer system has 64 kb (64×2^{10} bytes) of main memory connected to a microprocessor, which can read or write one byte at a time. The following three instructions are executed in order by the microprocessor. The register `al` is an eight-bit register.

```
mov [1000], 13  ;write value 13 to location at address 1000
mov al, [1000]  ;read value at address 1000 into register al
mov [2040], al  ;write contents of register al to address 2040
```

   i. What is the size of the data bus in bits? (1)
   ii. What is the size of the address bus in bits? (2)
   iii. What are the values passed on the data bus and on the address bus for each of the **THREE** instructions? (6)
   iv. Name the **THREE** addressing modes used in the instructions above. In each case, give an example from the instructions. (3)

   b. Main memory and cache memory normally make use of different types of memory: one is typically Dynamic RAM (DRAM) and the other is typically Static RAM (SRAM).
   i. State which type of RAM is more suitable for main memory. Name **ONE** advantage why it makes it more suitable. (2)
   ii. State which type of RAM is more suitable for cache memory. Name **ONE** advantage why it makes it more suitable. (2)

   c. Briefly describe the functionality of the following components of a CPU:
   i. Control Unit (CU); (1)
   ii. Arithmetic Logic Unit (ALU); (1)
   iii. Program Counter (PC); (1)
   iv. Current Instruction Register (CIR). (1)

(Total: 20 marks)

Questions continue on next page

2. a. The round-robin algorithm is used by an operating system to schedule processes. Describe how this algorithm works. (3)
   b. Is the round-robin algorithm pre-emptive or non-preemptive? Explain the reasoning behind your answer. (3)
   c. Mention **ONE** advantage and **ONE** disadvantage of the round-robin algorithm, and discuss how another scheduling algorithm could solve the disadvantage. (4)
   d. What is memory store protection? (3)
   e. One of the roles of a system administrator is to prevent unauthorised access to files.
      i. Mention **TWO** ways in which unauthorised users may try to get access to data stored on a computer. (2)
      ii. Discuss **TWO** techniques which the system administrator can use to prevent unauthorized access. (2)
   f. What is an address space in an operating system? Distinguish between a physical and a logical address. (3)

(Total: 20 marks)

3. A system has one single-bit input A and one three-bit input N. N is a three-bit unsigned integer. The system is required to produce the following output Y.

   - If $A = 0$ and $N \geq 3$, then $Y = 0$.
   - If $A = 1$ and $N \geq 5$, then $Y = 0$.
   - If $A = 0$ and $N \leq 2$, then $Y = 1$.
   - If $A = 1$ and $N \leq 4$, then $Y = 1$.

   a. Write down the range of the integers that can be represented by N. (1)
   b. Draw a truth table for the system output Y. (3)
   c. Using a Karnaugh map, obtain a minimised Boolean expression for Y. (5)
   d. Draw a diagram showing how the expression obtained in part (c) can be implemented using only NOT gates and NAND gates. The NAND gates can have two, three or four inputs. (7)
   e. Explain how one logic gate can be added to change the system such that the output Y is changed to:

      - If $A = \mathbf{1}$ and $N \geq 3$, then $Y = 0$.
      - If $A = \mathbf{0}$ and $N \geq 5$, then $Y = 0$.
      - If $A = \mathbf{1}$ and $N \leq 2$, then $Y = 1$.
      - If $A = \mathbf{0}$ and $N \leq 4$, then $Y = 1$.

      (2)
   f. The system is to be changed to accept negative as well as positive values of N. It is required that **all** values in the range $-6 \leq N \leq 6$ are to be allowed. Suggest a representation for N, and indicate the number of bits required. (2)

(Total: 20 marks)

4. a. Distinguish between parallel and serial transmission, giving an example in which each is used. (4)
   b. Name and briefly describe **THREE** layers in the OSI model. (3)
   c. Describe how a modem works. (3)
   d. What does the term "Asymmetric" in ADSL refer to? (2)
   e. E-learning and e-commerce are two types of Internet applications. Mention and describe **TWO** other applications. (4)
   f. Name and describe the operation of a retransmission scheme used in the event of errors occurring during data transmission. (4)

(Total: 20 marks)

5. In the following assembly program, `di`, `ax` and `dx` are 16-bit registers. The memory-read instructions retrieve one byte from main memory.

```
begin:
    mov di, 8000    ;set di to 8000
    sub ax, ax      ;subtract ax from ax
loop:
    mov dx, [di]    ;read byte from memory at address di into dx
    cmp dx, 0       ;compare dx to 0
    je end          ;conditional jump to end if dx = 0
    add ax, 1       ;add 1 to ax
    add di, 1       ;add 1 to di
    cmp dx, 128     ;compare dx to 128
    jl loop         ;conditional jump to loop if dx < 128
    add di, 1       ;add 1 to di
    cmp dx, 224     ;compare dx to 224
    jl loop         ;conditional jump to loop if dx < 224
    add di, 1       ;add 1 to di
    cmp dx, 240     ;compare dx to 240
    jl loop         ;conditional jump to loop if dx < 240
    add di, 1       ;add 1 to di
    jmp loop        ;unconditional jump to loop
end:
```

The memory at locations 8000 to 8010 contains the following values:

Address	8000	8001	8002	8003	8004	8005	8006	8007	8008	8009	8010
Contents	194	169	226	136	139	240	159	132	175	33	0

a. List **all** the instructions used in the program that are:
   i. data transfer instructions; (1)
   ii. arithmetic instructions; (1)
   iii. control transfer instructions. (1)

b. The instruction `sub ax, ax` will set `ax` to the same final value irrespective of what the initial value of `ax` is. Using any two different initial values of `ax`, show how the same final value is achieved. (2)

c. Determine the values inside registers `di` and `ax` every time the program execution reaches the `loop` label. Hint: `di` should never be greater than 8010. (12)

d. Write down the value of register `ax` when the program execution reaches the `end` label. (1)

e. One loop iteration starts when execution reaches the `loop` label and finishes when execution reaches either the `loop` label or the `end` label. When counting instructions, conditional jumps should be counted both when the jump is taken and when the jump is not taken.
   i. Count the minimum number of instructions executed in one loop iteration. (1)
   ii. Count the maximum number of instructions executed in one loop iteration. (1)

(Total: 20 marks)

Questions continue on next page

6. A local sailing club has setup a database for members and boats which they can use. The current version of the database consists of a single table called "sailing_club":

Member ID	Name	Surname	Boat ID	Boat Type	Boat Category
7	Anthony	Pace	1	Laser 4.7	Racing
3	Martha	Micallef	2	Mirror	Leisure
5	John	Borg	3	Laser Radial	Racing
5	John	Borg	4	Wayfarer	Leisure
2	Francesca	Attard	5	Laser Radial	Racing
3	Martha	Micallef	6	Optimist	Racing

   a. What are your initial observations about the sailing club table? What issues are there? (4)
   b. Create a new schema for the table(s) required to solve the problems identified in part (a). (12)
   c. Explain the notion of a foreign key in a database table. Mention which foreign key(s) are present in the schema you developed in your answer to part (b). (4)

(Total: 20 marks)

7. A university is presently accepting online registrations for courses from prospective students. A student would fill in the online application form and submit it electronically via a browser, attaching copies of his/her grade certificates. A clerk would later review the application form and save the form and copies of certificates in a database.

   The admissions board would then evaluate the application based on the entry in the database, and ask the clerk to send over a confirmation or rejection letter by post. A copy of such letters is placed in the "Confirmed applicant" or "Rejected applicant" folders respectively.
   a. Draw a Level-0 diagram for the above scenario (you may assume that a context-level diagram is the same as a level 0 diagram). (6)
   b. Draw the Level 1 diagram for the above scenario. (10)
   c. Describe what is meant by alpha and beta testing and state how you would use these techniques in the context of the university application. (4)

(Total: 20 marks)

8. Consider the following three classes:

```
public class FarmAnimal {

  public String name;

  public FarmAnimal(String name) {
     this.name = name;
     System.out.println(name);
  }

  public FarmAnimal() {
     this.name = "NoName";
  }

  public String getName() {
     return name;
  }
}


public class Cow extends FarmAnimal {

    public Cow() {

    }

    public Cow(String name) {
      super(name);
    }

    public String getName() {
      System.out.println(name);
      return name;
    }
}


public class Horse extends FarmAnimal {

  public Horse() {
     aboutHorse();
  }

  public void aboutHorse() {
    System.out.println("This is a horse");
  }
}
```

a. What is the output if the following code is executed?

```
Horse horse = new Horse();
FarmAnimal cow = new Cow("Daisy");
cow.getName();
```

(6)

Question continues on next page

b. How is the output of the code in part (a) affected if the `Horse` constructor was updated as follows?

```
public Horse() {
  super("Horse");
  aboutHorse();
}
```

(2)

c. Will changing the access modifier of the `String` variable "`name`" in `FarmAnimal` result in an error? Explain the reasoning behind your answer. (3)

d. What is the meaning of an abstract class in Java? (2)

e. Suppose that the developer needs to create a data structure for the `FarmAnimal` type. The developer has to decide between using a linked list or a sorted array (sorted on animal name). Explain the difference between these two data structures, performance wise, for search and insertions. (4)

f. Mention **THREE** advantages of using object-oriented programming instead of imperative programming. (3)

(Total: 20 marks)