

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD  
UNIVERSITY OF MALTA, MSIDA  
MATRICULATION EXAMINATION  
ADVANCED LEVEL  
SEPTEMBER 2015

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<b>SUBJECT:</b>	COMPUTING
<b>PAPER NUMBER:</b>	I
<b>DATE:</b>	1 <sup>st</sup> September 2015
<b>TIME:</b>	9.00 a.m. to 12.00 noon

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### 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.
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### Section A

1. *Recursion* can be a powerful and elegant programming technique for a variety of applications.
  - a. Explain recursion. Be sure to mention what the terms “base case” and “general case” mean in this context. [2 marks]
  - b. Consider the following Java method:

```
private static int a(int n) {
    if (n == 0)
        return(0);

    if (n == 1)
        return(1);

    return(a(n - 1) + a(n - 2));
}
```

What value would the following method call return?

`a(3);`

[3 marks]

2. In a programming language sometimes it is desirable to use *constants* in the code. The use of constants, instead of literal values, is considered good programming practice.
  - a. List two reasons why constants can be considered as a good programming practice. [2 marks]
  - b. Look at the two definitions of PI below:

```
static double PI = 3.14159;
```

```
static final PI = 3.14159;
```

What is the difference between the “static” and “static final” definitions?

[3 marks]

**Section B**

3. A binary floating-point number representation has an exponent  $x$  in the range  $-126 \leq x \leq 127$

- a. Give an example of an operation that will cause an overflow (the exponent is too large). For the operation, write both the operand values and the operator, for example,  $2^5 + 2^{-3}$ . [2 marks]
- b. Give an example of an operation that will cause an underflow (the exponent is too small). [3 marks]

4. Using a Karnaugh map, obtain a minimized expression for the following truth table.

<i>A</i>	<i>B</i>	<i>C</i>	<i>F</i>
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	don't care
1	0	1	don't care
1	1	0	0
1	1	1	1

[5 marks]

- 5. a. A peripheral device has two lines for the power supply and two lines for data transmission. Does the device use serial or parallel transmission? Give reasons for your answer. [3 marks]
- b. **Name** the technology used in typical pen drives for:
  - i. data transmission;
  - ii. data storage. [2 marks]

- 6. **Describe** how the following registers are used to fetch an instruction in the fetch/execute cycle:
  - a. Memory Address Register (MAR);
  - b. Memory Data Register (MDR);
  - c. Current Instruction Register (CIR);
  - d. Program Counter (PC); [5 marks]

7. For the assembly program snippet below, **determine** the final value stored in register AX in **hexadecimal**.

```

        JMP  MAIN          ; jump to label MAIN
FN:     MOV  DX, AX        ; set DX equal to AX
        SHL  AX, 1        ; shift AX to the left by 1
        ADD  AX, DX        ; add DX to AX
        RET                ; return from the subroutine
MAIN:   MOV  AX, 012H      ; set AX to the hex value 12
        CALL FN           ; call the subroutine at FN
    
```

[5 marks]

8. a. **Identify** THREE layers of the OSI model. [3 marks]  
 b. **Explain** briefly ONE of them. [2 marks]
9. Wireless is one medium employed for data transmission.  
 a. **Mention** THREE types of Wireless technologies; [3 marks]  
 b. **Mention** TWO other transmission media. [2 marks]
10. a. **Explain** what is a network topology. [2 marks]  
 b. **Mention** THREE examples. [3 marks]
11. a. What does JCL stand for? [2 marks]  
 b. Briefly **explain** the use of JCL. [3 marks]
12. Give one-line definitions for the following:  
 a. Deadlock;  
 b. Interrupt;  
 c. Block;  
 d. Polling;  
 e. Partitioning. [5 marks]
13. a. **Name** the mathematical notation mostly used in computers to process arithmetic statements. [1 mark]  
 b. **Describe** how TWO particular data structures are used to obtain and evaluate the mathematical notation mentioned in a) above. [4 marks]
14. Briefly **explain** each of the following and **mention** what they are used for:  
 a. Tokens;  
 b. Linker;  
 c. Parser;  
 d. Semantic analyser;  
 e. Syntax error. [5 marks]

15. a. **Mention** THREE main techniques employed to gather data during one of the phases of the Systems Development lifecycle. [3 marks]  
b. Briefly **explain** ONE of the techniques mentioned in part a) above. [2 marks]
16. a. Why is **modularity** commercially imperative for software maintenance? [3 marks]  
b. **Explain** ONE of the main categories of software maintenance. [2 marks]
17. a. What is the main aim of the **feasibility study** during the systems development life cycle? [1 mark]  
b. Briefly **explain** the following feasibility aspects:  
i. Technical; [2 marks]  
ii. Social. [2 marks]
18. a. When designing a relational database it is important to bear in mind that normalization of the tables must be carried out. Why is **normalization** important in a relational database system? [3 marks]  
b. **Explain** what is meant by a database in 3NF? [2 marks]
19. **Explain** the differences between a **primary** key, **secondary** key and a **foreign** key. [5 marks]
20. Being able to search through data structures is a very important feature.  
a. **Describe** both the **linear** and **binary search** algorithms. [3 Marks]  
b. **Describe** a scenario where a linear search may be preferable to a binary search for a list of items. [2 Marks]

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<b>SUBJECT:</b>	COMPUTING
<b>PAPER NUMBER:</b>	II
<b>DATE:</b>	2 <sup>nd</sup> September 2015
<b>TIME:</b>	9.00 a.m. to 12.00 noon

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**Directions to Candidates**

- Answer any **FIVE** questions.
  - Good **English** and orderly **presentation** are important.
  - All answers are to be written on the **booklet** provided.
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1. a. A seven-segment display is used to display a four-bit BCD digit. The middle segment is to be switched on when the digit is 2, 3, 4, 5, 6, 8 or 9.
- i. Draw a truth table for the function  $F$  that is true when the middle segment is to be switched on. For the inputs, indicate clearly which is the most significant bit. [3 marks]
- ii. Draw a Karnaugh map of the function, and hence obtain a minimized Boolean expression for the function. [6 marks]
- iii. Draw a diagram of an implementation of the minimized function using logic gates. [5 marks]
- b. A fixed-point two's-complement binary representation uses four bits for the integer part of a number and four bits for the fractional part. Write down the decimal value for the binary numbers
- i. 1100.1100;
- ii. 0011.0100. [4 marks]
- c. Describe one advantage of floating-point over fixed-point representations. [2 marks]

2. a. The following is an assembly program.

```

MOV AX, 0          ; set AX equal to 0
MOV BX, 5          ; set BX equal to 5
MOV CX, 3          ; set CX equal to 3
LOOP: MOV DX, BX   ; set DX equal to BX
      AND DX, 1    ; bitwise logic AND with 1
      JZ  SKIP     ; if DX is 0, jump to SKIP
      ADD AX, CX   ; add CX to AX
SKIP:  SHL CX, 1   ; shift CX to the left by 1
      SHR BX, 1    ; shift BX to the right by 1
      JNZ LOOP    ; if BX is not 0, jump to LOOP
    
```

- i. Determine the contents of the register AX at the end of the program. [8 marks]
  - ii. Determine the final contents of the register AX if the initial value of CX was 4 instead of 3. [3 marks]
  - iii. Deduce the arithmetic operation being performed by the program. [2 marks]
- b.
- i. Describe the difference between cache memory on the processor chip and main memory that is not on the processor chip. [3 marks]
  - ii. Identify which one of Static RAM (SRAM) and Dynamic RAM (DRAM) is typically used for cache memory and which one is used for main memory. Give reasons for your answer. [2 marks]
  - iii. Is flash RAM suitable for a computer's main memory? Give reasons for your answer. [2 marks]
3. a. During the Systems Development Lifecycle (SDLC) a number of modelling tools are used, namely: Use Case Diagrams, Data Flow Diagrams (DFD's), Jackson Structured Programming (JSP) and Flowcharts. In which of the stages of the SDLC are each of the mentioned tools mainly used? [4 marks]
- b. **Draw and name** the most common symbols used in both Data Flow Diagrams and Flowcharts and explain each symbol's usage within the model where it is used. [6 marks]
- c. Write notes on the following:
- i. modular design;
  - ii. black-box testing;
  - iii. predictive maintenance;
  - iv. program documentation;
  - v. change over techniques when implementing a new system. [10 marks]

4. a. Why is an interpreter, at times, preferred over a compiler during program development? [3 marks]
- b. During the *lexical analysis* stage *lexemes* are converted to *tokens*. Explain the THREE terms in italics. [3 marks]
- c. What is the function of the symbol table that is created during compilation? Outline the contents of the symbol table. [4 marks]
- d. The following are some BNF definitions for a certain programming language.
- ```
<assign> ::= <var> = <exp>
<var> ::= K | L | M | N | O
<exp> ::= <var> | <exp> + <exp> | <exp> * <exp>
```
- Describe the errors in the following assignment statements according to the definitions above:
- $L = M + P$
  - $K = N - L$
  - $N = K * (L + M)$
  - $M = N * L (K - O)$  [4 marks]
- e. What type of error do the assignment statements above have? [1 mark]
- f. Extend or modify the BNF definitions above such that a valid variable may also consist of the listed uppercase letters (K, L, M, N or O) followed by a single digit, such as K9. [5 marks]
5. Interrupt handling is an important function that the operating system performs.
- What is its purpose? [4 marks]
  - Explain TWO ways of handling interrupts. [8 marks]
  - What is the relation to the DMA? [8 marks]
6. Computer networks are an important part of modern computer systems.
- Define a computer network and give one real example; [4 marks]
  - Identify and describe FOUR different computer networks. [16 marks]

*Please turn the page.*

7. Consider the following code:

```

public abstract class Vehicle {
    private String colour;

    Vehicle() { setColour("[NOT SPECIFIED]"); }
    Vehicle(String c) { setColour(c); }
    public String getColour() { return(colour); }
    public void setColour(String c) { colour = c; }
    abstract int wheelCount();
}

public class Motorcycle extends Vehicle {
    static final int NUM_MOTORCYCLE_WHEELS = 2;

    private boolean hasSidecar;

    public Motorcycle() {
        super();
        setHasSidecar(false);
    }

    public Motorcycle(String c) {
        super(c);
        setHasSidecar(false);
    }

    public int wheelCount() { return(NUM_MOTORCYCLE_WHEELS); }
    public void setHasSidecar(boolean hsc) { hasSidecar = hsc; }
    public boolean getHasSideCar() { return(hasSidecar); }
}

public class Car extends Vehicle {
    static final int NUM_CAR_WHEELS = 4;

    private boolean rightHandDrive;

    public Car() {
        super();
        setRHD(false);
    }

    public Car(String c) {
        super(c);
        setRHD(false);
    }

    public Car(String c, boolean rhd) {
        super(c);
        setRHD(rhd);
    }

    public int wheelCount() {
        return(NUM_CAR_WHEELS); }

    public void setRHD(boolean rhd) {
        rightHandDrive = rhd; }

    public boolean isRHD() {
        return(rightHandDrive); }
}

```



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

```
Vehicle[] v = new Vehicle[5];

v[0] = new Motorcycle("Red");
v[1] = new Motorcycle("Blue");
v[2] = new Car("Orange");
v[3] = new Motorcycle("Green");
v[4] = new Car("Black");

for (Vehicle veh : v)
    System.out.println(veh.wheelCount());
```

[4 marks]

- b. If the `Motorcycle(String n)` constructor was updated as follows:

```
public Motorcycle(String c) {
    this();
}
```

- i. How would this affect the output from the program above?
  - ii. Would it have any adverse affects? [6 marks]
- c. Assume we have reverted back to the original `Motorcycle` constructor method. Also assume the following method is present in the main driver file:

```
static void updateColour(Vehicle veh, String c) {
    veh.setColour(c);
}
```

- i. What output would the following code produce?
- ```
Vehicle myV = new Motorcycle("Purple");
System.out.println(myV.getColour());
updateColour(myV, "Green");
System.out.println(myV.getColour());
```
- [2 marks]
- d. Good programming practice generally makes the act of programming, as well as future maintenance/modifications to code, much easier. Consider the following piece of code.

```
void foo(int w) {
    int i = 5;
    int j = w;
    int x;
    for (i = 5 ; i < 7 ; i++)
        x = x + i;
    bar(w + 5);
    return;
```

- i. List FOUR of the problems associated with this method with respect to good programming practice. [8 marks]

8. You have been hired to sort out the database issues at Bob's Birkirkara Pizzeria and Takeaway. Bob tried to make a database himself and has run into some issues. Bob's database consists of a single table/file as seen below. This file represents orders that have been phoned in.

-Bob Pace, 123 Main Street Valletta, 99698342, Pepperoni, Extra Olives, Extra Cheese, Doorbell does not work (knock)

-Wendy Wright, 45 Old Road Rabat, 93482349, Hawaiian

-Robert Grech, 6 Nazju Cortis Street Hamrun, 34024923. Capricciosa, Phone when close as I'll need to open gate

Upon inspecting the file it appears the format is as follows:

Name, Address, Phone, Type of Pizza ordered, Notes on the order (additional toppings, cooking directions or instructions on delivery)

Assumptions you can make:

- The types of pizza offered are: Margherita, Pepperoni, Capricciosa, Hawaiian, Funghi and Mexicana
  - Customers should be stored in their own table as this saves time for repeat business (person taking order would just verify address is the same).
- a. Create an entity relationship diagram showing the relationships between the tables needed to describe this database. Use the Crow's Foot notation. [10 marks]
- b. Convert the ER diagram created in a) into a relational database schema. Be sure to normalize (if needed) and make it clear what the primary and foreign keys are. [10 marks]