

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION

ADVANCED LEVEL

SEPTEMBER 2014

SUBJECT:	COMPUTING
PAPER NUMBER:	I
DATE:	2 nd September 2014
TIME:	9.00 a.m. to 12.00 noon

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. Consider the following piece of Java code:

```
byte c = 0;

for (c = 0 ; c < 300 ; c++) {
    DoStuff(c);
}
```

- a. **Explain** what is wrong with this **for** loop. [2 marks]
- b. How can the code be modified to **fix** the fault found in the code snippet? [3 marks]
2. Identify **FIVE** differences between an **interface** and an **abstract** class in Java. [5 marks]

Section B.

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

```
public static int rec(int n){
    if (n == 1)
        return (1);

    return(n + rec(n - 1));
}
```

- i. What **value** would the following method call return?

```
rec(5);
```

[3 marks]

4. A full adder has **three inputs** and **two outputs**. Write down the truth table for both outputs of the full adder. [5 marks]

5. The truth table for **one** of the segments in a **seven-segment** display is given below:

A_3	A_2	A_1	A_0	B
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1

Using a Karnaugh map, write down a **minimized** Boolean expression for B . [5 marks]

6. Briefly describe the following CPU registers:

- i. memory address register (MAR);
- ii. memory data register (MDR);
- iii. current instruction register (CIR);
- iv. program counter (PC);
- v. stack pointer (SP).

[5 marks]

7. A byte-addressable RAM is 4 kilobytes (KB) large.

- a. What is the **size** of the **address bus** in bits?
- b. How many bits can be stored inside the RAM?

[3 marks]

[2 marks]

8. The following are assembly instructions:

MOV, PUSH, POP, ADD, SUB, CMP, CALL, RET

- a. Which of the instructions, if any, are **arithmetic** instructions?
- b. Which of the instructions, if any, **affect** the **stack**?
- c. Which of the instructions, if any, **change** the **program counter** (PC)?

[1 mark]

[2 marks]

[2 marks]

9. a. What is the **difference** in the use of a **primary key** and a **foreign key**?

[2 marks]

b. What are the **three levels** of a DBMS?

[3 marks]

10. **Normalization** is a process carried out during relational database design. Describe the general goal of normalization and what level of normalization is acceptable. [5 marks]

11. a. What kind of process is the **round-robin** performed by the operating system? [2 marks]
b. Briefly **describe** how it works. [3 marks]
12. a. **Page frames** is a technique employed by the operating system to do what? [2 marks]
b. Name **THREE** other ways employed by operating systems to do the same job. [3 marks]
13. What are the following **protocols** used for?
a. HTML; [1 mark]
b. ADSL; [1 mark]
c. FTP; [1 mark]
d. ISDN; [1 mark]
e. POP3. [1 mark]
14. **Cable** is one medium employed for data transmission.
a. Name **THREE** types of cables used; [3 marks]
b. Identify **TWO** more transmission media. [2 marks]
15. a. What is the arrangement of the various **elements** on a network called? [2 marks]
b. Name **THREE** examples of such arrangements. [3 marks]
16. a. Briefly **explain** the main function and importance of:
i. the Lexical analyser; [2 marks]
ii. the Symbol table. [2 marks]
b. What are **lexemes** used for in the compilation phase? [1 mark]
17. a. **Explain** why the **Editor**, **Compiler** and **Linker** may be required when writing high-level language computer programs. [3 marks]
b. **Name** and **distinguish between** the two types of linking methods during the generation of object code. [2 marks]
18. a. **Mention TWO** of the **main** stages in Rapid Application Development (RAD) model. [1 mark]
b. Why is **RAD hard** to use with older **legacy** systems? [2 marks]
c. State and explain which is the **least** costly between the **Waterfall** and the **Rapid Application Development (RAD)** models. [2 marks]
19. a. Why is **Joint Application Development (JAD)** used in helping to identify business requirements? [3 marks]
b. How does JAD bridge the gap between the “**business illiterate**” and the “**computer illiterate**”? [2 marks]
20. **Mention** and **describe TWO** change-over techniques. [5 marks]

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UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
SEPTEMBER 2014

SUBJECT: COMPUTING
PAPER NUMBER: II
DATE: 3rd September 2014
TIME: 9.00 a.m. to 12.00 noon

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.
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1. a. Work out the representation of the decimal number 13 in **binary**. [2 marks]

b. **Left shift** the binary representation found in (a) by one, and work out the decimal representation of the new binary number. [2 marks]

c. **Left shift** the binary representation found in (b) by one once more, and work out the decimal representation of the new binary number. [2 marks]

d. **Deduce** the mathematical operation achieved by left shifting a binary number by one place. [2 marks]

e. **Calculate** the number of instructions executed in the assembly program below:

```

MOV R1, 5 ; set R1 to the value 5
MOV R2, 0 ; set R2 to the value 0
LOOP: CALL SUB ; call the subroutine
ADD R2, R3 ; set R2 to the sum R2 + R3
DEC R1 ; decrement R1 by 1
CMP R1, 0 ; compare R1 to the value 0
JNE LOOP ; if R1 is not 0, jump to LOOP
END ; pseudo-directive: end of program

```

```

SUB: MOV R3, R1 ; set R3 to the value of R1
SHL R3, 1 ; left shift R3 by one
RET ; return from the subroutine

```

[6 marks]

f. What is the value stored in register **R2** at the end of the program in (e)? [6 marks]

2. a. A processor is required to compute the sum of 6 values. How many **addition instructions** need to be executed? [2 marks]

b. A **two's-complement** signed integer unit is used for fixed-point arithmetic with **six bits** for the **integer** part and **two bits** for the **fractional** part.

i. What is the minimum (most negative) number that can be represented? In your answer include both the binary representation and the decimal value. [3 marks]

ii. What is the maximum (most positive) number that can be represented? In your answer include both the binary representation and the decimal value. [3 marks]

- iii. Six fixed-point values in the range $-1 \leq x < 6$ need to be added using this integer unit. What is the maximum possible value of the sum? Can this value be represented in this integer unit? [3 marks]
- c. A byte-addressable RAM has a 10-bit address bus. What is the size of the RAM in **bits**? [3 marks]
- d. Briefly **describe** how each of the following buses are used for both **reading** and **writing** data to main memory.
- i. Address bus [2 marks]
 - ii. Data bus [2 marks]
 - iii. Control bus [2 marks]
3. a. **Describe** why a **syntax diagram** can be useful in respect of high-level languages. [2 marks]
- b. **Draw** the complete syntax diagram of an unsigned integer in a high-level language of your choice. [3 marks]
- c. Given the following set of BNF rules for a fictitious programming language called **Vshort**:

```

<program> ::= program
            <declarationSequence>
            begin
            <statementSequence>
            end

<declarationSequence> ::= VAR <identifier>
<statementSequence> ::= <statement> | <statementSequence> ; <statement>
<statement> ::= sleep | wake | print | reset
<identifier> ::= <letter> | <identifier> [<letter> | <digit>]

```

determine whether the following would constitute a **valid program** in Vshort, giving **reasons** for your answers:

- i. program VAR X begin sleep ; wake ; print end
 - ii. programme VAR i65 begin sleep ; wake ; wake ; sleep end
 - iii. program VAR j2il begin reset end
 - iv. program test VAR test begin end
 - v. program VAR goto begin sleep ; print ; reset ; wake end
- [15 marks]
4. a. In which part of the System Life Cycle is **UML** mainly used? [1 mark]
- b. **Write** a short paragraph to **describe** why UML is used in the part of the System Life Cycle mentioned in a) above. [2 marks]
- c. **Define** a **Use Case Diagram** and its purposes. [4 marks]

- d. **Compare** and **differentiate** between a **Class Diagram** and a **Use Case Diagram**. [3 marks]
- e. A Data flow diagram (DFD) is a popular way to model the data flow within a system. **Draw** and **clearly label, FOUR** of the standard symbols used in this model. [4 marks]
- f. **Consider** the scenario depicted below and **model** it using a **context level DFD**.
 In a home delivery take-away restaurant, each order is taken by phone by the attendant on a carbon pad. The order price is calculated from the menu and the order is placed in the order file. The cook picks the order from the order file and prepares the food. When the food is prepared, the order becomes the delivery note for the contracted driver. [6 marks]
5. **Three** major methods are employed to store files on disk. Identify **TWO** of these methods and:
- explain** how they function; [6 marks]
 - give **ONE** advantage and **ONE** disadvantage for each method; [8 marks]
 - give an **example** of where each of these methods can be employed. [6 marks]
6. The Internet has evolved and became popular in different **application areas**. A typical example is **online news websites**, like *timesofmalta*, *maltatoday* and others. These allow individuals to access news articles from anywhere and at any time.
- Identify **FIVE** other such application areas. [5 marks]
 - Explain** the **use** and **functionality** of each application area mentioned in a). [10 marks]
 - Give** a real **example** for each Internet application area identified. [5 marks]
7. Consider the following array of values:

4	5	15	6	3	12	2
---	---	----	---	---	----	---

- Suppose we sort the list into ascending order using the **selection sort** algorithm. Show the state of the list **after each pass** through the algorithm. [6 marks]
- Consider again the application of the sorting algorithm above. In the general case (for a list with n items), for selection sort:
 - What is the **maximum** and **minimum** number of comparisons? [3 marks]
 - What would the **best/worst case** be for the **number of swaps** performed? [3 marks]
- The selection sort algorithm has a time complexity of $O(n^2)$. For a given problem, assume the selection sort algorithm takes 4 minutes to sort a given list. Approximately how long will it take the algorithm to solve a problem that is 3 times as large on the same computer? [2 marks]
- Assume you are a developer for a games company. You are writing the code that deals with drawing a team of adventurers (avatars) and other assets (creatures) they interact with on the screen. The order of these assets, regarding their z axis (depth relative to one another), needs to constantly be updated. Sorting needs to be done repeatedly whilst the game is being played. Assuming that you have software that includes both the quick sort algorithm and bubble sort, which algorithm would you use and why? [6 marks]

8. FDG (Fast Delivery Guaranteed) is a newly formed courier company. Their objective is to have door to door same day delivery of parcels across Malta. As their newly employed database administrator you have been asked to design their database.

Shipped items can be described by itemID (unique), weight (int), dimensions (varchar), destination (varchar), outletID (outlet that collected the item), transportID (transport action that manages the delivery) and final delivery date.

Shipped items are received at various outlets. Outlets are described by their outletID (unique) and address (varchar). Shipped items are delivered to their destination via FDG trucks. These are described with a transportID (unique), a Boolean value, delivered, indicating whether or not the delivery has taken place and a delivery route (varchar).

- a. **Create an Entity Relationship Diagram** that describes this system. [10 marks]
- b. **Convert** the ER diagram created in a) into a **relational database schema**. Be sure to **normalize** (if required) and **clearly indicate** which are the **Primary key (PK)** and the **Foreign key (FK)**. The database schema can be represented using the following notation:

ENTITY (attrb1, attrb2,....attrbN) [10 marks]