MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2014

SUBJECT:	COMPUTING
PAPER NUMBER:	I
DATE:	21st May 2014
TIME:	4.00 p.m. to 7.00 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 class

```
public class Circle{
      private double radius;
      public Circle(double r) {
            radius = r;
      }
      public void getArea(double area){
            area = 3.14 * (radius * radius);
      }
}
```

   a. What will the following code display?

```
Circle c = new Circle(5.0);
double area = 0.0;
c.getArea(area);
System.out.println("Area is " + area);
```

[2 marks]

   b. How might one modify the class **`Circle`** such that it behaves as expected? [3 marks]

2. a. What is the **distinction** between an **instance** of a class and a **class**? [2 marks]

   b. **Explain** the object-oriented concept of **polymorphism** and give an appropriate **example**. [3 marks]

Section B

3. **Minimize** the following Boolean expression so that it can be implemented using only **one** AND gate and **one** OR gate. Both the AND gate and OR gate can have two inputs only:

$$\overline{\bar{C}\,\bar{D} + \bar{A}\,\bar{B}\,\bar{C} + A\,\bar{B}\,\bar{C}}$$ [5 marks]

4. The ASCII code set contains 128 characters.
   a. How many **bits** are required to represent **ALL** the ASCII characters? [2 marks]

   b. The ASCII encoding of the character '0' is hexadecimal 30 and the encoding of the character '9' is hexadecimal 39. What is the ASCII encoding of the character '5' in hexadecimal? [1 mark]

   c. The ASCII encoding of the character 'A' is hexadecimal 41 and the encoding of the character 'Z' is hexadecimal 5A. What is the encoding of the character 'N' in hexadecimal? [2 marks]

5. Data transfer from a peripheral device to main memory can be achieved using DMA or interrupts. Briefly **describe** the difference between the **TWO** methods. [5 marks]

6. a. **Distinguish** between the **assembler** and the **linker** in the assembly process. [3 marks]

   b. What is a **cross** assembler? Why is a cross assembler important for very small microprocessors? [2 marks]

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

```
        MOV R1, 01H  ; set R1 to the value 1
        MOV R2, 040H ; set R2 to the value 40 hex
LOOP:   SHL R1, 1    ; left-shift R1 by one
        CMP R1, R2   ; compare R1 to R2
        JLE LOOP     ; if R1 <= R2, jump to LOOP
        END          ; pseudo-directive: end of program
```

[5 marks]

8. One popular data structure often employed is a *hash table*.
   a. **Explain** what a hash table is and briefly elaborate on its main characteristics. [3 marks]

   b. What **techniques** would a typical **hash function** employ? [2 marks]

9. The **Data Dictionary** (in relation to a Database Management System (DBMS)) is a very important component. Name **FIVE** important features/components that it lends to the DBMS. [5 marks]

10. Consider the following database table called '**books**'. Note the date format is 'YYYY-MM-DD'.

isbn	title	pub_date	quantity	author
470516542	Surfing: A Beginner's Guide	2008-04-14	0	Alf Anderson
201000237	Data Structures and Algorithms	1983-01-01	5	Alfred Aho & Jeffery Ullman
771071191	Team Canada 1972	2012-09-13	23	Andrew Podnieks
955685303	Grey's Land: The Alien Agenda	2008-02-25	3	George Redman
1579125484	Elvis Impersonation Kit	2006-12-07	1000	Laura Lee
1405356260	Curry	2010-07-14	17	Vivek Singh

Write down the result (in a **table format**) returned by the following SQL queries:

a.
```
SELECT title, pub_date
FROM books
WHERE pub_date >= '2009-01-01'
ORDER BY title
```
[3 marks]

b.
```
SELECT title, quantity
FROM books
WHERE pub_date > '1980-01-01' AND pub_date < '2010-01-01'
HAVING quantity > 5
```
[2 marks]

11. a. What does the **choice** of an operating system depend on? [2 marks]

b. Name **THREE** types of operating systems. [3 marks]

12. a. Give **TWO** reasons why one would want to protect files. [2 marks]

b. Name **THREE** facilities employed against unauthorised file access. [3 marks]

13. a. What is the purpose of **interrupt handling** performed by the operating system? [2 marks]

b. Name **THREE** other functions performed by the operating system. [3 marks]

14. a. Why is **error checking** and **recovery** important? [2 marks]

b. Name **THREE** error detection methods employed to check for errors. [3 marks]

15. a. What is the name of the **methodology** used to perform communication over a digital network? [2marks]

b. Name **THREE** different techniques of how this methodology is employed. [3 marks]

16. a. What is a **syntax diagram**? [1 mark]

    b. **Describe** why a syntax diagram can be used in respect of high level languages. [2 marks]

    c. **Draw** the syntax diagram of an unsigned integer in Java. [2 marks]

17. Use appropriate **short notes** and **examples** to explain the **difference** between the following language processing terms:
    a. a parse tree; [1 mark]

    b. a syntax diagram and BNF notation; [2 marks]

    c. non-terminal Symbol and Terminal Symbol; [2 marks]

18. a. The diagram in Figure 1 below shows the **binary tree** for an **arithmetic statement**. Traverse the tree in the appropriate manner to obtain the:
        i. the **infix** notation
        ii. the **prefix** notation
        iii. the **postfix** notation [3 marks]

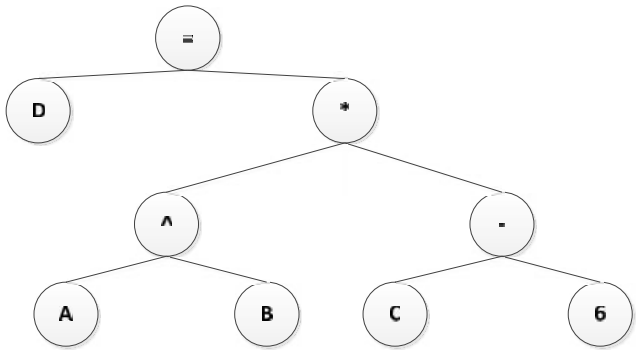

Figure 1: Note that the symbol '^' represents the exponentiation operator

    b. Which of the three notations mentioned in a) above is typically used by a computer to evaluate an arithmetic statement such as the one referred to, in part (a) above? [2 marks]

19. a. Which are the first **TWO** stages in the Systems Development Life Cycle? [2 marks]

    b. Briefly **describe ONE** of the last two stages of the Systems Development Life Cycle. [3 marks]

20. Both the **Waterfall** and **Rapid Application Development** (RAD) models have a requirements phase. **Describe** briefly, the **requirements** phases for **both** models, highlighting the **main difference** between them. [5 marks]

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SUBJECT:	COMPUTING
PAPER NUMBER:	II
DATE:	22nd May 2014
TIME:	4.00 p.m. to 7.00 p.m.

Directions to Candidates

· *Answer any **FIVE** questions.*
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1. A four-bit unsigned number A consists of the bits A_3, A_2, A_1 and A_0. A logic circuit is to be used to compare A to the value 10.

   a. What is the **maximum value** that can be represented by **four** bits? [1 mark]

   b. **Draw** a **truth table** for the logic circuit that gives an output logic value '1' when $A \leq 10$, and an output logic value '0' when $A > 10$. [5 marks]

   c. **Draw** the **Karnaugh map** for the truth table. [5 marks]

   d. Using the Karnaugh map, obtain a **minimized Boolean function** for the circuit in terms of bits A_3, A_2, A_1 and A_0, and **draw** the resulting circuit using logic gates. [4 marks]

   e. The circuit is to be modified so that the output is '1' when $A \leq 11$. Is the resulting circuit simpler or more complex than the original circuit? **State** reasons for your answer. [3 marks]

   f. It is possible to **determine** whether the number A is odd or even using only one bit. I**dentify** the bit, and **specify** whether it is '0' or '1' when A is even. [2 marks]

2. a. A computer memory has a word size of 32 bits and is word-addressable. The memory address consists of 28 bits. What is the **size** of the **memory** in megabytes (MB)? [4 marks]

   b. **Distinguish** between the **memory address register** (MAR) and the **memory data register** (MDR). [4 marks]

   c. **Distinguish** between **dynamic RAM** (DRAM) and **static RAM** (SRAM). [4 marks]

   d. **State** a typical application of DRAM and a typical application of SRAM. [2 marks]

   e. Distinguish between **immediate addressing**, **direct addressing** and **indirect addressing**. [6 marks]

3. A real-time operating system is specifically employed when the executing applications require to process data instantly to produce critical output.

   a. Give **THREE** examples of applications that require a real-time operating system, explaining why each application requires real-time processing. [12 marks]

   b. What is the **relative importance** of reliability and cost to the successful use of a real-time operating system? [8 marks]

4. With respect to transmission technologies over a communication network:

   a. **explain** the process of **Modulation**; [4 marks]

   b. **identify** and **distinguish** between **FOUR** different modulation techniques. [16 marks]

5. During the compilation process of a program, there are instances when the linker must be used in order for the compilation to be completed.

   a. What is meant by **compilation** and **linking**? [6 marks]

   b. Use an **example** to demonstrate how linking works during the compilation process. [6 marks]

   c. Justify **TWO** ways why a programmer would use the linker when writing and compiling programs. [8 marks]

6. The "New Tech Bank" is an online only bank servicing the personal banking needs of its clients. One of the bank's main processes is the registration of new clients which occurs online via a web-based application.

   A new client would just fill in the online application form, which is submitted electronically. A clerk would later review the application form and send by post two legal declaration forms, which have to be signed and returned back by the applicant. The online application form is saved online in the "New Applications" database whilst legal declaration forms are placed in the "Legal Documents" file. The Bank's registration process is finalized by the Bank Registrations' Assessor who accesses the respective files and reviews all documents.

   The Registrations' Assessor, in turn, would send over a confirmation or rejection letter accordingly. Likewise, a copy of such letters is placed in the "Confirmed Business" or "Rejected Business" folders respectively. At the end of the day, these folders are forwarded to the Managing Operations Department for statistical review.

   Using <u>proper</u> DFD notation:

   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*). [8 marks]

   b. **Draw** the **level 1 diagram** for the above scenario. [12 marks]

7. Consider the following **THREE** classes:

```
public abstract class Pet {
      private String name;

      Pet(String n) {
            name = n;
      }

      public Pet(){
            System.out.println("In Pet Constructor!");
      }

      public String getName(){
            return name;
      }

      public void setName(String n){
            name = n;
      }

      abstract String talk();
}

class Dog extends Pet{

      public Dog(){
            super("[None]");
            System.out.println("In Dog Constructor!");
      }

      public Dog(String n){
            super(n);
      }

      String talk(){
            return "Woof!";
      }
}


public class Cat extends Pet {

      public Cat(){
            super("[None]");
            System.out.println("In Cat Constructor!");
      }

      String talk(){
            return "Meow!";
      }
}
```

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

```
Pet[] a = new Pet[2];

a[0] = new Cat();
a[1] = new Dog("Rover");

for (Pet p : a)
      System.out.println(p.getName());

System.out.println(a[0].talk());
```

[8 marks]

b. If the **`Dog(String n)`** constructor was updated as follows:

```
public Dog(String n) {
      super(n);
      this();
}
```

i. How would this **affect** the program? [1 mark]

ii. Which are the **rules** that one has to follow when using **`super()`** and **`this()`**? [2 marks]

c. **Explain** why the following piece of code will generate an **exception** at runtime.

```
final int MAX_PETS = 25;
Pet[] pets = new Pet[MAX_PETS];

// We love cats.
for (int i = 0 ; i <= MAX_PETS ; i++)
      pets[i] = new Cat();
```

[2 marks]

d. Good programming practice generally involves trying to catch exceptions or errors and either dealing with them in the code or exiting the application gracefully. **Describe**, using an **example** of your choice, how you can handle exceptions in Java. [3 marks]

e. Assume that a developer needs to make a list for the **`Pet`** type. Since lists can be in various forms, the developer is trying to decide between using a **linked list** or a **sorted array** (sorted on pet name). **Explain** the **difference** between the two datastructures, **performance wise**, for **search** and **insertions**. [4 marks]

8. Consider the database table "**book_inventory**" below that lists the details for books that a bookstore has on the shelves. The primary key is **bookID**, which uniquely identifies a book.

bookID	**typeID**	**type**	**quantity**	**price**
1	1	Cooking	0	25.99
2	2	Travel	1	12.99
3	2	Travel	4	15.99
4	3	Sports	3	9.99
5	2	Travel	1	4.99

a. **Transform** this database such that the tables are in 3NF. **Identify** the respective **primary key** for each table. [5 marks]

b. If the database table **book_inventory** was left un-normalized what risks would you be running regarding **data integrity**? [2 marks]

c. Does the **book_inventory** table allow for a book to have more than one price? **Explain** why. [2 marks]

d. The bookstore owners have recently decided to open another store. The database needs to be **updated** to reflect the **inventory per store** rather than inventory as a whole (as the book_inventory table above does).
Using your normalized table from part (a):
   i. **describe** the structure of any **new tables** that need to be introduced; [6 marks]
   ii. **explain** what **modifications** should be made in order to represent the books available at each of the stores. [5 marks]

Assume that the data for the stores themselves would consist of a storeID and address. You can also assume that each store may have its own independent pricing policy so it may be the case that different stores have different prices for the same book.
***Remember** to keep the database normalized in 3NF.*