

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

UNIVERSITY OF MALTA, MSIDA

MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2017

SUBJECT: COMPUTING
PAPER NUMBER: I
DATE: 15th May 2017
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.
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SECTION A

1. Consider the following class.

```
public class Square {
    private int length;
    public Square(double len) {
        length = len;
    }
    public int getArea() {
        return length*length;
    }
}
```

- a. What is wrong with the above code? What modification should be done so that it compiles correctly? (2)
- b. Write a piece of code which instantiates the Square class and prints the area for length = 5. (1)
- c. Distinguish between method overloading and method overriding. (2)

(Total: 5 marks)

2. Consider the following Java method:

```
private int calculate(int n) {
    if (n == 0)
        return 1;
    if (n == 1)
        return 1;
    return 2*calculate(n-1);
}
```

- a. What value would this method return for the call `calculate(4)`? Show your working. (2)
- b. What type of programming is this called? (1)
- c. Mention **ONE** advantage and **ONE** disadvantage of using this type of programming. (2)

(Total: 5 marks)

SECTION B

3. a. Briefly describe amplitude modulation and frequency modulation. (2)
b. Briefly describe the terms TCP, DNS and IP ? (3)
(Total: 5 marks)
4. a. What is the difference between a half-duplex and a full-duplex connection? (2)
b. Briefly describe **THREE** switching techniques used to transmit data. (3)
(Total: 5 marks)
5. a. Briefly describe **THREE** ways in which data is organised using blocks for storage. (3)
b. Give **TWO** examples of UNIX-based operating systems. (2)
(Total: 5 marks)
6. a. Name **THREE** memory allocation schemes. (3)
b. What is the difference between round robin and priority scheduling? (2)
(Total: 5 marks)
7. Define using BNF notation a Maltese Postcode (E.g. ABC 1234). (Total: 5 marks)
8. a. Name and describe **THREE** tools that are used during the writing and compilation of programs in a high-level language? (3)
b. Name and describe **TWO** types of language translators. (2)
(Total: 5 marks)
9. a. Define the expression $2(1+5) \div 3$ in reverse polish notation (RPN)? (1)
b. Explain why RPN or postfix notation is useful when defining arithmetic expressions. (1)
c. Use a stack to evaluate the expression obtained in part (a). (3)
(Total: 5 marks)
10. Name and describe **FIVE** stages of the system life cycle. (Total: 5 marks)
11. An online shopping system enables an Administrator to view available products and also to add new products to the site's catalogue. Shoppers can then view products and purchase them. The purchasing function makes use functionality of a payment function.
Draw a Use Case Diagram that depicts this specification. (Total: 5 marks)
12. a. What is a DFD? (3)
b. What is an Entity Attribute Model? (2)
(Total: 5 marks)
13. Name and briefly explain **FIVE** important features/components of a DBMS. (Total: 5 marks)
14. Name **FIVE** disadvantages of databases over traditional file systems. (Total: 5 marks)

15. a. A two's-complement 8-bit integer has the hexadecimal value 8B. Write down the value in decimal. (2)
- b. A two's-complement fixed-point number has four integer bits and four fractional bits. Write down the decimal value for the binary number represented by 1000.1100 (3)
- (Total: 5 marks)**

16. Using Boolean Algebra, show that:

$$(\bar{A} + C)(\bar{A} + \bar{D})(B + C) = \overline{(A + \bar{B})(A + \bar{C})(\bar{C} + D)}$$

(Total: 5 marks)

17. a. Does USB make use of serial or parallel transmission? (1)
- b. Give **ONE** advantage of the transmission mode (serial or parallel) used by USB. (2)
- c. Distinguish between synchronous and asynchronous data transmission. (2)
- (Total: 5 marks)**

18. Name the addressing modes used for the underlined operands in the following assembly instructions:

- a. ADD DX, 1203 ;Add the constant 1203 to register the DX (1)
- b. ADD DX, 1203 ;Add the constant 1203 to register the DX (1)
- c. MOV AX, [BX+DI] ;Read from memory at location BX+DI (1)
- d. MOV [BP+SI], BX ;Write to memory at location BP+SI (1)
- e. MOV [0FFH], AX ;Write to memory at location 0FFH (1)

(Total: 5 marks)

19. For each of the following scenarios, suggest a kind of memory chip, giving a reason for your choice:
- a. An algorithm requires a very large data set consisting of fixed numbers (constants that do not need to be updated). Millions of devices that run the algorithm are to be produced.
- b. Some identifying information needs to be stored on card-like devices to be given to some users. Once the information is set, it should never be changed.
- c. A developer is using a development board. The developer needs to store the firmware program on the board memory. Many times, this program has to be updated. The firmware cannot be lost when the board is switched off.
- d. The firmware program of a consumer device is stored in the device memory. Every few weeks, the firmware needs to be updated. Millions of devices are to be produced.
- e. An application produces a very large amount of data in a short time. As soon as the data is produced, some algorithms make use of the data, and then the data can be discarded.

(Total: 5 marks)

Questions continue on next page

20. Using a Karnaugh map, determine a minimised expression for F in terms of A , B , C and D for the following truth table:

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

(Total: 5 marks)

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MATRICULATION EXAMINATION
ADVANCED LEVEL
MAY 2017

SUBJECT:	COMPUTING
PAPER NUMBER:	II
DATE:	16 th May 2017
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.
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-

1. a. A number is to be represented in binary-coded decimal (BCD), where each decimal digit is represented by a number of binary bits. What is the number of bits n required to store one decimal digit D ? (1)

- b. A digital device is required to produce the output F given by:

$$F = \begin{cases} 0, & 0 \leq D < 6 \\ 1, & 6 \leq D < 10 \\ \text{don't care otherwise} \end{cases}$$

Draw a truth table for F in terms of the n bits of D . (3)

- c. Using a Karnaugh map, determine a minimised expression for F in terms of the n bits of D . Keep in mind that in BCD, each decimal digit is represented by a number of binary bits. (3)

- d. Draw an implementation of F using only NAND gates and NOT gates. (4)

- e. A larger similar device is required to operate on a decimal number E in the range $0 \leq E < 10,000$. How many bits are required to represent this larger number using BCD? (2)

- f. The new device is required to produce the output G given by:

$$G = \begin{cases} 0, & 0 \leq E < 6000 \\ 1, & 6000 \leq E < 10,000 \\ \text{don't care otherwise} \end{cases}$$

Describe how you would modify the old device for the new requirements. (3)

- g. Write down the binary representation of the decimal number 6000 using:
- i. a BCD representation; (1)
 - ii. a normal binary representation. (2)
- h. State **ONE** advantage of normal binary representation over BCD representation. (1)

(Total: 20 marks)

2. a. Briefly describe the function of the following buses as part of the system bus:
- i. address bus; (1)
 - ii. data bus; (1)
 - iii. control bus. (1)
- b. A 128 megabit (128×2^{20} bits) memory device is connected to a digital system. The memory device is arranged in bytes (eight-bit words), and in one memory operation, a single byte will be stored to or retrieved from memory.
- i. Write down the size of the data bus in bits. (1)
 - ii. Determine the capacity of the device in bytes. (1)
 - iii. Hence determine the required size of the address bus in bit. (2)
- c. Describe **TWO** control signals that are used to control the memory device, and explain how they are used during the read and/or write operations. (4)
- d. High-performance microprocessors have on-chip cache memory.
- i. Why is cache memory more expensive than typical external memory? (2)
 - ii. How is cache memory used to improve the performance of the microprocessor? (2)
- e. Write down an example register for each of the following kinds of registers, and briefly describe the operation of the register you mentioned:
- i. data registers; (1)
 - ii. segment registers; (2)
 - iii. index registers. (2)

(Total: 20 marks)

3. The following is part of an assembly program. The registers ax, bx, cx and dx are all 16 bits wide.

```

                jmp start    ;jump to program starts

func:   and ax, 7    ;set ax = ax AND 7
        mov dx, ax  ;set dx = ax
        mov cx, dx  ;set cx = dx
        mov ax, 0   ;set ax = 0

next:   shl ax, 1    ;shift ax one bit to the left
        mov bx, cx  ;set bx = cx
        and bx, 4   ;set bx = bx AND 4
        jz skip     ;if result is 0, jump to skip
        add ax, dx  ;set ax = ax + dx

skip:   shl cx, 1    ;shift cx one bit to the left
        and cx, 7   ;set cx = cx AND 7
        jnz next    ;if result is *not* 0, jump to next
        ret         ;return from func

start:  mov ax, 5    ;set ax = 5
        call func   ;call func

finish:                ;program has finished

```

- a. Determine:
 - i. the contents of the registers `ax`, `bx`, `cx` and `dx` every time the execution reaches the next label. Note: This should **not** happen for more than four times, but it could happen for fewer times. (12)
 - ii. the contents of the register `ax` when the execution reaches the `finish` label. (3)
- b. Deduce the functionality of the function `func`, that is, the effect of the function on the contents of register `ax`. (3)
- c. Does the first instruction of the function (and `ax, 7`) have any effect during this execution? Why do you think this instruction is present? (2)

(Total: 20 marks)

4. Consider the following 3 classes:

```
public abstract class Animal {
    public String noise = "Growl";
    public Animal() {}
    public Animal(String noise) {
        this.noise = noise;
    }
    public void makeNoise() {
        System.out.println(noise);
    }
}

public class Bird extends Animal {
    public static final String birdNoise = "Squawk";
    public Bird() {
        super(birdNoise);
    }
    public Bird(String noise) {
        this.noise = noise;
    }
    public void makeNoise() {
        System.out.println(noise);
    }
}
```

Question continues on next page

```

public class Cat extends Animal {
    public static final String catNoise = "Meow";
    public Cat() {
        this(catNoise);
    }
    public Cat(String noise) {
        super();
    }
    public void makeNoise() {
        System.out.println(noise);
    }
}

```

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

```

Animal[] animals = new Animal[4];
animals[0] = new Cat();
animals[1] = new Bird("Screech");
animals[2] = new Bird();
animals[3] = new Cat("Purr");

for (int i=0; i<animals.length; i++)
    animals[i].makeNoise();

```

(4)

- b. Which OOP principle is being exploited in part (a)? (2)
- c. Is it possible to create an instance of the Animal class? Give a reason for your answer. (2)
- d. What is information hiding, and how would you improve the Animal, Cat and Bird classes in order to achieve better information hiding? (5)
- e. Good programming practice generally makes the act of programming, as well as future maintenance of code much easier. Consider the following code:


```

void bar(int q) {
    int x = 0;

    int z = q;

    while (x < 5)

        x++;

        foo(z + 7);

    return;

}

```

List **THREE** problems associated with this method with respect to good programming practice. (6)

- f. What is meant by the term serialization? (1)

(Total: 20 marks)

5. a. What is a protocol? Name **ONE** item that a protocol determines in data transmission. (2)
 b. Mention **THREE** protocols which form part of the OSI model, and explain each of their function. (12)
 c. Two Media Access Control methods are Token Passing and CSMA/CD.
 i. Explain why Media Access control is important for computer networks. (1)
 ii. Describe how the Token passing and CSMA/CD methods are used to achieve Media Access Control. (5)

(Total: 20 marks)

6. An operating system uses scheduling algorithms to assign processes to the processor.
 a. Name **TWO** things which a good scheduling algorithm should try to achieve. (2)
 b. Distinguish between polling and interrupts. (4)
 c. Describe the tasks performed by the interrupt handler when an interrupt occurs. (6)
 d. Virtual memory is a key feature of modern computing systems. Explain how virtual memory can be achieved using the technique of demand paging. (8)

(Total: 20 marks)

7. John is currently working for XYG News, a news organisation which maintains an online news portal. Over the past few months, John has formed part of the team which is currently developing a new version of the news portal that supports two types of stories. Video stories allow journalists to display a video for viewers to see whilst static stories simply consist of text and a number of images. It is worth noting that whilst static stories can exist with no images, a video story has to have a video associated with it.

Question continues on next page.

Consider the Java code snippets below and answer the questions that follow.

```
public abstract class NewsStory {  
    long id;  
    String title;  
    public void setTitle(String title) {...};  
    public String getTitle() {...};  
}
```

```
public class VideoStory extends NewsStory {  
    Video video;  
}
```

```
public class Video() {  
    public void play();  
    public void pause();  
}
```

```
public class StaticStory extends NewsStory {  
    String storyText;  
    Image[] images;  
}
```

```
public class Image() {  
    public void draw();  
}
```

- a. Produce a class diagram for the code shown above (10)
- b. Name and describe **TWO** change-over techniques which you would consider using for this particular scenario. Explain why you think each one might be appropriate. (3)
- c. Which would be your preferred choice of change-over technique if your manager asks you to recommend one and why? (2)
- d. Distinguish between Alpha and Beta testing. In your answer, mention at which point each one happens and who typically carries it out. (2)
- e. How would you organise a Beta test for XYG News given your choice of change-over technique? (3)

(Total: 20 marks)

8. Consider the following table:

Company	<u>Symbol</u>	Headquarters	<u>Date</u>	Close Price
Microsoft	MSFT	Redmond, WA	07/02/2016	€ 21.96
Microsoft	MSFT	Redmond, WA	08/02/2016	€ 23.93
Microsoft	MSFT	Redmond, WA	09/02/2016	€ 14.01
Oracle	ORCL	Redwood Shores, CA	07/02/2016	€ 21.27
Oracle	ORCL	Redwood Shores, CA	08/02/2016	€ 24.14
Oracle	ORCL	Redwood Shores, CA	09/02/2016	€ 14.33

- a. Transform the table above to 3rd Normal Form showing all steps involved. (12)
- b. Explain what is meant by a transitive dependence whilst also providing an example. (4)
- c. What is the problem with having transitive dependencies? (4)

(Total: 20 marks)