L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2018 SECOND SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	I
DATE:	3rd September 2018
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 snippet of Java code:

```
try {
   int i = Integer.parseInt("Test");
   System.out.println("Foo");
} catch (NumberFormatException nfe) {
   System.out.println("Bar");
}
System.out.println("Bar");
```

a. Suppose a NumberFormatException is thrown in the third line of code. What will be printed out? (2)
b. Distinguish between errors and exceptions in Java. (2)
c. Give an example of a Throwable class. (1)

(Total: 5 marks)

2. Consider the following snippet of Java code:

```
for (int i = 0; i < 3; ++i) {
    System.out.println(i*2);
}
```

a. What output is produced by this code? (3)
b. Is this a post-tested or a pre-tested loop? (1)
c. How would you modify the first line of the above code to get the following sequence of numbers: 2, 4, 6? (1)

(Total: 5 marks)

SECTION B

3. a. Give an example of an application which uses:
   i. half-duplex communication; (1)
   ii. full-duplex communication. (1)
   b. Sketch diagrams representing the topologies of bus, ring and star networks. (3)
   (Total: 5 marks)

4. a. Briefly describe **THREE** types of cabled transmission media. (3)
   b. Distinguish between ISDN and DSL. (2)
   (Total: 5 marks)

5. a. Mention and briefly describe **TWO** types of Internet applications. (2)
   b. Describe how a URL is converted into an IP address. (2)
   c. Why is it more preferable to use a URL than an IP address in a web browser? (1)
   (Total: 5 marks)

6. a. What is the system stack? Briefly describe how it works. (2)
   b. Sketch a diagram to show the three states that a process may be in, also showing the transitions between one state and another. (3)
   (Total: 5 marks)

7. a. What is meant by deadlock, and how can it be avoided? (2)
   b. Briefly describe **THREE** scheduling algorithms. (3)
   (Total: 5 marks)

8. a. What is meant by a feasibility study? Briefly discuss **TWO** feasibility aspects. (3)
   b. Sketch a flowchart showing the implementation of a pre-tested loop. (2)
   (Total: 5 marks)

9. a. Briefly discuss **THREE** types of system maintenance techniques. (3)
   b. When designing a new computing system, the system requirements need to be taken into account. One example is the processing power required (CPU type). Mention **TWO** other system requirements which should be considered. (2)
   (Total: 5 marks)

10. Define, using BNF notation, a Maltese ID card number. A Maltese ID card number consists of a six-digit number followed by a letter in the set {L,G,M,A}. (5)
    (Total: 5 marks)

11. In the context of language translators:
    a. what is a syntax diagram? (1)
    b. describe what is meant by linking; (2)
    c. distinguish between terminal and non-terminal symbols. (2)
    (Total: 5 marks)

12. a. Mention and briefly describe **TWO** database models (2)
    b. Why is database normalisation important? (1)
    c. Name **TWO** conditions for a database to be in the Third Normal Form. (2)
    (Total: 5 marks)

13. Suppose you were designing a database system for a company where customers can place orders. The company would like to store the following attributes: `CUSTOMER_NAME`, `CUSTOMER_ID`, `CUSTOMER_ADDRESS`, `ORDER_NUMBER`, and `ORDER_DATE`.

    a. Design the database table(s) which can store this information (use one column per attribute). (2)
    b. State which attributes you would select as primary and/or foreign keys. (3)

    (Total: 5 marks)

14. a. Mention **FOUR** types of sorting algorithms. (4)
    b. What is meant by a collision in a hash table? (1)

    (Total: 5 marks)

15. a. Distinguish between a double linked list and a queue. (2)
    b. Consider the following list of numbers: 3, 6, 8, 9, 2. Without need for calculations, describe how one would search for the number 8 using a:
       i. linear search; (1)
       ii. binary search. (2)

    (Total: 5 marks)

16. Using Boolean algebra, show that

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

    (5)

    (Total: 5 marks)

17. a. Write down the two's-complement eight-bit binary representation of the decimal number -77. (2)
    b. Write down the unsigned hexadecimal representation of the decimal number 179. (2)
    c. Write down the decimal representation of the unsigned hexadecimal number 2F. (1)

    (Total: 5 marks)

18. A laptop has a built-in keyboard that makes use of interrupts and a USB connector that makes use of polling.
    a. Describe how input is obtained from the keyboard via the interrupt mechanism. (2)
    b. Describe how input is obtained from a connected USB peripheral via the polling mechanism. (2)
    c. Highlight the main difference between the two methods. (1)

    (Total: 5 marks)

Questions continue on next page

19. The registers `ax` and `dx` are 16-bit registers. Determine the value of `ax` after the following assembly instructions are executed:

```
mov ax, 10      ;set ax = 10 in decimal
mov dx, 100     ;set dx = 100 in decimal
push ax         ;push ax onto stack
mov ax, dx      ;set ax = contents of dx
shl ax, 2       ;shift ax to the left by two bits
add dx, ax      ;set dx = dx + ax
pop ax          ;pop stack onto ax
add ax, dx      ;set ax = ax + dx
```

(Total: 5 marks)

20. For the five assembly instructions below, name the addressing mode of the underlined operands.

a. `add` **`ax`**`, [sp - 2]  ;add contents of memory location at sp - 2 to ax`

b. `add ax,` **`[sp - 2]`** `;add contents of memory location at sp - 2 to ax`

c. `mov` **`[sp]`**`, 25  ;store 25 into memory location pointed to by sp`

d. `mov [sp],` **`25`** `;store 25 into memory location pointed to by sp`

e. `mov` **`[sp - di]`**`, 30 ;store 30 into memory location at sp - di`

(Total: 5 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2018 SECOND SESSION

SUBJECT:	**Computing**
PAPER NUMBER:	II
DATE:	4th September 2018
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. In a seven-segment display for decimal digits, the middle segment is:

   - **on** for the digits 2,3,4,5,6,8 and 9; and
   - **off** for the digits 0,1 and 7

   A digital system with a four-bit input that represents one decimal digit is required to output a value G that is true if the middle segment is on. When the four-bit input is larger than 9, G can be anything (don't care condition).

   a. Draw a truth table for the output *G*. (2)
   b. Using Karnaugh maps, obtain an optimised Boolean expression for G. Do **not** minimise the expression further with Boolean algebra. (4)
   c. Hence draw an implementation of the system using only NAND gates and NOT gates. (6)
   d. The seven-segment display can also be used for hexadecimal digits, where the middle segment is:

      - **on** for the digits 2,3,4,5,6,8,9,A,B,D,E and F; and
      - **off** for the digits 0,1,7 and C

      A system is required to output a value H that is true if the middle segment is on. H has **no** don't care conditions.
      Add a column to the truth table in part (a) for the new output H. (1)
   e. Using Karnaugh maps, obtain an optimised Boolean expression for H. Do **not** minimise the expression further with Boolean algebra. (4)
   f. Compare the expression for G obtained in part (a) to the expression for H obtained in part (e). Can the expression for G be used for the hexadecimal display of part (d)? Can the expression for H be used for the decimal display of part (a)? Give reasons for your answer. (3)

(Total: 20 marks)

Questions continue on next page

2. a. A computer system uses memory-mapped input/output (I/O), and has an address length of 32 bits.
   i. Determine the maximum size of memory plus I/O that can be accessed with this address size. Give your answer in megabytes (1 MB is 2^{20} bytes) or gigabytes (1 GB is 2^{30} bytes), whichever is more suitable. (3)
   ii. 500 MB of the address space in this memory-mapped I/O system are allocated to PCI I/O devices. Determine the size of physical memory that can be accessed after allocating 500 MB of space to I/O. (2)
   iii. Describe the difference between memory-mapped I/O and isolated I/O. Your answer should include **ONE** relative advantage of each. (4)

   b. The computer's processor has a cache memory of size 1 MB. Explain why cache memory is typically of the SRAM kind, while main memory is typically of the DRAM kind. (4)

   c. In modern computer systems, the use of flash RAM has become very common for solid-state drives (SSDs) as an alternative to magnetic hard disk drives (HDDs). Describe the properties of flash RAM that are necessary for this application. In your answer, include comparisons to RAM and ROM, indicating what makes RAM and ROM unsuitable for SSDs. (4)

   d. Most I/O peripherals in modern computer systems are connected using serial, not parallel, data transmission. Compare serial and parallel data transmission, highlighting the advantages of serial transmission. (3)

(Total: 20 marks)

3. a. Distinguish between polling and interrupts? (4)

   b. Describe the procedure by which the interrupt handler processes interrupts. (6)

   c. Discuss **ONE** way in which multiple interrupts occurring at the same time can be handled. (2)

   d. Give examples of **TWO** possible sources of interrupts. (2)

   e. Discuss how files can be protected against access by unauthorised users or hardware failure. (6)

(Total: 20 marks)

4. The following is an assembly snippet. The registers `ax` and `dx` are 16-bit registers.

```
        mov ax, 0583h   ;set ax = hex 0583
ans0:                   ;here ax = hex 0583, bin 0000 0101 1000 0011

        mov dx, ax      ;set dx = ax
        shr dx, 8       ;logic shift dx by eight bits to the right
        and dx, 00FFh   ;set dx = dx AND hex 00FF
        and ax, 00FFh   ;set ax = ax AND hex 00FF
        shl ax, 8       ;logic shift ax by eight bits to the left
        or  ax, dx      ;set ax = ax OR dx
ans1:                   ;i. determine hex and bin value of ax here

        mov dx, ax      ;set dx = ax
        shr dx, 4       ;logic shift dx by four bits to the right
        and dx, 0F0Fh   ;set dx = dx AND hex 0F0F
        and ax, 0F0Fh   ;set ax = ax AND hex 0F0F
        shl ax, 4       ;logic shift ax by four bits to the left
        or  ax, dx      ;set ax = ax OR dx
ans2:                   ;ii. determine hex and bin value of ax here

        mov dx, ax      ;set dx = ax
        shr dx, 2       ;logic shift dx by two bits to the right
        and dx, 3333h   ;set dx = dx AND hex 3333
        and ax, 3333h   ;set ax = ax AND hex 3333
        shl ax, 2       ;logic shift ax by two bits to the left
        or  ax, dx      ;set ax = ax OR dx
ans3:                   ;iii. determine hex and bin value of ax here

        mov dx, ax      ;set dx = ax
        shr dx, 1       ;logic shift dx by one bit to the right
        and dx, 5555h   ;set dx = dx AND hex 5555
        and ax, 5555h   ;set ax = ax AND hex 5555
        shl ax, 1       ;logic shift ax by one bit to the left
        or  ax, dx      ;set ax = ax OR dx
ans4:                   ;iv. determine hex and bin value of ax here
```

a. Determine the value inside the register `ax` at the positions indicated by the following labels. In each case, give the answers in both hexadecimal and binary representations. For example at label `ans0`, the value inside `ax` is hexadecimal `0583`, which is binary `0000 0101 1000 0011`.

i. `ans1` (4)

ii. `ans2` (4)

iii. `ans3` (3)

iv. `ans4` (3)

b. Hence deduce the functionality of the assembly code between the labels `ans0` and `ans4`. (2)

Question continues on next page

c. Consider a situation where the assembly code between the labels `ans0` and `ans1` was rewritten such that the two bitwise logic `and` operations were removed.
   i. What effect, if any, does this change have on the result in part (a)? (1)
   ii. What effect, if any, would this change have on the result if the original value of `ax`, that is hexadecimal `0583`, was something else? Explain your reasoning in the answer. (3)

(Total: 20 marks)

5. a. Distinguish between:
   i. analogue and digital signals; (2)
   ii. modulation and demodulation. (2)

   b. Discuss **THREE** modulation schemes. (9)
   c. What is meant by a packet collision? Describe a technique that may be used to control packet collisions in a network. (5)
   d. Mention **TWO** types of hardware commonly used to route packets through a network. (2)

(Total: 20 marks)

6. a. Convert the following expressions to RPN:
   i. A * B + C / D (3)
   ii. D – B / C * A (3)
   iii. C * D – B / A (3)
   b. Distinguish between a compiler and an interpreter. (4)
   c. What is BNF used for? Give an example of BNF which represents a digit. (4)
   d. Mention and briefly describe **THREE** stages in the compilation process. (3)

(Total: 20 marks)

7. a. Discuss **THREE** reasons which may prompt an organisation to develop a new computing system. (6)
   b. Sketch a Use Case Diagram for a simple bank ATM system, in which a customer needs to first log in, and then can make any of the following three transactions: withdraw money, check balance and make a deposit. (7)
   c. How can a use case diagram help in determining system requirements? (2)
   d. Distinguish between bottom-up and top-down testing. (2)
   e. What is meant by change-over? Mention **TWO** change-over techniques. (3)

(Total: 20 marks)

8. a. Distinguish between a class and an object. (2)
   b. Consider the following code:

```
public int calculate(int x) {
       if (x == 0) return 0;
       if (x == 1) return 1;

       return calculate(x-1) + calculate(x-2);
}
```

   i. What type of programming is this known as? (1)
   ii. Mention **ONE** advantage and **ONE** disadvantage of this type of programming. (2)
   iii. Give the output of `calculate(5)` and show your working; (5)
   c. Discuss **THREE** object-oriented programming characteristics. (6)
   d. Consider the following set of numbers: {5, 3, 7, 1, 2}. Show how the bubble sort algorithm can sort these numbers in ascending order. (4)

(Total: 20 marks)