L-Università ta' Malta

SUBJECT:	**Computing**
PAPER NUMBER:	I
DATE:	14th December 2020
TIME:	4:00 p.m. to 7:05 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.

1. Consider the following method:

```
public double doCalculate(double num1, double num2) {

        return (num1 + num2)/2.0;

}
```

   a. Identify the parameters of this method. (1)
   b. Identify the return type of this method. (1)
   c. Are the parameters being passed by value or passed by reference? (1)
   d. Define how overriding is performed and explain what it would be used for. (2)
         (Total: 5 marks)

2. a. Consider the following method:

```
private void doSomething() {
    System.out.println("Something");
}
```

     i. Will the above code compile? (1)
     ii. Is the method accessible from another class? Give a reason for your answer. (2)
   b. Mention and briefly describe **TWO** OOP characteristics. (2)
         (Total: 5 marks)

3. a. Explain briefly what is meant by Electro-Magnetic Interference (EMI). (1)
   b. What is the difference between a public and a private IP address? (1)
   c. Name and briefly describe **THREE** layers in the OSI model. (3)
         (Total: 5 marks)

4. a. What wireless technology would you use to transmit over the following distances?
    i.   10 metres; (1)
    ii. 100 metres; (1)
    iii. thousands of kilometres. (1)
    b. Briefly describe **TWO** differences between IPv4 and IPv6. (2)
    (Total: 5 marks)

5. a. Give an application area for each one of the following types of operating system: Batch, Network, Real-time. (3)
    b. What is an Interrupt Vector Table? Briefly describe how it is used by the operating system. (2)
    (Total: 5 marks)

6. a. What is a page frame? (1)
    b. How does a page fault occur? (1)
    c. Mention **TWO** characteristics of pre-emptive scheduling. (2)
    d. What is the purpose of an interrupt in operating systems? (1)
    (Total: 5 marks)

7. a. What does cardinality mean in the context of databases? (1)
    b. Briefly describe what is meant by each of the following database elements, giving an example in each case:
    i.   record; (2)
    ii. attribute. (2)
    (Total: 5 marks)

8. a. Mention **ONE** reason why it is important to avoid redundancy in databases. (1)
    b. Design a database system for a retail company, which allows customers to order products. The company would like to store the following attributes: product name, product ID, order number, order status, customer ID, customer address. Design the database table(s) which can store this information. (4)
    (Total: 5 marks)

9. A company has five employees as shown in the list below:

Employee Names
George
Anthony
Lucy
Maria
Clive

    a. Construct a binary tree to store the above list of names in alphabetical order. (3)
    b. In the context of the binary tree that you construct, name and describe the traversal method that would retrieve the names in alphabetical order. (2)
    (Total: 5 marks)

10. Using pseudo code, design an algorithm which reads in a string from user input and prints it out in reverse using a stack. (5)
    (Total: 5 marks)

11. The Half-Adder Circuit adds together two binary digits, and outputs the sum and carry.
    a. Write down the truth table of a 1-bit half-adder circuit. (2)
    b. Draw the logic circuit. (3)
        (Total: 5 marks)

12. The answers to this question below can be in decimal or fraction form. Consider an 8-bit register, with an imaginary binary point as shown below:

	●						

    a. What is the largest positive number that can be represented with this format? (2)
    b. What is the smallest positive number that can be represented? (2)
    c. What is the largest negative number that can be represented? (1)
        (Total: 5 marks)

13. a. What is the purpose of the Program Counter (PC)? (2)
    b. What are the **THREE** components which make up the system bus? (3)
        (Total: 5 marks)

14. The CPU contains both general purpose and special purpose registers.
    a. Define the **TWO** types of registers and give **ONE** example of each. (4)
    b. What is the purpose of the cache? (1)
        (Total: 5 marks)

15. Different CPUs support different addressing modes.
    a. Define what is meant by addressing mode. (1)
    b. Define and give an example of:
        i.   register addressing mode; (2)
        ii. indirect addressing mode. (2)
        (Total: 5 marks)

16. SHL and SHR are two assembly code instructions that perform logical shifting. Consider the following assembly instructions:

```
MOV AX, 00101001        ; Move into AX the number 00101001
SHL AX, 1               ; Logical Shift Left by 1 bit and put
                          result in AX
SHL AX, 1               ; Logical Shift Left by 1 bit and put
                          result in AX
```

    a. What is the resulting binary value inside AX? (1)
    b. What is the effect of a logical left shift on the binary value? (1)
    c. What would be the resulting binary value if a RCL (rotate through carry left) instruction is executed on the final value of AX? (1)
    d. Suppose that a right shift by 1 bit is to be performed on the initial value of AX.
        i.   What is the effect of the right shift on this value? (1)
        ii. Is the answer correct? (1)
        (Total: 5 marks)
        Please turn the page.

17. a. Explain **TWO** reasons why natural languages are not used in computers. (2)
    b. Name **ONE** similarity between natural languages and formal languages. (1)
    c. In the context of language grammars, distinguish between terminal symbols and non-terminal symbols? (2)

    (Total: 5 marks)

18. Consider the following snippet of code:

```
public int calculate(int x) {
    int a = 4;
    int b = 2;
    x = x + a;
    if (x-a == x) {
      return x;
    }
    x = x + 2;
    return x;
}
```

    a. Identify **TWO** problems with the method above. (2)
    b. Name and use a code optimisation technique of your choice and rewrite the method and eliminate **ONE** of the problems you identified. (2)
    c. During the code generation phase, the compiler translates the entire source code into re-locatable machine code. Define the term re-locatable. (1)

    (Total: 5 marks)

19. a. What is the purpose of a feasibility study in the context of systems analysis and design? (2)
    b. The company that you work for has been hired to develop a Human Resources Management system. Name **THREE** phases of Systems Analysis that need to be used in such a context. (3)

    (Total: 5 marks)

20. a. Distinguish between a data flow diagram and a use-case diagram. (2)
    b. What are the **THREE** changeover techniques used in the implementation phase of the systems life cycle? (3)

    (Total: 5 marks)

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**ADVANCED MATRICULATION LEVEL
2020 SECOND SESSION**

SUBJECT:	**Computing**
PAPER NUMBER:	II
DATE:	15th December 2020
TIME:	4:00 p.m. to 7:05 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. Consider Figure 1, which shows the memory space inside a computer. The solid blocks correspond to allocated memory, while the empty spaces correspond to unused memory.
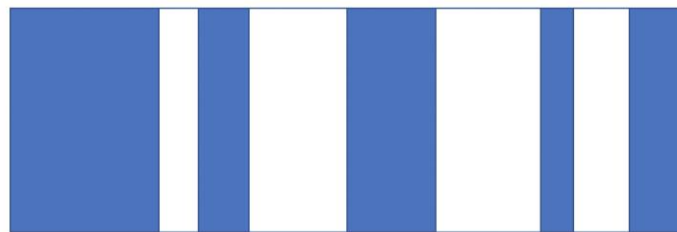

Figure 1 - Memory space inside a computer.

  a. i.   Name and describe the issue that is shown in the memory space shown in Figure 1.
                                                                                      (2)
      ii.   Why is this a problem for the operating system (OS)?   (2)
      iii. Describe how the OS would resolve this issue.   (4)
  b. Name and explain in detail **TWO** functions of the OS.   (4)
  c. Name and describe **TWO** states in which a process can be in.   (4)
  d. A company wants to investigate a problem with their servers. Someone has managed to access the servers from outside and some files are missing. Mention the tasks that one would perform to:
      i.   recover the missing data to allow the company's servers to resume operation.   (1)
      ii.   ensure that such an event does not occur again.   (1)
  e. Briefly describe what a network OS is used for, giving an example of the type of devices that such an OS runs on.   (2)
                                                                      (Total: 20 marks)

Please turn the page.

2. a. Describe **TWO** main issues which can occur as a result a computer network security breach. (2)
    b. For each issue you mentioned in part (a), describe **ONE** action you would take to protect against the issue. (4)
    c. Define what is wave modulation, and describe **ONE** of its benefits. (2)
    d. Mention **ONE** use of the HTTP protocol. Explain the difference between the HTTP and the HTTPS protocol. (3)
    e. State the name of the layer in the OSI model responsible for each of the following:
        i.   Controls the reliability of the link through flow control and error control (1)
        ii. Converts the digital bits into analogue signals for transmission (1)
        iii. Establishes, manages and terminates the connections between two computers. (1)
    f. A company has an office with six dumb terminal computers which all need to be connected to a main backbone to form a LAN.
        i.   Name the network topology one would use. (1)
        ii. Sketch a diagram of the network topology named. (3)
        iii. Mention **ONE** advantage and **ONE** disadvantage of such a topology. (2)

(Total: 20 marks)

3. Magnitude Comparator is a circuit capable of comparing the magnitude of two numbers and giving an output to indicate whether they are equal, the first greater than the second, or the first is smaller than the second. A 2-bit binary number comparator is shown in Figure 2.
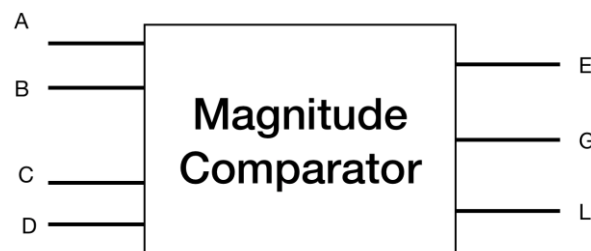

Figure 2 - Magnitude Comparator

    a. Derive the truth table for the **THREE** outputs E, G, and L. (8)
    b. Through the use of Karnaugh maps and/or other methods, derive the simplified expressions for E, G, and L. (8)
    c. Draw the logic circuit for the Magnitude Comparator. (4)

(Total: 20 marks)

4. A restaurant buys food from a supermarket. The restaurant requested a statement of all the invoices that were issued from the beginning of the year. The statement shows the following data:

- Invoice No
- Invoice Date
- Product Code
- Description
- Quantity
- Price per Unit
- Total Price

This is an extract of the statement given by the supermarket to the restaurant:

Invoice No	Invoice Date	Product Code	Description	Quantity	Price per Unit	Total Price
004	22/01/2020	VEG 01	Carrots	15	1.50	
		VEG 02	Potatoes	10	1.50	
		MEA 01	Ribeye	10	15.00	187.50
005	03/02/2020	FIS 01	Tuna	8	12.00	
		FIS 02	Salmon	12	12.00	240.00
006	13/02/2020	PIZ 01	Margherita	10	3.00	
		BUR 01	Beef Burger	10	2.50	55.00
…	…	…	…	…	…	…

a. Explain why the above table is not in the 1st Normal Form and give at least **TWO** examples. (3)
b. Recreate the table(s) in 1st Normal Form for the data given above. (5)
c. Outline the condition that attributes must meet, in relation to composite primary keys to produce 2nd Normal Form. (2)
d. Referring to the answer given in part (c), construct the table(s) in 3rd Normal Form. (6)
e. Explain the use of the following SQL commands:
   i. SELECT; (1)
   ii. FROM; (1)
   iii. WHERE; (1)
   iv. ORDER BY. (1)

(Total: 20 marks)

Please turn the page.

5. a. Consider the following code:

```
public void algorithm (int myArray[]) {
 int n = myArray.length;
 for (int i = 0; i < n-1; i++) {
      int min_idx = i;
      for (int j = i+1; j < n; j++) {
          if (myArray[j] < myArray[min_idx]) {
              min_idx = j;
          }
       }
      int temp = myArray[min_idx];
      myArray[min_idx] = myArray[i];
      myArray[i] = temp;
 }
}
…
int arr[] = {64,25,12,22,11};
algorithm(arr);
```

State the contents of `arr` after `algorithm(arr)` is executed in the last line. (5)

b. Explain the following Java keywords, giving an example in each case:
    i.   static; (2)
    ii. this; (2)
    iii. protected. (2)

c. Explain what a pointer is, and describe how it is used in **ONE** data structure of your choice. (2)

d. What does the *is-a* relationship refer to? Given **ONE** example which demonstrates such as relationship. (2)

e. With the help of diagrams, explain and illustrate the operations of a stack. (5)

(Total: 20 marks)

6. a. Define and describe the terms PROM, EPROM and EEPROM. (6)

b. How many possible memory locations can a processor with n address lines address? (1)

c. Define the term decoder. (2)

d. A system has a 16-bit address bus and 64K of addressable memory. Assuming that the memory is logically organised as a 2-dimensional array of 256 rows by 256 columns, derive and describe a solution for effectively addressing the memory. (3)

e. Suppose that the memory is organised in 8 chips of 8K each. Using an appropriate diagram, how would you address the memory? (8)

(Total: 20 marks)

7. a. Define and highlight the differences between compilers and interpreters. (2)
    b. Name and describe the **THREE** stages of compilation. (9)
    c. Describe the differences between static linking and dynamic linking. (4)
    d. In a computer language, statements are separated by semi-colons. An assignment statement obeys the following rules:
        - It must start with a letter followed by alternate operators and letters.
        - The only operators allowed are "+", "-", "*", "÷", and "=".
        - The first operator must be a "=".
        - There must be only one "=" in the statement.
        - The statement must contain at least one operator.
        - The statement must contain no other letters.

        Using BNF notation, define the syntax of such an assignment statement. (5)
        (Total: 20 marks)

8. a. Consider the following short assembly language program.

```
init: MOV AX, 5      ; Move 5 into register AX
      MOV BX, 4      ; Move 4 into register BX
      MOV DX, 0      ; Move 0 into register DX
loop: ADD DX, AX     ; Add AX with DX and store value in DX
      DEC BX         ; Decrement BX
      JNZ loop       ; Jump to loop if BX is not 0
exit: hlt            ; Halt
```

     i. By performing a dry run of this program, determine the value of the contents of DX. (4)
     ii. Suppose that AX has been changed to 6, and BX has been changed to 6. What will the value of DX be? Show your working. (5)
     iii. What function does this program perform? (1)

    b. Now consider the following assembly language program.

```
init:  MOV AX, 12    ; Move 12 into register AX
       MOV BX, 5     ; Move 5 into register BX
start: CMP AX, BX    ; Compare AX with BX
       JG label      ; Jump to label if AX > BX
       JMP exit      ; Jump to exit
label: ADD AX, BX    ; Add value of AX to BX and store in AX
       MOV CX, AX    ; Move the value of AX into CX
       SUB CX, BX    ; Subtract the value of BX from CX and store in CX
       SUB AX, CX    ; Subtract the value of CX from AX and store in AX
       MOV BX, CX    ; Move the value of CX into BX
exit:  hlt           ; Halt
```

     i. By performing a dry run of the above program, determine the final values of AX and BX. (4)
     ii. Suppose that AX has been changed from 12 to 7, what will the final values of AX and BX be? Show your working. (4)
     iii. What will happen if the value of AX is changed to 3? (1)
     iv. What is the function of the above program? (1)
        (Total: 20 marks)