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| SUBJECT: | Computing |
| PAPER NUMBER: | I |
| DATE: | 22 nd June 2021 |
| 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 classes:

```

public class SuperClass {
    public SuperClass() {
        System.out.println("Super class");
    }

    public double doSomething(double a, double b) {
        return a*b;
    }
}

public class SubClass extends SuperClass {
    public double doSomething(double a, double b) {
        return a + b;
    }

    public double doSomething(int a, int b) {
        double c = super.doSomething(a, b);
        return a + b + c;
    }
}

```

a. What is the output of the following statements:

i. `SubClass subclass = new SubClass();` (1)

ii. `System.out.println(subclass.doSomething(3, 5));` (1)

iii. `System.out.println(subclass.doSomething(3.2, 5.1));` (1)

b. Suppose the following method was added to the class `SubClass`:

```
public double doSomething(int a, int b) {
    double c = super.doSomething(a, b);
    return a + b + c;
}
```

Would the code still compile? Give **ONE** reason for your answer. (2)

c. Distinguish between method overriding and method overloading. Indicate where these two occur in the classes `SuperClass` and `SubClass`. (4)

d. What is the meaning of the keyword `this` in Java? (1)

(Total: 10 marks)

SECTION B

2. A company would like to setup a network security system which controls incoming and outgoing network traffic to their intranet.

a. What is the name of such a system? (1)

b. Briefly describe how such a system operates. (2)

c. Where should such a system be installed? (1)

d. Name **ONE** threat that such a network security system protects against. (1)

(Total: 5 marks)

3. a. Analyse the following scenarios and state the appropriate switching protocol you would use for **each** one:

i. A route and its associated bandwidth need to be reserved from source to destination. (1)

ii. Messages need to be sent in their entirety. (1)

b. State which of serial or parallel communication is used in **each** of the following scenarios:

i. Wired connection between a computer and a printer. (1)

ii. Wired connection between a computer and a monitor. (1)

c. Twisted pair is one form of cabled media. State another type of cabled medium. (1)

(Total: 5 marks)

4. A Banking System has the following entities and relationships:

- a Client has at least one account;
- a Client has only one bank branch address;
- an Account has at least one client as a signatory.

Draw an ER diagram using the Crow's Foot notation. Show the relationships that exist between the proposed entities. (5)

(Total: 5 marks)

5. a. What is meant by the atomic value in a database? (1)

b. Name and briefly explain **FOUR** important features/components of a DBMS (Database Management System). (4)

(Total: 5 marks)

6. Two devices send an interrupt request to the CPU at the same time.

a. Briefly describe how the CPU can decide which interrupt request to process first. (2)

b. Interrupt handling is one task performed by an operating system. Name **THREE** other tasks. (3)

(Total: 5 marks)

7. a. A computer system has a particular feature which allows its connected hardware to access its main memory without requiring the intervention of the CPU.

i. What is the feature called? (1)

ii. Name **ONE** hardware system which makes use of this feature. (1)

b. What is meant by process starvation? Explain how this can occur by giving an example. (2)

c. What does the phrase "mask an interrupt" mean? (1)

(Total: 5 marks)

8. a. Distinguish between a linear queue and a circular queue. (2)

b. Show by means of a dry-run, how the array [29,10,14,37,14,7] would be sorted using the Merge Sort algorithm. (3)

(Total: 5 marks)

9. a. Write pseudocode for the binary search algorithm which would allow you to retrieve the number 'X' from an ordered list of numbers. (3)

b. Given an ordered list of 1,000,000 numbers, would you recommend the binary search algorithm or the sequential search algorithm? Explain your answer in terms of how performance of the algorithm changes according to the number of items. (2)

(Total: 5 marks)

Please turn the page.

10. Simplify the following logic equation in full. Name the laws that you use:

$$F = A.B + A \oplus B$$

(5)

(Total: 5 marks)

11. a. Convert the following hexadecimal numbers to decimal:

i. $1A_{16}$ (1)

ii. 74_{16} (1)

b. Consider an 8-bit register containing 10010011_2 . What are its contents if it represents:

i. a 2 decimal digit Binary Coded Decimal (BCD) number; (1)

ii. an unsigned binary number; (1)

iii. a signed binary number. (1)

(Total: 5 marks)

12. a. Explain and highlight the differences between synchronous and asynchronous data transfer, with respect to communication with/within the CPU. (2)

b. In the context of devices with varying speeds, mention how synchronous transfer is achieved. (1)

c. Distinguish between synchronous and asynchronous transfer in terms of efficiency and implementation complexity. (2)

(Total: 5 marks)

13. What is the difference between general purpose and special purpose registers? Give **TWO** examples of **each** type of register. (5)

(Total: 5 marks)

14. a. What is an instruction set? (1)

b. Identify the operands and opcodes in the following instruction:

INSTRUCTION: MOV AX, 20 ; Move 20 into register AX (3)

c. What is symbolic addressing? (1)

(Total: 5 marks)

15. a. Which are the **TWO** instructions that modify the stack? By drawing a stack data structure, show how the stack changes with these two instructions. (4)

b. How does the stack keep track of its top-most item? (1)

(Total: 5 marks)

16. Consider the following BNF which defines a decimal number:

```

<dec_num> ::= <pt><num>|<num><pt><num>
<num>     ::= <digit>|<num><digit>
<digit>   ::= 0|1|2|3|4|5|6|7|8|9
<pt>     ::= .

```

Using a parse tree (top-down approach), prove that 1.273 is syntactically correct.

(Total: 5 marks)

17. a. What are the differences between top-down and bottom-up approach with respect to system design? (2)

b. Mention **THREE** advantages of writing in a modular design. (3)

(Total: 5 marks)

18. a. What does the semantic analysis phase of the compilation process do? Which data structure is used during this stage? (2)

b. Identify and name **THREE** errors in the code below, which would typically detected during semantic analysis. (3)

```

public class Calculator {
    public int calculate(int x, int y) {
        int y = x + z + "b";
        return y;
    }
}

```

(Total: 5 marks)

19. Mr Borg from company ABC Ltd, wants to check information about a certain product that the company sells. Mr Borg enters the stock number, and the system outputs the product's description and quantity of items in stock. Using the De Marco notation, draw a top-level DFD that illustrates the process of this query. (5)

(Total: 5 marks)



| | |
|---------------|----------------------------|
| SUBJECT: | Computing |
| PAPER NUMBER: | II |
| DATE: | 23 rd June 2021 |
| TIME: | 9:00 a.m. to 12:05 p.m. |

Directions to Candidates

- Answer **Question 1 and any other FOUR** 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 two classes shown below:

```
public abstract class Sequence {
    public abstract int createSequence(int n);
}

public class FibonacciSequence extends Sequence {
    public int createSequence(int n) {
        if(n == 0)
            return 0;
        else if(n == 1)
            return 1;
        else
            return createSequence(n - 1) + createSequence(n - 2);
    }
}
```

a. What would the output of the following be? Show your working.

```
FibonacciSequence fib = new FibonacciSequence();
for (int i = 0; i < 6; i++) {
    System.out.println(fib.createSequence(i));
}
```

(6)

- b. Re-write the `createSequence` method such that it does **not** use recursion. (6)
- c. Which type of OOP characteristic is being exploited in the two classes? Explain where this principle is being used. (2)
- d. Can a second sub-class be created of the `Sequence` class, which does **not** override the `createSequence` method? Give **ONE** reason for your answer. (2)
- e. Discuss **TWO** ways in which Object-oriented programming differs from Imperative programming. (4)

(Total: 20 marks)

2. A computer network for the new branch of a company is required. It is located on the same floor of an office building.
- a. The company's network policy is to have **all** nodes connected to a single backbone.
 - i. What type of network topology is this known as? (1)
 - ii. Sketch a diagram of such a topology. (2)
 - iii. List **ONE** advantage and **ONE** disadvantage of such a topology. (2)
 - b. The CSMA/CD protocol is often used with the above topology.
 - i. What does the acronym CSMA/CD stand for? Explain how it works and why does it need to be used with the above topology. (4)
 - ii. In which layer of the OSI model does such a protocol operate? (1)
 - iii. A similar protocol is CSMA/CA. What does this acronym stand for? Distinguish between this protocol and CSMA/CD. (3)
 - iv. Describe how Token Passing is used to achieve Media Access Control. (4)
 - c. Another possible network topology is to have a central computer which decides where to forward the incoming packets based on information contained inside.
 - i. Describe the information contained in the packets which helps the central computer decide where to forward these packets. (2)
 - ii. In this scenario, the central computer is taking on a role of a common networking device. Name this device. (1)
- (Total: 20 marks)**
3. An operating system is required in a car manufacturing plant. In this plant, a number of automated and robotic machines need to work in perfect synchronicity one after each other, with well-defined and fixed time constraints to produce different parts.
- a. Identify which type of operating system is most suitable. Explain for what type of tasks is the selected operating system suitable for? (3)
 - b. To ensure smooth operation, each process needs to run for exactly the same time. Which scheduling algorithm should be deployed to achieve this? (1)
 - c. A serious issue would result if two processes are waiting for resources held by each other.
 - i. What is this scenario known as? (1)
 - ii. Why is this scenario a serious issue? (1)
 - iii. How could the CPU realise that this scenario has occurred? (2)
 - iv. In order to prevent such a situation from occurring, the operating system can attempt to deny one of four conditions. Name and describe **each** of these conditions? (4)
 - d. Car manufacturing is an intensive procedure, and the CPU cannot afford to waste time on unrelated tasks. Name **THREE** ways how the operating system should be configured to avoid time wasting, and describe how they contribute to time-saving. (6)
 - e. The files on the operating system need to be protected against unauthorised access. The system administrator requires access to the full filesystem, whereas employees only require access to their own user folders. Describe **TWO** ways how protection against unauthorised access can be implemented. (2)

(Total: 20 marks)

4. A company currently uses a spreadsheet to keep track of its employees. The company would like to use a more professional database-based approach. This is what the employee spreadsheet currently looks like:

| Surname | Name | Department | Branch | Salary | Phone Number |
|---------|-----------|--------------|------------|--------|-------------------|
| Saliba | Mark | Sales | Sliema | 22,000 | 452313, 123421 |
| Cassar | Anne | Marketing | Paola | 24,000 | 732912 |
| Zammit | Paul | Software Dev | Birkirkara | 35,000 | 293801 |
| Mifsud | Christine | Software Dev | Birkirkara | 35,000 | 192021 |
| Axiaq | Joe | Sales | Sliema | 23,000 | 203019 |
| Mifsud | Christine | Marketing | Paola | 27,000 | 482012, 192031 |

- Give **THREE** reasons why a professional database approach is better than using a spreadsheet to store, query and update the data. (3)
- State **TWO** issues with how the data is stored in the above table. (2)
- Transform the table above to 3rd Normal Form showing **all** steps involved including explanations. (12)
- Suggest **ONE** database application that the company may use. (1)
- Distinguish between a Data Manipulation Language (DML) and a Data Description Language (DDL). (2)

(Total: 20 marks)

5. A rotating shaft has 16 different positions. This shaft is to be connected to a computer such that the shaft position is encoded in digital form. To ensure reliable operation, a small change in the analogue shaft position changes only 1 bit in the output digital word (Gray Code).

Assume that **each** shaft position is labelled 0 – 15 in BCD.

- Draw the truth table for the converter to be used to change from BCD to Gray Code. (8)
- Using Karnaugh maps, derive the minimised logic expression for **each** output. (8)
- Draw the final logic circuit of the BCD to Gray Code converter. (4)

(Total: 20 marks)

Please turn the page

6. a. The number 8 needs to be written to memory location 7.
- Briefly describe how the CPU handles asynchronously such a write request to memory? (4)
 - Suppose that a read request is to be made to the memory at the same location. List **TWO** main differences between the read and write operations. (2)
- b. A computer has n address lines.
- How many possible memory locations can be accessed? (1)
 - Which circuit is used to address **each** of the possible memory locations? Briefly describe how this circuit operates. (3)
- based on the Von Neumann architecture
- c. The two most important parts in a processor are ALU and CU. Define and explain the functions of **both** components. (4)
- d. An instruction at memory location 100 needs to be executed. How would the processor that you have designed execute the instruction? (6)

(Total: 20 marks)

7. A new programming language called "COMP" is being developed. In this language, each statement is separated by semi-colons. The company is having problems developing a metalanguage equivalent of an assignment statement, which must obey the following rules:
- an assignment statement must start with a letter followed by alternate operators and letters;
 - the only operators that are allowed are "+", "-", "*", "/", and "=";
 - the first operator must be an equal, of which there should only be one;
 - the statement must contain at least one operator;
 - the statement must contain no other letters.
- a. Define metalanguage. (1)
- b. Using BNF notation, define the syntax of the assignment statement described above. (7)
- c. What is the main purpose of a parse tree? (1)
- d. Name and briefly describe **THREE** methods of code optimisation. (3)
- e. Using different types of code optimisation, perform an optimisation on the following snippets of code:
- `x = 7+3+c;` (1)
 - ```

a = 90;
b = 20;
for (int i = 0; i < 2; i++) {
 c = i*Math.sin(a)/Math.sin(b);
}

```

(3)
  - ```

for (int i = 0; i < 4; i++) {
    System.out.println("Hello");
}

```

(4)

(Total: 20 marks)

8. Miriam enjoys writing programs in assembly language. She frequently has to write to registers and access memory locations. Miriam has recently developed the following two assembly language programs:

Program 1:

```
MOV CX, 4 ; Move 4 into register CX
ADD CX, 5 ; Add 5 to the contents of CX and store in CX
MOV BX, CX ; Move the value of CX into register BX
INC BX ; Increment the value of BX
MOV AX, BX ; Move the contents of BX into register AX
MOV DX, CX ; Move the contents of CX into register DX
```

Program 2:

```
MOV DX, 8 ; Move 8 into register DX
MOV AX, 9 ; Move 9 into register AX
SUB DX, 4 ; Subtract 4 from register DX and store in DX
MUL DX, DX ; Multiply DX by DX storing the value in DX
MOV CX, DX ; Move the contents of DX into register CX
INC CX ; Increment CX
DEC AX ; Decrement AX
MOV BX, CX ; Move the value of CX into register BX
```

- a. Name the addressing mode shown in each of the following examples:
- i. MOV AX, 0513H (1)
 - ii. INC CX (1)
 - iii. MOV CX, [AX] (1)
 - iv. MOV AX, #14H (1)
 - v. MOV AX, [AX + DI] (1)
- b. By performing a dry run, determine the final values of registers AX, BX, CX, DX for the first program. Assume that **all** registers are initialised to 0. (4)
- c. By performing a dry run, determine the final values of registers AX, BX, CX, DX for the second program. Assume that **all** registers are initialised to 0. (6)
- d. Miriam is confused about the type of assembler that she is to use to assemble the above code.
- i. Name and briefly describe **THREE** different types of assemblers. (3)
 - ii. Which assembler would be most useful for the above two programs? Why? (2)

(Total: 20 marks)

| | |
|---------------|-------------------------------|
| SUBJECT: | Computing Practical Tasks |
| PAPER NUMBER: | Task 1 |
| DATE: | 29 th January 2020 |
| TIME: | 2 hours 5 minutes |

General Instructions:

- Answer **all** questions.
- This task should be completed within 2 hours 5 minutes. The first 5 minutes are reading and noting time.
- This paper has **THREE** questions with a total of 30 marks.
- Only the "BlueJ" programming environment shall be used throughout the practical task.
- Candidates are **not** allowed to make use of the `Math` class throughout the paper.
- The path where the project folder should be created and saved is to be set to the Computer Desktop or as otherwise instructed. It should be named to *Name Surname Id Card Number* (e.g. Joe Borg 123456M). All work must be saved in this project folder.
- Candidates are requested to include an inline comment with their name, surname and ID card number before starting each question.
- At the end of the exam, candidates are to print a copy with the help of the technician and save a copy of their project folder on the USB stick provided by MATSEC.
- Candidates are to sign each of their printouts.
- Before leaving, candidates are to sign the attendance sheet, write down the time at which they leave the examination room (Time Out) and the username, if any, on the attendance sheet.
- Marks will only be awarded if the above instructions are followed.

1. *Include an inline comment with your details before starting the question. Good practices such as brief inline comments, indentation and naming standards are expected.* (1)

You are to design and implement a program using one class called 'Task1Question1' which performs the following:

- a) Obtain the dimensions of a rectangle (length and breadth) from a user, and store the dimensions in two variables using an appropriate datatype. (2)
- b) Calculate the area of the rectangle (length × breadth) -and store it in another variable. (2)
- c) Calculate the perimeter of the rectangle (2×length + 2×breadth) and store it in another variable. (2)
- d) Check whether the area is greater than the perimeter. If yes, then output the statement 'The area of the rectangle is greater than its perimeter', if not then output the statement 'The perimeter of the rectangle is greater than its area'. (3)

(Total: 10 marks)

2. *Include an inline comment with your details before starting the question. Good practices such as brief inline comments, indentation and naming standards are expected.* (1)

You are to design and implement a program using one class called 'Task1Question2' which performs the following:

- a) Obtain a natural number n from a user and use this number to output a pattern using the '*' symbol to form a triangle. For example, if $n = 3$ the following is displayed:

```
*  
**  
***
```

(4)

- b) You are to develop a simple quiz question. The program should output the question "How many sides does a triangle have?" and then obtain an answer from the user, using a suitable datatype. If the answer is correct (the input is 3), then output "Correct answer!", otherwise keep asking for an answer from the user until the answer is correct. (2)
- c) Write a program to input two decimal numbers from the user at run time, and display the maximum number and the sum of the two numbers. (3)

(Total: 10 marks)

3. *Include an inline comment with your details before starting the question. Good practices such as brief inline comments, indentation and naming standards are expected.* (1)

You are to design and implement a program using one class called 'Task1Question3' which performs the following:

- a) Ask the user to input a time in minutes as a decimal number and convert and output this number in hours. (3)
- b) Obtain another time in minutes from the user, and calculate the average time and the difference between the two times in minutes. (3)
- c) Swap the two variables containing the two times and output their new values. (3)

(Total: 10 marks)

Print all your work (3 questions) and save a copy of your work on the pen drive provided by MATSEC. All printouts shall be signed.