



SUBJECT:	Computing
PAPER NUMBER:	I
DATE:	4 th October 2021
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.
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1. Consider the following code:

```
int[] myList = {4,6,2,1,3};
for (int i = 0; i < myList.length; i++) {
    myList[i] += 2*i;
    if (i > 2) {
        break;
    }
}
```

- a. What are the contents of `myList` after this code has been executed? (5)
- b. Write down the **TWO** additional lines of code required in order to place the above code within a method, which receives `myList` as a parameter and returns `myList`. (2)
- c. Describe the changes to this code in order to make it shorter but still have it behave in the same way. (2)
- d. Assuming that the length of `myList` passed to the method is between 4 and 10, what would happen when executing the code if `myList.length` was replaced by the number 20? (1)

(Total: 10 marks)

2. A manager wants to upgrade a computer network for the XYZ company.

- a. Currently, employees connect to the computer's main server through its IP address, 10.60.32.23. What change should be made to allow the employees to instead use the server name, `server.xyz.mt`? (2)
- b. The company's computers are presently connected via copper cables and a lot of errors occur during data transmission.
 - i. What is this phenomenon known as? (1)
 - ii. Briefly describe **TWO** other cable types that you could use in order to reduce these errors. (2)

(Total: 5 marks)

3. a. Distinguish between a digital signature and a digital certificate. (2)
 b. A video with a size of 2 GB is transferred over a communications link in 10 minutes.
 i. Calculate the bit rate of the link. You may give your answer as a fraction. (2)
 ii. Which protocol would you use to transfer the video? (1)

(Total: 5 marks)

4. a. Briefly describe the **THREE** levels of the database schema. (3)
 b. Give **TWO** examples of 4th generation applications which may be used to create databases. (2)

(Total: 5 marks)

5. a. Briefly describe how the operating system prevents processes from accessing storage allocated to other jobs. (2)
 b. A particular process scheduling algorithm runs process **A** for 1 second and then swaps it with process **B** as process **A** needs access to a resource.
 i. What state is process A now in? (1)
 ii. What other states can a process be in? (1)
 iii. With this scheduling algorithm, a given process is in running mode for only 5% of the time. What condition is this called? (1)

(Total: 5 marks)

6. Consider the following SALES table:

Sales Table

Product_Name	Quantity	Price	Branch_Location	Date
Sofa	1	500	San Gwann	10/07/2021
Chair	4	200	Attard	12/07/2021
Wardrobe	3	300	San Gwann	13/07/2021
Desk	1	200	St Paul's Bay	13/07/2021
Table	3	600	Attard	19/07/2021
Shelf	6	200	Attard	22/07/2021

- a. What is the result of the following SQL query:

```
SELECT Product_Name from SALES
WHERE Price >= 300 and Quantity > 2
ORDER BY Branch_Location
```

(2)

- b. What is the result of the following SQL query:

```
SELECT Branch_Location, sum(Quantity) from SALES
GROUP BY Branch_Location
HAVING SUM(Quantity) > 2
```

(3)

(Total: 5 marks)

7. a. Which file allocation method would the operating system use if it required:
- fastest access; (1)
 - flexibility in terms of file size. (1)
- b. In isolated I/O, memory and I/O have a separate address space and all addresses can be used by the memory. Briefly describe how the situation is different for memory mapped I/O. (2)
- c. Name **ONE** tool which may be used to edit the contents of a file. (1)

(Total: 5 marks)

8. a. Consider the sorted linked list [3,4,6,8,9]. Describe how:
- number 8 could be deleted from the list; (2)
 - number 5 could be added to the list. (2)
- b. What is a stack used for in computing? (1)

(Total: 5 marks)

9. a. Which precondition is necessary in order for binary search to be used? (1)
- b. Show and explain how the list [1,6,4,7,2] could be sorted using Merge Sort. (4)

(Total: 5 marks)

10. The following is a binary number in unnormalised form, having an 8-bit mantissa and a 4-bit exponent.

0.0101000 0100

- What is its decimal equivalent? (2)
- What is the equivalent number in normalised form? (3)

(Total: 5 marks)

11. a. Using NOR gates **only**, derive a logic expression for:
- $$X = A.B \quad (2)$$
- b. Draw the logic circuit for the above expression using **only** NOR gates. (3)

(Total: 5 marks)

12. a. A computer has n -address lines. How many possible memory locations can be accessed? (1)
- b. Name and describe the device which is used to select the appropriate memory location. (3)
- c. What is a memory address map? (1)

(Total: 5 marks)

13. Special internal registers are used during normal operation. For the following registers, briefly describe their main function:
- Program Counter; (1)
 - Status/Flag Register; (1)
 - Stack Pointer; (1)
 - Instruction Register; (1)
 - Memory Data Register. (1)

(Total: 5 marks)***Please turn the page***

14. a. In the context of compilers and language translators, what is the purpose of a linker? (1)
 b. Name and briefly describe **TWO** types of linking. (4)

(Total: 5 marks)

15. a. Briefly describe the function of a symbol table. (1)
 b. Name **TWO** typical errors which are detected during this syntax and analysis stage of the compilation process. Provide a code example to demonstrate **each** error you mention. (4)

(Total: 5 marks)

16. a. During normal operation, an assembly language program does not run sequentially, but will need to continue execution from another point in the program. This is achieved through the use of jump or branch instructions. Name and describe the **TWO** types of branch instructions. (4)
 b. Name the application of the following assembly language program.

```
MOV AX, #0010 ; Move the value 00102 to register AX
NOT AX; Perform the NOT operation on AX
ADD AX, #0001 ; Add the value 00012 to register AX and store answer in
                AX.
```

(1)

(Total: 5 marks)

17. Consider an 8-bit register, called AX. For a particular program to continue running, bits 0, 2, 4, and 7 of this register should be set to 1. Jane has written two simple programs to check if this condition has been satisfied.

```
i.  AND AX, #10010101 ; AND the value 10010101 to register AX
    CMP AX, #10010101 ; Compare the value of AX to 10010101

    JMP CONTINUE      ; Jump to the Continue label

ii. OR  AX, #10010101 ; OR the value 10010101 to register AX
    CMP AX, #10010101 ; Compare the value of AX to 10010101

    JMP CONTINUE      ; Jump to the Continue label
```

Explain which program will work successfully and justify your answer. (5)

(Total: 5 marks)

18. a. Discuss **FOUR** reasons that may prompt a company to develop a new system? (4)
 b. In which part of the system development lifecycle may a UML be used? (1)

(Total: 5 marks)

19. a. Utilising one or two short paragraphs of text, provide a hypothetical specification of a small system that you are familiar with. (2)
 b. State, with adequate reasoning, which parts of your specification will be explained by:
 i. a Use-Case Diagram; (1)
 ii. a Data Flow Diagram; (1)
 iii. a Class Diagram. (1)

(Total: 5 marks)



SUBJECT:	Computing
PAPER NUMBER:	II
DATE:	5 th October 2021
TIME:	4:00 p.m. to 7:05 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 following code:

```
public abstract class Vehicle {

    private String colour;
    int num_wheels = 0;

    Vehicle() {
        setColour("[NOT SPECIFIED]");
    }

    Vehicle(String c) {
        setColour(c);
    }

    public String getColour() {
        return(colour);
    }

    public void setColour(String c) {
        colour = c;
    }

    abstract int wheelCount();
}

public class Bicycle extends Vehicle {

    static final int num_wheels = 2;

    private boolean hasTrailer;

    public Bicycle() {
        super();
        setHasTrailer(false);
    }

    public Bicycle(String c) {
        super(c);
        setHasTrailer(false);
    }
}
```

```

    }

    public int wheelCount() {
        return(num_wheels);
    }

    public void setHasTrailer(boolean hsc) {
        hasTrailer = hsc;
    }

    public boolean getHasTrailer() {
        return hasTrailer;
    }
}

public class Car extends Vehicle {

    public Car() {
        super();
        num_wheels = 4;
    }

    public Car(String c) {
        super(c);
    }

    public int wheelCount() {
        return(num_wheels);
    }
}

```

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

```

Vehicle[] v = new Vehicle[5];
v[0] = new Bicycle("Red");
v[1] = new Bicycle();
v[2] = new Car("White");
v[3] = new Bicycle("Black");
v[4] = new Car();

for (Vehicle veh : v) {
    System.out.println(veh.wheelCount());
}

```

(5)

- b. If the return statement of `wheelCount()` method in the `Bicycle` class was updated from `return(num_wheels)` to `return(super.num_wheels)`, how would this affect the output from the program above? (3)
- c. Name **THREE** OOP principles and show how they are being used in the code above. (6)

- d. Good programming practice generally makes the act of programming, as well as future maintenance and modifications to code, easier. Consider the following piece of code

```
void mymethod(int x, int y) {
    if (y < x) {int z = x; x = y; y=z;}
    for (int i = x; i <= y; i++)
        anotherMethod(i);
}

void anotherMethod(int x) {System.out.println(x);}
```

- i. List **THREE** problems associated with this method with respect to good programming practice, and rewrite the code to eliminate. (3)
- ii. Rewrite the code to address these problems. (3)

(Total: 20 marks)

2. Charles wants to display a number of digits on a 7-segment display such as the one shown below. To display the numbers correctly, he needs to design a BCD to 7 segment decoder circuit.

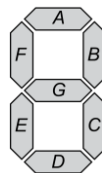


Figure 1

(Adapted from: https://commons.m.wikimedia.org/wiki/File:7_Segment_Display_with_Labeled_Segments.svg)

- a. By considering only the digits in the range 0 – 9, write the truth table for the complete 7 segment display. (10)
- b. By using Karnaugh map techniques, minimise the logic expression for the segment B in full. (4)
- c. Draw the logic circuit for segment B. (6)

(Total: 20 marks)

3. You are required to design a memory controller for a new processor that the company that you are working for is designing. The maximum addressable memory space that the processor will be able to address is 1024_{10} . Your boss has come up with the idea to use one memory chip and one decoder. However, such a system would not be optimal.
- a. If a single memory chip is to be used, design a solution using **TWO** decoders, to completely address the memory chip. Clearly write any assumptions used with regards to the logical organisation of the memory. (10)
 - b. A single memory chip with 1024_{10} address lines is not available, thus the solution is to use 8 memory chips instead.
 - i. In terms of addressable space, how large should each chip be? (2)
 - ii. Design a solution using **TWO** decoders to completely address the memory chips. (8)

(Total: 20 marks)

Please turn the page.

4. a. Consider the fragment of assembly code below. Prior to execution, register `AX` contains 3_{10} and register `BX` contains 4_{10} . By performing a dry run and showing your working, what will be the contents of registers `AX`, `BX`, and `CX` after execution?

```

MOV CX,0           ; Move 0 into CX
AGAIN: ADD CX, AX   ; ADD CX to AX, storing in AX
DEC BX            ; Decrement BX
JZ DONE          ; Jump to Done if 0
JMP AGAIN        ; Jump to Again
DONE: MOV AX, 0    ; Move 0 into AX
MOV BX, 0        ; Move 0 into BX

```

(10)

- b. `SHL` and `SHR` are two shift operations used in assembly language to shift a (binary) number by one bit left or right, respectively. Suppose that the 8-bit register `AX` contains the value of 13_{10} .
- What will the value of `AX` be following **TWO** successive right shifts? Give the answer in decimal and show your working. (5)
 - Which mathematical operations are taking place by performing shifts? (2)
- c. Define each of the following terms:
- Macro Assembler; (1)
 - Cross Assembler; (1)
 - Meta Assembler. (1)

(Total: 20 marks)

5. a. A stationery shop manages subscriptions to a number of magazines. Customers can subscribe to receive one or more of the magazines. Each magazine has a category, such as home decor or football, and a yearly subscription rate, which is the cost of subscribing to receive a magazine for 12 months.

The details of customers' subscriptions to magazines are stored in a database using the three entities: Magazine, Subscription and Customer.

- Define clearly, using a short notation (as in the example of ENTITY shown below), the three entities Magazine, Subscription and Customer. ENTITY (attrb1, attrb2,....attrbN). Name appropriately the entities and explain your choice of primary and foreign keys. (6)
 - Define the data types for the attributes within the Magazine entity. (3)
 - Construct an Entity-Relationship diagram for the database. (7)
- b. Discuss **TWO** advantages of relational databases over traditional file systems. (2)
- c. Discuss **TWO** disadvantages of relational databases over traditional file systems. (2)

(Total: 20 marks)

6. Consider the network infrastructure shown below.

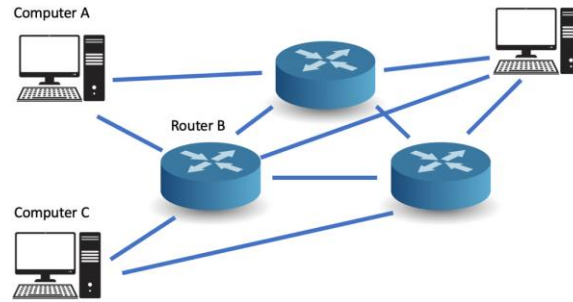


Figure 2

- a. What type of network topology is being used? Give a reason for your answer. (2)
- b. Suppose that router B receives a packet from computer A, and decides to forward the packet to computer C.
 - i. What information enables router B decide to forward the packet to computer C? (1)
 - ii. Describe which protocol layer(s) within the OSI seven-layer protocol stack is/are used in order for the packet forwarding process to happen. (6)
- c. An example of the bitstream that Computer C receives is 10000001 | 1, where the first byte represents the data and the final bit represents the parity bit. Assuming even parity is being used, did an error occur during transmission? Give a reason for your answer. (2)
- d. Name and describe **THREE** other connectivity devices. (6)
- e. Biometrics are commonly used nowadays to protect computer infrastructure from attack. Name and describe **ONE** type of biometrics. In your answer explain where it would be used. (3)

(Total: 20 marks)

7. a. Which type of operating system should be used in each of the following scenarios:
 - i. Users prepare and submit jobs to the computer, which are then run in one go. (½)
 - ii. An office with a number of PCs which do not have sufficient storage space for an operating system, but have a good network connection. (½)
 - iii. A network of computers which requires sharing of files and hardware devices. (½)
 - iv. A time-critical computing system such as the one used in an aeroplane. (½)
- b. In order to determine if a printer is ready from a print operation, the CPU of a computer checks its status regularly.
 - i. What is this process known as? (1)
 - ii. Name a disadvantage of this approach. (1)
 - iii. Describe another technique that could be used instead, which does not suffer from this disadvantage. (2)
- c. Distinguish between logical and physical address spaces. (4)
- d. What is a page fault, and how does the operating system recover from it? (4)
- e. Which scheduling algorithm would you select which ensures an equal time slice for each process? Give **ONE** advantage and **ONE** disadvantage of such an algorithm. (3)
- f. Name and describe the problem that is solved by the technique known as defragmentation. How does defragmentation address this issue? (3)

(Total: 20 marks)

Please turn the page.

8. A theatre group would like to develop a new computerised booking system so that they can keep track of bookings. This new system will be replacing the old system currently in place.
 - a. Name and describe the main stages of the system development life cycle that that should be followed to ensure that a good system is delivered. (7)
 - b. One of the preliminary stages in the system development life cycle is to be able to prepare a study containing the scope and objectives of the proposed system. Name and describe the **SIX** aspects that should be considered when designing a system such as the one described above. (6)
 - c. The following partially completed data flow diagram (DFD) pertains to a part of the new system which will be responsible for handling bookings where a customer is buying tickets in person (not online).

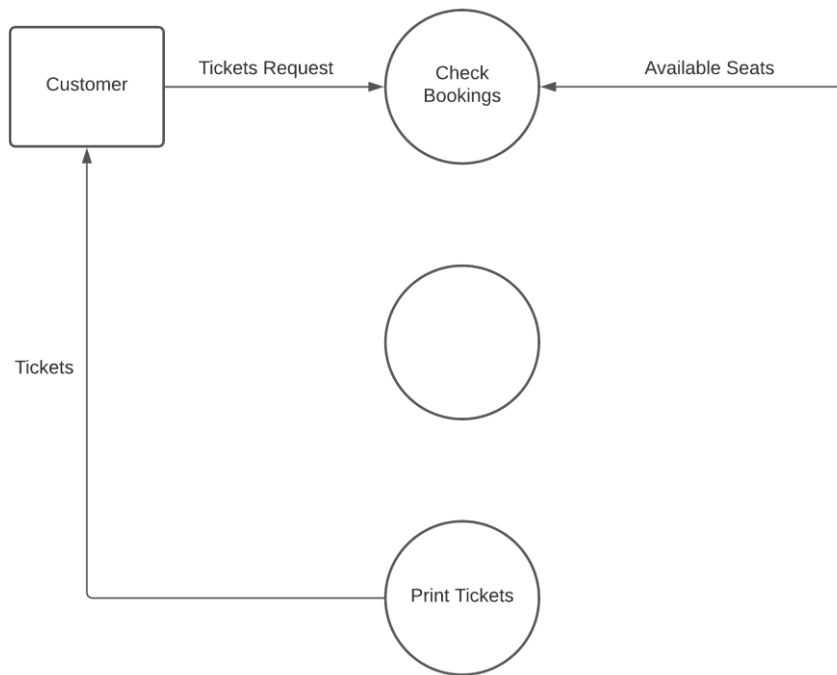


Figure 3

- i. Complete the diagram. If needed, state any assumptions you make. (5)
- ii. Provide a textual description of the system represented by your diagram. (2)

(Total: 20 marks)