



MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING, SCIENCE AND TECHNOLOGY

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: INFORMATION SYSTEMS FOR CHEMICAL ENGINEERS

CODE: HCHE 516

SESSIONAL EXAMINATIONS

APRIL 2023

DURATION: 3 HOURS

EXAMINER: L. NYATHI (MISS)

INSTRUCTIONS

1. *Answer **All** questions.*
2. *Marks are awarded for the manner in which you present your solution.*
3. *Calculators are permitted*
4. *Total marks 100*

Additional material(s):

QUESTION 1

- a) List **five** advantages of MATLAB as a tool for solving engineering problems. [5]
- b) Explain the use of the following MATLAB commands:
- (i) `clc`
 - (ii) `clear all` [2]
- c) What is the difference between a vector and a matrix? [2]

QUESTION 2

- a) Assuming the following assignments:
- ```
>> a = [3 4 5; 6 4 3; 2 1 2];
>> b = [5 3 4; 5 6 2; 3 4 9];
```
- (i) What will be the result of the following expression?  

```
>> a(2,:) * b(:,2) ./ 9.^ 1/2 + b(1,3) / a(3,2)
```

 [2]
  - (ii) What is the value of the vector  $C$  after the following lines of code:  

```
>> a(2,:) = []
>> C = length (a)
```

 [2]
- b)  $A = \text{magic}(4)$  gives the following matrix:
- |    |    |    |    |
|----|----|----|----|
| 16 | 2  | 3  | 13 |
| 5  | 11 | 10 | 8  |
| 9  | 7  | 6  | 12 |
| 4  | 14 | 15 | 1  |
- (i) Write MATLAB code to replace the 2nd and 3rd rows of  $A$  with 0s. You must use the **zeros** function (but only once). [2]
  - (ii) Write a code to interchange the first and second columns of  $A$ . [2]
  - (iii) Write a code to delete the third row of  $A$  [1]
  - (iv) Write a code to create a matrix  $R$  that will contain the elements of  $A$  that are lesser than 4. Write the exact result of the operation. [3]

### QUESTION 3

Consider the expression given below:

$$\sum_{n=1}^{100} \frac{n}{(2n+3)^2}$$

Use a *for* loop to evaluate the expression [5]

### QUESTION 4

Study the following lines of code and answer the questions that follow:

```
Rows = 4
```

```
Columns = 5
```

```
Arr = ones (rows, columns)
```

```
i = 1
```

```
while i <= rows
```

```
 for j = columns : -2 : 1
```

```
 Arr(i, j) = i + j;
```

```
 end
```

```
 i = i + 1
```

```
end
```

```
fprintf('%d\n', j)
```

```
fprintf('%d\n', Arr(rows, columns))
```

- What is the value of **j** printed in the first fprintf statement? [3]
- How many elements of the array changed as a result of the two loops? [3]
- What is the value printed in the final fprintf statement? [3]

### QUESTION 5

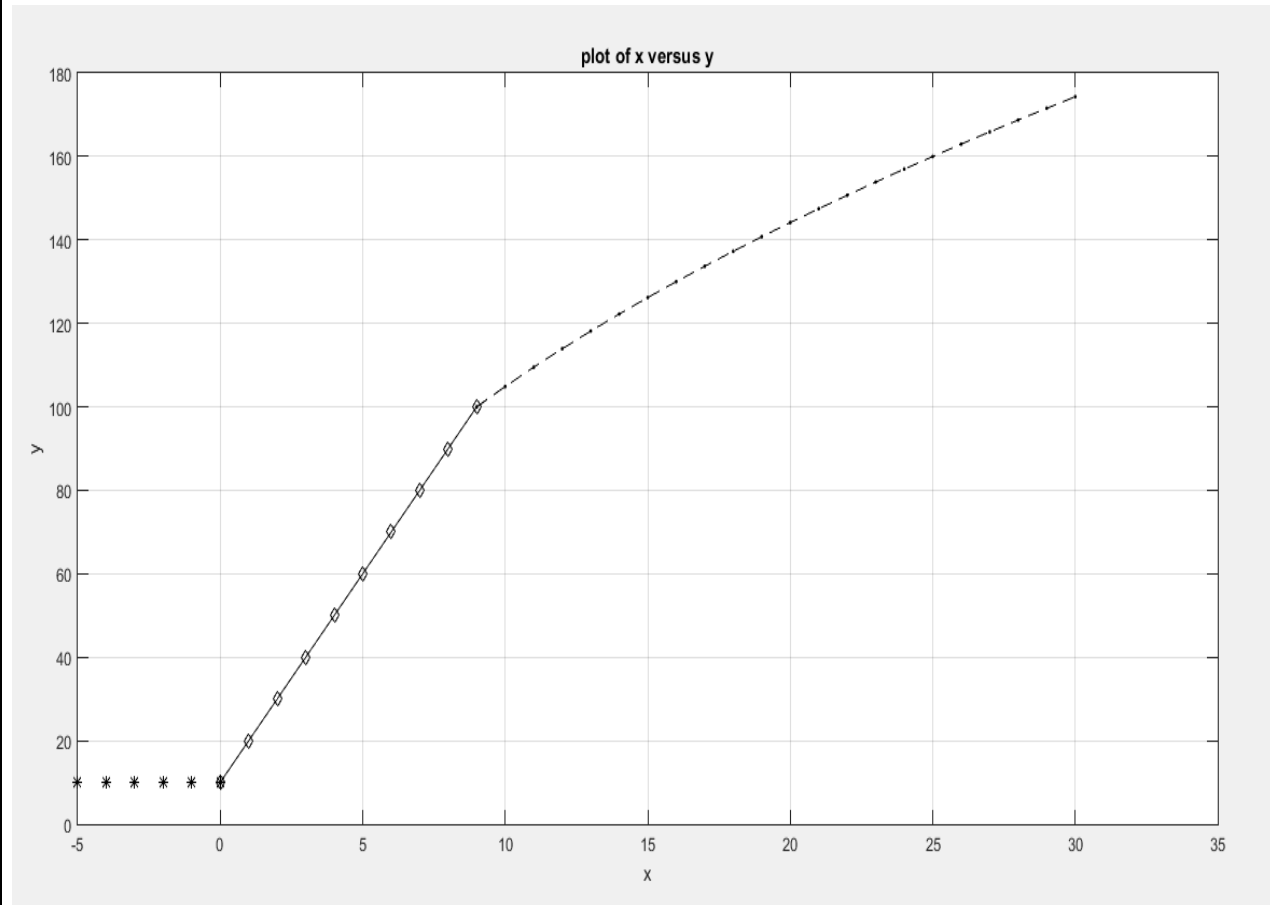
Write a MATLAB script to plot the function:

$$y = \begin{cases} 15\sqrt{4x + 10} & x \geq 9 \\ 10x + 10 & 0 \leq x \leq 9 \\ 10 & x < 0 \end{cases}$$

For  $-5 \leq x \leq 30$ .

Ensure there are at least 35 intervals in the range for  $x$ .

Your code should replicate **Figure 1** below, with the appropriate labels, title and formatting. [10]



**Figure 1**

### QUESTION 6

Write a **flowchat** for a function called **VisFunction** that takes in a vector,  $V$ , and produces a new vector,  $W$ , of the same length as  $V$  where each element of  $W$  is the sum of the corresponding element in  $V$  and the previous element of  $V$ . Consider the previous element of  $V(1)$  to be 0. [10]

### QUESTION 7

Write a MATLAB script that calculates a user's total mobile telephone costs at the end of a month for a flexible post-paid billing system. Assume that the user's service usage information is stored somewhere and is retrievable by the user; and your script will calculate the total cost depending on his/her input.

Use the following algorithm for the calculation:

- 1) Ask the user if he/she is on a monthly post-paid billing system. If the response is 'yes' then proceed otherwise end the program with the message: "This program is for only post-paid clients".
- 2) Request the user to put in the number of peak and off peak minute calls he/she made for the month. Use R0.06/second and R0.015/second as rates for peak and off-peak call charges respectively.
  - 2.1) Ask the user if he/she bought any SMS bundles this month. If the response is 'yes,' then,
    - 2.2) Use the **menu** function to ask the user the type of bundle he/she purchased.

Then use a **switch case** statement to assign the cost per bundle according the rates in **Table 1**.

**YOU MUST USE THE MENU FUNCTION AND THE SWITCH CASE STATEMENT FOR THIS STEP.**

**Table 1: SMS bundle rates**

| <b>Cost</b>   | <b>Per number of SMS</b> |
|---------------|--------------------------|
| <b>R10</b>    | For 20 SMS               |
| <b>R25</b>    | For 50 SMS               |
| <b>R35</b>    | For 100 SMS              |
| <b>R50</b>    | For 200 SMS              |
| <b>R67.50</b> | For 300 SMS              |

3.1 Ask the user if he/she used any broadband data. If the response is ‘yes’, then

3.2 Ask the user how much data he/she used for the month and calculate the total cost using the charge per Mega byte (MB) given in **Table 2**. You can use any type of selection structure for this step.

**Table 2: Broadband data rates**

| <b>Total data used</b> | <b>Cost in Rand per MB</b> |
|------------------------|----------------------------|
| <b>&lt;= 8MB</b>       | 1.16                       |
| <b>&lt;= 30MB</b>      | 0.93                       |
| <b>&lt;= 110MB</b>     | 0.80                       |
| <b>&lt;= 175MB</b>     | 0.68                       |
| <b>&lt;= 300MB</b>     | 0.46                       |
| <b>&gt; 300MB</b>      | 0.30                       |

4. Add up all of the user’s costs (use the variable: TotalCosts) and output the result using the following statement:

```
fprintf('Your total cost for this month is R %5.2f\n', TotalCosts);
```

Comment your work – marks are awarded for effectiveness of comments.

Present your work neatly – marks are awarded for the clarity and effectiveness of presentation.

[20]

### QUESTION 8

A cylindrical tank is full of water. A small hole is drilled in the bottom of the tank so that the water leaks out. The mathematical model of the system is the differential equation which shows the relationship between the height of the liquid ( $h$ ) and the output flowrate ( $q_o$ ). Surface area of the bottom of the cylindrical tank is  $A = 0.4 \text{ m}^2$ . Velocity of the liquid coming out through the hole is  $v$  and the area of the hole  $a = 0.001 \text{ m}^2$ .

- i) Form a differential equation for the rate at which the height of the water in the tank is changing. [5]
- ii) Write a MATLAB code to solve the differential equation and find the ultimate liquid level ( $h$ ) of the tank. [5]

### QUESTION 9

- a) Write a code for a function called **vecSFunction** that takes in a vector,  $C$ , and produces a new vector,  $D$ , that contains all the elements in vector  $C$  that are smaller or equal to 45. The numbers should be in the same order as they were in vector  $C$ . Please note that you do not know the length of vector  $C$  i.e., the function should accept a vector of any length. [10]
- b) Write a script that calls the function **vecSFunction** where the input vector is  $C = [45 \ 2 \ 8 \ 4 \ 7 \ 2 \ 64 \ 2 \ 57 \ 2 \ 45 \ 7 \ 43 \ 2 \ 5 \ 73 \ 3 \ 523 \ 3 \ 4 \ 3 \ 0 \ -65 \ -343]$  [4]
- c) What will be the output of the script? [1]

**END OF EXAMINATION**