MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

Chemical and Processing Engineering Department

INFORMATION SYSTEMS FOR CHEMICAL ENGINEERS

CODE: HCHE 516

SESSIONAL EXAMINATIONS
MARCH-APRIL 2021

DURATION: 3 HOURS

EXAMINER: MR F.K. CHIKAVA

INSTRUCTIONS

1. *Answer **ALL** questions.*
2. *Each question carries 20 marks.*
3. *Marks are awarded for the manner in which you present your solution.*
4. *Scientific Calculators are permitted.*
5. *Total marks: **100***

Question 1

a) List **3 (three)** advantages of MATLAB that motivates its use as a tool for solving engineering problems. **[3]**

b) Explain the significance/use of the following on the MATLAB interface:

(i) Command window

(ii) Workspace **[2]**

c) Explain the use of the following MATLAB commands:

(i) clc

(ii) clear all **[2]**

d) Differentiate between a syntax and a programming error. **[3]**

e) A = magic (4) gives the following matrix:

16	2	3	13
5	11	10	8
9	7	6	12
4	14	15	1

(i) Write a MATLAB code to replace the 2nd and 3rd rows of A with 1s. You must use the **ones** function (but only once). **[2]**

(ii) Write a code (using the **prod** function in MATLAB) to calculate the product of the first three elements of the 3rd row of A. **[2]**

(iii) Write a code to create a matrix Z that will contain the elements of A that are greater than 3. Write the exact result of the operation. **[3]**

f) What will be the value of C after the following lines of code:

```
>> B = 1 : 3 : 20
>> C = length(B)
```
[2]

g) Evaluate the following expression using MATLAB operator precedence rules:

```
>>  3.*20./2 – 9.^1/3*2
```
[1]

Question 2

a) Consider the expression given below

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

(i) Write a code to **vectorize** this summation

(ii) Use a ***for*** loop to evaluate the expression

(iii) Use a ***while*** loop to evaluate the expression

[10]

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

```
for i = 1:5
    for j = 1:4
        a = i + j
        if a >= 3, disp ('break')
            break
        end
    end
end
```

(i) What is the value of 'a' after the final 'end' statement? **[3]**

(ii) What is the value of 'i' after the final 'end' statement? **[2]**

(iii) What is the value of 'j' after the final 'end' statement? **[2]**

(iv) How many times will the 'disp' statement be run? **[2]**

Question 3

a) Write a code for a function called **mysteryFunction** 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.

Please note that you do not know the length of vector V i.e., the function should accept a vector of any length.

b) Write a script that calls the function **mysteryFunction** where the input vector is V = [1:6]. Note the output of this script is [1 3 5 7 9 11].

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 4

As a Junior Project Engineer in a pharmaceutical company, your job is to obtain quotations from various vendors for a new 100 mL vial filling machine to replace the obsolete machine that your organization is currently using. Capital costs are generally the same, therefore, the choice of the filler to be bought will depend mainly on the operating costs associated with each machine type.

There are three products that you plan to fill on this new machine and each of them require that the machine be cleaned at certain frequencies as per the current regulatory requirements:

Table 1

Product	**Frequency of cleaning required**
Epirubicin	Once every 500 vials
Doxorubicin	Twice every 200 vials
Irinotecan	Once every 100 vials

In addition to the information in Table 1, a filler machine manufacturer has given you the following information about the machines they have in stock:

Table 2

Machine Type	Operating cost per cleaning cycle
A	$700
B	$1220
C	$860
D	$300

Write a Matlab code that can be used to calculate the costs associated with filling a specific product on a specific machine type, assuming that you are going to be producing **10 000** vials of each product.

Hints:

i) Use the **menu** function to obtain inputs from the user

ii) Use **fprintf** or **disp** to output the results

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 5

If you have a mass hanging from a spring, pulling down on the mass and releasing it causes the mass to oscillate up and down. Eventually, the oscillations will 'decay' until we no longer see them. How fast the oscillations decay is a function of the damping of the system.

The response of the system is determined by formulating and solving a differential equation. Equation 1 is the solution to the **underdamped** condition, in which the damping is low enough to allow the mass to oscillate.

$$y = \left[y_0 cos\ (\omega_D\ t)\ +\ \frac{y_O \delta\omega}{\omega_D}\ sin(\omega_D\ t)\right] e^{-\delta\omega t} \qquad (1)$$

where,

y = the displacement of the mass relative to its original position at any time.

y_O= the initial displacement (the displacement at time = 0); an indication of how much the mass has been pulled down.

ω = the natural frequency of the system; a measure of how fast the system will oscillate freely.

δ = the damping coefficient; a value between zero and one.

t = time

ω_D= the damped frequency which is given by:

$$\omega_D = \omega\sqrt{1\ -\delta^2}$$

Equation 1 is plotted in Figure 1 for the following parameters: a time (t) domain of 0 to 5 seconds, y_O= 3, $\omega = 2\pi$ radians/second and $\delta = 0.10$

'e' is the exponential function and can be calculated using the MATLAB function ***'exp'***.

Write the MATLAB code to produce the graph in Figure 1. Use an appropriate resolution for the time vector. Ensure the code produces appropriate formatting i.e., grid, labels, title.

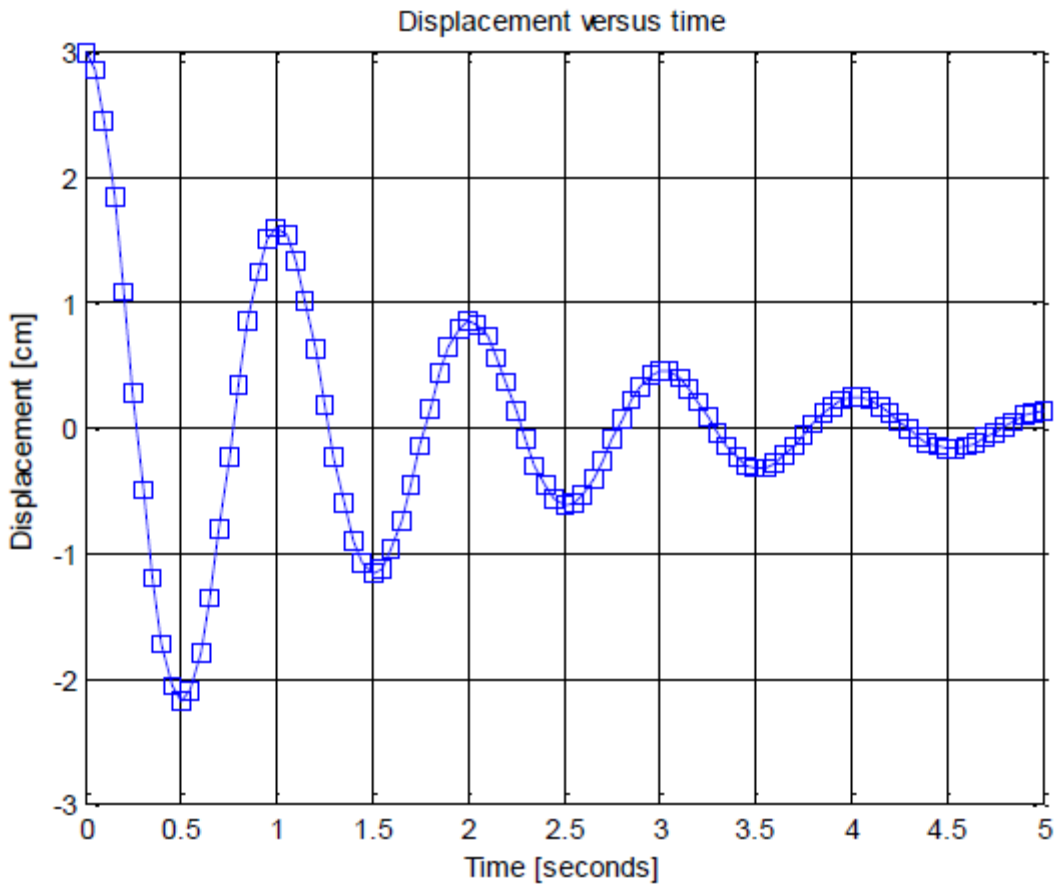

Figure 1

[20]

END OF EXAM