MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

CHEMICAL AND PROCESSING ENGINEERING DEPARTMENT

INFORMATION SYSTEMS FOR CHEMICAL ENGINEERS

CODE: HCHE 516

SESSIONAL EXAMINATIONS
SEPTEMBER 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.*

Question 1

(a) List **3 (three)** reasons why an Engineer would choose to use MATLAB as a tool for solving engineering problems. **[3]**

(b) Describe the use of the following common MATLAB functions

    (i)   `find`

    (ii) `help`

    (iii) `clc`

    (iv) `clear all` **[4]**

(c) Differentiate between a syntax and a programming error. Provide **an example** for each. **[4]**

(d) `A = magic (4)` gives the following matrix:

$$
\begin{array}{cccc}
16 & 2 & 3 & 13 \\
5 & 11 & 10 & 8 \\
9 & 7 & 6 & 12 \\
4 & 14 & 15 & 1
\end{array}
$$

Answer the following questions in relation to the original matrix A given above:

(i)   Write a code to obtain the transpose of matrix A **[1]**

(ii) Write a MATLAB code to swap the 2nd and the 4th rows of matrix A **[1]**

(iii) What would be the output to the command window if the following lines of code are executed?

```
k = find (A>10)
A(k)= -1
```
[3]

(e) Evaluate the following expression using MATLAB precedence rules

```
2 + round (6/9+3*2)/2-3
```
[2]

(f) What will be the result of the following expression?

```
p = size (ones(4,5))
```
[2]

Question 2

(a) The following MATLAB function has been written. Study the function and answer the questions that follow:

```
function [ x ] = mysteryFunction( V )

    x (1) = V(1)

    for i=2:length (V)

        x(end + 1)= V(i-1)+ V(i)

    end

end
```

(i)   What is the **function name**, **input arguments** and **output arguments**?

[3]

(ii)   Perform a line-by-line analysis of the code in order to explain the purpose of the function. **[4]**

(iii) Given the vector

```
a = [1:6]
```

Write lines of code that calls the function above to perform operations on vector `a`. **[3]**

(iv)   What would be the output from the function after the lines of code from (iii) above are executed? **[3]**

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

```
mat = ones (4,4);
for i=4:-1:1
    j=1;
    while j<4
        a = i+j;
        if a>=4
            disp ('out of the inner loop')
            break
        else
            mat (i,j)= a;
        end
        j=j+1
    end
end
```

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

(ii)   How many of the original elements are changed after the final 'end' statement?   **[2]**

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

Question 3

In statistics, the standard deviation is a measure of the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean of the set, while a high standard deviation indicates the values are spread out over a wider range.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}}$$

σ = population standard deviation

N = the size of the population

x_i = each value of the population

μ = the population mean

TASK: Develop an algorithm in the form of a pseudo code or flow diagram to calculate the standard deviation of a population using the above formula. **Note that it is not required for you to translate your algorithm into MATLAB.**

[20]

Question 4

A probability function that describes many processes is the normal or Gaussian function. The function has two parameters:

(i)   The mean (μ) is the mean of the outcomes in the process, locates the peak of the curve and is the most likely value to occur in the random process.

(ii) The standard deviation/variance (σ) describes the width or spread of the curve.

The normal probability function is described by the following equation:

$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}$$

Use this function to replicate the plot in Figure XXXX, where there are three cases of the normal distribution function with same mean, $\mu = 10$, but three different standard deviations: $\sigma = 1, 2$ and 3. $\sigma = 1$ has the highest peak, $\sigma = 2$ has the next peak and $\sigma = 3$ has the lowest peak.

Note:

- The exponential function e^x in MATLAB is expressed by 'exp(x)' and the word 'pi' is a constant for π.

- You must use an appropriate resolution to match the graphs.
- Your plot must have the appropriate formatting i.e. labels and legend.
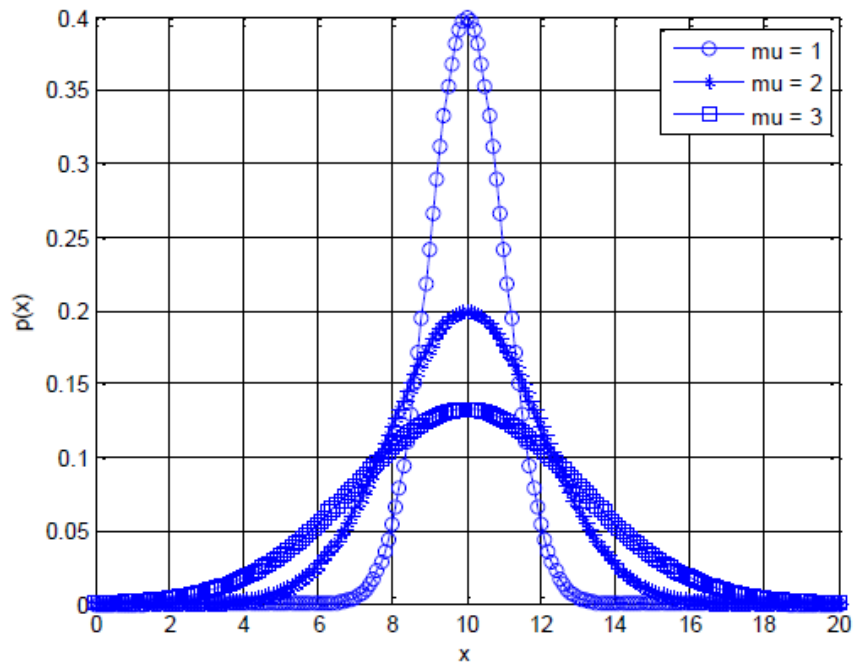- **Use any color of your choice for the graphs**

Figure XXXX

[20]

Question 5

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 (Table 2) 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.

The code should only be used by Project Engineers within your department. To achieve this, you should first ask the user to enter a password. The correct password to continue using the code is **4001**. If a wrong password is entered, the code should display "*You are not authorised to use this* code" and should not allow the user to proceed.

Hints:

i)   Use the **if block** to check the password

ii)   Use the **menu** function to obtain product and machine inputs from the user

iii)   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]**

END OF EXAM