MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: INFORMATION SYSTEMS FOR CHEMICAL ENGINEERS

CODE: HCHE 516

SESSIONAL EXAMINATIONS

NOVEMBER 2022

DURATION: 3 HOURS

EXAMINER:MS L. NYATHI

INSTRUCTIONS

1. *This exam consists of two sections*
2. *Answer all questions*
3. *Marks are awarded for the manner in which you present your solutions*

Additional material(s): Calculators

SECTION A – 60 MARKS

QUESTION 1

a) List **5 (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) Differentiate between a syntax and a programming error. **[3]**

QUESTION 2

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

    $>> B = 1 : 3 : 20$

    $>> C = \text{length}(B)$ **[2]**

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

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

    (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 Z that will contain the elements of A that are greater than 3. Write the exact result of the operation. **[3]**

QUESTION 3

a) Consider the expression given below

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

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

     (ii)   Use a ***while*** loop to evaluate the expression   **[10]**

QUESTION 4

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

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

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

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

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

(d) How many times will the 'disp' statement be run?   **[3]**

QUESTION 5

Many physical phenomena can be described by the Arrhenius equation. For example, reaction-rate constants for chemical reactions are modeled as:

$$k = k_0 e^{-\frac{Q}{RT}}$$ where

k_0 = constant with units that depend upon the reaction

Q= activation energy, kJ/kmol

R= ideal gas constant, kJ/kmol K

T= temperature in K.

For a certain chemical reaction, the values of the constants are

$Q = 1000$ J/mol, $k_0 = 10$ s^{-1}, $R = 8.314$ J/mol K, for T from 300 K to 1000 K.

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

Write the MATLAB code to produce the graph in **Fig.1** for finding the values of rate of constant (k). Ensure that the code produces appropriate formatting i.e., grid, labels, title etc.

Reaction Rate Constants
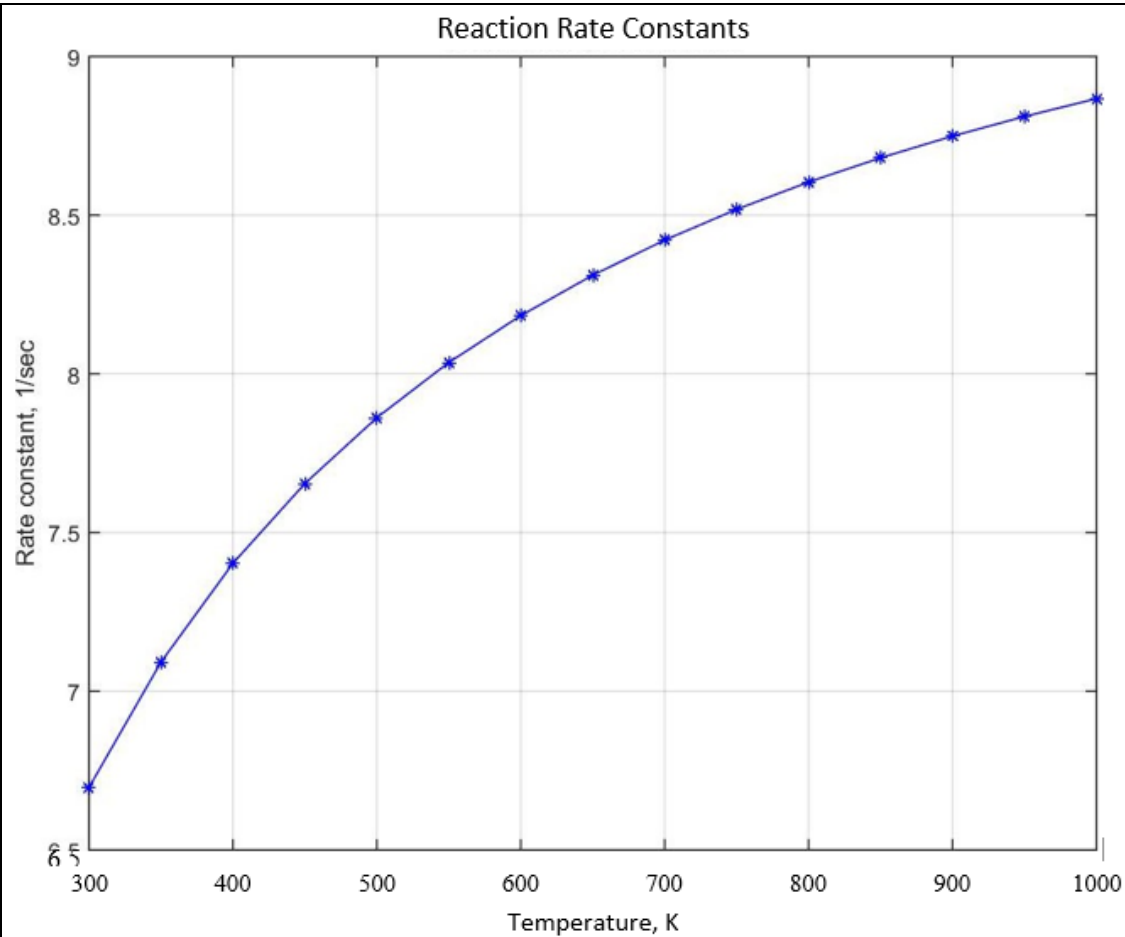
Fig.1

[10]

QUESTION 6

a) Write a **pseudo code** 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]**

SECTION B – 40 MARKS

QUESTION 7

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.

N.B Use **fprintf** 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. **[15]**

QUESTION 8

A fluid of constant density starts to flow into an empty and infinitely large tank at a volumentric flowrate of q_i =8 L/s. A valve regulates the outlet flow to a constant q_o = 4 L/s.

a) Write the differential equation which shows the rate of change of volume of the water in the tank. **[5]**

b) Write a MATLAB code to solve the differential equation and find the volume of the water in the tank over a 100 second interval. **[5]**

   N.B At time t = 0, the volume inside the tank V=0

QUESTION 9

Write the code for a function called **cdFunction** that takes in a vector, C, and produces a new vector, D, that is the same as the vector D except that all of the 2's have been deleted.

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

c) Write a script that calls the function cdFunction where the input vector is C = [4 5 2 8 4 7 2 64 2 57 2 45 7 43 2]. **[15]**

Note the output of this script is [4 5 8 4 7 64 57 45 7 43].

END OF EXAMINATION