



MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING, SCIENCE AND TECHNOLOGY

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: COMPUTATIONAL METHODS FOR CHEMICAL ENGINEERS

CODE: CHEP 221

SESSIONAL EXAMINATIONS

JUNE 2023

DURATION: 3 HOURS

EXAMINER: MISS N. T. MADZIWA

INSTRUCTIONS

- 1. Answer **ALL** questions in section **A** and choose any 2 questions in section **B***
- 2. Start a new question on a fresh page*
- 3. Total marks 100*

Additional material(s): Calculator

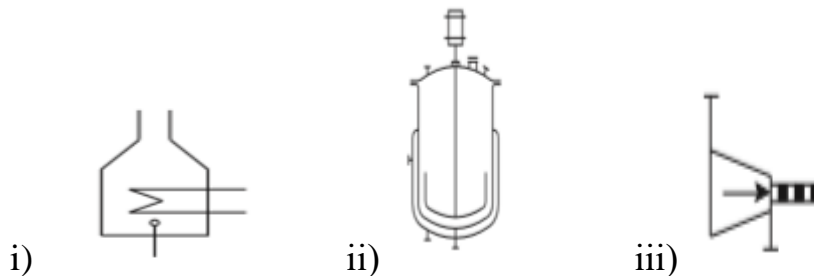
SECTION A

QUESTION 1

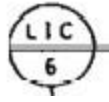
- a) Explain the significance of the following diagrams to Chemical Engineers
- i. Block Flow Diagram [1]
 - ii. Process Flow Diagram [2]
 - iii. Piping & Instrumentation Diagram [2]
- b) i. Explain what a pressure vessel is in relation to equipment in a chemical plant. [2]
- ii. What are the distinct components of a pressure vessel for design purposes? [5]
- c) Explain the following terms when used in Process simulations
- i. Sequential modular [1]
 - ii. Equation-Oriented (Simultaneous-Nonmodular) [1]
 - iii. Simultaneous-Modular [3]
- d) Compare and contrast the services that the Solver and Goal seek functions in Microsoft Excel provide to the application's end users. [3]

QUESTION 2

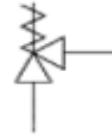
- a) State the equipment or instrument name represented by the following symbols in Chemical Engineering drawings. [5]



iv)



v)



b) Explain the following types of actuators when used in a chemical engineering plant

i. Pneumatic actuators [2]

ii. Motor actuators [1]

iii. Digital or solenoid actuators [2]

c) Explain what the ASME Boiler and Pressure vessel code (ASME BPVC) is. [2]

d) The ASME BPVC is document format that has divisions, sections, subsections and appendices. The commonly applied sections across different industries are section IV to VIII. Describe the content covered in these sections. [8]

QUESTION 3

a) State any **3 (three)** ways in which pressure vessels classified in the Chemical industry. [3]

b) The hydrostatic pressure test is normally performed on pressure vessels by process operating and maintenance teams. What is the purpose of this test? Outline the procedural steps in performing this test. [7]

c) Outline;

- i. The basic steps and [5]
- ii. how or source the information you need and where to find it at each stage in developing a process simulation using ChemCAD. [5]

SECTION B

QUESTION 4

- 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` [1]
 - (ii) `clear all` [1]
- c) Differentiate between a syntax and a programming error. [3]
- d) 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
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? [3]

QUESTION 5

- a) Write a MATLAB *function* $d = dsc(c)$ that takes a one-dimensional array of numbers c and returns an array d consisting of all the numbers in array c with all neighbouring duplicated numbers being removed. For example, if $c = [1\ 2\ 2\ 2\ 3\ 1]$, then $d = [1\ 2\ 3\ 1]$.

Comment on your work – marks are awarded for effectiveness of comments. Present your work neatly – marks are awarded for the clarity and effectiveness of presentation. [10]

- b) A probability function that describes many processes is the normal or Gaussian function. The function has two parameters:
- 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.
 - 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 1, 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.
- P (1) graph should be blue in colour, circle (o) markers for all data points and a continuous line.
- P (2) graph should be blue in colour, cross (×) markers for all data points and a dashed line.
- P (3) graph should be blue in colour, square (□) markers for all data points and a dotted line.
- Label the x-axis as ('x')
- Label the y-axis as (p('x'))
- Show grid lines and the legend
- Give the plot title the ('Figure 1')

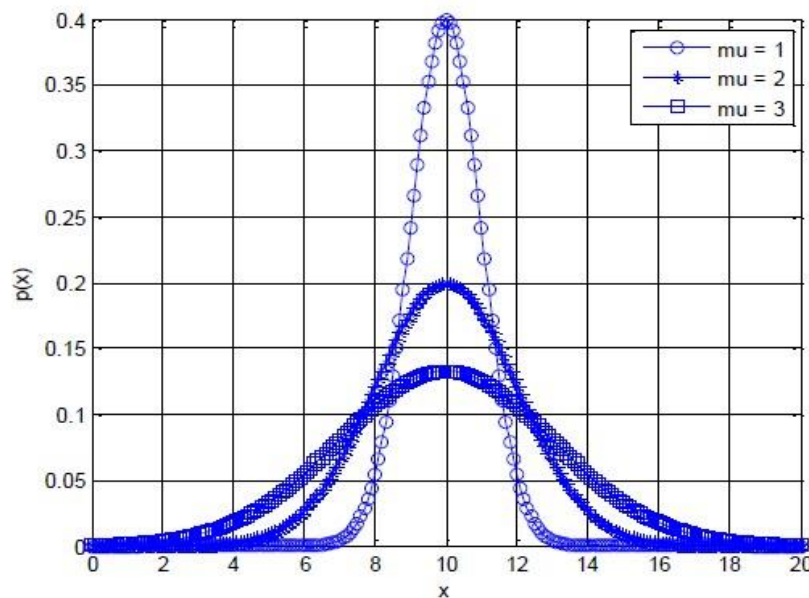


Figure 1

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

[10]

QUESTION 6

a) Write a MATLAB code step by step to solve the differential equation and plot the following function on a plot/graph:

Consider an 80 kg paratrooper falling from 600 meters. The trooper is accelerated by gravity, but decelerated by drag on the parachute.

Governing equation:

$$m \frac{d^2y}{dt^2} = -mg + \frac{4}{15}V^2$$

m = paratrooper mass (kg)

g = acceleration of gravity (m/s^2)

V = trooper velocity (m/s)

y = height (m)

Initial velocity is assumed zero

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

Present your work neatly – marks are awarded for the clarity and effectiveness of presentation. [10]

b) 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 .

Use this function to replicate the plot in Figure 2

- y_1 graph should be black in colour, circle (o) markers for all data points and a continuous line.
- y_2 graph should be red in colour, square (\square) markers for all data points and a dashed line.
- y_3 graph should be blue in colour, cross (\times) markers for all data points and a dotted line.
- Label the x-axis as ('x')
- Label the y-axis as ('y')
- Show grid lines and the legend
- Give the plot title the ('plot of x versus y')

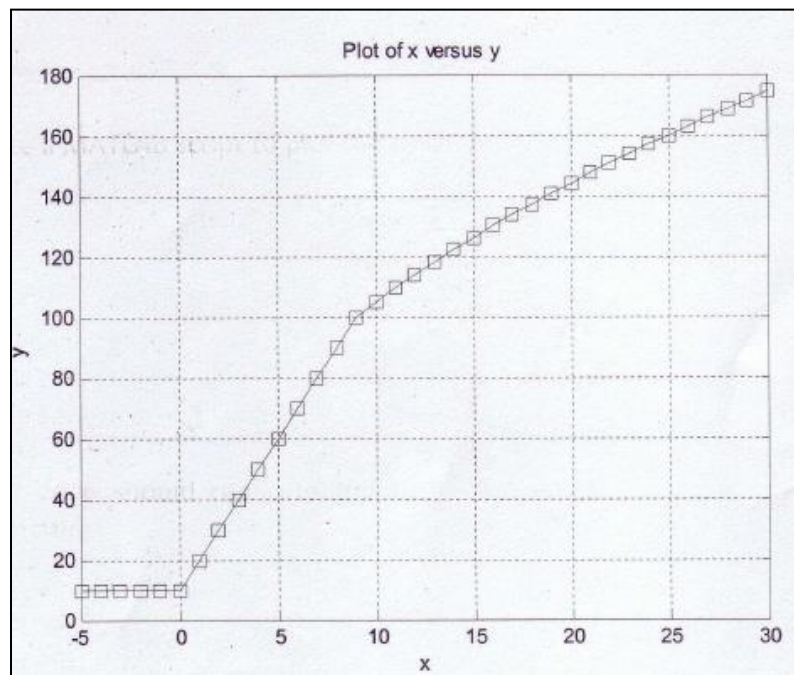


Figure 2

[10]

END OF EXAMINATION