The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc. / B. Ed. Degree Programme

Department	: Mathematics
Level	: 05
Name of the Examination	: Final Examination
Course Title and - Code	: Introduction to MATLAB programming – ADU5320
Academic Year	: 2024/25
Date	: 26.05.2024
Time	: 09.30a.m. –11.30a.m.
Duration	: Two Hours

General Instructions

1. Read all instructions carefully before answering the questions.

2. This paper consists of **FOUR (04) pages.**

3. **This paper consists of TWO sections: Section A and Section B.**

Section A

    o This section is **compulsory.**

    o It consists of FOUR (04) Questions.

Section B

    o This section consists of FIVE(05) Essay Type Questions and each question carries 100 marks.

    o Answer only any THREE (03) questions.

4. Answer for each question should commence from a new page.

5. Involvement in any activity that is considered as an exam offense will lead to punishment.

6. Use blue or black ink to answer the questions.

7. Clearly state your index number in your answer script.

PART A

1. a) Consider a simple RC circuit with resistance $R = 220\ \Omega$ and capacitance $C = 100 \times 10^{-6}F$. Write a MATLAB program to compute the following and display the values:

i) The time constant τ of the circuit.

ii) The voltage across the capacitor $V_c(t)$ after **2 seconds**, assuming the initial voltage $V_0 = 5V$.

Use the formulas
- $\tau = R \cdot C$
- $V_c(t) = V_0 \cdot \left(1 - e^{-t/\tau}\right)$ (30 marks)

b) Write MATLAB codes to find the following limit.

i. $\lim\limits_{x \to 0^-} \dfrac{x^3 - 1}{\sqrt{x^2 + 1} - 1}$ (10 marks)

ii. $\lim\limits_{x \to 0} \left[\lim\limits_{y \to 0} \dfrac{x^2 + y^2}{\sqrt{x^2 + y^2 + 3} - 1} \right]$ (10 marks)

c) Consider the two functions $f(x) = x^3 + 2x + 5$ and $g(x) = x^2 - 3x + 1$, satisfy the quotient rule $\left(\dfrac{f}{g}\right)' = \dfrac{f' \cdot g - f \cdot g'}{g^2}$. Write a MATLAB program to verify the quotient rule for these two functions.
(**Hint**: Use if-else statements). (30 marks)

d) Consider the following data points representing the height (in meters) of an object at different distances along a track. You need to use **spline interpolation** to estimate the height at a specific point.

Distance (m)	Height (m)
0	10
2	15
5	12
8	20

Use cubic spline interpolation to estimate the height at a distance of 6 meters. (20 marks)

[Total marks 100]

1

PART B : Answer only THREE (03) questions

1. a) Write a MATLAB program to calculate the area of a triangle. (25 marks)

   b) Write a MATLAB program to count how many digits are there in a given number.

   (75 marks)

   [Total marks100]

2. a) Write a MATLAB program to calculate electricity bill based on units consumed with the following slab rates:

   - First 100 units → Rs. 40 per unit
   - Next 100 units (101–200) → Rs. 60 per unit
   - Beyond 200 units → Rs. 100 per unit

   Also:

   - If the total bill exceeds Rs.2500, apply a overcharge of 10% on the total amount.
   - If the units entered are negative, display "Invalid input".

   Display the final bill amount.

   (**Hint**: Use if-else statements)

   [Total marks100]

3. a) Given the function $f(x,y) = x^2 y + 3xy^2 + y^3$. Write MATLAB codes to compute the second-order partial derivatives $\dfrac{\partial^2 f}{\partial x \partial y}$ and $\dfrac{\partial^2 f}{\partial y \partial x}$. (25 marks)

   b) Write a MATLAB program to compute the area enclosed between the curve $y = \sin(x) \cdot e^{-x}$ and the x −axis, over the $x = 0$ interval to $x = \infty$. (25 marks)

   c) The following **dataset** contains the weekly study hours (rounded to the nearest hour) of 15 students. Compute the variance, standard deviation, and interquartile range (IQR) of the study hours using MATLAB codes.

   Dataset:

   study_hours = [5, 8, 10, 6, 7, 9, 4, 12, 11, 6, 8, 9, 10, 5, 7] (50 marks)

   [Total marks100]

4. A file named 'sales_data.csv' has the following data. Use this given data file to answer the following questions.

Year	Sales (units)	Revenue (Rupees)
2010	150	20000
2011	180	24000
2012	170	22000
2013	160	21000
2014	200	26000
2015	190	29000
2016	210	31000
2017	180	24000
2018	160	21000
2019	220	33000
2020	210	31000

(Note that the file is saved **only with the numeric data values.**)

Use MATLAB commands to perform the following tasks:

a) Import the **'sales_data.csv'** file into MATLAB.   (10 marks)

b) Extract revenue data for the years 2017 to 2019.   (20 marks)

c) Calculate the total sales over the entire period (2010-2020).   (15 marks)

d) Plot the sales trend (units sold) from 2010 to 2020.   (15 marks)

e) Interpolate the sales after the first quarter of 2013.   (20 marks)

f) Forecast the revenue from 2020 to 2022.   (20 marks)

[Total marks100]

3

5. a) Write MATLAB commands to solve the following system of ordinary differential equations.

$$x'(t) = 3x(t) + 4y(t) - 2z(t)$$
$$y'(t) = 2x(t) - y(t) + z(t)$$
$$z'(t) = x(t) + 3y(t) + 4z(t).$$

(20 marks)

b) Consider a system where the temperature $T(t)$ of a metal object changes over time due to both cooling and an external heating function. The rate of change of the temperature $T(t)$ is governed by the following first-order differential equation:

$$\frac{dT}{dt} = -3T + 2e^{-0.5t}\sin t + \cos t + 6$$

Here, $T(t)$ is the temperature of the object at time t, and the initial temperature of the object is $T(0) = 50$ degrees Celsius.

Write a MATLAB program to compute the following:

i) **Numerically approximate** the temperature $T(t)$ at any given time t on the interval $t \in [0,10]$.

(50 marks)

ii) Estimate the temperature at $t = 5$ based on the numerical solution.

(30 marks)

[Total marks100]

********* END OF QUESTION PAPER *********

4