



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.

Tel: +254 (0)799529958, +254 (0)799529959, +254 (0)712524293

Website: [www.must.ac.ke](http://www.must.ac.ke) Email: [info@must.ac.ke](mailto:info@must.ac.ke)

---

## University Examinations 2022/2023

FIRST YEAR, FIRST SEMESTER EXAMINATION FOR THE DOCTOR OF PHILOSOPHY IN  
MATHEMATICS

### SMA 8111: COMPUTATIONAL METHODS 1

DATE: APRIL 2023

TIME: 3 HOURS

---

**INSTRUCTIONS:** Answer question *one* and any other *two* questions

---

#### QUESTION ONE (30 MARKS)

- a) Describe major components of MATLAB environment (6 marks)
- b) Identify the uses of the following commands in MATLAB
- (i) `clc` (1 mark)
  - (ii) Percentage (1 mark)
  - (iii) `clear` (1 mark)
- c) Given the matrix 
$$\begin{bmatrix} e^2 & 3 & \sqrt{4} \\ 3 & sn\ 3 & 6 \\ 1 & x^2 & 4 \end{bmatrix}$$
- (i) Write the imputed MATLAB code for matrix A (2 marks)
  - (ii) Write the command that is used in MATLAB to evaluate eigenvalues of matrix A (1 mark)
  - (iii) Determinant of A (1 mark)
- d) Given the polynomial  $a = (s^2 + 2s + 1)$  and  $b = (s^3 + 4s^2 + 5s + 1)$ , write the command that evaluate the following in MATLAB
- i) Roots of b (3 marks)
-

- ii) Division of a and b (1 mark)
- iii) Characteristic polynomial a. (1 mark)
- iv) Integration of b (1 mark)
- e) Define the following terms as used in mathematica
  - i) Kernel (1 mark)
  - ii) Front end (1 mark)
- f) Write down the meaning of each brackets as used in mathematica
  - i. ( ) parentheses (1 mark)
  - ii. [ ] square brackets (1 mark)
  - iii. { } curly brackets (1 mark)
- g) Given the system 
$$\begin{matrix} 5x + 2y = 9 \\ 8x - 3y = -4 \end{matrix}$$
  - (i) Write a mathematica command that will solve the system (3 marks)
  - (ii) Write a command that will plot the two lines on the same axes using the intervals  $-5 \leq x \leq 5$  and  $0 \leq y \leq 5$  (3 marks)

**QUESTION TWO (15 MARKS)**

- a) Write a program in mathematica to plot the curves for the equations,  $y = \sin(x)$ ,  $y = \cos(x)$  and  $y = 3x - 6$  in a single figure window using plot command and hold commands. Illustrate how legend command is used to indicate different style used for the different curves plotted on the same graph. Use the interval  $0 \leq x \leq 2\pi$  (10 marks)
- b) Given a 2 x2 matrix A, where  $A = \begin{pmatrix} 4 & 1 \\ 0 & 8 \end{pmatrix}$ 
  - (i) Write the codes inputed in command window for matrix A (3 marks)
  - (ii) The code that evaluates Det of A (1 marks)
  - (iii) The code that evaluate the eigenvalue of A (1 mark)

**QUESTION THREE (15 MARKS)**

Write a MATLAB program that plots six different subplots; linear function, parabolic function, a cubic function, sine function, cosine function and an exponential function, use different styles for every subplot, label and axes and give a title for each plot.

#### QUESTION FOUR (20 MARKS)

$$x + 2y + 3z - 3 = 0$$

- a) Given the system of equations  $3x - y + z = 1$  write the mathematica input that solves the equation  $4x + 2y - z = 2$  (3 marks)

- b) Given the function  $y = \cos 2x$ , write a command that

(i) Plot the curve  $p1 = x \cos(2x) - 1, 2.5 \leq x \leq 2.5$  (3 marks)

(ii) Plot curve p2 which is the derivative of p1. Using green for this curve  $-2.5 \leq x \leq 2.5$  (3 marks)

(iii) Plot  $p3 = \cos 2x - 2.5 \leq x \leq 2.5$  using red for this plot (3 marks)

(iv) Plots the 3 curves on the same axes (3 marks)

#### QUESTION FIVE (15 MARKS)

Given the sets of equations

$$\frac{dS}{dt} = \Pi - (\mu + \lambda)S,$$

$$\frac{dE}{dt} = \lambda S - (\alpha_1 + \mu)E,$$

$$\frac{dI}{dt} = \alpha_1 E - (\mu + \delta + \alpha_2)I,$$

$$\frac{dR}{dt} = \alpha_2 I - (\mu + \alpha_3)R.$$

Where  $\lambda = \beta(\eta_1 E + \eta_2 I)$

With the initial condition  $S = 10000, E = 400, I = 100, R = 0$  and  $\Pi = 1000, \beta = 0.0005, \alpha_1 = 0.2, \delta = 0.01, \mu = 0.02, \alpha_2 = 0.2, \alpha_3 = 0.03, \eta_1 = 0.001, \eta_2 = 0.01, \text{tspan} = 100$

Write 2 script that will solve the equations using ode45 and plot them in 4 different figures