



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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## University Examinations 2023/2024

FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF  
COMPUTER TECHNOLOGY, BACHELOR OF DATA SCIENCE AND BACHELOR OF  
COMPUTER SCIENCE

### SMC 3210: NUMERICAL LINEAR ALGEBRA

DATE: DECEMBER 2023

TIME: 2 HOURS

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

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#### QUESTION ONE (30 MARKS)

a) Define the following terms (3 marks)

- i. Orthogonal matrix
- ii. Upper triangular matrix
- iii. Singular matrix

b) The system of linear equations is given as

$$x_1 + x_2 + 2x_3 = 9$$

$$2x_1 + 4x_2 - 3x_3 = 1$$

$$3x_1 + 6x_2 - 5x_3 = 0$$

Find the solution set of the system by back substitution (4 marks)

c) Use crammer's rule to solve the system of equations below

$$2x + 3y - z = 5$$

$$4x + 4y - 3z = 3 \quad (10 \text{ marks})$$

$$-2x + 3y - z = 1$$

d) Construct a  $3 \times 4$  matrix A having

$$a_{ij} = \begin{cases} i + j & \text{when } i > j \\ 0 & \text{when } i = j \\ i - j & \text{when } i < j \end{cases} \quad (3 \text{ marks})$$

e) The matrix A is defined as

$$A = \begin{bmatrix} 1 & 2 & -3 \\ 0 & 3 & 2 \\ 0 & 0 & -2 \end{bmatrix}$$

Find the adjoint of A (5 marks)

f) Test the consistency of the equation below

$$2x + 6y = -11$$

$$6x + 20y - 6z = -3$$

$$6y - 18z = -1$$

(5 marks)

### QUESTION TWO (20 MARKS)

a) Matrix  $A = \begin{bmatrix} 1 & 3 & 2 \\ 0 & -2 & 4 \\ 2 & -1 & 3 \end{bmatrix}$  and  $B = \begin{bmatrix} -2 & 3 & -4 \\ 0 & -1 & 5 \\ 2 & 3 & -1 \end{bmatrix}$

Find:

i.  $AB$  (3 marks)

ii.  $2A - 3B$  (2 marks)

b) Find the determinant of the matrix P below

$$P = \begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 4 & 4 \end{bmatrix} \quad (5 \text{ marks})$$

c) Solve the system below by reducing the matrix into echelon form

$$x_1 + x_2 - 2x_3 = 3$$

$$4x_1 - 2x_2 + x_3 = 5$$

$$3x_1 - x_2 + 3x_3 = 8$$

(10 marks)

### QUESTION THREE (20 MARKS)

- a) Use the Carley Hamilton theorem to find the inverse of matrix A below

$$A = \begin{bmatrix} 4 & 3 & 1 \\ 2 & 1 & -2 \\ 1 & 2 & 1 \end{bmatrix} \quad (10 \text{ marks})$$

- b) A 3x3 matrix is given as

$$P = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix} \text{ find the Eigen values of the matrix} \quad (10 \text{ marks})$$

### QUESTION FOUR (20 MARKS)

- a) Find the inverse of the matrix A using the Gauss Jordan method

$$A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix} \quad (10 \text{ marks})$$

- b) Use the matrix inversion method to solve the system of linear equations below

$$\begin{aligned} x + y + z &= 3 \\ x + 2y + 3z &= 4 \\ x + 4y + 9z &= 6 \end{aligned} \quad (10 \text{ marks})$$

### QUESTION FIVE (20 MARKS)

- a) Find the Eigen values and the Eigen vector corresponding to each of the Eigen values of the Eigen values of the matrix A below

$$A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix} \quad (10 \text{ marks})$$

- b) Determine the Rank of the matrix  $A = \begin{bmatrix} 1 & 4 & 5 \\ 2 & 6 & 8 \\ 3 & 7 & 2^2 \end{bmatrix}$  (5 marks)

c) Find the characteristic roots of matrix C below

$$C = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$$

(5 marks)