



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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UNIVERSITY EXAMINATIONS 2022/2023

SECOND YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF
BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

SMC 3210: NUMERICAL LINEAR ALGEBRA

DATE: APRIL 2023

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Define the following terms (3marks)

- i. A diagonal matrix
- ii. A null matrix
- iii. Orthogonal matrix

b) Construct a 3 x 4 matrix A having

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

c) Use the method of substitution to solve the linear system below (4marks)

$$r + 2s + t = 3$$

$$2r + 3s - t = -6$$

$$3r - 2s - 4t = -2$$

d) If $A = \begin{bmatrix} 4 & 2 & 5 \\ 1 & 3 & -6 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 & 2 \\ 3 & 1 & 4 \end{bmatrix}$ evaluate (2marks)

i. $A - B$ (2marks)

ii. $A + B$ (2marks)

e) Find the cofactors of the elements and use them to compute the inverse of the matrix

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

f) The matrix A is define as (6marks)

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

Find the eigen values of $3A^3 + 5A^2 - 6A + 2I$

QUESTION TWO (20 MARKS)

- a) Find the inverse of the matrix A using the Gauss- Jordan method (10marks)

$$A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$$

- b) Prove that a matrix A and its transpose A^T have the same characteristics roots (5marks)

- c) Using Cayley Hamilton theorem, find the inverse of the matrix (5marks)

$$A = \begin{bmatrix} 4 & 3 & 1 \\ 2 & 1 & -2 \\ 1 & 2 & 1 \end{bmatrix}$$

QUESTION THREE (20 MARKS)

- a) i. What is a square Matrix? (2marks)
 ii. Construct a square matrix P of order 3x3 in which

$$p_{ij} = (-1)^{i+j} \quad (3marks)$$

- b) find the characteristic roots of the matrix

$$C = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix} \quad (5marks)$$

- c) find the eigen values and the corresponding eigen vectors of the matrix (10marks)

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

QUESTION FOUR (20 MARKS)

- a) Given that $A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$, find matrix p, such that $P^{-1}AP$ is diagonal matrix

(10marks)

- b) Solve the following system of equations using Cramers' rule (10marks)

$$5x - 7y + z = 11$$

$$6x - 8y - z = 15$$

$$3x + 2y - 6z = 7$$

QUESTION FIVE (20MARKS)

- a) Test the consistency of the equations below (5marks)

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

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

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

- b) Use matrices to solve $x + y + z = 3$, $x + 2y + 3z = 4$, $x + 4y + 9z = 6$ (5marks)
- c) Show that for each of the following matrices A, the system $AX = b$ can be solved by Jacobi iteration with guaranteed convergence (5marks)

$$\begin{pmatrix} 6 & -2 & 4 \\ 2 & -8 & 1 \\ -2 & 0 & 4 \end{pmatrix}$$

- d) Find the solution of the following system of equations using Gauss-seidel iterative method by performing the first four iterations with initial conditions

$$18x + y - 2z = 21$$

$$4x + 16y - z = -16$$

$$2x - 3y + 20z = 26$$