COM SATS University Islamabad, Lahore Campus

Department of Mathematics

COURSE HANDBOOK

1	**Course Title**	Linear Algebra
2	**Course Code**	MTH 231
3	**Credit Hours**	3(3,0)
4	**Semester**	Fall 2022
5	**Resource Person**	Dr. Tayyaba Akram
6	**Supporting Team Members**	Will be informed later
7	**Contact Hours (Theory)**	3 hours per week
8	**Contact Hours (Lab)**	Not Applicable
9	**Office Hours**	Shall be communicated later

10 Course Introduction

This course is an introduction to Linear Algebra and to some of its significant applications. It is designed for a course at the freshman level. This course introduces many applications of linear algebra in other areas of mathematics, physics, economics, engineering, and computer sciences. Linear Algebra is the undergraduate course that will have the more impact on student's computing skills through conceptual learning. The emphasis is on the computational and geometrical aspects of the subject, keeping abstraction to a minimum.

11 Learning Objective

The main objective of this course is to help the students to learn the basic ideas of linear algebra and to see some of its applications. By the end of this course, students should be able to:

- Understand some applications of systems of linear equations.
- Perform the operations of addition, scalar multiplication, and multiplication, and find the transpose and inverse of a matrix.
- Calculate determinants using row operations, column operations, and expansion down any column and across any row.
- Prove elementary statements concerning the theory of matrices and determinants.
- Understand about vector addition, scalar multiplication, inner products, projections, norms, orthogonal vectors, linear independence, spanning sets, subspaces, bases, and dimension for Rn and abstract vector spaces.
- Write the relationships between A being invertible, det A, AX = 0 having a solution, the rank of A, and the rows of A being linearly independent.
- Use the Gram-Schmidt process to orthogonalize matrices.
- Find the kernel, range, rank, and nullity of a linear transformation.
- Find the matrix associated with a linear transformation with respect to given bases, and understand the relationship between the operations on linear transformations and their corresponding matrices.
- Find the change-of-basis matrix.
- Understand the concept of linear transformations.
- Calculate eigenvalues and their corresponding eigenspaces.

	• Determine if a matrix is diagonalizable, and if it is, diagonalize it.
12	**Course Contents**
System of Linear Equations and matrices, determinants; vector and inner product spaces, matrix representations of Linear transformations, eigenvalues and eigenvectors, Diagonalization of symmetric matrices, Cayley-Hamilton Theorem.	
13	**Lecture/Lab Schedule**
Lecture	Topics
Week 1	**Matrices and system of linear equations** i. System of Linear equations (Ax = b) ii. Homogenous system of Linear equations (Ax = 0) iii. Matrix, iv. Matrix Operations and row equivalent matrices v. Algebraic properties of matrix operations
Week 2	**Properties of matrices with its applications** i. Partitioned matrices ii. Special properties of matrix, iii. Echelon form iv. Reduced Echelon form
Week 3	**Methods of solving systems of linear equations** i. Gauss-Jordan elimination method ii. Gauss-Jordan reduction method
Week 4	**Determinant and methods of finding inverse of a matrix** i. Singular matrices and non-singular matrices ii. Method for finding inverse via row operations. iii. Introduction to determinants, iv. Properties of determinants
Week 5	**Adjoint of a matrix and Cramer's rule** i. Cofactor expansion and adjoint of a matrix ii. The inverse of a matrix using determinants iii. Cramer's Rule
Week 6	**Vector spaces** i. Introduction to binary operations ii. Introduction to vector spaces iii. Subspaces.
Week 7	**Introduction to basis of a vector space** i. Linear Dependence and Independence. ii. Linear spanning iii. Basis and Dimensions iv. Computing a spanning set
Week 8	**Basis and Dimensions**
Week 9	**Coordinate vectors** i. Coordinate vectors ii. Matrix of coordinate change of basis.
Week 10	**Vector spaces associated to a matrix and rank of a matrix** i. Row space ii. Column space iii. Rank of a matrix iv. Dimension of a row/column space

	v. Null space and Nullity
Week 11	**Inner product and its applications** i. Introduction to inner product ii. Properties of inner product iii. Orthogonal and orthonormal sets iv. The Gram-Schmidt process.
Week 12	**Eigenvalues and Eigenvectors** i. Eigenvalues and Eigenvectors ii. Eigen space and basis of eigen space iii. Similar Matrices iv. Cayley Hamilton theorem
Week 13	**Diagonalization and its applications**
Week 14	**Linear transformation and their properties** i. Linear transformation from $R^n \rightarrow R^m$. ii. Properties of linear transformations iii. Matrix of linear transformations
Week 15	**Kernel and Range of Linear Transformations** i. Kernel of linear transformation ii. Range of linear transformation iii. Dimension theorem

17.	**Text Book**	Introduction to Linear Algebra, by B. Kolman (9th Edition)
18.	**Reference Books**	1. Elementary Linear Algebra, by Anton (8th Edition) 2. Linear Algebra and its applications, by David C Lay (3rd Edition)