**NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES**
**LAHORE CAMPUS**


Linear Algebra Outline according to OBE, FALL-2022

# FILE CONTENTS

Outline of Linear Algebra (CS, DS, SE)

DEPARTMENT OF SCIENCES & HUMANITIES

| | | | |
|---|---|---|---|
| **Department** | Department of Sciences & Humanities | **Dept. Code** | S & H |
| **Course Title** | Linear Algebra | **Course Code** | MT1004 |
| **Pre-requisite(s)** | - | **Credit Hrs.** | 3 |
| **Moderator** | Dr. Tayyaba/Dr. Akhlaq Ahmad | | |
| **Course Instructors** | Dr. Akhlaq Ahmad (BCS-3C, 3E), Mr. Saleem Chishti (BSE-3A,3B), Mr. Qasim Noor (BSDS-,1A,1B), Dr. M. Javaid (BCS-3A,3B), Dr. M. Awais Umar (BDS-1C, 1D), Dr. M. Nasir (BCS-3F,3G), Sara Asghar (BCS-,1D). | | |
| **Note:** | It is a tentative schedule of the course. It may vary (if required). | | |

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| **Course Objective** | The objective is to impart training to the students in this very important branch of Mathematics. Students are expected to learn about system of linear equations, vector spaces, inner products, Eigen values and linear transformations. Attempt will be made to introduce the students to postulation and axiomatic approach in Mathematics. This course also emphasizes the application of linear algebra in science and real life. |

| No. | Assigned Program Learning Outcome (PLO) | Level | Tool |
|---|---|---|---|
| 01 | | | |

*I = Introduction, R = Reinforcement, E = Evaluation.*
*A = Assignment, Q = Quiz, M = Midterm, F = Final, L = Lab, P = Project, W = Written Report.*

| No. | Course Learning Outcome (CLO) Statements | Tools |
|---|---|---|
| 01 | • Use concept of elementary row operations to find the inverse of square matrices, determinant of a matrix and solving the system of linear equations. | Q1, A1, M1, F |
| 02 | • Properties of vectors in 2-space, 3-space and n-space and recognize vector spaces and/or subspaces to compute their bases and its dimension. | Q2, A2, M2, F |
| 03 | • Perform Eigen Value analysis and use it to Diagonalize a matrix and/or find its powers. | Q3, A2, M2, F |
| 04 | • Identify inner product spaces and/or perform Gram Schmidt process/QR decomposition using inner products. | Q4, M2, A3, F |
| 05 | • Express a linear transformation graphically using matrices and to solve problems. | Q3, A3, F |

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|---|---|---|
| **Text Book(s)** | **Title** | Elementary Linear Algebra |
| | **Author** | Howard A. Anton (Latest Edition) |
| | **Publisher** | |
| **Ref. Book(s)** | **Title** | Linear Algebra with Applications |
| | **Author** | Bernard Kolman (Latest Edition) |

| Week | Course Contents | Chapter | CLO |
|---|---|---|---|
| 01 | **System of Linear Equations and Matrices**<br>1.1 Introduction to linear system<br>1.2 Gaussian Elimination<br>1.3 Matrices and Matrix operations | 1 | 01 |
| 02 | 1.4 Inverses; Algebraic properties of Matrices<br>1.5 Elementary Matrices and Method of finding matrix inverse | 1 | 01 |
| 03 | 1.6 More on linear systems and Invertible Matrices<br>1.7 Diagonal, Triangular and Symmetric matrices<br>1.8 Matrix Transformations | 1 | 01, 05 |
| 04 | **Determinants**<br>2.1 Determinants by Cofactor Expansion<br>2.2 Evaluating Determinants by row reduction<br>2.3 Properties of Determinants; Cramer's rule | 2 | 02 |
| 05 | **MID TERM-I** | | |
| 06 | **Euclidean Vector Spaces**<br>3.1 Vectors in 2-space, 3-space and n-space<br>3.2 Norm, Dot Product, and Distance in $R^n$<br>3.3 Orthogonality of vectors<br>3.4 The Geometry of Linear Systems<br>3.5 Cross Product | 3 | 03 |
| 07 | **General Vector Spaces**<br>4.1 Real Vector Spaces<br>4.2 Subspaces | 4 | 05 |
| 08 | 4.3 Linear Independence / Dependence<br>4.4 Coordinates and Basis for a vector space<br>4.5 Dimension<br>4.6 Change of Basis | 4 | 02 |
| 09 | 4.7 Row space, Column Space and Null Space<br>4.8 Rank and Nullity<br>4.9 Basic Matrix Transformations in $R^2$ and $R^3$<br>4.10 Properties of Matrix Transformations (if time permits at the end) | 4 | 02 |
| 10 | **Eigenvalues and Eigen vectors**<br>5.1 Eigenvalues and Eigenvectors<br>5.2 Diagonalization of matrices | 5 | 03 |
| 11 | **Inner Product Spaces** | | |

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|---|---|---|---|
| | 6.1 Inner product spaces<br>6.2 Angle and Orthogonality in Inner product Spaces | 6 | 04 |
| 12 | 6.3 Gram-Schmidt Process, QR- Decomposition | | |
| 13 | **MID TERM II** | | |
| 14 | **General Linear Transformations**<br>8.1 General Linear Transformations<br>8.2 Compositions and Inverse Transformations | 8 | 05 |
| 15 | 8.3 Isomorphism<br>8.4 Matrices for General Linear Transformations<br>8.5 Similarity | 8 | 05 |
| If time permits | 7.1 Orthogonal Matrices<br>7.5 Hermitian, Unitary and Normal Matrices | | |
| | **FINAL EXAM** | | |

**Evaluation Procedure & Marks Distribution:**

| **Assessment Tools** | **Total No. of** | **Weightage** |
|---|---|---|
| Quizzes | As announced by instructor (3 at least) | 10% |
| Assignments | As announced by **Moderator** (3 at least) | 8% |
| Homework | As announced by instructor (7 at least) | 7% |
| Mid Term Exam | 2 | 25% |
| Final Exam | 1 | 50% |

Grading Scheme: *Relative*