**NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES**

**LAHORE CAMPUS**



Linear Algebra Outline according to OBE, FALL-2025

**FILE CONTENTS**

Outline of Linear Algebra (CS, SE, DS)

DEPARTMENT OF SCIENCES & HUMANITIES

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| **Department** | | Department of Sciences & Humanities | **Dept. Code** | S&H | | |
| **Course Title** | | Linear Algebra | **Course Code** | MT1004 | | |
| **Pre-requisite(s)** | | - | **Credit Hrs.** | 3 | | |
| **Moderator** | | Prof. Dr. Akhlaq Ahmad | | | | |
| **Course Instructors** | | Prof. Dr. Akhlaq Ahmad (BCS-3A, 3B, 3C), Ms. Maria Shabir (BCS-3D, 3E), Mr. Muzamil Hanif (BCS-3F, 3G), Mr. Abdul Hafeez Sheikh (BCS, 3H, 3J) | | | | |
| **Note:** | | It is a tentative schedule of the course. Any change(s) will be communicated by the respective instructor (if required). | | | | |
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| **CourseObjective** | | 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. | | | | |
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| **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 subspacesto 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 Anton and Anton Kaul (Latest Edition) |
| **Publisher** | John Wiley & Sons |
| **Ref. Book(s)** | **Title** | Linear Algebra with Applications |
| **Author** | Bernard Kolman(Latest Edition) |

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| --- | --- | --- | --- |
| **Week** | **Course Contents** | **Chapter** | **CLO** |
| 01 | **System of Linear Equations and Matrices**  1.1 Introduction to linear system  1.2 Gaussian Elimination  1.3 Matrices and Matrix operations | 1 | 01 |
| 02 | 1.4 Inverses; Algebraic properties of Matrices  1.5 Elementary Matrices and Method of finding matrix inverse | 1 | 01 |
| 03 | 1.6 More on linear systems and Invertible Matrices  1.7 Diagonal, Triangular and Symmetric Matrices | 1 | 01,05 |
| 04 | **Determinants**  2.1 Determinants by Cofactor Expansion  2.2 Evaluating Determinants by Row Reduction  2.3 Properties of Determinants; Cramer’s rule | 2 | 02 |
| 05 | **MID TERM-I** |  |  |
| 06 | **Euclidean Vector Spaces**  3.1 Vectors in 2-space, 3-space and n-space  3.2 Norm, Dot Product, and Distance in Rn  3.3 Orthogonality  3.4 The Geometry of Linear Systems  3.5 Cross Product | 3 | 03 |
| 07 | **General Vector Spaces**  4.1 Real Vector Spaces  4.2 Subspaces  4.3 Spanning Sets | 4 | 05 |
| 08 | 4.4 Linear Independence / Dependence  4.5 Coordinates and Basis  4.6 Dimension  4.7 Change of Basis | 4 | 02 |
| 09 | 4.8 Row space, Column Space and Null Space  4.9 Rank, Nullity, and the Fundamental Matrix Spaces | 4 | 02 |
| 10 | **Eigenvalues and Eigen vectors**  5.1 Eigenvalues and Eigenvectors  5.2 Diagonalization | 5 | 03 |
| 11 | **Inner Product Spaces**  6.1 Inner product spaces  6.2 Angle and Orthogonality in Inner product Spaces | 6 | 04 |
| 12 | 6.3 Gram-Schmidt Process, QR-Decomposition |  |  |
| 13 | **MID TERM II** |  |  |
| 14 | **Linear Transformations**  1.8 Introduction to Linear Transformation  1.9 Compositions of Matrix Transformations  8.1 General Linear Transformations  8.2 Compositions and Inverse Transformations | 1,8 | 05 |
| 15 | 8.3 Isomorphism (If time permits)  8.4 Matrices for General Linear Transformations  8.5 Similarity (If time permits)  8.6 Geometry of Matrix Operators (Mandatory) | 8 | 05 |
| 16 | 7.1 Orthogonal Matrices  7.5 Hermitian, Unitary and Normal Matrices | 7 | 05 |
|  | **FINAL EXAM** |  |  |

**Evaluation Procedure & Marks Distribution:**

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

Important Note(s):

1. Student(s) of any section can visit the moderator office in case of any academic issue.
2. Relative grading scheme will be used at the end of the semester.
3. If an instructor is teaching more than one section in a same degree program then combined grading scheme will be used for all the sections the instructor is teaching.
4. Moderator/Staff (S&H)-Furqan Ashraf will forward the Assignment(s) questions to all the sections.
5. Any kind of plagiarism will result strict disciplinary action as per university rules.
6. University require 100% attendance in the course. Absence of a maximum of 20% of the total lecture hours may be condoned for genuine reasons, such as medical illness. Failure to meet the attendance requirement the student will not be allowed to sit in final exam.

**Best of Luck**