

COMSATS University Isalmabad, Lahore Campus

**COURSE HANDBOOK**

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| **1** | **Course Title** | | | | Linear Algebra |
| **2** | **Course Code** | | | | MTH 231 |
| **3** | **Credit Hours** | | | | 3(3,0) |
| **4** | **Semester** | | | | FA20 |
| **5** | **Resource Person** | | | | Maqsood Ahmad |
| **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 basis. * 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. | | | | | |
| **13** | | | **Lecture/Lab Schedule** | | |
| **Lecture** | | | **Topics** | | |
| **Week 1** | | | **Matrices and system of linear equations**   1. System of Linear equations (Ax = b) 2. Homogeneous system of Linear equations (Ax = 0) 3. Matrix, 4. Matrix Operations and row equivalent matrices 5. Algebraic properties of matrix operations | | |
| **Week 2** | | | **Properties of matrices with its applications**   1. Partitioned matrices 2. Special properties of matrix, 3. Echelon form 4. Reduced Echelon form | | |
| **Week 3** | | | **Methods of solving systems of linear equations**   1. Gauss-Jordan elimination method 2. Gauss-Jordan reduction method | | |
| **Week 4** | | | **Determinant and methods of finding inverse of a matrix**   1. Singular matrices and non-singular matrices 2. Method for finding inverse via row operations. 3. Introduction to determinants, 4. Properties of determinants | | |
| **Week 5** | | | **Adjoint of a matrix and Cramer’s rule**   1. Cofactor expansion and adjoint of a matrix 2. The inverse of a matrix using determinants 3. Cramer’s Rule | | |
| **Week 6** | | | **Vector spaces**   1. Introduction to binary operations 2. Introduction to vector spaces 3. Subspaces. | | |
| **Week 7** | | | **Introduction to basis of a vector space**   1. Linear Dependence and Independence. 2. Linear spanning 3. Basis and Dimensions 4. Computing a spanning set | | |
| **Week 8** | | | **Basis and Dimensions** | | |
| **Week 9** | | | **Coordinate vectors**   1. Coordinate vectors 2. Matrix of coordinate change of basis. | | |
| **Week 10** | | | **Vector spaces associated to a matrix and rank of a matrix**   1. Row space 2. Column space 3. Rank of a matrix 4. Dimension of a row/column space 5. Null space and Nullity | | |
| **Week 11** | | | **Inner product and its applications**   1. Introduction to inner product 2. Properties of inner product 3. Orthogonal and orthonormal sets 4. The Gram-Schmidt process. | | |
| **Week 12** | | | **Eigenvalues and Eigenvectors**   1. Eigenvalues and Eigenvectors 2. Eigen space and basis of eigen space 3. Similar Matrices | | |
| **Week 13** | | | **Diagonalization and its applications** | | |
| **Week 14** | | | **Linear transformation and their properties**   1. Linear transformation from Rn → Rm. 2. Properties of linear transformations 3. Matrix of linear transformations | | |
| **Week 15** | | | **Kernel and Range of Linear Transformations**   1. Kernel of linear transformation 2. Range of linear transformation 3. Dimension theorem | | |
| **14** | | | **Course Assessment** | | |
| The assessment of this module shall have following breakdown structure  First Sessional Test 10%  Second Sessional Test 15%  Quizzes/Assignments 25%  Terminal Examination 50%  The minimum pass marks for each course shall be 50%. Students obtaining less than 50% marks in any course shall be deemed to have failed in that course. The correspondence between letter grades, credit points, and percentage marks at CIIT shall be as follows:   |  |  |  |  | | --- | --- | --- | --- | | **Grades** | **Letter Grade** | **Credit Points** | **Percentage Marks** | | A | ( Excellent) | 4.0 | 90and above | | A- |  | 3.7 | 85-89 | | B+ |  | 3.3 | 80-84 | | B | (Good) | 3.0 | 75-79 | | B- |  | 2.7 | 70-74 | | C+ |  | 2.3 | 65-69 | | C | (Average) | 2.0 | 60-64 | | C- |  | 1.7 | 55-59 | | D | (Minimum passing) | 1.3 | 50-54 | | F | (Failing) | 0.0 | Less than 50 |   **Note:** The marks to be assigned to students shall be in whole numbers and are not same as followed in the annual system of Lancaster University. | | | | | |
| **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) | |
| **19.** | **Attendance Policy** | | | | |
| Every student must attend 80% of the lectures/seminars delivered in this course. | | | | | |
| **20.** | **Field Trips/Case Studies/Seminars/Workshop** | | | | |
| Not Applicable | | | | | |