Lahore University of Management Sciences

MATH 120 – Linear Algebra with Differential Equations
Sec-I , Sec- II

Fall Semester 2023-2024

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Course URL (if any)	https://lms.lums.edu.pk/

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	5	Duration	2 hours
Recitation/Lab (per week)	Nbr of Lec(s) Per Week		Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week		Duration	

Course Distribution	
Core	Core for SBASSE
Elective	
Open for Student Category	All students
Close for Student Category	none

COURSE DESCRIPTION
This is the first course of a two semester sequence in linear algebra. This course gives a working knowledge of: systems of linear equations, matrix algebra, determinants, eigenvectors and eigenvalues, finite-dimensional vector spaces, matrix representations of linear transformations, matrix diagonalization, changes of basis, Separable and first-order linear equations with applications, 2nd order linear equations with constant coefficients, method of undetermined coefficients, Systems of linear ODE's with constant coefficients, Solution by eigenvalue/eigenvectors, Non homogeneous linear systems.

COURSE PREREQUISITE(S)	
•	**Pre-req:** MATH 101 & Equivalence: MATH 121
•	**Anti-req:** MATH 121 & MATH 120H & Equivalence MATH 120H

COURSE OBJECTIVES	
• • •	To acquire a good understanding of the concepts and methods of linear algebra To develop the ability to solve problems using the techniques of linear algebra To develop critical reasoning by writing short proofs based on the axiomatic method To compute the solution of first order and higher order ordinary differential equations To solve system of linear ODEs using eigenvalues and eigenvectors

Learning Outcomes

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• • •	Students will learn to Set up and solve systems of linear equations Perform matrix operations as appropriate Evaluate determinants and use their properties Understand and use linear transformations Work in real vector spaces Use the concepts of subspace, basis, dimension, row space, column space, row rank, column rank, and nullity Use inner products Use and construct orthonormal bases Perform QR decompositions Apply linear algebra for best approximation and least squares fitting Evaluate and apply eigenvectors and eigenvalues Understand the features of general linear transformations such as kernel, range, inverses, matrix representations, similarity, and isomorphism Solve first and higher order ODEs Solve system of linear ODEs using eigen values and eigen vectors Use Mathematica and Maple to solve ODEs and system of ODEs

Grading Breakup and Policy

Assignment(s): assignments are optional but are good preparation for the quizzes and exam
Home Work:
Quiz(s): 80%
Class Participation:
Attendance:
Midterm Examination:
Project:
Final Examination: 20%

Examination Detail

Midterm Exam	Yes/No: N0 Combine Separate: Duration: Preferred Date: Exam Specifications:
Final Exam	Yes/No:: Yes Combine Separate: Separate Duration: 3 hours Exam Specifications: No calculators, no notes, no books

COURSE OVERVIEW

Week/ Lecture/ Module	Topics	Recommended Readings	Objectives/ Application
•	**Systems of linear equations**	**Chapter 1**	**Systems of linear equations and matrices**
•	Gaussian Elimination	**Chapter 1 Section 1.1 1.2**	**Systems of linear equations and matrices**
•	Matrices and matrix operations	**Chapter 1 Section 1.3**	**Systems of linear equations and matrices**
•	Matrix arithmetic	**Chapter 1 Section 1.4**	**Systems of linear equations and matrices**
•		**Chapter 1 Section 1.4**	**Systems of linear equations and**

	Inverses		matrices
•	Elementary matrices and inverses	Chapter 1 Section 1.5	Systems of linear equations and matrices
•	Further results on systems of linear equations and inverse	Chapter 1 Section 1.6	Systems of linear equations and matrices
•	Diagonal, trigonal, and symmetric matrices	Chapter 1 Section 1.7	Systems of linear equations and matrices
•	Determinants	Chapter 2	Determinants
•	Cofactor expansion	Section 2.1 and 2.2	Determinants
•	Properties of determinants	Section 2.3	Determinants
•	Euclidean vector spaces	Chapter 4	Euclidean vector spaces
•	Euclidean n-space	Section 4.1	Euclidean vector spaces
•	Linear transformations from Rm to Rn	Section 4.2 and 4.3	Euclidean vector spaces
•	General Vector Space	Chapter 5	
•	Real vector spaces	Section 5.1	Vector spaces
•	Subspaces	Section 5.2	Vector spaces
•	Basis and dimension	Section 5.4	Vector spaces
•	Row space, column space, null space	Section 5.5	Vector spaces
•	Rank and nullity	Section 5.6	Vector spaces
•	Applications		
•	Eigenvalues and eigenvectors	Chapter 7	
•	Eigenvalues and eigenvectors	Section 7.1	Eigenvalues and eigenvectors
•	Diagonalization	Section 7.2	Eigenvalues and eigenvectors
•	Ordinary differential equations	Differential equations with boundary value problems by Dennis G Zill	
•	Introduction to differential equations	Chapter 1	
•	Basic definitions and terminology	Sections 1.1, 1.2	
•	First order differential equations	Chapter 2	
•	Systems of linear first order differential equations	Chapter 8	
•	Homogeneous linear systems with constant coefficients	Section 8.1, 8.2	Systems of linear first order differential equations
•	Solution by eigenvalue/eigenvectors, non homogenous linear systems	Section 8.2, 8.3	Systems of linear first order differential equations
•	Applicatiions		

Textbook(s)/Supplementary Readings
There is no required text but the following texts will be used for reference. 1. Elementary linear algebra (2005) Howard Anton, 9th edition, John Wiley and Sons 2. Differential equations with boundary-value problems by Dennis G. Zill and Michael R. Cullin (5th Edition Brooks/Cole) Handouts on topics will also been uploaded on the LUMS website

Helping Software's : Mathematica Maple 14, 16

A first course in linear algebra, RA Beezer, http://linear.ups.edu/ |