Ghulam Ishaq Khan Institute of Engineering Sciences and Technology
Faculty of Engineering Sciences (FES)

MT-102 Differential Equations and Linear Algebra I

Pre-Requisite: MT-101 Calculus I
Instructors: Dr. Sheharyar Pervez
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Office hours: Monday to Friday, 10:30 am to 11:30 am (G-27, FES)

Course Introduction

This course presents basic concepts of matrix algebra, methods of solving systems of linear equations, basic concepts of vector spaces, and methods of computing determinants, eigenvalues and eigenvectors. Students should be able to classify and identify different types of linear differential equations, explicitly solve several important classes of ordinary differential equations and apply ideas from linear algebra in order to solve linear ordinary differential equations. They should model certain physical phenomena using differential equations and reinterpret their solutions physically. Use analytic techniques to compute solutions to various differential equations.

Course Contents

- Matrix Algebra
- System of linear Equations and their solutions
- Determinants
- Introduction to Complex Numbers
- Eigenvalues and Eigenvectors
- Differential Equations: definitions and terminology
- First order differential equations and their applications
- Second and higher differential equations
- Series solution for differential equations

Mapping of Class Learning Outcome (CLOs) to Program Learning Outcomes (PLOs)

S. No	CLOs	PLOs	Bloom Taxonomy
Upon completion of this course, students will be able to:			
CLO1	Solve different problems concerning the theory of basic linear algebra.	PLO1	C3 (Applying)
CLO2	Apply different solution techniques to first order differential equations and system of differential equations arising in various applied problems.	PLO1	C3 (Applying)
CLO3	Apply various techniques to solve second and higher order linear differential equations.	PLO1	C3 (Applying)

Direct Assessment tools based on CLOs

Assessment Tools	CLO-1	CLO-2	CLO-3
Quizzes	20%	25%	25%
Assignments	10%	5%	5%
Midterm Exams	45%	45%	0%
Final Exam	25%	25%	70%

Grading Policy		
Assessment Items		**% Marks**
1.	**Assignment**	**10%**
2.	**Quizzes**	**20%**
3.	**Mid-Term Exam**	**30%**
4.	**Final Exams**	**40%**

Text and Reference Books

Textbooks:

1. A First Course in Differential Equations with Modeling Applications by Dennis G. Zill, Brooks Cole USA (10th edition 2013).
2. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley USA (10thEdition 2011).

Reference books:

1. Elementary Differential Equations and Boundary-Value Problems by William E. Boyce, Richard C. DiPrima, Wiley USA (10th Edition 2015).
2. Differential Equations for Engineers and Scientists by Yunus A. Cengel et.al., McGraw-Hill USA (1st Edition 2013).

Administrative Instruction

- **Student Attendance is expected to be 100%, and minimum 80% (mandatory) attendance that is required to sit in the final exams.**
- **Student must pay the attention for reading the text books chapter for course assessment rather than lecture slides**
- **All the direct assessment tools i.e., Quizzes, Assignment, Midterms and final Exams must be attempted. Failure to attempt in any of the assessment tools without any medical reasons may results to fail in that particular assessment.**
- **For any queries, please contact the instructors during his office hours.**

Lecture Breakdown

Lecture#1	MATRIX ALGEBRA. Notion of a matrix, matrix addition, scalar multiplication, matrix multiplication and its motivation,
Lecture#2	Algebraic properties of matrix operators, transpose of a matrix
Lecture#3	Linear system of equations. Gauss elimination method. Elementary row operations.
Lecture#4	Continue to lecture # 3
Lecture#5	Continue to lecture # 3
Lecture#6	Linear independence and dependence of vectors. Rank of matrix.
Lecture#7	General properties of solutions of the linear systems. Homogeneous and non-Homogeneous linear systems
Lecture#8	Determinants and their properties
Lecture#9	Expansion by Cofactors
Lecture#10	Cramer's rule
Lecture#11	Gauss-Jordan elimination method.
Lecture#12	Invertible matrices and computation of an inverse matrix

Lecture#13	Complex Numbers: Complex numbers; Polar form; DeMoivre's theorem; nth roots of a complex number; Complex exponentials and Euler's formula.
Lecture#14	Complex Numbers: Continue
Lecture#15	Eigenvalues and eigenvectors
Lecture#16	Continue to lecture # 13
Lecture#17	DIFFERENTIAL EQUATIONS. Definitions and terminology.
Lecture#18	First order differential equations. Separable, Homogeneous, Exact, Linear and Bernoulli equations. Applications
Lecture#19	Continue to lecture # 16
Lecture#20	Continue to lecture # 16
Lecture#21	Continue to lecture # 16
Lecture#22	Second-order differential equations, which reducible to first-order differential equations.
Lecture#23	Continue to lecture # 22
Lecture#24	Linear differential equations of higher order. Initial and boundary - value problems
Lecture#25	Linear independence and dependents of the solutions
Lecture#26	Wronskian and general solution
Lecture#27	Construction of second solution from a known solution
Lecture#28	Annihilator operator method.
Lecture#29	Continue to lecture # 28
Lecture#30	Homogeneous and non-homogeneous differential equations with constant coefficients and their solution
Lecture#31	Continue to lecture # 30
Lecture#32	Undetermined coefficients.
Lecture#33	Variation of parameters.
Lecture#34	Cauchy -Euler equation
Lecture#35	Series solution of differential equations about arbitrary points and regular singular points
Lecture#36	Continue to lecture # 35
Lecture#37	Series solution of Legendre differential equations
Lecture#38	Method of Frobenius
Lecture#39	Continue to lecture # 38
Lecture#40	Continue to lecture # 38
Lecture#41	Series solution of Bessel's differential equations
Lecture#42	Matrix system of linear first order differential equations. Homogeneous system with: (i) distinct real eigenvalues, (ii) complex eigenvalues, and (iii) repeated eigenvalues
Lecture#43	Continue to lecture # 42
Lecture#44	Continue to lecture # 42
Lecture#45	Continue to lecture # 42