MTH108: Mathematics II

Programme: B.Tech.	Year: 2nd	Semester : Second
Course : Core	Credits :4	Hours : 40

Course Context and Overview (100 words):
Linear Algebra is the basic tools to learn and understand about differential equations. Linear Algebra along with elementary calculus provides the techniques for the solutions of differential equations, whereas differential equations are the tools to express the laws of nature. Understanding behaviors of solutions of differential equations is fundamental to much of contemporary science and engineering. Ordinary differential equations (ODE's) deal with functions of one variable, which can often be thought of as time. Different techniques for solving ODEs and it's applications will be covered in this course.

Prerequisite Courses: Mathematics I

Course Outcomes (COs):

On completion of this course, the students will have the ability to:
CO1 Understand the concepts of vector spaces, subspaces, basis, range space, null space and geometry interpretation.
CO2 Computation of eigenvalues and eigenvectors of a matrix, knowledge of diagonalization.
CO3 Knowledge of the concept of the differential equations
CO4 Clean knowledge of qualitative behavior of solutions of differential equations and finding the analytical solutions of linear and non-linear differential equations.
CO5 Knowledge of Laplace transformation, Fourier series and Fourier Integral which are applicable in various scientific and engineering applications.

Course Topics:

Topics	Lecture Hours	
UNIT - I **1. Topic**		
1.1 Matrices and operations on matrices and their properties;	2	

Topics	Lecture Hours	
Special matrices Transpose; Trace;		
1.2 Vector spaces, sub-spaces, Linear Dependence/Independence; Basis; Dimension; Co-ordinates with respect to a basis; Complementary sub-spaces; Linear Transformation,	6	
1.3 Inner Products; Norm of a vector, Cauchy-Schwarz Inequality; Orthonormal basis, Gram-Schimdt process,	3	
1.4 Eigen Values/Eigen Vectors, Characteristic Polynomial; Diagonalisable matrices; Similarity of matrices.	4	
UNIT - II **2. Topic**		
2.1 Introduction to Differential Equations., First Order ODE y'=f(x,y), geometrical interpretation of solutions, Separable forms, Exact Equations, integrating factor, Linear Equations, Orthogonal Trajectories, Picard's Theorem, Qualitative properties and Theoretical aspects, Euler's Method, Elementary classifications of equations F(x,y,y')=0.	7	
2.2 Second Order Linear differential equations: fundamental system and general solution of homogeneous equation, reduction of order	3	
UNIT - III **3. Topic**		
3.1 Existence and uniqueness of solution for second order IVP, Wronskian and general solution of non-homogeneous equations	3	
3.2 Euler-Cauchy Equations, extensions of the results to higher order linear equations, Higher order Differential Equations,	1	
3.3 Power series method	1	
UNIT - IV **4. Topic**		
4.1 Legendre Polynomials, Frobenius Method	2	
4.2 Bessel equation , Properties of Bessel functions	1	
4.3 Sturm Liouville BVP, Orthogonal functions,	1	
4.4 Qualitative behaviour of solutions of second order ODE, Sturm comparison Theorem.,	2	
4.5 Laplace transform, Fourier Series and Integrals.	5	

Textbook references (IEEE format):

Text Book:

1. Kenneth Hoffman & R. Kunze, *Linear Algebra*, Prentice Hall 2nd Ed, 1971.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, 8th edition, Wiley publishers.
3. George F. Simmons, Steven G. Krantz, *Differential Equations*: *Theory, Technique And Practice,* Tata McGraw-Hill Education.

Reference books:

1. G. Strang, *Linear Algebra and Its Applications*, Thomson Brooks/Cole, 2007.
2. S. Kumaresan, *Linear Algebra, A Geometric Approach*, Prentice Hall India, 2008.
3. Coddington, *An Introduction to Ordinary Differential Equations*.

Additional Resources

(NPTEL, MIT Video Lectures, Web resources etc.): IIT Kanpur Lecture Notes, MIT Video Lectures by Strang, QEEE Course for Linear Algebra by N. Nataraj

Evaluation Methods:

Item	Weightage
Quizzes	15
Attendance	5
Midterm Exam	30
Final Examination	50

Prepared By:
Course Instructor name:
Last Update: