LINEAR ALGEBRA & DIFFERENTIAL EQUATIONS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Course Code	:		**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–S	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Understand** basic concepts of linear algebra to illustrate its power and utility through applications to science and Engineering.
2. **Apply** the concepts of vector spaces, linear transformations, matrices and inner product spaces in engineering.
3. **Explain** the course algebraically as well as geometrically.
4. **Solve** problems in cryptography, computer graphics and wavelet transforms.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

- **Lecture method** means it includes not only traditional lecture method, but different type of teaching methods may be adopted to develop the course outcomes.
- **Interactive Teaching:** Adopt the **Active learning** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
- Show **Video/animation** films to explain functioning of various concepts.
- Encourage **Collaborative** (Group Learning) Learning in the class.
- To make **Critical thinking**, ask at least three Higher order Thinking questions in the class.
- Adopt **Problem Based Learning**, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Show the **different ways to solve** the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every **concept can be applied to the real world** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

INTRODUCTION:

System of Linear equations, Row reduction and echelon form, Rank of a matrix by row echelon form, Gauss elimination, Inverse of a matrix by Gauss Jordan LU.

UNIT – II	**08 Hours**

Vector spaces – Subspaces, Linear independence – Span - Bases and Dimensions -Finite dimensional vector spaces, Dimensions, finite dimensional vector spaces.

UNIT – III	**09 Hours**

Linear transformation - Matrices of linear transformations, Vector space of linear transformations – Inner Product, Orthogonal Vectors – Projections, Gram- Schmidt Orthogonalization process.	
UNIT – IV	**07 Hours**
Introduction to Eigenvalues and Eigenvectors, Diagonalization of a Matrix.	
UNIT – V	**07 Hours**
Linear second order ordinary differential equation with constant coefficients, Solutions of homogenous and non-homogenous equations, Method of variation of parameters, Solutions of Cauchy-Euler and Cauchy-Legendre differential equations	

Course Outcome	**Description**
At the end of the course the student will be able to:	
1	Apply the abstract concepts of matrices and system of linear equations using decomposition methods.
2	Explain the basic notion of vector spaces and subspaces.
3	Apply the concept of vector spaces using linear transforms which is used in computer graphics and inner product spaces
4	Implement the concept of linear transforms and orthogonality in computer graphics and imaging.
5	Make use of techniques for solving differential equation in dynamical systems.

Table: Mapping Levels of COs to POs / PSOs

COs	**Program Outcomes (POs)**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	0	0	0	0	0	0	0	0	2			
CO2	3	3	0	0	0	0	0	0	0	0	0	2			
CO3	3	3	3	0	0	0	0	0	0	0	0	2			
CO4	3	3	3	0	0	0	0	0	0	0	0	2			
CO5	3	3	2	0	0	0	0	0	0	0	0	1			

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

[1] D C Lay, S R Lay and JJ McDonald, Linear Algebra and its Applications, Pearson India, Fifth edition, 2016.

[2] Gilbert Strang, Linear Algebra and its Applications, 4th Edition, Thomson Brooks/Cole, Second Indian Reprint 2007.

[3] Bernard Kolman and David, R. Hill, Introductory Linear Algebra- An applied first course, 9th Edition, Pearson Education, 2011.

[4] George B. Thomas, D. Weir and J. Hass, Thomas' Calculus, 13th edition, Pearson, 2014.

[5] Erwin Kreyszig, Advanced engineering mathematics, Wiley, London, 1972.

REFERENCE BOOKS:

[1] Gilbert Strang, Introduction to Linear Algebra, 5th Edition, Cengage Learning, 2015.
[2] B S Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers.
[3] Stephen Andrilli and David Hecker, Elementary Linear Algebra, 5th Edition, Academic Press 2016.
[4] Robert C Busby, Contemporary linear algebra, Howard Anton, Wiley, 2003.
[5] Farin and Hansford, Practical Linear Algebra, CRC Press, 2013.

E-Resources:

- https://nptel.ac.in/courses/111101115
- https://nptel.ac.in/courses/111108066
- Linear Algebra Basics | Coursera
- https://nptel.ac.in/courses/111108081
- https://nptel.ac.in/courses/111106100
- Differential Equations for Engineers Course (HKUST) | Coursera

Activity Based Learning (Suggested Activities in Class)

1. Introduce the concept of matrix transformations, such as translation, rotation, scaling, and reflection. Provide visual examples and interactive tools that allow students to manipulate shapes and observe the effects of different transformation matrices.
2. Using real-life scenarios or word problems to make the activity of solving linear equations using matrix method.
3. Some real-world scenarios that can be modelled using ODEs, such as population growth, radioactive decay, or chemical reactions that can be discussed and solve using appropriate methods.
4. Real world problem solving and puzzles using group discussion.
5. Demonstration of solution to a problem through experiential learning.