Semester 1

Linear Algebra, Differential Calculus and Laplace Transforms

Course Code	Teaching hours per week				Credits	Exam hours	Course type	CIE Marks	ESE Marks
	L	T	P	R					
26NBCBS101	2	1	0	0	3	2 Hrs. 30 Min.	Theory	40	60

1. **Preamble:** To provide a comprehensive understanding and basic techniques of matrix theory to analyze linear systems and to offer advanced knowledge and practical skills in solving second-order ordinary differential equations and partial derivatives and applying Laplace transforms, enabling students to analyze and model dynamic systems encountered in engineering disciplines effectively.

2. **Prerequisites:** Basic knowledge of single variable calculus and matrix operations.

Module Number	Syllabus Description	Contact Hours
1	**Matrix:** Linear Systems of Equations: Gauss Elimination, Row Echelon Form, Rank of a Matrix, Test for Consistency: Homogeneous and Non-Homogeneous (without proof), Linear Independence and dependence of vectors, The matrix Eigen Value Problem, Determining Eigen values and Eigen vectors, Properties of eigen values, Diagonalization of matrices. (Quadratic form excluded) **[Text 1: Relevant topics from sections 7.3, 7.4, 8.1, 8.4]**	**9**
2	**Partial Differentiation:** Functions of two or more variables, Partial derivatives, Differentials and Local linear approximation, The Chain rule, Implicit Differentiation, Maxima and Minima of functions of two variables. **[Text 2: Relevant topics from sections 13.1, 13.3, 13.4, 13.5, 13.8]**	**9**
3	**Differential Equations:** Homogeneous linear Ordinary	**9**

	Differential Equations of second order, Superposition principle, Homogeneous linear ordinary differential equations of second order with constant coefficients, Wronskian – Linear independence or dependence of solutions, Non-homogenous linear ordinary differential equations (with constant coefficients) – General solution, Particular solution by the method of undetermined coefficients (for the functions of the form ke^{ax}, kx^{n}, $k\sin ax$, $k\cos ax$), Solution by variation of parameters (Second Order) **(Text 1: Relevant topics from sections 2.1, 2.2, 2.6, 2.7, 2.10)**	
4	**Laplace Transforms:** Laplace Transform – Linearity property, First shifting theorem, Transform of derivatives, Unit step function, Second shifting theorem, (Initial value problems involving unit step function is excluded), Inverse Laplace Transforms, Convolution theorem (without proof), Solution of initial value problem by Laplace Transform (Second order with constant coefficient). **(Text 1: Relevant topics from sections 6.1, 6.2, 6.3, 6.5)**	**9**
	Total hours	36

Course Assessment Method
(CIE: 40 Marks, ESE: 60 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination -1 (Written)	Internal Examination -2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

3. Course Outcomes

At the end of the course students should be able to:

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Solve systems of linear equations and diagonalize matrices.	K3
CO2	Compute partial and total derivatives, determine maxima and minima of multivariable functions.	K3
CO3	Solve homogeneous and non-homogeneous linear differential equations with constant coefficients.	K3
CO4	Compute Laplace transforms and apply them to solve ordinary differential equations.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

4. Mapping of Course Outcomes with Program Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO1	3	3	2	2	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	2

5. Text Books

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10th edition, 2016
2	Calculus, Early Transcendentals	H.Anton, I.Biven, S.Davis	Wiley	12th edition, 2024

6. Reference Books

Sl No	Title of Book	Name of Author/s	Publisher	Edition and Year
1	Thomas' Calculus	Maurice D. Weir, Joel Hass, Christopher Heil, Przemyslaw Bogacki	Pearson	15th edition, 2023
2	Essential Calculus	J. Stewart	Cengage	2nd edition, 2017
3	Elementary Linear Algebra	Howard Anton, Chris Rorres	Wiley	11th edition, 2019
4	Bird's Higher Engineering Mathematics	John Bird	Taylor& Francis	9th edition, 2021
5	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39th edition, 2023
6	Calculus	H. Anton, I. Biven, S.Davis	Wiley	12th edition, 2024
7	Signals and Systems	Simon Haykin, Barry Van	Wiley	2nd edition, 2002

7. Video Links or any other Reference Materials

Sl No	Details like Web link, Publication Details	Module
1	https://archive.nptel.ac.in/course.html	1
2	https://archive.nptel.ac.in/course.html	2
3	https://archive.nptel.ac.in/course.html	3
4	https://archive.nptel.ac.in/course.html	4

8. Question paper:

MODEL QUESTION PAPER

FEDERAL INSTITUTE OF SCIENCE AND TECHNOLOGY(FISAT)
(Autonomous)
FIRST SEMESTER B. TECH DEGREE EXAMINATION (2026 Scheme)

Course Code: 26NBCBS101

Course Name: Linear Algebra, Differential Calculus And Laplace Transforms

Max. Marks: 60		**Duration: 2 hours 30 minutes**

PART A

		Answer all questions. Each question carries 3 marks	CO	Marks
1		Find the rank of a matrix A = $\begin{bmatrix} 3 & 0 & 2 & 2 \\ -6 & 42 & 24 & 54 \\ 21 & -21 & 0 & -15 \end{bmatrix}$	1	(3)
2		Check whether the following vectors are linearly independent or not: (1,3,-1), (2,3,3), (3,0,-1).	1	(3)
3		Show that $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$, $f(x,y) = e^x cosy$	2	(3)
4		If $f(x,y) = 4x^3y^2 + 5x - 2y$, find $\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}$ $at\ (1,2)$	2	(3)
5		Show that form a {sinx, cosx}basis of solutions for the ordinary differential equation $y'' + y = 0$.	3	(3)
6		Find the general solution of the ordinary differential equation $y'' + 5y' + 6y = 0$	3	(3)
7		Find L $(e^t cos3t)$	4	(3)

8		Find $L^{-1}(\frac{1}{s^2-2s-15})$	4	(3)

PART B				
Answer any one full question from each module. Each question carries 9 marks				
Module 1				
9	a)	Use Gauss elimination to find the solutions of: x+y+z =6; x-y+2z =5,2x +y -z =1	1	(4)
	b)	Find eigenvalues and eigenvectors of the matrix A = $\begin{bmatrix} 0 & 1 & 1 \\ 0 & 2 & 0 \\ 2 & 1 & 3 \end{bmatrix}$	1	(5)
10	a)	Diagonalize the following matrix, $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$	1	(9)
Module 2				
11	a)	Using the chain rule, evaluate $\frac{\partial z}{\partial u}$, $\frac{\partial z}{\partial v}$ where $z= x^2 + y^2$, x=u+v, y= u-v.	2	(4)
	b)	Find the local linear approximation L (x,y,z) to f (x,y,z) = xyz at (1, 2, 3). Also, find the error in the approximation at (1.001, 2.002, 3.003).	2	(5)
12	a)	If u = f(2x-3y, 3y-4z, 4z-3x), then prove that $\frac{1}{2}u_x + \frac{1}{3}u_y + \frac{1}{4}u_z = 0.$	2	(4)
	b)	Locate all relative extrema and saddle points of $f(x,y) = 3x^2 -2xy +y^2 - 8y$.	2	(5)

Module 3

13	a)	Solve using the method of undetermined coefficients $y'' - y' - 2y = x^2$	3	(4)
	b)	Solve using the method of variation of parameters $y'' + 4y = tan2x.$	3	(5)
14	a)	Find a homogenous second order ordinary differential equation with the basis of solutions $e^x cos3x, e^x sin3x$	3	(4)
	b)	Solve the initial value problem $y'' + 4y' - 5y = 0, y(0) = 2, y'(0) = -5.$	3	(5)
Module 4				
15	a)	Find $L^{-1}\left[\frac{2s+5}{s^2 - 4s + 13}\right]$	4	(4)
	b)	Solve the initial value problem $y'' - 3y' + 2y = 4, y(0) = 2, y'(0) = 3$	4	(5)
16	a)	Using the Convolution theorem, find $L^{-1}\left[\frac{1}{s(s^2+4)}\right]$	4	(4)
	b)	Find L $[3u(t - 2)cos(t - 2)]$	4	(5)
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