COURSE TITLE	**CALCULUS AND LINEAR ALGEBRA**
COURSE CODE	**01EC0117**
COURSE CREDITS	**4**

Objective:

1 The aim of this course is to build a strong foundation in essential mathematical concepts such as calculus, linear algebra, and vector calculus. These topics are not only important for understanding the basics of engineering mathematics but are also crucial for solving real-life problems in electronics, communication, and computer-based systems. The course is designed to help students think logically, approach problems analytically, and prepare them for more advanced subjects in their core branch, including signal processing, control systems, and machine learning.

Course Outcomes: After completion of this course, student will be able to:

1 Apply calculus and vector calculus theorems to solve engineering problems. (Bloom's Level: Apply)

2 Apply foundational mathematical concepts to support learning and problem-solving in advanced subjects such as Signals & Systems, Machine Learning, and Control Systems. (Bloom's Level: Apply)

3 Analyze and solve systems of linear equations, compute eigenvalues and eigenvectors, and apply matrix diagonalization techniques in engineering models using linear algebra concepts. (Bloom's Level: Analyze)

4 Compare and contrast various mathematical methods or approaches to solve the given problem and choose the best. (Bloom's Level: Evaluate)

Pre-requisite of course: Students should have basic knowledge of algebra, coordinate geometry, trigonometry, elementary calculus, and understanding of basic functions and graphs as studied in 12th Grade level.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	1	0	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Differential Calculus** Limit of Functions of a Single Variable, Continuity and Differentiability, Mean Value Theorem: Rolle's Theorem, Mean Value Theorem: Lagrange's Theorem, Mean Value Theorem: Cauchy's Theorem, Taylor and Maclaurin Series Expansions, Functions of Two Variables: Limits, Partial Derivatives and Total Derivative, Chain Rule for Multivariable Functions, Maxima and Minima; Lagrange's Method of Multipliers	10

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Contents : Unit	Topics	Contact Hours
2	**Integral Calculus** Definite Integrals – Basics and Evaluation, Properties of Definite Integrals, Improper Integrals – Introduction, Convergence of Improper Integrals, Applications: Area Under Curves, Applications: Surface Area of Solids of Revolution, Applications: Volume of Solids of Revolution, Beta Function – Definition and Properties, Gamma Function – Definition and Properties, Mean Value Theorem of Integral Calculus	10
3	**Linear Algebra** Systems of Linear Equations and Gaussian Elimination, Consistency of Systems of Equations, Matrix Types, Operations, and Inverse, Rank and Echelon Form of a Matrix, Vector Spaces – Definition and Examples, Linear Dependence and Independence, Basis and Dimension of Vector Spaces, Linear Transformations and Matrix Representation	8
4	**Eigen Theory and Diagonalization** Introduction to Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors, Diagonalization of Matrices – Concept and Process, Applications of Diagonalization in Systems of Equations, Cayley-Hamilton Theorem – Statement and Proof, Matrix Functions Using Cayley-Hamilton Theorem, Introduction to Quadratic Forms, Positive Definiteness and Classification of Quadratic Forms	8
5	**Vector Calculus** Scalar and Vector Point Functions, Gradient – Definition, Properties, and Physical Interpretation, Divergence – Definition, Properties, and Physical Interpretation, Curl – Definition, Properties, and Physical Interpretation, Line Integrals – Concept and Applications, Surface Integrals – Concept and Applications, Green's Theorem and Stokes' Theorem (Statement Only), Brief Introduction to Divergence Theorem and Applications	8
Total Hours		**44**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Tutorial-1** Practice on limits, continuity, and differentiability of functions.	1
2	**Tutorial-2** Mean value theorems and Taylor/Maclaurin's series.	1
3	**Tutorial-3** Multivariable functions: partial derivatives, chain rule.	1
4	**Tutorial-4** Maxima, minima and Lagrange's multipliers.	1
5	**Tutorial-5** Definite and improper integrals; application-based problems.	1

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
6	**Tutorial-6** Area, volume, and surface area by integration.	1
7	**Tutorial-7** Beta and Gamma functions – theory and numerical problems.	1
8	**Tutorial-8** System of linear equations; Gaussian elimination and echelon forms.	1
9	**Tutorial-9** Vector space concepts: basis, dimension, linear independence.	1
10	**Tutorial-10** Linear transformations and matrix representations.	1
11	**Tutorial-11** Eigenvalue problems and diagonalization techniques.	1
12	**Tutorial-12** Cayley-Hamilton Theorem; quadratic forms and definiteness.	1
13	**Tutorial-13** Gradient, divergence, curl and their physical interpretation.	1
14	**Tutorial-14** Vector theorems: Green's, Stokes', and Gauss divergence (applications & statements).	1
Total Hours		**14**

Textbook :

1 Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, 2015

2 Higher Engineering Mathematics, B.S. Grewal, 44th Edition, Khanna Publishers, 2017

References:

1 Introduction to Linear Algebra, Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Wellesley Cambridge Press, 2016

2 Calculus and Analytical Geometry, Calculus and Analytical Geometry, George B. Thomas and Ross L. Finney, 9th Edition, Pearson Education, 2010

3 Mathematical Analysis, Mathematical Analysis, S.C. Malik and Savita Arora, Revised Edition, New Age International Publishers, 2012

4 Advanced Differential Equations, Advanced Differential Equations, M.D. Raisinghania, 19th Edition, S. Chand & Company Ltd., 2012

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	20.00	40.00	10.00	10.00	10.00

Instructional Method:

1 Chalk & talk / whiteboard lectures
2 Power point presentations
3 Collaborative Learning
4 Simulation Based Learning
5 Problem Solving

Supplementary Resources:

1 NPTEL Online Course, Engineering Mathematics-I by Prof. Jeetendra Kumar (IIT Kharagpur) https://onlinecourses.nptel.ac.in/noc21_ma58/preview

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