DEPARTMENT OF BASIC SCIENCE (MATHEMATICS)

EEE STREAM

Course Title:	**Vector calculus, Laplace Transforms & Numerical techniques**	Semester	**II**
Course Code:	**BMATE201**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)	3:1:2:0	Exam Hours	03
Total Hours of Pedagogy	40 hours Theory + 10 to12 Lab slots	Credits	04

Course learning objectives: The goal of the course **Vector calculus, Laplace Transforms & Numerical techniques** for Electricals and Electronics Engineering stream is to

CLO 1. Familiarize the importance of Vector calculus, Vector Space and Linear transformation for electronics and electrical engineering.

CLO 2. Have an insight into solving ordinary differential equations by using Laplace transform techniques.

CLO 3. Develop the knowledge of solving electronics and electrical engineering problems numerically.

Teaching-Learning Process

Pedagogy (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution of some exercises (post-lecture activity).

Module-1:Vector Calculus (8 hours)

Introduction to Vector Calculus in EC & EE engineering applications.

Vector Differentiation: Scalar and vector fields. Gradient, directional derivative, curl and divergence - physical interpretation, solenoidal and irrotational vector fields. Problems.

Vector Integration: Line integrals, Surface integrals. Applications to work done by a force and flux. Statement of Green's theorem and Stoke's theorem. Problems.

Self-Study: Volume integral and Gauss divergence theorem.

Applications: Conservation of laws, Electrostatics, Analysis of streamlines and electric potentials. (RBT Levels: L1, L2 and L3)

Module-2: Vector Space and Linear Transformations(8 hours)

Importance of Vector Space and Linear Transformations in the field of EC & EE engineering applications.

Vector spaces: Definition and examples, subspace, linear span, Linearly independent and dependent sets, Basis and dimension.

Linear transformations: Definition and examples, Algebra of transformations, Matrix of a linear transformation. Change of coordinates, Rank and nullity of a linear operator, Rank-Nullity theorem(only statement))

Self-Study: Angles and Projections. Rotation, reflection, contraction and expansion.

Applications: Image processing, AI & ML, Graphs and networks, Computer graphics. (RBT Levels: L1, L2 and L3)

Module-3: Laplace Transform(8 hours)

Importance of Laplace Transform for EC & EE engineering applications.

Existence and Uniqueness of Laplace transform (LT), transform of elementary functions, region of convergence. Properties of LT, LT of special functions periodic functions (square wave, saw-tooth wave, triangular wave, full & half wave rectifier)(only statement), Heaviside Unit step function.

Inverse Laplace Transforms: Definition, properties, evaluation using different methods, applications to solve ordinary differential equations.

Self-study: Convolution theorem, Verification of convolution theorem.

Applications: : Signals and systems, Control systems, LR, CR & LCR circuits.

(RBT Levels: L1, L2 and L3)

Module-4 Numerical Methods -1(8 hours)

Importance of numerical methods for discrete data in the field of EC & EE engineering applications.

Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson methods (only formulae). Problems. Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula (All formulae without proof). Problems.

Numerical integration: Trapezoidal, Simpson's (1/3)rd and (3/8)th rules(without proof). Problems.

Module-5 Numerical Methods -2(8 hours)

Introduction to various numerical techniques for handling EC & EE engineering applications.

Numerical Solution of Ordinary Differential Equations (ODE's): Numerical solution of ordinary differential equations of first order and first degree - Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor-corrector formula (No derivations of formulae). Problems.

Self-Study: Adam-Bashforth method.
Applications: Estimating the approximate solutions of ODE. (RBT Levels: L1, L2 and L3).

List of Laboratory experiments (2 hours/week per batch/ batch strength 15)
10 lab sessions + 1 repetition class + 1 Lab Assessment

1. Finding gradient, divergent, curl and their geometrical interpretation and Verification of Green's theorem Evaluation of improper integrals.
2. Computation of basis and dimension for a vector space and Graphical representation of linear transformation
3. Visualization in time and frequency domain of standard functions
4. Computing inverse Laplace transform of standard functions
5. Laplace transform of convolution of two functions
6. Solution of algebraic and transcendental equations by Regula-Falsi and Newton-Raphson method
7. Interpolation/Extrapolation using Newton's forward and backward difference formula
8. Computation of area under the curve using Trapezoidal, Simpson's (1/3)rd and (3/8)th rule.
9. Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method.
10. Solution of ODE of first order and first degree by Runge-Kutta 4th order and Milne's predictor-corrector method

Suggested software: Mathematica/MatLab /Python/Scilab

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line integral and surface integral.
2. Demonstrate the idea of Linear dependence and independence of sets in the vector space, and linear transformation
3. To understand the concept of Laplace transform and to solve initial value problems.
4. Apply the knowledge of numerical methods in analyzing the discrete data and solving the physical and engineering problems.
5. Get familiarize with modern mathematical tools namely MATHEMATICA/ MATLAB /PYTHON/ SCILAB

Course Assessment and Evaluation Details (both CIE and SEE)

Continuous Internal Evaluation: 50 marks		
Theory Assessment Tool	**Marks**	**Reduced marks**
IAT-1	50	15
IAT-2	50	
Assessment -1	10	10
Assessment -2(activity based)	10	
Lab Assessment Tool	**Marks**	**Reduced marks**
Conducting Experiment and Laboratory Record(10 labs)	15(each lab)	15
Lab Test	10	10
Semester End Examination (SEE) : 50 marks		
SEE	**Marks**	**Reduced marks**
Course end examination (Answer any one question from each unit – Internal choice)	100	50

Suggested Learning Resources:

Text Books

1. **B. S. Grewal**: "Higher Engineering Mathematics", Khanna Publishers, 44th Ed., 2021.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.

Reference Books

3. **V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017
4. **Srimanta Pal & Subodh C.Bhunia**: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016.
5. **N.P Bali and Manish Goyal**: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.
7. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co., New York, 6th Ed., 2017.
8. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education(India) Pvt. Ltd 2015.
9. **H. K. Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics" S. Chand Publication, 3rd Ed., 2014.
10. **James Stewart: "**Calculus" Cengage Publications, 7thEd., 2019.
11. **David C Lay:** "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.
12. **Gareth Williams:** "Linear Algebra with Applications", Jones Bartlett Publishers Inc., 6th Ed., 2017.
13. **Gilbert Strang:** "Linear Algebra and its Applications", Cengage Publications, 4th Ed. 2022.
14. **William Stallings:** "Cryptography and Network Security" Pearson Prentice Hall, 6th Ed., 2013.
15. **Kenneth H Rosen:** "Discrete Mathematics and its Applications" McGraw-Hill, 8th Ed. 2019.
16. **Ajay Kumar Chaudhuri:** "Introduction to Number Theory"NCBA Publications, 2nd Ed., 2009.
17. **Thomas Koshy:** "Elementary Number Theory with Applications"Harcourt Academic Press, 2nd Ed., 2008.

Web links and Video Lectures (e-Resources):

http://nptel.ac.in/courses.php?disciplineID=111

- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/

COs and POs Mapping (Individual teacher has to fill up)

COs	Pos											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1												
CO2												
CO3												

CO4												
CO5												

Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped