II Semester

Course Title: Mathematics-II for Electrical & Electronics Engineering stream [As per Choice Based Credit System (CBCS) scheme]

(From the academic year 2022-23)

Course Code	22MATE21	CIE Marks	50
Credits	04	SEE Marks	50
Course Type	Integrated		
Contact Hours/Week (L-T-P)	2-2-2	Total Marks	100
Contact Hours of Pedagogy	42 hours Theory +10 Lab slots	Exam Hours	03

Course objectives: The goal of the course **Mathematics-II for Electrical & Electronics Engineering stream (22MATE21)** is to

- **Familiarize** the importance of Integral calculus and Vector calculus essential for electronics and electrical engineering.
- **Analyze** electronics and electrical engineering problems by applying Partial Differential Equations.
- **Develop** the knowledge of solving electronics and electrical engineering problems numerically.

Module-1 Vector Calculus

(6L+3T)

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 (6L+2T)

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. Inner product spaces and orthogonality.

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

(6L+3T)

Importance of Laplace Transform for EC & EE engineering applications.

Existence and Uniqueness of Laplace transform (LT), transform of elementary functions, region of convergence, Properties–Linearity, Scaling, t-shift property, s-domain shift, differentiation in the s-domain, division by t, differentiation and integration in the time domain, LT of special functions-periodic functions (square wave, saw-tooth wave, triangular wave, full & half wave rectifier), Heaviside Unit step function, Unit impulse function.

Inverse Laplace Transforms:

Definition, properties, evaluation using different methods, convolution theorem (without proof), problems, and Applications to solve ordinary differential equations.

Self-Study: 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

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

Solution of algebraic and transcendental equations: Regula-Falsi method and Newton-Raphson method (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.

Self-Study: Bisection method, Lagrange's inverse Interpolation, Weddle's rule.

Applications: Estimating the approximate roots, extremum values, Area, volume and surface area.

(RBT Levels: L1, L2 and L3)

Module-5 Numerical methods -2

(5L+3T)

Introduction to various numerical techniques for handling EC & EE applications. Numerical Solution of Ordinary Differential Equations (ODEs):

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 for electric circuits.

(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
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's: Mathematica/MatLab/Python/Scilab

Semester End Examination (SEE):

Theory SEE will be conducted by Institute as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- 1. The question paper will have ten questions. Each question is set for 20 marks.
- 2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- 3. The students have to answer 5 full questions, selecting one full question from each module.

Course outcome (Course Skill Set)

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

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

Suggested Learning Resources:

Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year) 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

- 1. V. Ramana: "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017
- 2. Srimanta Pal & Subodh C. Bhunia: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016.
- 3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.
- 4. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw Hill Book Co., Newyork, 6th Ed., 2017.
- 5. Gupta C.B, Sing S.R and Mukesh Kumar: "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education(India) Pvt. Ltd 2015.
- 6. **H. K. Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics" S. Chand Publication, 3rd Ed., 2014.
- 7. James Stewart: "Calculus" Cengage Publications, 7th Ed., 2019.
- 8. David C Lay: "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.
- 9. Gareth Williams: "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6th Ed., 2017.

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/
- VTU e-Shikshana Program
- VTU EDUSAT Program

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

- Quizzes
- Assignments
- Seminar