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 | Total Marks | 100 |
| Contact Hours/Week (L-T-P) | $2-2-2$ | Exam Hours | 03 |
| Contact Hours of Pedagogy | 42 hours Theory <br> +10 Lab slots |  |  |

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)

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 NewtonRaphson 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

| $\mathbf{1}$ | Finding gradient, divergent, curl and their geometrical interpretation and Verification of <br> Green's theorem |
| :--- | :--- |
| $\mathbf{2}$ | Computation of basis and dimension for a vector space and Graphical representation of <br> linear transformation |
| $\mathbf{3}$ | Visualization in time and frequency domain of standard functions |
| $\mathbf{4}$ | Computing inverse Laplace transform of standard functions |
| $\mathbf{5}$ | Laplace transform of convolution of two functions |
| $\mathbf{6}$ | Solution of algebraic and transcendental equations by Regula-Falsi and Newton-Raphson <br> method |
| $\mathbf{7}$ | Interpolation/Extrapolation using Newton's forward and backward difference formula |
| $\mathbf{8}$ | Computation of area under the curve using Trapezoidal, Simpson's (1/3)rd and (3/8)th <br> rule |
| $\mathbf{9}$ | Solution of ODE of first order and first degree by Taylor's s series and Modified Euler's <br> method |
| $\mathbf{1 0}$ | Solution of ODE of first order and first degree by Runge-Kutta 4th order and Milne's <br> 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, <br> line integral and surface integral. |
| :--- | :--- |
| CO 2 | Demonstrate the idea of Linear dependence and independence of sets in the vector <br> 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 <br> phenomena |
| CO 5 | Get familiarize with modern mathematical tools namely <br> 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

