

## Core-IX

## Mathematical Methods for Electronics

### Course outcomes

- Understand and apply vector calculus concepts, including scalar and vector fields, gradient, divergence, and curl, in the analysis of physical phenomena and mathematical models.
- Calculate line, surface, and volume integrals and apply fundamental theorems such as Gauss's Divergence Theorem, Stoke's Theorem, and Green's Theorem to solve problems in diverse areas of science and engineering.
- Express vector operators (gradient, divergence, curl, and Laplacian) accurately in both Cartesian and spherical polar coordinates, enabling precise calculations and interpretations in different coordinate systems.
- Solve ordinary differential equations (ODEs) using various techniques, including exact equations, auxiliary equations, power series, and the Frobenius method, allowing for the analysis and prediction of dynamic systems.

### Unit 1

- Vector Calculus (10hrs): Scalar and Vector Fields, Gradient of a Scalar function, Divergence of a Vector function, Curl, Line, Integral, Surface Integral and Volume Integral (Simple Problems), Gauss Divergence Theorem, Stoke's Theorem and Green's Theorem (Statement and Proof), Spherical Polar Coordinates, Expressions for Gradient, Divergence, Curl and Laplacian Operator in Cartesian and Spherical, Polar, Coordinates
- Ordinary Differential Equation (10hr): Linear first-order ODEs, Wronksian, exact ODEs, auxiliary equation. Inhomogeneous second order, ODEs, method of undetermined coefficients Green's function method, power series method, Frobenius method, Beta and Gamma Functions, Series Solutions for Bessel, Legendre and Hermite, Differential Equations

### Unit 2

Transforms and their applications (10hrs): Periodic functions, Series expansion, Fourier coefficients, Completeness relation, Dirichlet's, Conditions (Statement Only), Fourier transforms, Laplace transforms, Solving ODEs using Laplace transforms, Dirac Delta function

### Unit 3

COMPLEX VARIABLES (10hrs): Basics of Complex Numbers and their Graphical Representation, Euler's Formula, De-Moivre's Theorem, Functions of Complex Variables, Limit, Continuity and Differentiability, Analytic Function, Definition, Cauchy-Riemann Conditions, Examples of Analytic Functions, (Analyticity), Cauchy-Riemann Conditions in Polar Form

## Unit 4

MATRICES (10Hours): Special Types of Matrices, Symmetric and Skew, symmetric Matrices, Hermitian and Skew-ermitian Matrices, Orthogonal Matrices, Unitary Matrices, Characteristics Equation, Determination of Eigen values and Eigen vectors, Statement and Proof of Cayley-Hamilton Theorem, Simple Problems, Inverse of Matrix by CH Theorem, Diagonalization of  $2 \times 2$  Real Symmetric Matrices

### Suggested References:

- ✓ *Mathematical Physics, H. K. Dass, S. Chand & Co. Ltd. (2010).*
- ✓ *Mathematical Physics, Sathya Prakash, Sultan Chand & Sons, New Delhi, Fifth Revised and Enlarged Edition, 2006, (Reprint 2007).*
- ✓ *Mathematical Physics, B. D. Gupta, Vikas Publishing house Pvt. Ltd. (2010)*
- ✓ *Mathematical Methods for Physicists, G. Arfken, (5th Edition), Academic Press, (2000).*
- ✓ *Mathematical Physics, B.S. Rajput, 8th Edition, Pragati Prakashan (1978).*
- ✓ *Foundations of Mathematical Physics, Sadri Hassani, Second Edition, Springer*
- ✓ *Mathematical methods for Physics and Engineering, K.F.Riley, M.P.Hobson & S.J.Bence, Cambridge University Press, 3rd Edition.*