# FACULTY OF ENGINEERING & TECHNOLOGY

## Effective from Academic Batch: 2022-23

**Programme:** Bachelor of Technology (Automobile Engineering)

**Semester:** IV

**Course Code:** 202003401

**Course Title:** Complex Variable, Numerical Analysis and PDE

**Course Group: Basic Science Course**

**Course Objectives:** The main objective of this course is to provide students with the theory of functions of a complex variable which is the branch of mathematical analysis that investigates functions of complex numbers. Students to learn the basics of Modeling and solution of partial differential equations. Also, various numerical methods to develop problem solving skills used in varied engineering disciplines.

**Teaching & Examination Scheme:**

| Contact hours per week | | | Course Credits | Examination Marks (Maximum / Passing) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | J/V/P* | | Total |
| Lecture | Tutorial | Practical | | Internal | External | Internal | External | |
| 3 | 2 | 0 | 4 | 50 / 18 | 50/17 | - | - | 100 /35 |

\* **J**: Jury; **V**: Viva; **P**: Practical

**Detailed Syllabus:**

| Sr. | Contents | Hours |
|---|---|---|
| 1 | **Complex Analysis:**<br>Complex Numbers: Polar form of complex numbers, De Moivre's Theorem, roots of complex numbers.<br>Functions of complex variable: Exponential function, circular functions, Hyperbolic function, Inverse hyperbolic functions, Logarithm function. Limit continuity and Differentiability of complex function, analytic function. Cauchy –Riemann Equations. Harmonic function.<br>Complex Integration: Line integral in the complex plane, Cauchy's theorem, Cauchy's integral formula.<br>Sequence and Series of complex terms: Convergent test, power series, functions given by power series, Taylor series. | 10 |
| 2 | **Fourier Analysis:**<br>Periodic function, Trigonometric series. Fourier series of functions of any period, Fourier series of even and odd functions, half-range expansions. Fourier Transform. | 6 |
| | | |

| 3 | **Laplace Transform:** Laplace transform, Linearity, First shifting theorem, Transform of Derivatives and integrals, Unit step function, second shifting theorem, Differentiation and integration of transform, Inverse Laplace transform, Convolution, integral equations, Partial fraction, Solution of Differential Equations by using Laplace Transform. | 7 |
|---|---|---|
| 4 | **Series Solution of Differential Equation:** Power series method, theory of the power Series method, Bessel`s Equation, Bessel functions, Orthogonal functions. | 5 |
| 5 | **Partial Differential Equations:** Formation of Partial differential equations, Solution of a partial Differential equation, Solution by direct integration, Linear equations of the first order, Non-linear equation of first order. Homogeneous linear equation with constant coefficient, Non homogeneous linear equation with constant coefficients, Classification of second order linear partial differential equations, Method of separation of variables, one-dimensional wave equation, one-dimensional heat equation, two-dimensional heat equation, Laplace equation. | 8 |
| 6 | **Numerical Methods :** Roots of algebraic and transcendental equation: Bisection method, False Position method, secant method and Newton-Raphson method Solution of a system of linear Equations: Gauss- Jacobi method and Gauss-Seidel method. Numerical solution of ordinary Differential equations: Euler and Runge-Kutta method $4^{th}$ Order. Numerical integration: Trapezoidal and Simpson`s rules. Interpolation: Newton`s forward interpolation and Newton's backward interpolation formula, Newton`s divided difference formula, Lagrange`s interpolation formula. | 9 |

## List of Practicals / Tutorials:

| 1 | Complex Numbers. |
|---|---|
| 2 | Functions of Complex Variable |
| 3 | Complex Integration and Series of Complex Terms |
| 4 | Fourier Series |
| 5 | Fourier Transforms |
| 6 | Laplace Transforms and Differentiation, Integration of Transforms |
| 7 | Inverse LT, Convolution, Solutions of ODE by using LT |
| 8 | Series Solution of Differential Equation |
| 9 | Partial Differential Equations |
| 10 | Applications of PDE |
| 11 | Roots of Equation and Solution of System of Linear Equations |
| 12 | Interpolation |
| 13 | Numerical Solution of ODE and Numerical Integration |

**Reference Books:**

| 1 | Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons |
|---|---|
| 2 | Higher Engineering Mathematics, B S Grewal, Khanna Publishers |
| 3 | Numerical Methods for Engineers Steven C Chapra, Raymond P Canale, Mc Graw Hill Education |
| 4 | Introductory Methods of Numerical Analysis by S S Sastry, PHI Learning Pvt Ltd |

**Supplementary learning Material:**

| 1 | Lecture Note |
|---|---|
| 2 | https://nptel.ac.in/courses/111/103/111103070/ |
| 3 | https://nptel.ac.in/courses/111/107/111107056/ |
| 4 | https://nptel.ac.in/courses/127/106/127106019/ |
| 5 | https://nptel.ac.in/courses/111/105/111105035/ |

**Pedagogy:**

- Direct Classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment (Tutorials)
- Interactive methods
- Seminar/Poster presentation

**Internal Evaluation:**

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

**Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):**

| Distribution of Theory Marks | | | | | | R: Remembering; U: Understanding; A: Application, N: Analyze; E: Evaluate; C: Create |
|---|---|---|---|---|---|---|
| R | U | A | N | E | C | |
| 30% | 30% | 30% | 10% | 0% | 0% | |

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

## Course Outcomes (CO):

| Sr. | Course Outcome Statements | %weightage |
|---|---|---|
| CO-1 | Students are able to understand the basic knowledge and concepts of complex analysis. | 20 |
| CO-2 | Able to express a periodic function as an infinite sum of sines and cosines. | 15 |
| CO-3 | Able to apply Laplace transforms to solve linear ODE arising from physical problems. | 15 |
| CO-4 | Able to understand fundamental concepts of PDE and their role in modern mathematics and applied contexts. | 20 |
| CO-5 | Able to apply numerical methods to find solutions of (algebraic and transcendental) equation and solution of system of linear equations | 20 |
| CO-6 | Able to apply various interpolation methods and work out numerical differentiation and integration. Also, able to solve ODE numerically. | 10 |

| Curriculum Revision: | |
|---|---|
| Version: | 2 |
| Drafted on (Month-Year): | June-2022 |
| Last Reviewed on (Month-Year): | - |
| Next Review on (Month-Year): | June-2027 |