

COURSE TITLE	NUMERICAL & STATISTICAL TECHNIQUES
COURSE CODE	01EC0309
COURSE CREDITS	4

Objective:

- 1 This course aims to introduce students to essential numerical and statistical techniques (methods) widely used in engineering applications. Through this course, students will gain the ability to model, analyze, and solve problems involving approximation, uncertainty, and data-driven decision-making.

Course Outcomes: After completion of this course, student will be able to:

- 1 Use concepts of computer arithmetic to examine numerical errors and ensure accuracy and stability in engineering computations.
- 2 Formulate and implement numerical techniques for obtaining approximate solutions of algebraic and transcendental equations, including solutions of systems of linear equations.
- 3 Develop interpolation models and employ numerical differentiation and integration methods to address engineering problems involving discrete datasets.
- 4 Solve ordinary differential equations using numerical approaches for modeling engineering systems, and utilize statistical techniques such as correlation, regression, and hypothesis testing for interpretation of experimental data and informed decision-making.

Pre-requisite of course: Basic understanding of calculus, matrices and linear algebra, and fundamental concepts of probability and statistics and knowledge of basic computational or programming skills will be helpful for implementing numerical methods.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	1	0	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	Computer Arithmetic Floating Point Representation of Numbers, Normalized Floating Point Numbers and Arithmetic Operations, Types of Errors in Numerical Methods, Error Analysis in Numerical Computations, Solution of Algebraic and Transcendental Equations – Introduction, Bisection Method, Regula-Falsi Method, Newton–Raphson Method, Gauss Elimination Method for Linear Systems, Iterative Methods – Gauss Jacobi and Gauss Seidel Methods	10

Contents : Unit	Topics	Contact Hours
2	Interpolation & Numerical Integration and Differentiation Introduction to Finite Differences, Differences of a Polynomial, Newton's Forward Interpolation Formula, Newton's Backward Interpolation Formula, Lagrange's Interpolation Formula, Numerical Differentiation – Basic Formulae for Derivatives, Numerical Integration – Trapezoidal Rule, Numerical Integration – Simpson's Rule	8
3	Numerical Solution of Ordinary Differential Equations Initial-Value and Boundary-Value Problems, Picard Method for Solution of Differential Equations, Taylor's Series Method, Euler's Method and Its Variants, Runge-Kutta Methods (Second and Fourth Order), Predictor-Corrector Methods	6
4	Probability, Correlation and Regression Analysis Basic Concepts of Probability, Conditional Probability and Bayes' Theorem, Random Variables – Discrete and Continuous, Joint Random Variables – Joint and Marginal Distributions, Standard Probability Distributions – Binomial, Poisson, Normal, Statistical Properties of Distributions – Mean and Variance, Applications of Probability in Engineering Problems, Correlation Analysis – Types, Coefficient of Correlation, Probable Error, Regression Analysis – Concept, Regression Lines, Linear and Multiple Linear Regression, Regression Computation and Comparison – Algorithms, Standard Error of Estimate, Correlation vs Regression	10
5	Sampling, Hypothesis Testing and Central Limit Theorem Population, Sample, and Sampling Techniques, Standard Error and Sampling Distributions, Central Limit Theorem – Concept and Significance, Applications of Central Limit Theorem in Engineering Data Analysis, Fundamentals of Hypothesis Testing – Null and Alternative Hypotheses, Level of Significance, Critical Region, Types of Errors in Hypothesis Testing – Type I and Type II Errors, Statistical Tests for Small and Large Samples – Including Student's t-distribution, Chi-Square Test and Its Properties – Including additive property	8
Total Hours		42

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	Tutorials During the semester, students shall be engaged in solving numerical problems under the supervision of the faculty in the form of tutorials. Each tutorial session shall be of 1 hours duration. Additionally, selected tutorials may incorporate the use of MATLAB/Python to solve mathematical problems, thereby providing exposure to computer-aided problem-solving techniques.	14
Total Hours		14

Textbook :

- 1 Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 2017
- 2 Numerical Methods for Scientific and Engineering Computations, M. K. Jain, S. R. K. Iyengar & R. K. Jain, New Age International, 2004

References:

- 1 Applied Numerical Methods with MATLAB for Engineers and Scientists, Applied Numerical Methods with MATLAB for Engineers and Scientists, S. C. Chapra, Tata McGraw Hill, 2008
- 2 Fundamentals of Mathematical Statistics, Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, 2020

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
5.00	10.00	40.00	20.00	20.00	5.00

Instructional Method:

- 1 The internal evaluation will be done based on the continuous evaluation of students during tutorial in and class-room.
- 2 Students may use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory, etc.
- 3 The course delivery method will depend upon the requirements of content and need of the students. The teacher in addition to conventional teaching methods (Chalk and Talk) may use any of the tools/techniques such as demonstration, role play, Quiz, brainstorming, Flipped class, Project based learning, Collaborative learning, MOOCs etc. for effective teaching.

Supplementary Resources:

- 1 <https://www.coursera.org/learn/numerical-methods-engineers>
- 2 <https://www.udemy.com/course/numerical-methods-matlab-for-engineering-students-part-1/>
- 3 <https://www.udemy.com/course/programming-numerical-methods-in-python/>
- 4 https://onlinecourses.nptel.ac.in/noc19_ma21/preview
- 5 http://vlabs.iitb.ac.in/vlabs-dev/labs/numerical_lab/labs/explist.php