Applied Mathematics-III

1.1 Course Number: MA 222

1.2 Contact Hours: 41 (L) Credits: 11 [LTP: 3-1-0]

1.3 Semester-offered: Odd (IIIrd)

1.4 Prerequisite: Real Analysis and Calculus, Linear Algebra, Computer and Matlab Programming

1.5 Syllabus Committee Member:

2. **Objective:**

i. To introduce a broad range of numerical methods for solving mathematical problems arising in Science and Engineering.

ii. To provide a basic understanding of the derivation, analysis, and use of numerical methods, with an understanding of finite precision arithmetic, conditioning, and stability of the various methods.

iii. To develop an understanding of the central statistical models and methods that are widely used in modern applications.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	**Numerical Solutions of Nonlinear/System of Linear Equations and Least-Squares Techniques**	Solution of nonlinear algebraic and transcendental equation: bisection method, fixed point iteration, Newton-Raphson, Regula-Falsi and generalized Newton's method for multiple roots. Solution of linear simultaneous equations by direct methods (Gauss elimination, Gauss Jordan & LU decomposition) and iterative methods (Gauss Jacobi and Gauss-Seidel iterative method). Least-squares, solving least-squares problem, least-squares data fitting and validation, and nonlinear regression.	**7**
2	**Interpolation Techniques and Numerical Quadrature Rules**	Interpolation: Finite difference operator and their relationships, difference tables, interpolation formulae, divided differences, Lagrange and Hermite interpolations. Numerical integration: Trapezoidal and Simpsons rules with errors and their combinations.	**7**
3	**Numerical Solutions of Differential Equations**	Solution of ODE: Initial & boundary value problem. Methods for IVP: Picards, Taylors, Euler's, Modified Euler's & Runge-Kutta methods for solving 1st order ordinary differential equations. Finite difference method for BVP. Solution of PDE: Laplace's equation by Gauss-Jacobi method, heat conduction equation by Bender-Schmidt method and wave equation by explicit formula.	**7**

4	**Random Variables and Some Special Distributions**	Various approaches of probability: classical, frequency and axiomatic, rules on probability, conditional probability, independence, Bayes' theorem. Univariate random variables: discrete and continuous, distribution functions and their properties, probability mass and density functions, expectation & variance. Discrete probability distributions: Bernoulli, Binomial, Negative Binomial, Poisson and approximations. Continuous probability distributions: Uniform, Exponential, Normal & approximation of binomial distribution.	**8**
5	**Descriptive Statistics**	Statistical Terminology: Inferential statistics, population, sample, parameter, statistic, random sample, sampling techniques. Summarizing and Exploring Data: Concept of frequency distribution, measures of central tendency, moments, measures of dispersion/variability, measures of skewness and kurtosis.	**5**
6	**Testing of Hypotheses**	Null and alternate hypothesis, simple & composite hypotheses, critical region, N-P lemma, tests for mean, variance in one sample problems. Chi-square goodness of fit test, Contingency table, test of independence.	**4**
7	**Regression & Correlation**	Simple linear regression and correlation analysis. Multiple linear regression.	**3**
		Total	**41**

4. Readings

4.1 Textbooks:

- *Numerical Methods for Engineers* by Steven C. Chapra and Raymond P. Canale; McGraw Hill Education India Private Limited.
- *Applied Numerical Analysis* by C. F. Gerald and P. O. Whitely; Pearson Education India.
- *Probability and Statistics in Engineering* by Hines, Montgomery, Goldsman & Borror. Wiley Student Edition.

4.2 Reference books:

- ✓ *Numerical Methods for Scientific and Engineering Computation* by M. K. Jain, S. R. K. Iyengar and R. K. Jain; New Age Pvt. Pub, New Delhi.
- ✓ *Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares* by S. Boyd and L. Vandenberghe; Cambridge University Press.
- ✓ *An Introduction to Mathematical Statistics and its Applications* by Larsen & Marx. Pearson.
- ✓ *Probability and Statistics* by Spiegel, Schiller and Srinivasan. Tata McGraw-Hill Pub. Co. Ltd.
- ✓ *Introduction to Probability and Statistics* by J. Susan Milton & J.C. Arnold, 4th Ed., Tata McGraw-Hill Pub. Co. Ltd.

5 Outcome of the Course:

This course will help students to choose, develop and apply the appropriate numerical techniques for their problems, interpret the results, and assess accuracy. The students will also be able to identify the statistical methods and to apply statistical/deterministic approaches to solve an engineering problem having stochastic in nature.