Course Syllabi: UMA032 Numerical and Statistical Methods (L : T : P :: 3 : 1 : 2)

1. **Course number and name:** UMA032; Numerical and Statistical Methods

2. **Credits and contact hours:** Credits: 4.5; Hours: 6

3. **Text book, title, author, and year**

   - *Conte, S.D and Carl D. Boor, Elementry Numerical Analysis: An Algorithmic approach, Tata McGraw Hill, New York (2005).*
   - *Johnson, R., Miller, I. and Freunds, J., Miller and Freund's Probability and Statistics for Engineers, Pearson Education(2005) 7th ed.*
   - *Gerald C.F and Wheatley P.O., Applied Numerical Analysis, Pearson Education (2008) 7thed.*
   - *Mathew, J.H., Numerical Methods for Mathematics, Science and Engineering, Prentice Hall Inc.J (2002).*
   - *Meyer, P.L.. Introductory Probability and Statistical Applications, Oxford (1970) 2nded.*
   - *Jain M.K., Iyengar, S.R.K., and Jain, R.K. Numerical Methods for Scientific and Engineering Computation, New Age International (2008) 5thed.*
   - *Walpole, Ronald E., Myers, Raymond H., Myers, Sharon L. and, Keying Ye, Probability and Statistics for Engineers and Scientists, Pearson Education (2007) 8thed.*

   a. Other supplemental materials
      - Nil

4. **Specific course information**

   a. Brief description of the content of the course (catalog description)

   Numerical Methods (60% Weightage).
   Floating-Point Numbers: Floating-point representation, Rounding, Chopping, Error analysis, Condition and instability.
   Non-Linear Equations: Bisection, Secant, Fixed-point iteration and Newton-Raphson methods, Order of convergence.
   Linear Systems and Eigen-Values: Gauss-elimination method (using Pivoting strategies) and Gauss-Seidel Iteration method. Rayleigh's power method for eigen-values and eigen-vectors.
   Interpolation: Finite differences, Newton's Forward and Stirling interpolating polynomials, Lagrange and Newton's divided difference interpolation formula with error analysis.
   Numerical Integration: Newton-Cotes quadrature formulae (with error) and Gauss - Legendre quadrature formulae.
   Differential Equations: Solution of initial value problems using Taylor Series, Euler's and Runge-Kutta (up to fourth order) methods.
   Statistical Methods (40% Weightage)
   Random Variables: Definition, Distribution Function, Discrete and Continuous Random Variables, Probability functions, Cummulative distributions functions, Mathematical expectation.
   Probability Distributions: Binomial, Poisson, Geometric, Uniform, Normal, Exponential and Log- Normal distribution.
   Sampling Distributions: Sampling distribution of Means and variance, Chi-Square distribution, t - distribution and F - distribution.

Hypothesis Testing: General concepts, Testing a Statistical Hypothesis, one and two tailed tests, Critical region, Confidence interval estimation. Single and two sample tests on proportion, mean and variance.

Linear Regression and Correlation: Linear Regression, Least Square principal and the Fitted models, Karl Pearson's Correlation Coefficient, Rank Correlation, Lines of Regression (two variables only).

Laboratory Work

Programming exercises on numerical and Statitical methods using C or C++ languages.

1. To detect the interval(s) which contain(s) root of equation f(x)=0 and implement bisection Method to find root of f(x)=0 in the detected interval.
2. To find the root of f(x)=0 using Newton-Raphson and fixed point iteration methods.
3. To evaluate the Newton's Forward Lagrange and divided difference interpolating polynomials of degree $\leq$ n, Based on (n+1) points.
4. To solve linear system of equations using Gauss elimination (without pivoting) method.
5. To solve linear system of equations using Gauss- seidel method.
6. To find the dominant eigen-value and associated eigen-vector by Rayleigh power method.
7. To integrate a function numerically using trapezoidal and Simpson's rule.
8. To solve the initial value problem using modified Euler's and Runge-kutta methods.
9. Generation of random numbers for Binomial and Poisson distributions using Linear Congruential Generator Algorithm.
10. Regression analysis using least square principle.
11. Correlation analysis for bivariate distribution.

5. **Specific goals for the course**

After the completion of the course, the students will be able to:

- Understand the various approaches dealing the data using theory of probability.
- Analyze the different samples of data at different level of significance using various hypothesis testing.
- Develop a framework for estimating and predicting the different sample of data for handling the uncertainties.
- Understand error, source of error and its affect on any numerical computation and also analyzing the efficiency of any numerical algorithm.
- Learn how to obtain numerical solution of nonlinear equations using Bisection, Newton – Raphson and fixed-point iteration methods.
- Solve system of linear equations numerically using direct and iterative methods.
- Understand the methods to construct interpolating polynomials with practical exposure.

6. **Brief list of topics to be covered**

- Floating-Point Numbers
- Non-Linear Equations
- Linear System and Eigen Values
- Interpolation
- Numerical Integration, Differential Equation
- Random Variables
- Probability Distributions
- Sample Distributions
- Hypothesis Testing
- Linear Regression and Correlation