NUMERICAL METHODS FOR ENGINEERS

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PRE-REQUISITES : 12th standard Math background

INTENDED AUDIENCE : First or second year undergraduate students in any branch of engineering (or science)

COURSE OUTLINE :

The development of fast, efficient and inexpensive computers has significantly increased the range of engineering problems that can be solved reliably. Numerical Methods use computers to solve problems by step-wise, repeated and iterative solution methods, which would otherwise be tedious or unsolvable by hand-calculations. This course is designed to give an overview of numerical methods of interest to scientists and engineers. However, the focus being on the techniques themselves, rather than specific applications, the contents should be relevant to varied fields such as engineering, management, economics, etc.

ABOUT INSTRUCTOR :

Prof. Niket Kaisare is a Professor of Chemical Engineering in IIT-Madras. He works in the area of modeling, design and control for energy applications. He has over ten years of research/teaching experience in academia, and three-year experience in Industrial R&D. He uses computational software, including MATLAB, FORTRAN, Aspen and FLUENT extensively in his research and teaching.

COURSE PLAN :

Week-1: Introduction & Approximations
Motivation and Applications
Accuracy and precision; Truncation and round-off errors; Binary Number System; Error propagation
Week-2: Linear Systems and Equations
Matrix representation; Cramer's rule; Gauss Elimination; Matrix Inversion; LU Decomposition;
Week-3: Linear Systems and Equations
Iterative Methods; Relaxation Methods; Eigen Values
Week-4: Algebraic Equations: Bracketing Methods
Introduction to Algebraic Equations
Bracketing methods: Bisection, Reguli-Falsi;
Week-5: Algebraic Equations: Open Methods
Secant; Fixed point iteration; Newton-Raphson; Multivariate Newton's method
Week-6: Numerical Differentiation
Numerical differentiation; error analysis; higher order formulae
Week-7: Integration and Integral Equations
Trapezoidal rules; Simpson's rules; Quadrature
Week-8: Regression
Linear regression; Least squares; Total Least Squares;
Week-9: Interpolation and Curve Fitting
Interpolation; Newton's Difference Formulae; Cubic Splines
Week-10: ODEs: Initial Value Problems
Introduction to ODE-IVP
Euler's methods; Runge-Kutta methods; Predictor-corrector methods;
Week-11: ODE-IVP (Part-2)
Extension to multi-variable systems; Adaptive step size; Stiff ODEs
Week-12: ODEs: Boundary Value Problems
Shooting method; Finite differences; Over/Under Relaxation (SOR)