Course No. : MTH308

Course title: Numerical Analysis & Scientific Computing - I

Pre-requisite(s): MTH102A

Credits: 3L-0T-1P-0A [10]

Semester: Even

Department/IDP: Mathematics & Statistics

Instructor(s): A Anand

Course contents:

1. Introduction to scientific computing [7]

    •   Approximations in scientific computing :- Relative and absolute errors, truncation and rounding Errors,
    •   Error propagation and amplification (forward and backward errors), conditioning, stability and accuracy.
    •   Computer arithmetic
    •   Mathematical softwares and libraries (including extended precision)
    •   Visualization
    •   Recall of programming elements

2. Systems of linear equations [9]

    •   Linear systems :- Existence and uniqueness
    •   Sensitivity and conditioning
    •   Solving linear systems:- Gaussian elimination
    •   Special linear systems
    •   Iterative methods :- Stationary iterative methods (Jacobi, Gauss-Seidel, SOR, conjugate gradient), multigrid methods

3. Nonlinear equations [6]

    •   Solutions :- Existence and uniqueness
    •   Sensitivity and conditioning
    •   Convergence rates
    •   Non-linear equations in one dimension (fixed point iterations, Newton's method, secant method, inverse interpolation)
    •   System of non-linear equations (fixed point iterations, Newton's method, secant method)

4. Eigenvalue problems [3]
    •   Existence and uniqueness
    •   Sensitivity and conditioning
    •   Computing eigenvalues and eigenvectors

5. Approximation and interpolation [9]
    •   Approximation :- Least squares and minimax approximation
    •   Interpolation :- Existence, uniqueness and conditioning
    •   Polynomial interpolation
    •   Lagrange, divided difference, finite difference
    •   Hermite and spline interpolation, inverse interpolation
    •   Piecewise polynomial interpolation

- Trigonometric interpolation and the Fast Fourier Transform (FFT)

6. Numerical differentiation and integration [6]
   - Integration :- Existence, uniqueness and conditioning
   - Numerical quadratures :- Newton-Cotes, Clenshaw-Curtis, Gaussian quadratures
   - Composite and adaptive quadratures
   - Improper integrals
   - Differentiation :- Review of finite difference approximations
   - Chebyshev differentiation and FFT
   - Richardson extrapolation
   - Integral Equations (optional)

Recommended books:
- Scientific Computing - An Introductory Survey, Michael Heath
- An Introduction to Numerical Analysis, Kendall E. Atkinson
- Elementary Numerical Analysis: An Algorithmic Approach, S. D. Conte & C. de Boor
- Introduction to Numerical Analysis, J. Stoer, R. Bulirsch

Estimated student enrolment: 100

Departments to which the proposed course will be of interest: MTH, ME, CE, AE

Other faculty members interested in teaching the proposed course: MTH faculty

Any other remarks:

Dated:_____ Proposer: A Anand

Dated:_____ DUGC Convener:_____

<div align="center">

The course is approved / not approved

Chairman, SUGC

Dated:_____

</div>