ME 542 Numerical Analysis (2-0-2-6)

Introduction to numerical analysis, Significant digits, Types of errors; Stability; Accuracy; Solutions of Linear Algebraic Equations: Direct elimination methods, Pitfalls of elimination methods, Norm and condition number; Iterative methods, Accuracy and convergence of iterative methods; Solution of Eigenvalue Problems; Solutions of Nonlinear Equations: Newton's method, System of nonlinear equations, Convergence and Error analysis; Interpolation: Lagrange polynomials, Divided difference polynomials, Hermite and cubic spline interpolation, Least square approximation; Numerical Differentiation – Unequally spaced data and Equally spaced data, Error estimation and extrapolation; Numerical quadrature – Newton-Cotes, Gauss quadrature, Multiple integrals; Initial and boundary value problems – Classification of ODEs, One step methods, Convergence and numerical stability analysis, Solution of higher order equations, Multistep methods, Convergence and stability analysis.

Laboratory component: The lab is intended to be a platform for students to get used to scientific computing. Strong emphasis is laid on computer programming and the student is expected to write his own programs/codes for prototypical mathematical problems which will have real--life applications in the area of computational mechanics.

Texts/References

1. M. T. Heath, Scientific Computing - An Introductory Survey, Revised Second Edition, SIAM, 2018
2. S. D. Conte and C. de Boor, Elementary Numerical Analysis, Third Edition, Tata McGraw-Hill Education, 2005.
3. F.B. Hildebrand, Introduction to Numerical Analysis, Second (Revised) Edition, Courier Dover Publications, 1987.
4. E. Kreyszig, Advanced Engineering Mathematics, Tenth Ed., John Wiley and Sons, 2010.
5. R. L. Burden and J. D. Faires, Numerical Analysis, 9th Edition (second Indian Reprint 2012), Brooks/Cole, 2011.
6. L.N. Trefethen, David Bau III, Numerical Linear Algebra, SIAM, 1997.
7. A.Quarteroni, R. Sacco, and F. Saleri. Numerical Mathematics, Springer-Verlag, New York, 2000.
8. G. M. Phillips and P. J. Taylor, Theory and Applications of Numerical Analysis, Second Edition, Academic Press, 1996.
9. J. D. Hoffman, Numerical Methods for Engineers and Scientists, Second Edition (Special Indian Edition), CRC Press, 2001.
10. K. E. Atkinson. An Introduction to Numerical Analysis, Second Edition, Wiley, 2004.
11. R. W. Hamming, Numerical Methods for Scientists and Engineers, Second Edition, Dover, 1986.