ADVANCED COMPUTATIONAL TECHNIQUES

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PRE-REQUISITES : Basic UG course in Mathematics/ Undergraduate Calculus

INTENDED AUDIENCE : UG or PG of any Engineering course, Mathematics,Physics and Postgraduate student of Mathematics/Mechanical/Aerospace/Chemical Engineering

COURSE OUTLINE :

There are several basic online courses on numerical methods available, however a course which can provide a foundation for the advanc`signed as an introductory course on advanced topics on numerical methods for engineering and science students. It is intended to teach the implementation of numerical methods rather than just provide theoretical foundations of the methods. Scientific computing is an integral part of several disciplines including computational mathematics. The completion of this course will equipped the students in handling advanced computational tools. All the methods will be illustrated by working out several examples. Pre-requisite for this course is the basic knowledge of undergraduate calculus and elementary numerical methods.

ABOUT INSTRUCTOR :

Prof. S. Bhattacharyya, FNASc is Chair Professor in the Dept. Mathematics, IIT Kharagpur. He is in HAG scale since 2010. His specialization is Applied Mathematics. He is teaching courses on Numerical Analysis, Partial Differential Equations, Numerical solutions of PDEs and other related courses on a regular basis for the B.Tech, MSc and PhD students at IIT Khargpur for the past 29 years. His research works involve numerical solutions of PDEs and he has published more than 160 research papers inreputed international journals. He has undertaken several sponsored research projects and guided 19 PhD students. Prof. Bhattcahrayya has organized and delivered lectures in several Conferences,AICTE sponsored short term courses and GIAN courses on the topics related to Applied Mathematics.He has received several fellowships for research collaboration in USA, UK and Germany

COURSE PLAN :

Week 1: Overview on Elementary Numerical Methods. Hermit Interpolations, Cubic Splines, Numerical quadrature,General Features of PDEs. Well posed problem. Finite Difference Methods for Parabolic PDEs: 1-D heat equation. Explicit and Implicit Methods, Truncation Error, Stability and Convergence, Von Neumann stability analysis, Lax equivalence theorem for convergence.

Week 2: Tri-diagonal system, Alternating Direction Implicit Scheme and applications; Non-linear PDEs, Iterative Methods:Newton linearization technique, Quasi-linearization technique. Non-linear advection-diffusion equations, Burgers equations.

Week 3: Finite Difference Methods for Elliptic PDEs, Poisson equations; Iterative Methods for linear system, Conjugate Gradient Methods, Multigrid Techniques; Higher-order compact difference schemes, Bolck-tridiagonal Systems,Applications.

Week 4: Linear hyperbolic equation, Finite difference method for one dimensional wave equation, Upwind scheme, Lax Method,Lax-Wendroff Scheme; MacCormack Scheme; Stability analysis. Numerical Schemes for One-Dimensional Conservation Laws; Godunov method; Flux splitting;Applications.