Numerical Solution of Ordinary and Partial Differential Equations - Web course

COURSE OUTLINE

A. Numerical Solution of Ordinary Differential Equations

1. Numerical solution of first order ordinary differential equations: Piccard's method Taylor series method, Euler and modified Euler method, Runge Kutta methods.
2. Multi-step methods: Predictor corrector methods
3. Systems of equations and higher order equations.
4. Linear Boundary value problems: Shooting methods, Finite Difference Methods
5. Convergence criteria, Errors and error propagation, Stiff equations.
6. Nonlinear Boundary Value Problems

B. Numerical Solution of Partial Differential Equations

1. Classification, Finite Difference representation
2. Parabolic PDE: Explicit and implicit schemes. Compatibility, Stability and Convergence
3. Elliptic PDE: Solution of Laplace/Poisson PDE ADI and SOR schemes,
4. Hyperbolic equations: Finite difference schemes, Method of characteristics

COURSE DETAIL

Particulars	Hours
Numerical solution of order Ordinary Differential Equations	
Initial value problems: definition, existence of solution, need for numerical solutions, Finite difference equation, truncation error	1

NP-TEL

NPTEL

http://nptel.ac.in

Mathematics

Pre-requisites:

A sufficient knowledge of Differential equations and Numerical methods

Additional Reading:

Fox, L. Numerical Solution of Ordinary & Partial Differential Equation, Pergamon Press

Coordinators:

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Piccard's method of successive approximation. Taylor series method, Euler and modified Euler method	4
Runge Kutta methods, Stability Analysis	2
Multi-step methods: Predictor corrector methods Milne's method, Adams-Moulton method, Adams Bashforth method	4
Systems of equations and higher order equations	2
Linear Boundary value problems: Shooting methods, Finite Difference Methods	4
Convergence criteria, Errors and error propagation, Stiff equations	2
Nonlinear Boundary Value Problems	1
Numerical solution of Partial Differential Equations	
Introduction to well posed PDE, Classification, various types of governing conditions, Finite Difference representation of derivatives	3
Parabolic PDE: Solution for one Dimensional equation, explicit and various implicit schemes	3
Discussion on compatibility, stability and convergence of above schemes, extension to 2d Heat Conduction equation	3
Elliptic PDE:, Solution of Laplace/ Poisson PDE in Cartesian and Polar system	2
ADI and SOR schemes	2
Methods for solving diagonal systems, Treatment of irregular boundaries	2
Hyperbolic equations – wave equation, Finite difference explicit and implicit schemes, stability	3

analysis	
Method of characteristics and their significance	2

References:

1. G.D. Smith, "Numerical Solution of Partial Differential Equations : Finite Difference Methods" (Oxford Applied Mathematics & Computing Science Series).
2. R K Jain , "Numerical Methods for Scientific and Engineering Computations": M K Jain, S R K Iyengar.
3. John Wiley, "Finite Difference methods for partial Differential equations": Forsythe G.E. & Wasow, WR.
4. Gerald, C.F. & Wheatley P.O. "Applied Numerical Analysis", Pearson Education Asia.