

NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR, JHARKHAND-831014

Department of Mathematics

Course Hand out for M. Sc, 3rd (Autumn) Semester, 2019 Batch, Session: 2020-21

Course No.: MA506- (LTP 3-1-0)

Credit: 4

Course Title.: Numerical Solution of Ordinary and Partial Differential Equations

Instructor-in-charge: Dr. Hari Shankar Prasad

Date: 25-06 -2020

Course Description

Unit: 1

Ordinary Differential Equations (ODEs): Numerical solutions of Initial value problem (IVP) - Difference equations, stability, error and convergence analysis. Single step methods - Taylor series method, Euler method, Picard's method of successive approximation, Runge Kutta Method. Multi step methods - Predictor-Corrector method, Euler PC method, Milne and Adams Moulton PC method. System of first order ODE, higher order IVPs. Numerical solutions of Boundary value problem (BVP) - Linear BVP, finite difference methods, shooting methods, stability, error and convergence analysis, non-linear BVP, higher order BVP.

Unit: 2

Partial Differential Equations (PDEs): Classification of PDEs, Finite difference approximations to partial derivatives, convergence and stability analysis. Explicit and Implicit schemes - Crank-Nicolson scheme, tri-diagonal system, Laplace equation using standard five-point formula and diagonal five point formula. ADI scheme, hyperbolic equation, explicit scheme, method of characteristics. Solution of one dimensional heat conduction equation by Schmidt and Crank Nicolson methods. Solution of wave equation.

Scope

- # To provide good fundamental concepts of numerical methods to solve scientific problems.
- # To make proficient in computer oriented numerical techniques.

Objective

- At the end of this course, the students will be able to understand the importance and effectiveness of computer oriented numerical methods.
- At the end of this course, the students will be able to apply the Numerical Techniques, effectively, in solving various kind of scientific problems.

Text Books

T1: Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Numerical Methods for Scientific and Engineering Computation", 4th Edition, New Age International (P) limited, Publishers, New Delhi, 2003.

T2: G D Smith, Numerical solution of partial differential equations: Finite difference methods, Oxford University press, 3rd Ed. 1985.

Reference Books

R1: Jain, M.K., "Numerical Solution of Differential Equations", 4th Edition, New Age International (P) limited, Publishers, New Delhi, 2018.

R2: G. Evans, J. Blackledge, P. Yardley, Numerical Methods for Partial Differential Equations, 2nd edition, Springer, 2001.

R3: Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall, 1st Impression, 2007.

Course Plan

<i>Lecture No.</i>	<i>Learning objectives</i>	<i>Topics to be covered</i>	<i>Refer to Chap., See(Book) to be checked</i>
2-4	Numerical solutions of IVP	Numerical solutions of <i>Initial value problem (IVP)</i> , Difference equations, stability, error and convergence analysis.	6(T1), 1(R1)
8-18	Single and Multi-step methods for IVP	Single step methods - Taylor series method, Euler method, Picard's method of successive approximation, Runge Kutta Method. Predictor-Corrector (PC) method, Euler PC method, Milne and Adams Moulton PC method. System of first order ODE, higher order IVPs.	6(T1), 2-3(R1), 7(R3)
19-29	Numerical solutions of BVP	Linear <i>boundary value problem(BVP)</i> , finite difference methods, shooting methods, stability, error and convergence analysis, Non-Linear BVP, higher order BVP.	7(T1), 4(R1), 4(R2), 8(R3)
30-44	Partial Differential Equations (PDEs)	Classification of PDEs, Finite difference approximations to partial derivatives, convergence and stability analysis. Explicit and Implicit schemes Tri-Diagonal system. Parabolic PDEs: Solution of one-dimensional heat conduction equation by Schmidt and Crank Nicolson methods. Elliptic PDEs: Laplace equation using standard five-point formula and diagonal five-point formula, ADI scheme. Hyperbolic PDEs: explicit scheme, method of characteristics. Solution of wave equation.	1-5(T2), 5, 6 & 7(R1), 9, 10 & 11(R3)

Evaluation Scheme

Sl. No.	Evaluation Component	Duration	Max. Marks	Date & Time	Nature of the Component
1	Mid Term	2 Hrs	30		Closed Book
3	End Term	3 Hrs	50		Closed Book
4	Assignment		5		Take Home
5	Attendance and Punctuality in class		5		
5	Class Test/Reports/Project/Seminar		10		Closed Book

Instructor In-charge (MA506)