MA7366 Numerical Solution for Partial Differential Equations

Pre-requisites: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1: [11 (L) Hours]

Classification of PDEs, finite difference approximations to derivates, truncation errors, boundary conditions: Dirichlet, Neumann and Robin type boundary conditions. Review of iterative methods to linear system of equations: Jacobi, Gauss-seidel, SOR. Matrix form of iterative methods and their convergence. Initial value problems, Initial boundary value problems and their analysis of convergence, consistency and stability. Lax theorem, Von Neumann criterion for stability.

Module 2: [11 (L) Hours]

Parabolic equations: explicit and implicit methods for one- and two-dimensional parabolic equations, Crank-Nicolson method, numerical examples, weighted average approximation, consistency, convergence and stability, alternate direction method in two dimensions, Peaceman-Rachford scheme, Douglas-Rachford scheme.

Module 3: [10 (L) Hours]

Hyperbolic equations: Finite difference methods for first and second order wave equation, Laxwendroff explicit method, CFL condition for one and two dimensions, ADI schemes for two dimensional hyperbolic equations, Lax-wendroff method for a system of hyperbolic equations, Wendroff's implicit approximation, reduction of a first order equation to a system of ordinary differential equations, numerical examples.

Module 4: [10 (L) Hours]

Elliptic equations: Numerical examples: a torsion problem, a heat conduction problem with derivative boundary conditions. Finite differences in polar co-ordinates, techniques near a curved boundary, improvement of the accuracy of the solutions. Analysis of the discretization error of the five-point approximation to Poisson's equation.

References

1. *K. W. Morton & D. F. Mayers, **Numerical solution of partial differential equations**, Cambridge, 2nd Edn., 2011.*
2. *G. D. Smith**, Numerical solution of partial differential equations, finite difference methods**, Oxford, 3nd Edn., 2010.*
3. *Randall J. Leveque**, Finite difference methods for ordinary and partial differential equations**, SIAM, 2007.*
4. *J. W. Thomas, **Numerical partial differential equations: Finite difference methods**, Springer, 2010.*

Course Outcome: *Students learn numerical solution of partial differential equations with an understanding of convergence, stability and consistency*