Department of Mathematics
Faculty of Mathematics & Computer Science
PhD, Mathematics

Course Code	AM 605
Course Title	High Resolution Computational Methods for Partial Differential Equations
Course Credits	04

Course objectives:

To equip the students with the high resolution advanced numerical methods, to solve linear/nonlinear elliptic, parabolic and hyperbolic PDES with significant first derivative terms and related benchmark problems.

Minimum Pre-requisites:

Numerics of ordinary and partial differential equations, Computer programming.

Course Structure:

Unit-I: High resolution numerical method for multi-dimensional elliptic PDEs with nonlinear first derivative terms; iterative methods (Jacobi, Gauss-Seidel and SOR) for singularly perturbed elliptic BVPs; Convergence analysis for higher order schemes; High resolution methods for non-linear bi- and tri-harmonic elliptic PDEs.

Unit-II: High resolution two-level implicit finite difference approximations for diffusion-convection equation; Stability analysis (Matrix method and Von-Neumann method); Error analysis; Operator splitting and ADI methods for two- and three-dimensional diffusion-convection equations; Cubic Spline approximation for nonlinear parabolic equations and application to diffusion-convection equation.

Unit-III: High resolution three-level implicit methods for second order hyperbolic equations with significant first derivative terms; Von-Neumann stability analysis and CFL condition; Application to Telegraphic and damped wave equations and their stability analysis; Operator splitting and ADI methods for two- and three-dimensional

Telegraphic equation; Cubic Spline approximation for nonlinear hyperbolic equations and application to various physical models.

Reading suggestions:

- **J.W.Thomas**, Numerical Partial Differential Equations: Finite Difference Methods, Springer and Verlag, Berlin, 1998.
- **J.W.Thomas**, Numerical Partial Differential Equations: Conservation Laws and Elliptic Equations, Springer and Verlag, Berlin, 1999.
- I. Priyadarshini and R.K. Mohanty, High Resolution Compact Numerical Method for the System of 2D Quasilinear Elliptic Boundary Value Problems and the Solution of Normal Derivatives on an Irrationali Domain with Engineering Applications, *Engineering with Computers*, 38(2022) S539-S560.
- R.K. Mohanty and S. Sharma, A New High Accuracy Method Based on Off-step Cubic Polynomial Approximations for the Solution of Coupled Burgers' Equations and Burgers-Huxley Equation, *Engineering with Computers*, 37 (2021) 3049-3066.
- R.K. Mohanty and G. Khurana, A New High Accuracy Cubic Spline Method Based on Half-step Discretization for the System of 1D Non-linear Wave Equations, *Engineering Computations,* 36 (2019 930-957.
- R.K. Mohanty, New High Accuracy Super Stable Alternating Direction Implicit Methods for Two and Three Dimensional Hyperbolic Damped Wave Equations, *Results in Physics,* 04 (2014) 156-163.
- R.K. Mohanty and R. Kumar, A New Fast Algorithm Based on Half-step Discretization for One Space Dimensional Quasilinear Hyperbolic Equations, *Applied Mathematics and Computations*, 244 (2014) 624-641.
- R.K. Mohanty and N. Setia, A New High Accuracy Two-level Implicit Off-Step Discretization for the System of Two Space Dimensional Quasi-linear Parabolic Partial Differential Equations, *Applied Mathematics and Computations,* 219 (2012) 2680- 2697.

Evaluation and weightage:

- 30% for Computer practicals
- 30% for Mid-Term examination
- 40% for End-Term examination