Department of Mathematics
Faculty of Mathematics & Computer Science
M.Sc. (Applied Mathematics), 3rd Semester

Course Code	AM 302
Course Title	Numerics of Partial Differential Equations
Course Credits	04

Course objectives:

To equip the students with the numerical techniques, that is, finite difference and finite element methods to solve linear/nonlinear elliptic, parabolic and hyperbolic partial differential equations and related physical problems.

Minimum Pre-requisites:

Theory of partial differential equations. Numerics of ordinary differential equations. Computer programming.

Course structure:

Finite difference methods for 2D and 3D elliptic boundary value problems (BVPs) of second and fourth order approximations; Solution of large system of algebraic equations corresponding to discrete problems and iterative methods (Jacobi, Gauss-Seidel and SOR); Alternating direction methods.

Different 2- and 3-level explicit and implicit finite difference approximations to heat conduction equation; Stability analysis (Energy method, Matrix method and Von-Neumann method); Compatibility, consistency and convergence of the difference methods; Difference scheme based on derivative boundary conditions and its stability condition; ADI methods for 2- & 3-D parabolic equations.

Methods of characteristics for evolution problem of hyperbolic type; Von-Neumann method for stability analysis; Operator splitting methods for 2D and 3D wave equations; Explicit and implicit difference schemes for first order hyperbolic equations and their

stability analysis; System of equations for first order hyperbolic equations; Conservative form.

Finite element methods for second order elliptic BVPs; Finite element equations; Variational problems; Triangular and rectangular finite elements; Standard examples of finite elements; Mixed finite element methods.

Reading suggestions:

- **J.C. Strickwerda**, Finite Difference Schemes & Partial Differential Equations, SIAM publications, 2004.
- **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.
- **C. Johnson**, Numerical Solution of Partial Differential Equations by Finite Element Methods, Dover publications, 2009.
- **A. J. Davies**, The Finite Element Method: An Introduction with Partial Differential Equations, Oxford University Press, 2011.

Evaluation and weightage:

- 20% for Computer practicals
- 10% for Quiz
- 30% for Mid-Term examination
- 40% for End-Term examination