Approval: 4th Senate Meeting

Course Name: Numerics of Partial Differential Equations
Course Number: MA- 609
Credits: 3-0-0-3 (L-T-P-C)
Prerequisites: MA 607 (Numerical Analysis); Knowledge in Differential Equatio **n**

Intended for: M.S./Ph.D, B.Tech. 3rd and 4th year students
Distribution: Elective
Semester: Even/Odd

Preamble: Partial Differential Equations frequently arise in the field of science and engineering. The primary goal of this course is to develop the basic understanding of the construction of numerical algorithms in two fundamental numerical approaches namely Finite Difference and Finite Element, and perhaps more importantly the applicability and limits of their appropriate uses. This course will be the second course (after MA 607) in numerical analysis and it requires the knowledge of MA 607.

Course Outline: This course will emphasize on the development of Finite Difference and Finite Element numerical approaches to provide numerical solutions of Partial Differential Equations. The main objective of the course is to provide basic concepts of these two fundamental numerical approaches, their advantages and drawbacks in solving a PDE along with convergence and stability analysis.

Modules:

Unit 1: Introduction to Finite difference schemes -Finite difference schemes for partial differential equations, explicitschemes, implicit schemes, single step schemes, multi-step schemes. **[5]**

Unit 2: Finite difference schemes for boundary value problems –FTCS, backward Euler and Crank-Nicolson schemes, ADI methods, Lax Wendroff method, upwind scheme. **[10]**

Unit 3: Consistency, stability and convergence Analysis -Stability analysis by von Neumann method, CFL condition, Lax's equivalence theorem. **[10]**

Unit 4: Introduction to Finite element method - Finite element method for partial differential equations, variational methods, method of weighted residuals. **[7]**

Unit 5: Finite element discretization and error analysis -Finite element discretizations for one-dimensional and two-dimensional elliptic equations, a priori and a posteriori error estimates. **[10]**

Textbooks and Reference Book

Textbooks:

1. G. D. Smith, Numerical Solutions to Partial Differential Equations, Oxford University Press, 3rd Edn., 1986.
2. C. Johnson, Numerical Solution of Partial Differential Equations by the Finite Element Method, Dover Publications, 2009.

References:

1. **J**. C. Strikwerda, Finite Difference Schemes and Partial Differential Equations, SIAM, 2004.

2. E. Suli, Finite Element Methods for Partial Differential Equations, University of Oxford, 2000.
3. P. Niyogi, S. K. Chakrabartty, M. K. Laha, Introduction to Computational Fluid Dynamics, Pearson Publications, 2011.
4. J. N. Reddy, An Introduction to Finite Element Method, 3rd Edn., McGraw Hill, 2005.