Department of Mathematics
Faculty of Mathematics & Computer Science
M.Sc. (Applied Mathematics), 4th Semester

Course Code	AM 403 (b)
Course Title	Finite Element Analysis
Course Credits	04

Course objectives:

To give exposure of the fundamental concepts, theoretical basis and application of finite element methods and application of FEM to solve differential equations. To provide students with the technical tools enabling them to solve differential equations, which arises in the modeling of real life phenomena.

Minimum pre-requisites:

Theory of differential equations and Functional Analysis

Course structure:

Introduction: Spaces of continuous functions, Spaces of integrable functions, Elements of Sobolev Spaces, Poincare inequality, Lax-Milgram Theorem.

FEM for Elliptic Problems : Abstract variational formulation of elliptic boundary value problem, Piecewise linear basis functions(1D & 2D), Calculation and assembly of stiffness matrix, The self-adjoint elliptic problem, , Galerkin formulation and Cea's Lemma, Optimal error bound in the energy norm, Aubin-Nitsche duality argument.

Piecewise polynomial approximation : The finite element, Examples of triangular finite elements, Polynomial approximation in Sobolev spaces(Bramble-Hilbert lemma), Optimal error bounds in the H^1 norm.

A posteriori error analysis by duality: reliability, efficiency and adaptivity.

FEM for Parabolic Problems: Finite element approximation of initial boundary value problems. Energy dissipation, conservation and stability. Analysis of finite element methods for parabolic problems.

Reading suggestions:

- S. C. Brenner and R. L. Scott, The Mathematical Theory of Finite Element Methods, 2nd Edition, Springer-Verlag, New York, 2002.
- K. Eriksson, D. Estep, P. Hansbo, & C. Johnson, Computational

Differential Equations.
CUP, 1996.

- C. Johnson, Numerical Solution of Partial Differential Equations by the Finite Element
  Method. CUP, 1990

- Endre Suli, Lecture Notes on Finite Element Methods for Partial Differential Equations, Mathematical Institute, University of Oxford.

- P.G. Ciarlet, The Finite Element Methods for Elliptic Problems, North Holland, Amsterdam, 1978.

- C. Mercier, Lectures on Topics in Finite Element Solution of Elliptic Problems, TIFR Lectures on Mathematics and Physics Vol. 63, Narosa Publ. House, New Delhi, 1979.

- Z. Chen, Finite Element Methods And Their Applications, Springer-Verlag, New York, 2005.

- M. Ainsworth and J. T. Oden, A Posteriori Error Estimation in Finite Element Analysis, John Wiley and Sons, 2000.

- V. Thomee, Galerkin Finite Element Methods for Parabolic Problems, 2nd Edition, Springer-Verlag, Berlin, 2006.

Evaluation and weightage:

- Theory examination: 20+30 marks
- Quiz/Presentation/Assignment: 20 marks
- Practical: 25 marks +05 marks (attendance)