

Department of Mathematics

Faculty of Science

MATH 751 (206751) ADVANCED NUMERICAL ANALYSIS

3(3-0-6)

Prerequisite Consent of the instructor

Course Descriptions :

Review of the solution of ordinary differential equations and sets of linear systems. Difference equations. Boundary value problems. Numerical analysis of elliptic, parabolic, and hyperbolic partial differential equations. Analysis of stability and error estimates. Numerical double interpolation and multi-integration; numerical treatment of integral equations (Variation techniques)

Course Contents

No. of Lecture Hours

1. Review of the solution of ordinary differential equations and sets of linear equations	5
- Existence and uniqueness	
- Analytic methods	
- Euler method and methods based on numerical quadrature	
- Predictor - corrector methods	
- Runge - Kutta methods	
- High order equations and systems of first order equations	
2. Difference equations	4
- Linear difference equation with constant coefficients	
- Solution of linear difference equations	
- Similarity between solutions of differential equation and difference equation	
- Exact difference equations	
- Exact difference method and solvability of the difference equations	
3. Analysis of stability and error estimate	5
- Mathematical and computational aspects of an algorithm	
- Types of errors	
- Estimation of round - off and truncation errors	
- Numerical instability of an algorithm	
- Ill - conditioned problem	

4. Boundary value problems	5
- Introduction	
- The shooting method	
- The method of superposition	
- Finite difference method and accuracy of finite difference solution	
- Defined - higher order methods	
5. Partial differential equations	12
- Classification of elliptic, parabolic and hyperbolic partial differential equations	
- Finite difference methods and solvability of the difference equation	
- Accuracy of the difference equation solution	
- Higher - order methods	
- Variable mesh size	
- Richardson's method and the Dufort - Frankel method	
- The Crank - Nicolson method	
- Problems with two space variables	
6. Numerical double interpolation and multi-integration	8
- Interpolation in two variables	
- Triangular interpolation	
- Bilinear interpolation	
- Elementary multiple integration over standard regions	
- Change of order of integration and change of variables	
- Decomposition into standard regions	
- Cartesian products and product rules	
- Multiple integration by sampling	
7. Integral equation	6
- Integral equation formulation	
- Picard method of successive approximation	
- Solution by variational techniques	