METU NCC

AEROSPACE ENGINEERING DEPARTMENT

ASE301 NUMERICAL METHODS FOR AEROSPACE ENGINEERING

Catalog Data : ASE 301 Numerical Methods for Aerospace Engineering. (3-0) 3.

Numerical solution of Ordinary Differential Equations (ODE), initial value problems, Runge-Kutta methods, adaptive stepping, systems of ODEs, higher order ODEs, boundary value problems. Numerical solution of partial Differential Equations (PDE): Finite Volume method, numerical solution using triangular grids, Finite Difference method, model equations, finite difference approximations, convergence and stability analysis of finite difference equations, numerical solutions of parabolic PDEs, elliptic PDEs, hyperbolic PDEs.

Prerequisite : MECH 310 Numerical Methods.

References :

- Numerical Methods for Engineers, by Chapra & Canale, 1998 (for ODEs)
- Numerical Methods and Analysis, by Buchanan & Turner (for ODEs)
- Numerical Analysis, by Burden and Faires (General)
- Numerical Methods for PDEs: Finite Difference and Finite Volume Methods, by Mazumder
- Numerical Partial Differential Equations: Finite Difference Methods, by Thomas
- Numerical Solution of Partial Differential Equations: Finite Difference Methods, by Smith
- Finite Difference Schemes and Partial Differential Equations, by Strikwerda
- Solving Hyperbolic Equations with Finite Volume Methods by Vázquez-Cendón
- An Introduction to Computational Fluid Dynamics: The Finite Volume Method by Versteeg & Malalasekera
- Computational Fluid Dynamics for Engineers 1, by Hoffmann & Chiang
- Computational Fluid Mechanics and Heat Transfer by Anderson, Tannehill & Pletcher
- Numerical Computation of Internal and External Flows 1: Fundamentals of Numerical Discretization, by Hirsch
- Computational Techniques for Fluid Dynamics 1: Fundamental and General Techniques, by Fletcher
- Computational Methods for Fluid Flow by Peyret & Taylor

Topics :

1. INTRODUCTION (4 hrs): Preliminary remarks, Computer arithmetic, Taylor series expansion, Error definitions

2. NUMERICAL SOLUTION OF ODEs (9 hrs): Initial value problems, Euler's method, Multi-step methods, Runga-Kutta methods, Stability analysis, Systems of ODEs, Higher order ODEs, Boundary-value problems

3. NUMERICAL SOLUTION OF INTEGRAL EQUATIONS (9 hrs): Integral conservation laws, Unstructured grids, Boundary conditions, Finite Volume Method, Evaluation of fluxes, Solution of 2-D Diffusion Eqn.

4. NUMERICAL SOLUTION OF PDEs (9 hrs): Classification of PDEs, Model equations, Finite Difference approximations, Finite Difference Method, Consistency, stability, convergence, Discrete perturbation stability analysis, Von Neumann stability analysis

5. NUMERICAL SOLUTION OF PARABOLIC PDEs (5 hrs): Explicit methods, Implicit methods, Crank-Nicolson method, Alternating Direction Implicit (ADI) method

6. NUMERICAL SOLUTION OF ELLIPTIC PDEs (4 hrs): Jacobi iteration method, Gauss-Seidel iteration method (SOR), Successive Line Over-Relaxation Method (SLOR)

7. NUMERICAL SOLUTION OF HYPERBOLIC PDEs (3 hrs): Upwind differencing, artificial viscosity, Lax-Wendroff method, Crank-Nicolson method, Dissipation and dispersion errors, Solution of non-linear wave equation

Grading : Classwork : 25%, Midterm Exam : 30%, Final Exam : 45%.