Syllabus

AE305 - NUMERICAL METHODS IN AEROSPACE ENGINEERING

Instructors : İsmail H. TUNCER
Office: AE-212
E-mail: ismail.h.tuncer@ae.metu.edu.tr

Yusuf ÖZYÖRÜK
Office: AE-106
E-mail: yusuf.ozyoruk@ae.metu.edu.tr

DESCRIPTION

Departmental IT resources and usage policies, computer arithmetic, Numerical solution of Ordinary Differential Equations (ODEs): Initial value problem; Euler's method; Runge-Kutta methods; stability analysis; solution of systems of ODEs; solution of higher order ODEs; boundary value problems. Numerical solution of integral equations, Finite Volume Method on unstructured grids; Numerical solution of Partial Differential Equations (PDEs): Finite Difference Method; classification of PDEs, model equations; consistency, convergence and stability analysis; solution of parabolic PDEs, elliptic PDEs and hyperbolic PDEs.

REQUIREMENTS

- ES361
- Experience in Fortran programming and graphical data analysis.
- It is recommended that you refresh your knowledge on linear algebra, vector analysis, differentiation and integration rules, and differential equations.

TEXTBOOK

- Class notes will mainly be used.

REFERENCE BOOKS

- *Numerical Methods for Engineers*, by S.C. Chapra and R.P. Canale, 1998 (for ODEs)
- *Numerical Methods and Analysis*, by J.L. Buchanan and P.R. Turner (for ODEs)
- *Computational Fluid Dynamics for Engineers*, Volume 1, by Klauss A. Hoffmann and Steve T. Chiang
- *Computational Fluid Mechanics and Heat Transfer* by Dale A. Anderson, John C. Tannehill and Richard H. Pletcher
- *Numerical Computation of Internal and External Flows*, Volume 1: Fundamentals of Numerical Discretization, by Charles Hirsch
- *Computational Techniques for Fluid Dynamics*, Volume 1: Fundamental and General Techniques, by Clive A.J. Fletcher
- *Computational Methods for Fluid Flow* by Roger Peyret and Thomas D. Taylor

GRADING POLICY

- Classwork : 10%
  Homework Assignments : 20%
  Midterm Exam : 30%
  Final Exam : 40%.
- The letter grade is based on the transformed standart scores, which are based on the mean and the standart deviation of all the grade distributions.

TENTATIVE OUTLINE

		Class hours
1.	INTRODUCTION Preliminary remarks AE IT resources and usage policies Computer arithmetic **Taylor series expansion** Error definitions	4 hrs
2.	NUMERICAL SOLUTION OF ODE's Initial value problems Euler's method Multi-step methods **Runga-Kutta methods** Stability analysis Systems of ODEs Higher order ODEs Boundary-value problems	9 hrs
3.	NUMERICAL SOLUTION OF INTEGRAL EQUATIONS Integral conservation laws Unstructured grids Boundary conditions **Finite Volume Method** Evaluation of fluxes Solution of 2-D Diffusion Equation	9 hrs
4.	NUMERICAL SOLUTION OF PDEs Classification of Partial Differential Equations Model equations Finite Difference approximations **Finite Difference Method** Consistency, stability, convergence Discrete perturbation stability analysis Von Neumann stability analysis	9 hrs
5.	NUMERICAL SOLUTION OF PARABOLIC PDEs Explicit methods Implicit methods Crank-Nicolson method Alternating Direction Implicit (ADI) method	5 hrs
6.	NUMERICAL SOLUTION OF ELLIPTIC PDEs Jacobi iteration method Gauss-Seidel iteration method (SOR) Successive Line Over-Relaxation Method (SLOR)	4 hrs
7.	NUMERICAL SOLUTION OF HYPERBOLIC PDEs Upwind differencing, artificial viscosity Lax-Wendroff method Crank-Nicolson method Dissipation and dispersion errors Solution of non-linear wave equation	3 hrs