

MAE 290B
Numerical Methods for Differential Equations
Winter 2018. Material covered for Midterm

Readings

- Notes taken during my lectures
- P. Moin book. Chapter 2: section 2.1 to 2.5. Chapter 4: sections 4.1 - 4.11.
- Posted solutions of HW 1 and HW 2

Topics

- Derivation of finite difference approximation (FDA) of spatial and temporal derivatives using Taylor series. Obtaining truncation error and order of accuracy of a given FDA. Obtaining the modified wave number. Knowledge of first and second-order accurate formulae for f' and f'' .
- Numerical solution of ODE corresponding to initial value problem (IVP),

$$\frac{dy}{dt} = f(y, t) \quad y(t = 0) = y_0 .$$

Different methods. Explicit vs. implicit. Forward Euler, backward Euler, Crank-Nicolson, Runge-Kutta

Accuracy. Local error and global error. Stability restriction on time step for linear equation $dy/dt = \lambda y$ obtained using the amplification factor. Stability diagram in complex plane.

Conversion of higher-order ODEs to a system of first-order ODEs.

System of ODEs. Eigenvalues of the system and stability analysis.

Nonlinear ODE. Nonlinear system of ODEs.

Adaptive time step for accuracy.

Stiff ODE. Stiff system of ODEs.

- Numerical solution of boundary value problem (BVP).
Shooting (iterative) method.
Equilibrium (direct) method. Incorporation of boundary conditions. Tridiagonal system and Thomas algorithm.