Nov 15th, 2026

HOMEWORK-5

(Submit it at the start of the next lecture, 23 Nov 2026)

Consider Navier-Stokes equations (NSE) that includes both parabolic, hyperbolic and elliptic equations. The NSE contain three equation types that have their own characteristic behavior. Depending on the governing parameters, one behavior can be dominant. The different equation types require different solution techniques. For inviscid compressible flows, only the hyperbolic part survives.

Parabolic part

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0$$

Elliptic equation

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=-\frac{1}{\rho}\frac{\partial P}{\partial x}+\frac{\mu}{\rho}\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)$$

Hyperbolic part

a) Solve 1D NSE (with no pressure gradient) for viscous, incompressible flow utilizing FTCS, Upwind, L-W, C-N and show their stability conditions and compare them.

b) What is Cell Reynolds Number (Re_{cell}) ? Solve part a for FTCS and Upwind. Show the solution in terms of Re_{cell}.