Midterm #2 Coverage Summary -

Coverage: Chapt. 10 (Navier-Stokes Eqns.)
Chapt. 11 (Exact Solutions)

N-S eqn: (no need to study 10.1)

- understand concept of stress tensor & index notation (τ_{ij})
- velocity gradient tensor $\frac{\partial u_i}{\partial x_j}$ can be written as sum of two parts $\frac{\partial u_i}{\partial x_j} = e_{ij} + \frac{1}{2}\zeta_k$

$$e_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right) \text{ strain rate Tensor}$$

$$\zeta_k = \left(\frac{\partial u_i}{\partial x_j} - \frac{\partial u_j}{\partial x_i}\right) \text{ vorticity}$$

- stress - strain rate model

$\frac{\partial \tau_{ji}}{\partial x_j}$ is the net viscous force/volume.

model : $\tau_{ji} = 2\mu e_{ji}$ stress tensor is proportional to strain rate tensor

if τ_{ji} (as used in the text) is to include all of the forces (Press.; viscous; & volume compression)

$$\tau_{ji} = \underbrace{-\frac{2}{3}\mu\theta\delta_{ji}}_{\text{vol. comp.}} - \underbrace{P\delta_{ij}}_{\text{press}} + \underbrace{2\mu e_{ji}}_{\text{viscous}}$$

Resulting N-S eqn.

- Know the physics of each term
- how to simplify is incompressible, μ=constant.

N-S expressed using vorticity : changes to convective accel. and viscous terms.

Exact Soln: (simplified form)

- what are nonlinear terms
- how to Apply boundary & initial conditions
- see example flows to see how integrated to get velocity.
- Stokes 1st problem
  - interpretation of similarity soln.
  - evaluation of wall stress.
  - evaluation of viscous layer, $\delta(t)$
  - evaluation of vorticity, circulation.