Course: ENME 641

Title: Viscous Flow
Location/Time: ENGR 1108 – Monday, Wednesday, 5:00-6:15 pm
Online access: elms.umd.edu

Instructor:

Prof. Amir Riaz
3127 Martin Hall, 305-405-0707
Office Hours: Thursday, 2 - 4pm

Summary:

The course focuses on the study of fluid flow problems for which viscous effects play a major role. Examples of steady and unsteady flows and exact solutions to the Navier-Stokes equations will be discussed. Confined flows, porous media flows, lubrication and thin-film approximations will be discussed. Boundary layer theory will be presented along with the stability analysis of laminar flow and its transition to turbulence.

Topics:

- Exact solutions of Navier-Stokes Equations
- Asymptotic approximations
- Confined flows
- Boundary layers
- Flow stability

Suggested Reference Books:

Incompressible Flow, *R. L. Panton*
Viscous Fluid Flow, *F. M. White*

Exams:

Midterm – In class
Final – Project

Grading:

Homework:	50%
Midterm:	25%
Final:	25%

Course outline:

- Preliminaries
  - Conservation of Mass, momentum and energy
  - Specification of viscous stress tensor
  - Viscosity; measurement and calculation
  - Constitutive laws for viscosity
  - Vorticity generation and transport
- Solutions of Navier-Stokes Equations
  - Similarity solutions
  - Buoyancy dominated flow
  - Compressible flow
  - Stokes flow
  - Lubrication approximation
  - Hele-Shaw cell
  - Porous media flow
  - Thin-film approximation
  - Asymptotic approximations
- Stability of viscous flow
  - Perturbation techniques
  - Normal mode analysis
  - Orr-Sommerfeld equations
  - Stability of parallel viscous flows
  - Natural convection
  - Transition to turbulence
  - Nonlinear stability
- Laminar boundary layers
  - Similarity and exact solutions
  - Approximate solutions
  - Separated flows
  - Stability of boundary layers
  - Transition to turbulence