# Fundamentals of Fluid Mechanics B Syllabus

### Course Objectives, Policies, and Grading

### Weekly Schedule

1. Overview of course syllabus. Review of mass conservation in differential form. Newton's law for a system with varying mass.
2. Viscous fluxes in momentum equation. Mean free path in a gas. Derivation of viscosity. Viscous form of the momentum equation.
3. Analogy of viscous fluxes with shear stresses in solid mechanics. Fluid kinematics and strain rates: volume distortion, angular distortion. Navier's linear stress-strain relationship.
4. Stokes' hypothesis. Mechanical pressure. Navier-Stokes equations. Navier-Stokes equations for constant density flows. Poiseuille flow.
5. Couette flow in a journal bearing. Torque and power needed to rotate a bearing. Viscous momentum equation in cylindrical and axisymmetric coordinates.
6. Rotary viscous coupling problem. Double film on wall problem.

7. Fully-developed flow in pipes. Darcy and Fanno friction factor. Derivation and applicability of the hydraulic diameter. Stokes flow.
8. Stokes flow in duct with varying area cross section. Reynolds equations for lubrication theory.
9. Stokes flow around a sphere. Oseen's approximation. Rayleigh's problem over an unsteady flat plate: self-similar solutions.
10. Rayleigh problem wall shear stress. Analogy with the boundary layer. Velocity in boundary layer using polynomial fit through boundary conditions.
11. Shear stress in boundary layer. Boundary layer thickness. Blasius solution. Displacement thickness. Self similar solution to a jet in an infinite domain.
12. Viscous momentum equation in integral form. Drag force on cylinder through measurement of wake velocity. Self similar solution to the far wake.
13. The vortex force. Helmholtz theorem, D'Alembert paradox. How to create vorticity using viscosity. Kelvin's circulation theorem.
14. Vorticity flux at the wall in a boundary layer. Vorticity equation. Vortex line. Vortex stretching.