2.25

6 Viscous Flows

6.1 The equation of motion for viscous flows. Surface stress; stress tensor; symmetry of the stress tensor; the equation of motion in terms of the stress tensor; the stress tensor for Newtonian fluids; the Navier-Stokes equations; summary of the governing equations and boundary conditions for incompressible flows and constant-density flows; boundary conditions for viscous flows.

6.2 Comments on the character of the Navier-Stokes equations at low and high Reynolds numbers; laminar flows and their stability; turbulence.

6.3 Some truly inertia-free flows: Steady, laminar fully developed pipe flows; laminar Couette flows with and without pressure gradient.

6.4 (Almost) inertia-free flows. Criteria for quasi-steady, locally-fully-developed (quasi-parallel) laminar flow. Examples: Flows in various converging and diverging channels, free-surface flows, and lubrication theory.

6.5 Rayleigh's problem of the transient motion induced by a flat plate that moves in its own plane: an archetypal example of laminar viscous flow with significant inertial effects. The viscous diffusion time and its implications in various types of flows, including boundary layers in steady laminar flow.

Read:

Special 2.25 Notes by Sonin	(i)	"Equation of Motion for Viscous Fluids."
	(ii)	"Criteria for inertia-free and locally fully-developed flows."

Fay: Chapter 6.

Problems**:** (Shapiro & Sonin): 6.3, 6.6, 6.10, 6.13, 6.20, 6.16, 6.22, 8.3.