Homework 1: AE550, Viscous Fluid Flow

Problem 1.

Prandtl illustrated boundary layer behavior with an example from mechanics; A free vibration of a system consisting of a mass, a spring and a viscous damper is essentially described by

$$a\frac{d^2u}{dy^2} + \frac{du}{dy} + u = 0 \tag{1}$$

a is much smaller than one. This equation mimics the convection-diffusion character of the Navier-Stokes equations. Solve this equation with the following boundary condition $u(0)=2$ and u at $y = \infty$ remains bounded. Plot the $u(y)$ profile for $0 < y < 2$ for a=0, 0.01 and 0.1. Comment on your results.

Problem 2.

Show that the viscous terms in the x-momentum equations for compressible flow (Eq. 3.42, first equation) reduce to $\mu\nabla^2\vec{v}$ in an incompressible medium.