Homework #2

1. Consider an incompressible fluid whose Cauchy stress tensor is in the form

$$\mathbf{T} = -p\mathbf{I} + 2\mu_0 |\mathbf{D}|^{r-2} \mathbf{D}.$$

Study a simple shear flow between two infinite parallel plates located in y = -1 and y = 1. At the boundary assume Navier's slip boundary condition with $\gamma^* = 0, 1, \infty$. Find the solution u(y) assuming that the flow is normalized by

$$Q := \int_{-1}^1 u(y) \,\mathrm{d}y.$$

Use the following material parameters in the calculations: $\mu_0 = 1$ Pa s, Q = 2 m²/s. Plot the results in three graphs corresponding to r = 1.5, 2, 10.

2. Show that if (p, \mathbf{v}) satisfies homogeneous incompressible Navier-Stokes equations then

$$\mathbf{v}_{\lambda}(t,x) = \lambda \mathbf{v}(\lambda^2 t, \lambda x),$$
$$p_{\lambda}(t,x) = \lambda^2 p(\lambda^2 t, \lambda x)$$

also satisfies Navier-Stokes equations.