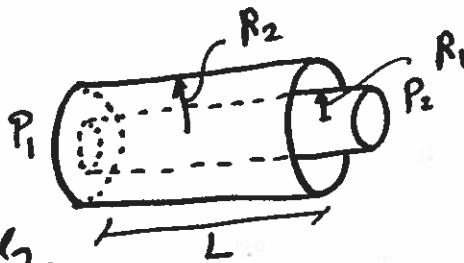


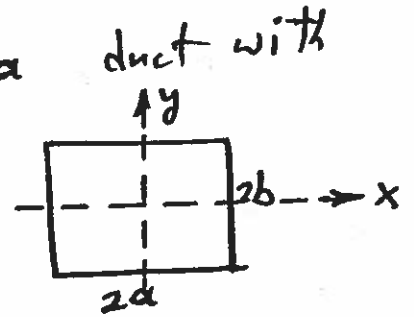
1. Show that the Oseen and Taylor vortices with
- $$v_\theta = \frac{\Gamma}{2\pi r} \left(1 - e^{-r^2/4\nu t} \right), \quad v_r = v_z = 0$$
- and
- $$v_\theta = \frac{\Gamma}{8\pi} \frac{r^2}{\nu t^2} \exp\left\{-\frac{r^2}{4\nu t}\right\}, \quad v_r = v_z = 0$$
- are exact solutions of the Navier-Stokes equation.

2. Obtain the velocity profiles $v_z(r)$ and $v_\theta(r)$ for helical flow in an annular region.

The inner and outer pipes rotate with angular velocities ω_1 and ω_2 respectively.



3. Find the velocity profile for a duct with rectangular cross-section. Assume steady flow with a constant $\frac{dP}{dz}$.



4. Determine the unsteady velocity profile which is developed if the lower plate is set suddenly in motion.

The fluid is initially at rest.

