Homework 2 MIA503E Due: March 27, 2018

1) Use the momentum equation to derive an equation for the transport of vorticity:

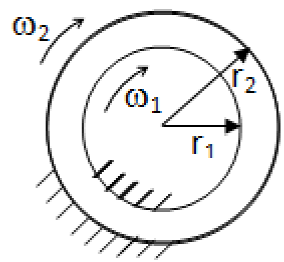
$$\boldsymbol{w_i = \varepsilon_{ijk}\frac{\partial u_k}{\partial x_j}}$$

Momentum equation for incompressible flow

$$\boldsymbol{\rho\frac{Du_i}{Dt} = -\frac{\partial p}{\partial x_i} + \mu\,\frac{\partial^2 u_i}{\partial x_j \partial x_j}}$$

Write the result also in vector notation. Which term will disappear in 2D?

2) For the flow between concentric rotating cylinders, find the temperature distribution with the following boundary conditions. $\boldsymbol{\omega_2 = 0}$, $\boldsymbol{T_2, \omega_1, r_1, r_2}$ are given and inner cylinder is adiabatic.



3) The figure for this problem shows a conduit whose cross section is the shape of an equilateral triangle. For the coordinate system shown in the figure, the equations of the three sides are

$$z + \frac{b}{2\sqrt{3}} = 0$$

$$z + \sqrt{3}y - \frac{b}{\sqrt{3}} = 0$$

$$z - \sqrt{3}y - \frac{b}{\sqrt{3}} = 0$$

Look for a solution for the velocity distribution in this conduit of the following form:

$$u(y,z) = \alpha(z + \frac{b}{2\sqrt{3}})(z + \sqrt{3}y - \frac{b}{\sqrt{3}})(z - \sqrt{3}y - \frac{b}{\sqrt{3}})$$

Determine the value of the constant α such that the assumed form of solution is exact, with the value of this constant being expressed in terms of the applied pressure gradient.