# Fluid Mechanics: Assignment 4

Due on: November 14, 2018

1. For two-dimensional ideal flow, show separately that:

   (a) $\nabla\psi.\nabla\phi = 0$

   (b) $-\nabla\psi X\nabla\phi = |\bar{u}|^2\hat{e_z}$

   (c) $|\nabla\psi|^2 = |\nabla\phi|^2$

   (d) $\nabla\phi = -\hat{e_z}X\nabla\psi$

2. For the cases of point source and point vortex, show that the lines of constant $\phi$ are perpendicular to the lines of constant $\psi$.

3. Given A, find 'p' such that the resultant can grow in finite time.

$$A = \begin{bmatrix} -1 & p \\ 0 & -2 \end{bmatrix}$$

   where, resultant vector, $\bar{u}_R = \bar{v}_1 e^{-\lambda_1 t} + \bar{v}_2 e^{-\lambda_2 t}$
   $\bar{v}_{1,2}$ and $\lambda_{1,2}$ are the corresponding eigenvectors and eigenvalues respectively.

4. Get velocity profile and streamlines for a doublet (constructed by a source and a sink of equal strength separated by $\epsilon \to 0$ )