AEM 313 Problem Set #3

Due: 13th September 2016 by 5:00pm

1. For a generic wake deficit velocity of:

$$V_\infty - u = AV_\infty \exp\left(-By^2\right)$$

   - Draw the generic wake deficit velocity showing how varying A and B changes the profile. Actual wake deficits **far** downstream theoretically converge to this function.
   - Determine the drag coefficient when A = 0.5 and B=0.1. Hint:

$$\int_0^\infty \exp(-Bx^2) = \frac{\sqrt{\pi}}{2\sqrt{B}} Erf\left(\infty\right) = \frac{\sqrt{\pi}}{2\sqrt{B}}$$

2. Watch "Vorticity Part 1" and "Vorticity Part 2" at http://web.mit.edu/hml/ncfmf.html.
   - Provide a statement verifying that you completed both videos.
   - Provide a **short** summary/abstract of these films. Concise, technical, and succulent.
3. Determine the vorticity field $\omega(x, y)$ of the following flow:

$$u(x, y) = y + \cos(x)$$
$$v(x, y) = \sqrt{x} + \sin(y)$$

4. For the following flow (N.b velocities are in **cylindrical coordinates**):

$$u_r(\mathrm{r}, \theta) = \frac{\Lambda}{2\pi r}$$
$$\mathrm{u}_\theta(\mathrm{r}, \theta) = \frac{\Gamma}{2\pi r}$$

   - Compute the circulation about a unit circle
   - Compute the divergence about a unit circle
   - Where is this flow rotational? Where is this flow irrotational?