80 POINTS **HOMEWORK 5** **DUE: 2/18/15**

Please save your submission as HW05_[your last name].ipynb (for example, HW05_Smith.ipynb) and email it to the instructor or send a link to it on GitHub.

1. (20 points) For the flow field of a single vortex of strength $\Gamma = 1$ located at $(0,0)$, numerically calculate the circulation around the vortex, i.e. compute the integral $\oint(\mathbf{v}\cdot\mathbf{t})ds$ on some path around the vortex. Does your answer match your intuition? How does your numerical answer vary if you choose a path close to the source vs. farther away from it? Explain.

2. (10 points) Place 3 clockwise and 3 counterclockwise vortices at points of your choosing, with strengths of your choosing, and compute $\oint(\mathbf{v}\cdot\mathbf{t})ds$ numerically on some path that encloses all of the vortices. Does your answer match your intuition?

3. (50 points) This problem concerns the case of an infinite row of equal-strength, equally spaced vortices, shown in Figure 1. Please refer to the Python notebook Infinite row of vortices.

Figure 1

a. (20 points) Plot the flow field around a finite (but large) number of vortices. Zoom out and plot the whole flow field (including all the vortices) and zoom in and show the flow field near the center of the row. What do you notice happens near the center?

b. (20 points) Plot the flow field for an infinite row of vortices. Use the same strength and spacing from part (a), and produce two plots using the same axis scaling as part (a). How do these plots differ from the corresponding plots from part (a)?

c. (10 points) Add a free stream to the infinite row of vortices. What can you say about the change of pressure above and below the row of vortices?