<u>PFLOW Tutorial</u>

The following steps will familiarize you with the program PFLOW. This program will be used to solve several homework problems. This short tutorial will guide you through the basics of PFLOW. The end result will produce two figures which you do **NOT** need to hand in.
It is highly recommended that you read the full instruction.

1. At any server Sun station, enter your username and password to login.

2. At an server prompt: *athena%* `add /mit/13.021`

3. To start the program: *athena%* `/mit/13.021/programs/pflow &`

4. Two windows will appear: Main Window, Singularities Table.

5. In the Singularities Table, change the magnitude of the freestream to 1.0, and keep the angle as $0°$.

6. Add a "Dipole" by first pressing the *Add Dipole* button (third from the left), and then placing it on the screen at $(-1, 1)$.

7. Modify the dipole's properties in the Singularity Table to the new position $(0, 0)$, with a magnitude of 1.0 and direction of $180°$. Observe the corresponding change in Main Window.

8. Add a "Vortex" by first pressing the *Add Vortex* button (fourth from the left), and then placing it on the screen at $(1, 1)$.

9. Modify the vortex's properties in the Singularity Table to the new position $(0, 0)$, with a magnitude of +5.0.

10. Draw streamlines originating at the following points:

    $(-8, 9), (-8, 8), (-8, 7), (-8, 6), (-8, 5), (-8, 4), (-8, 3), (-8, 2), (-8, 1), (-8, 0)$
    $(-8, -9), (-8, -8), (-8, -7), (-8, -6), (-8, -5), (-8, -4), (-8, -3), (-8, -2), (-8, -1)$
    $(-8, 2.5), (-8, 2.7)$
    To draw the streamlines, select the Draw Streamlines button (sixth button from the left) and then click on the grid at the desired point.

    To get points in between the grid lines, first turn off the Snap to Grid option under the Options Menu.

    To determine where you are on the grid, right click and the position will appear in the message window (at the bottom of the main window).

11. Print the streamlines. Under the File menu choose the Print... item. In the Print Dialog, select the print to file option and enter the name of the file you wish to print. This is Figure 1.

12. If you wish to save what you have done, you may do so by picking the Save As item under the File Menu. (It is probably a good idea to save at this time.)

13. Add Data Points at the following points:

    $$(-3, 0), (-2, 0), (-1, 0), (-0.5, 0.5), (0, -0.5), (0.5, 0.5), (1, 0), (2, 0), (3, 0)$$

    To add a data point, select the Add Data Point button (seventh button) and then click on the screen at the desired point.

    To view the data points that you have picked, select the Show Datapoints Table from the Options menu. You can edit the position of the data point as if it were a spread sheet. If you wish to import the data collected at these points into another program, you can click the "Dump to File" button.

14. Display the data point graph by selecting Show Datapoint Graph under the Options menu. Plot U_x, U_y, speed, and pressure and print this graph. This is figure 2. Observe behaviors of U_x, U_y, speed, and pressure at each point. Note: in the Datapoint Graph window, under Options, you may need to turn on Plot U_x and Plot U_y; the data is plotted by datapoint, not by coordinates. Observe behaviors of U_x, U_y, speed, and pressure at each point.

15. Vary the magnitude of the vortex, dipole, and free-stream by modifying the singularities table and view the influences of each item to the streamlines, Datapoints Table and Datapoints Graphs.

16. To exit Pflow, pick Exit from the File menu.

17. You may now log out of the server terminal.