2.20 Marine Hydrodynamics, Spring 2005

PFLOW Homework #1

For the following problems, you may write answers to questions in the blank space on the figures/tables that the questions refer to, or on a separate sheet of paper. Put the problem number/letter by each answer.

1. Construct what is called a "Rankine Half Body" by using a uniform stream and a source. Let the uniform flow have magnitude of 1 and angle of 0. Place a source (strength m = 10.0) in the work area at $(0, 0)$.

   (a) Draw streamlines to determine the flow pattern. Find the dividing streamline. Print this and call it Figure 1. In Figure 1, label the stagnation point and dividing streamline. Measure and record the vertical width of the body at the y-axis ($x = 0$). Record the coordinates of the stagnation point and the corresponding velocity components and pressure.

   (b) What is the velocity potential of this flow for the given singularity strength?

2. Construct what is called a "Rankine Oval" by adding a sink (strength = -10.0) at $(3, 0)$ to the flow with uniform stream and source from Problem 1. Move the source to $(-3, 0)$.

   (a) Draw streamlines to determine the flow pattern. Find the dividing streamline. Print this and call it Figure 2. In Figure 2, label the stagnation point(s) and dividing streamline. Measure and record the vertical width of the body at the y-axis ($x = 0$). Record the coordinates of the stagnation point(s) and the corresponding velocity components and pressure(s).

   (b) What is the velocity potential for this flow for the given singularity strengths?

3. For the "Rankine Oval" constructed in Problem 2, change the source/sink strength to ± 20.

   (a) Draw streamlines to determine the flow pattern. Find the dividing streamline. Print this and call it Figure 3. In Figure 3, label the stagnation point(s) and dividing streamline. Measure and record the vertical width of the body at the y-axis ($x = 0$). Record the coordinates of the stagnation point(s) and the corresponding velocity components and pressure(s).

   (b) What is the velocity potential for this flow for the given singularity strengths?

4. Construct a cylinder by replacing the source and sink in problem 3 with a dipole (strength = 50.0, angle = 180.0)at the origin. You should still have the uniform stream.

   (a) Draw streamlines to determine the flow pattern. Find the dividing streamline. Print this and call it Figure 4(a). In Figure 4(a), label the stagnation point(s) and dividing streamline. Measure and record the vertical width of the body at the y-axis ($x = 0$). Record the coordinates of the stagnation point(s) and the corresponding velocity components and pressure(s).

   (b) Place data points along the body from the upstream stagnation point, over the top of the cylinder to the downstream stagnation point and then along the bottom of the cylinder. Use Datapoint Table to list the points you chose. Call this Table A and print it. Use the Datapoint Graph window to plot the distribution of speed and pressure. Call this Figure 4(b) and print it.

   (c) Is there a net pressure force acting on the cylinder? If the answer is no, justify it; if the answer is yes, justify it and specify the direction.

   (d) What is the velocity potential for this flow for the given singularity strengths?

5. Add a vortex (strength = -10.0) to the cylinder model of problem 4 at the origin.

   (a) Draw streamlines to determine the flow pattern. Find the dividing streamline. Print this and call it Figure 5(a). In Figure 5(a), label the stagnation point(s) and dividing streamline. Measure and record the vertical width of the body at the y-axis ($x = 0$). Record the coordinates of the stagnation point(s) and the corresponding velocity components and pressure(s).

   (b) Place data points along the body. Use Datapoint Table to list the points you chose. Call this Table B and print it. Use the Datapoint Graph window to plot the distribution of speed and pressure. Call this Figure 5(b) and print it.

   (c) Is there a net pressure force acting on the cylinder? If the answer is no, justify it; if the answer is yes, justify it and specify the direction.

   (d) What is the velocity potential for this flow for the given singularity strengths?