

Homework VII.

Due *Monday November 13, 2006.*

Read: Chapter 11

Problems:

1. Sketch the streamlines for the flow with streamfunction $\psi = 3x^2 - y$. Can you find a velocity potential for this flow?
2. Show that the streamfunction $\psi = x^2/a^2 + y^2/b^2$ gives a solution for two-dimensional flow inside an ellipse with boundary $x^2/a^2 + y^2/b^2$. What is the vorticity of the flow?
3. Show that in three dimensions the velocity potential

$$\phi = Ux \left[1 + \frac{a^3}{2r^3} \right]$$

corresponds to flow past a sphere. [Here r is the radial distance from the origin.]

4. Find the drag on a cylinder in potential flow by integrating the pressure field (10-22) around the surface of the cylinder. What is the result if you integrate only over the front half? [Think carefully about the component of the normal in the x -direction.]
5. Compute the Reynolds, Froude and Mach numbers for an aircraft carrier steaming at full speed. [Use the properties of water, not air.]

Comments:

For two-dimensional incompressible irrotational flows, we can find the velocity potential by solving Laplace's equation. You will not be responsible for solving potential flow problems, but you will be responsible for using the solutions for ψ or ϕ to obtain \mathbf{u} and p . In particular, **you must read and understand the solution for flow around a cylinder** on pages 127–128.