

Homework Set #2

Problem 1

Open up your favorite web browser, go to <http://web.mit.edu/fluids/www/Shapiro/ncfmf.html> , and watch the 30-minute video titled “Deformation of Continuous Media” and answer the following questions:

- (a) Name four important characteristics of the principal axes.
- (b) What does vorticity measure?

Problem 2

(Adapted from R. M. Olson and S. J. Wright, *Essentials of Engineering Fluid Mechanics*, 5th edition, Harper & Row, New York, 1990)

Determine if the following velocity fields describe the flow of an incompressible fluid and if they do, then determine if the flow is irrotational. Clearly show your logic.

(a) $V_x = x^2 \cos(y)$; $V_y = -2x \sin(y)$

(b) $V_x = x + 2$; $V_y = 1 - y$

(c) $V_x = xyt$; $V_y = x^3 - \frac{y^2 t}{2}$

(d) $V_x = \ln(x) + y$; $V_y = xy - \frac{y}{x}$

(e) $V_x = x + y$; $V_y = x - y$

Problem 3

The following functions of x and y are proposed stream functions for a steady, incompressible flow:

(a) $\psi_1 = x^2 + 2y$

(b) $\psi_2 = 5x^2 y^2$

For each proposed function:

- (i) determine functions for the velocity components: V_x and V_y ,
- (ii) determine if the flow is irrotational, and
- (iii) sketch several streamlines (lines of constant ψ) in the x - y plane ($-5 < x < 5$; $0 < y < 5$).
- (iv) What steady physical flow might this flow field represent? (Remember that because there is no flow across a streamline, every streamline could be represent a solid boundary.)