

ME 5440 - Intermediate Fluid Mechanics

Homework Assignment 2

Due on September 11th, 2009

1. The velocity field of a fluid is given by

$$U_i = f_i(x_j, t)$$

Show that, if the flow is steady, the equations describing the points, x_i , along the streamline, pathline and streakline have the same form.

2. Show that the streamlines and pathlines coincide for

$$U_i = \frac{x_i}{1+t}$$

3. Consider the following two-dimensional flow field defined by the velocity components:

$$U_1 = \frac{U_2}{1+t} \quad U_2 = 1$$

Find and plot the following lines:

- (a) streamline through (1, 1) at $t = 0$
 - (b) pathline for a particle release at (1, 1) at $t = 0$
 - (c) streakline at $t = 0$ which passes through (1, 1)
4. Consider the following two-dimensional flow field defined by the velocity components:

$$U_1 = ax_2 \quad U_2 = -a(x_1 - bt)$$

where a and b are nonzero constants. Find and describe the following lines:

- (a) streamline through (1, 1) at $t = t_0$
- (b) pathline for a particle release at (1, 1) at $t = t_0$