

AME 538/ME 438
Homework
Prof. J. M. Powers
Due: October 11, 1994

Fluid Kinematics

1. Consider the flow field $v_1 = x_2, v_2 = x_1$.
 - a) Find a closed-form analytic expression for the equation of a general pathline of a fluid particle of the form $x_1 = x_1(t), x_2 = x_2(t)$. At $t = 0$ the particle is located at $(x_1, x_2) = (x_1^o, x_2^o)$.
 - b) Find a closed form analytic expression for the equation of a general streamline through (x_1^o, x_2^o) and show this is equivalent to a pathline for this steady flowfield.
 - c) Consider generally the motion of a family of fluid particles located initially, $t = 0$, on the line segment $x_1 = 1, 0 \leq x_2 \leq 1$. Consider specifically three particles of the family which at $t = 0$ are at $(1, 0), (1, 1/2), (1, 1)$. Plot the location of each of the three particles at $t = 0, t = 1, t = 2$. The curve which connects each of the points at fixed time is called a *time line*. Sketch the location of the time lines at $t = 0, t = 1, t = 2$ for this family of fluid particles. If possible, find a general expression for the time line at $t = \hat{t}, x_2 = x_2(x_1; \hat{t})$ for the entire family of particles.
2. Use the Fortran program provided to plot streamlines in the domain $0 \leq x_1 \leq 1, 0 \leq x_2 \leq 1$ for the following flow field

$$v_1 = \sin(2\pi x_2)$$

$$v_2 = x_2 - x_1^2$$