Fluid Mechanics and Rate Processes: Fluid Kinematics Tutorial: August 11, 2016

P1. The position of a fluid particle in a two- dimensional, Lagrangian system is described as:

$$x = x_0 e^{-kt} + y_0(1 - e^{-2kt})$$
$$y = y_0 e^{kt}$$

Find **(a)** the Equation of the fluid particle trajectory, and **(b)** the velocity field in the Eulerian system.

P2. Find the acceleration components at point (1, 1, 1) for the following flow field:

$$u = 2x^2 + 3y\,,\quad v = -2xy + 3y^2 + 3zy\,,\quad w = -\frac{3}{2}z^2 + 2xz - 9y^2 z$$

P3. The velocity and density field in a diffuser are given by

$$u = u_0 e^{-2x/L} \qquad \text{and} \qquad \rho = \rho_0 e^{-x/L}$$

Find the rate of change of density at $x = L$

P4. The velocity field is defined by $\vec{V} = ay\hat{i} + b\hat{j}$, where a =1s^{-1}, b =2 m/s; coordinates are measured in meters.

Find: **(a)** Equation of streamline passing through $(x, y) = (b, b)$

(b) At t = 1s, coordinates of particle that passed through point (1, 4) at t = 0

(c) At t = 3s, coordinates of particle that passed through point (-3, 0) at t = 1s