Homework #1
Introduction to physical oceanography
(due Monday Oct 3)

1. Suppose the trajectories of fluid elements are given by

$$\begin{aligned} x &= x_0 e^{-\alpha t} \\ y &= y_0 e^{\alpha t} \\ z &= z_0 \end{aligned}$$

   where x_0, y_0, z_0 are the position coordinates of the element at $t = 0$.

   (a) Find the Eulerian velocity field. [Hint: the Lagrangian velocity is the time derivative of the Lagrangian trajectories $x(t, x_0), y(t, y_0)$; the desired Eulerian velocity is obtained by expressing these velocities as function of (x, y, t) rather than as function of time and the initial locations (x_0, y_0, t).

   (b) Find the streamlines and sketch them.

2. Read Knauss 2nd edition chapter 3.

3. **Challenge problem: optional**. Suppose the Eulerian velocity field (u, v, w) in the Cartesian coordinate system (x, y, z) is

$$\begin{aligned} u &= -\mu x - \Omega y \\ v &= \mu y + \Omega x \\ w &= 0 \end{aligned}$$

   Calculate the fluid trajectories for elements which at $t = 0$ have coordinates x_0, y_0, z_0. Consider the cases $\Omega > \mu$ and $\Omega < \mu$ explicitly in your final discussion.