1. Consider the Laminar Ekman layer above a Rigid Surface:

The following simplified momentum equations:

\[-fv = \frac{-1}{\rho} \frac{\partial p}{\partial x} + \nu \frac{d^2u}{dz^2}\]
\[fu = \frac{-1}{\rho} \frac{\partial p}{\partial y} + \nu \frac{d^2v}{dz^2}\]

can be further simplified by expressing pressure gradients in terms of Geostrophic velocity components as:

\[-f(v - V_g) = \nu \frac{d^2u}{dz^2} (u - U_g) \quad (1)\]
\[f(u - U_g) = \nu \frac{d^2v}{dz^2} (v - V_g) \quad (2)\]

Assuming \( U_g \) and \( V_g \) are height independent, solve Equations 1 and 2 subject to the following boundary conditions:

\[u = 0 \quad v = 0 \quad \text{at} \quad z = 0\]
\[u \to U_g \quad v \to V_g \quad \text{as} \quad z \to \infty\]

For the final solution, have the \( x \)-axis oriented with the Geostrophic wind vector (i.e., \( U_g = G \) and \( V_g = 0 \)). Plot your solution as a hodograph and as vertical velocity profiles of \( u \) and \( v \). The solution should be: where \( a \) is the inverse of the Ekman Depth.

\[u = G\left[1 - e^{-az} \cos(az)\right]\]
\[v = Ge^{-az} \sin(az)\]

2. Please explain the phenomena of Eckman pumping.
3. Solve problems 1, 2 and 3 from Ch.14 of Kundu.