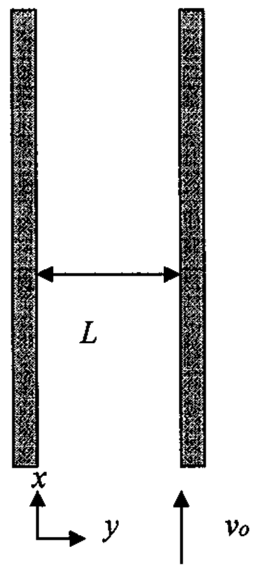
Transport Phenomena

Make all possible assumptions and show all your work.

1. (20%) Define and give the physical interpretations of the following terms.
   Prandlt mixing length
   Eddie diffusivity
   Reynolds number
   Continuum theory
   Mach number

2. (15%) Consider an incompressible fluid confined between two parallel, vertical surfaces. One surface, shown to the left, is stationary, while the other is moving upward at a constant velelocity, v_o. If we consider the fluid Newtonian and the flow laminar, derive the velocity profile when the fluid is subject to a pressure gradient $\frac{dP}{dy}$.

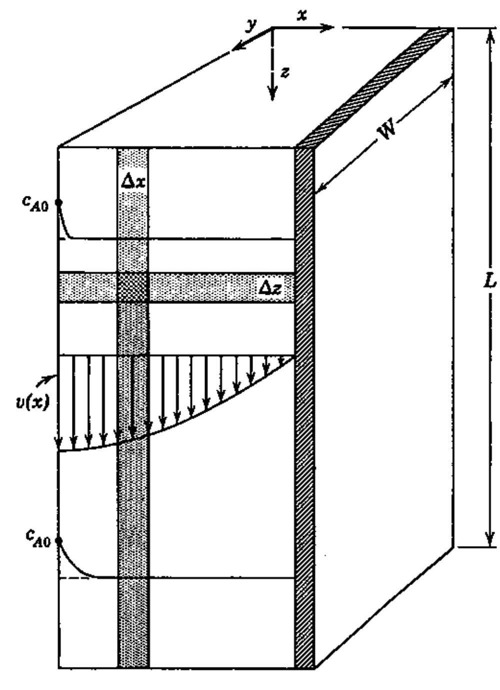


3. (15%) Use the von-Kármán integral method to find the velocity profile, boundary layer thickness, and friction coefficient for the laminar boundary layer over a flat plate by the form $v_x = a \sin by$.
   The governing equation can be simplified as $\frac{\tau_o}{\rho} = \frac{d}{dx}\int_0^\delta v_x(v_\infty - v_x)$

4. (25 %) A slab occupying the space between y = 0 and y = b is initially at temperature T_0. At time t > 0, the surface at y = 0 is suddenly raised to T_1 and maintained there, and the surface at y = b is kept adiabatic. Find the unsteady-state temperature profile T(y, t) within the slab.

5. (25 %) Consider the absorption of gas *A* by a laminar falling film of liquid *B* flowing down against a vertical solid wall, as shown below. The thickness and the maximal surface velocity of the falling film are δ and v_{max}, respectively.

The material *A* is only slightly soluble in *B* and the contact time between the fluid and the wall is so short, so that the viscosity μ of the liquid is not changed appreciably and the diffusion takes place very slowly and is confined merely to the gas-liquid interface region. Find the steady state concentration profile of *A*, C_A (x, z), within the flowing film.



Absorption into a falling film.