ME 437/537 **Exam 1**

Problem 1. (35 points) Consider a one-dimensional diffusion process with a space dependent diffusivity in the absence of a flow field. The governing equation is given by

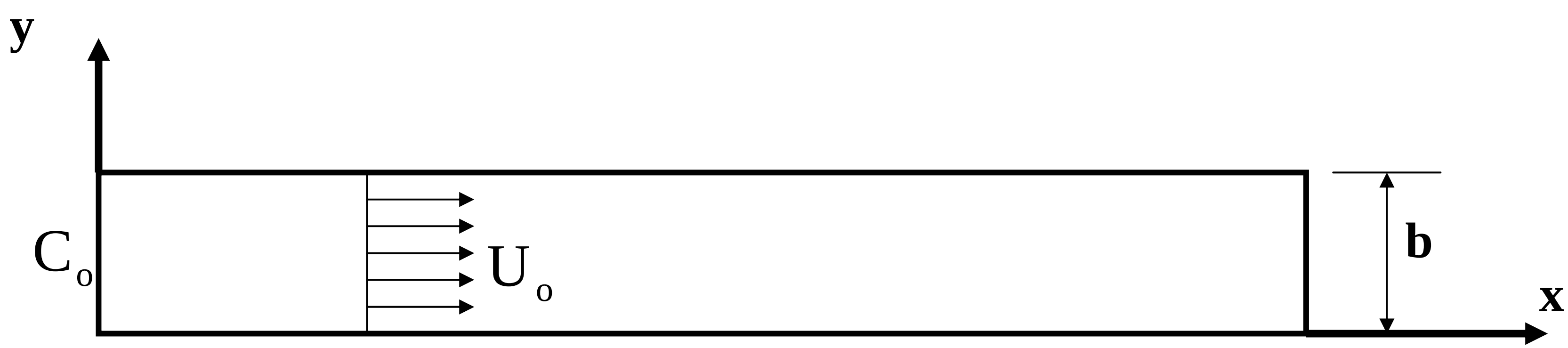
$$\frac{\partial c}{\partial t} = \frac{\beta}{y} \frac{\partial^2 c}{\partial y^2}$$

Here β is a constant. Assume an initially uniform concentration of aerosols in the neighborhood of an absorbing wall. The initial and boundary conditions are:

$$C(y,0) = C_0 \qquad C(0,t) = 0 \qquad C(\infty,t) = C_o.$$

a) Find the appropriate similarity variable , reduce the governing equation and boundary conditions to the similarity form. b) Does this equation accept a similarity solution? c) Find the formal solution.

Problem 2. (35 points) Consider a dilute suspension of aerosols between two semi-infinite parallel plates that are distance b apart as shown. Assume that the gas velocity is a constant in x-direction and is given by. Suppose the inlet concentration is C_o, and the concentration at the surface of the plates are zero.



a) Suppose c(x,y) and simply the diffusion equations. b) Find the steady concentration in the duct. Assume the diffusivity D is constant.

Problem 3.(30 points) Consider a 0.3 μm particles of density of 2000 kg/m3 in air under normal condition.

Find the terminal velocity with and without Cunningham correction.

Determine the diffusivity.

Find the intensity of Brownian excitation for a Δt of 10-6 s.

When the particle is falling in a shear field of 1000 s-1, find the Saffman lift force.

(Assume a kinematic viscosity of 1.5×10^{-5} m2/s, a temperature of 300 K, and λ=0.07μm. For other needed parameters assume typical values.)