Department of Mechanical Engineering, BUET.
ME 6125: Mechanics of Viscous Fluid

Assignment-3

(**Due Date: 17 August 2013**, **Sunday**. *Submit hard-copy, at class*)

1. In Figure 1, a plane channel flow is shown which is composed of the flow of two superimposed non-mixable fluids, i.e. fluids *A* and *B* that flow simultaneously through a channel formed by two parallel plates. The fluid that is on the lower part of the channel has density ρ_A, viscosity μ_A and mass flow m_A. The fluid that is on the top of fluid A has the density ρ_B, viscosity μ_B and mass flow m_B.
Solve the Navier-Stokes equation for this flow. Plot the velocity distribution and comment.
Assume steady flow.

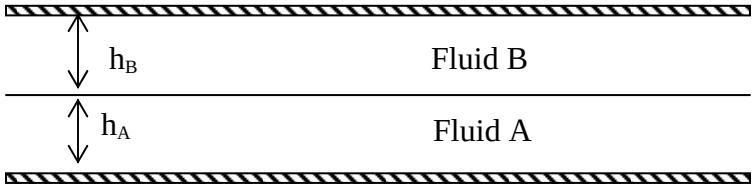

Figure 1. Two-layer plane channel flow.

2. A Newtonian liquid is contained between two horizontal, infinitely long and wide plates, separated by a distance 2*H*, as illustrated in Figure 2. The liquid is initially at rest; at time t=0+, both plates start moving with constant speed V.

(a) Write the governing equation, the boundary and the initial conditions for this transient flow.
(b) What is the solution for $t \leq 0$?
(c) What is the solution for $t \rightarrow \infty$?
(d) Find the time-dependent solution $u_x(y\ ,\ t)$ using separation of variables.
(e) Plot the velocity profiles at t = 0, 0+, $t_1 > 0$ and ∞.

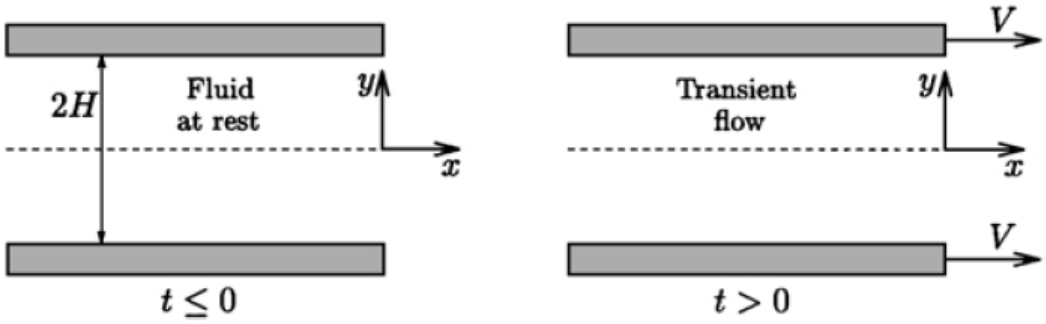

Figure 2. Transient Couette flow.

3. Solve the equations of motions for transient plane Poiseuille flow as shown in Figure 3. Plot the velocity distribution at different time and comment.

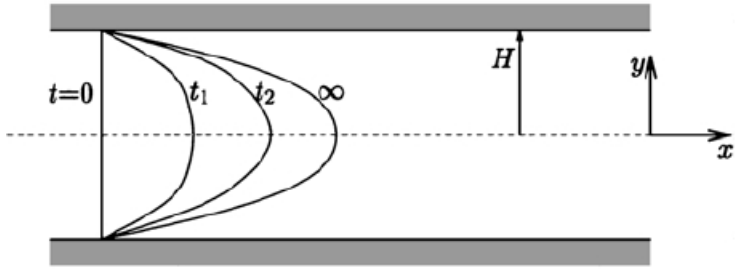

Figure 3. Transient plane Poiseuille flow.