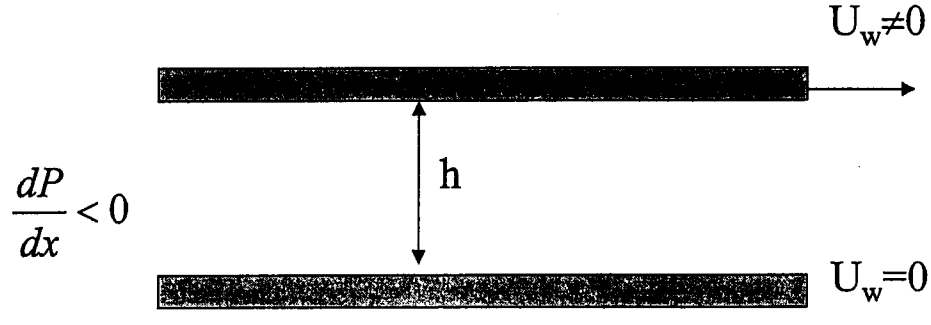
1. For a uniform flow over a circular cylinder, please answer the following questions based on potential flow theory. (30 points)
   (a) Determine the complex potential of the flow field, F(z). (5 points)
   (b) Write down the boundary conditions. (5 points)
   (c) Determine velocity potential and stream function. (5 points)
   (d) Determine velocity distribution, V_r, and V_θ. (5 points)
   (e) What is the pressure coefficient, C_p? (5 points)
   (f) Verify D'Alembert Paradox. i.e. $F_x=0$, and $F_y=0$. (5 points)

2. Consider a "general Couett flow" with a moving wall and a constant pressure gradient (Fig. 1). Please answer the following questions. (20 points)
(a) What is the velocity distribution? (10 pointS)
(b) What is the shear stress distribution? (5 points)
(c) What is the location where the velocity is the maximum? (5 points)



3. Two concentric circular cylinders enclose a viscous fluid. If the inner cylinder (with a radius of r_1) is at rest and the outer one (with a radius of r_2) rotates at a constant angular velocity (ω), calculate the torque required to rotate the outer cylinder and that required to hold the inner cylinder at rest. (25 points)

4. Explain the difference between "scale-similar' and "self-similar" problems. Using "self-similar" transformation, please transform the following partial differential equation to ordinary differential equation. (25 points)

$$\frac{\partial u}{\partial t} = \gamma \frac{\partial^2 u}{\partial y^2}$$