Open-Channel Hydraulics
H.W.#2. Navier-Stokes Equations

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1. Parallel flow through a straight channel

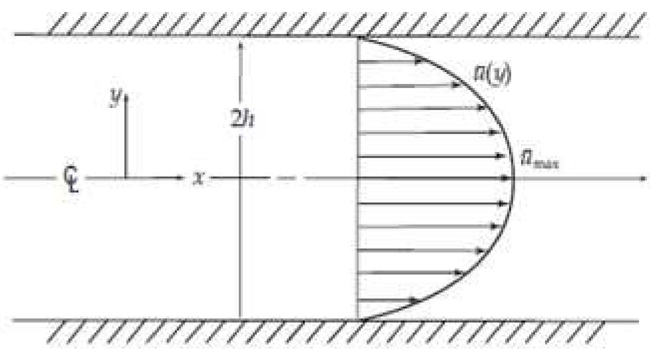
Consider 2D flow depicted in the figure below. For steady, incompressible flow, the continuity and momentum equations are given by, respectively,

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\nu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)$$

$$u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}=-\frac{1}{\rho}\frac{\partial p}{\partial y}+\nu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)$$

Solve these equations analytically with appropriate boundary conditions.



2. Couette flow

Consider the flow between two parallel infinite plates. The upper plate is moving at a velocity U. The flow is two-dimensional, steady, incompressible.

(1) Obtain the governing equation(s).

(2) Give the proper boundary conditions for the governing equation(s).

(3) Solve these analytically.