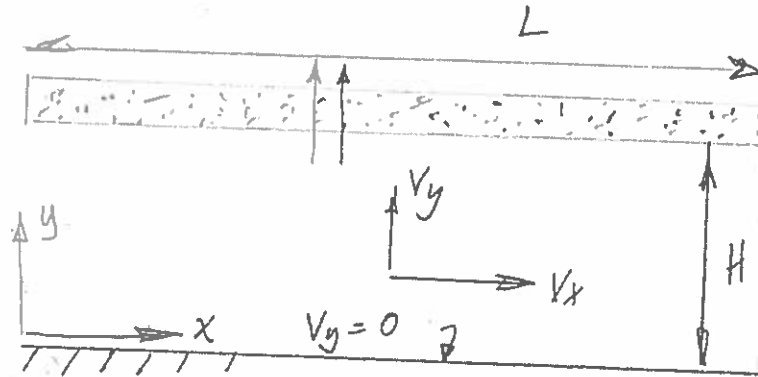


MANE 6520 - Fluid Mechanics

Homework #3 - Thursday 22 September 2022, due Thursday 29 September.



Consider two parallel plates shown. The flow is 2-D, steady, incompressible (with density ρ) and the fluid is Newtonian (constant viscosity μ). Both plates are stationary. The lower plate is solid (impermeable) and the upper plate is porous. The width is W into the paper.

The velocity in the x-direction is $v_x = 6V \frac{x^2}{LH} \left(\frac{y}{H} - \frac{y^2}{H^2} \right)$ and the pressure is

$$p = 6\mu \frac{V}{H} \frac{x^2}{L^2}$$

- 1) Find the velocity in the y -direction v_y .
- 2) Find the strain rate (stretching) tensor $\dot{\gamma}$.
- 3) Find the vorticity (spin) tensor ω .
- 4) Find the vorticity vector as $\Omega = \frac{1}{2} \nabla \times \mathbf{v}$.
- 5) Find the stress tensor σ .
- 6) Find the force on the lower and upper surfaces, \mathbf{F}_1 and \mathbf{F}_2 .
- 7) Find the mass flow rates (out is positive) at the surfaces $x = 0$ and L ; and $y = 0, H$.
- 8) From 7) show that global continuity (mass balance) is solved.
- 9) For $H = 5 \text{ mm}$, $L = 50 \text{ mm}$, $W = 1 \text{ m}$, $V = 1 \text{ m/s}$, $\rho = 800 \text{ kg/m}^3$, $\mu = 50 \text{ mPa-s}$; find the numerical answers to parts 6) and 7). Check units.