

Attempt all questions; Make appropriate assumptions if needed, and state them clearly

1. (a) A flow field is expressed as: $\vec{v} = ay\hat{i} + bx\hat{j}$, where, $a = 1 \text{ s}^{-1}$ and $b = -1 \text{ s}^{-1}$. Determine the equation for the streamline passing through this point $(x, y) = (2, 2)$. Sketch a family of streamlines and velocity vectors. (3+2)
- (b) A student measured the shear stress of an unknown fluid for different strain rates (deformation rates). Her plot is reproduced in the following figure. Comment on whether the fluid is Newtonian, shear thinning, or shear thickening. (2)

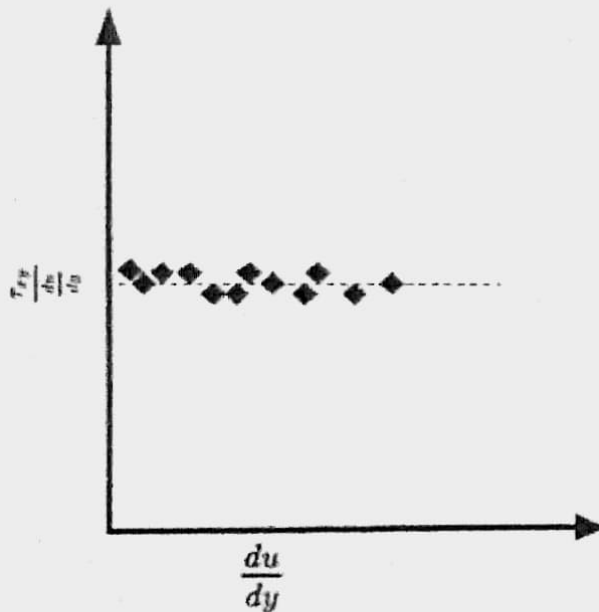


Figure 1: Problem 1b

- (c) The ventilation in the ESE 102 needs to be improved using a fan extractor. Tests are to be done to estimate the fan selection that would be required. The concentration of CO_2 C_{CO_2} (ppm) depends on the number of students N , the pressure drop produced by the fan, ΔP , the fan diameter, D , motor speed, ω , and air density ρ , gravity, g , and air viscosity, μ . Determine the dimensionless parameters that characterize this problem. (7)

2. (a) A horizontal axisymmetric jet of air with a 10 mm diameter strikes a stationary vertical disk of 200 mm diameter. A manometer is connected to the center of the disk. If the deflection, $h = 200$ mm, and the manometer liquid has $SG = 1.75$, determine the velocity of the jet at the nozzle exit. What is the volumetric flow rate of the air?

(5+1)

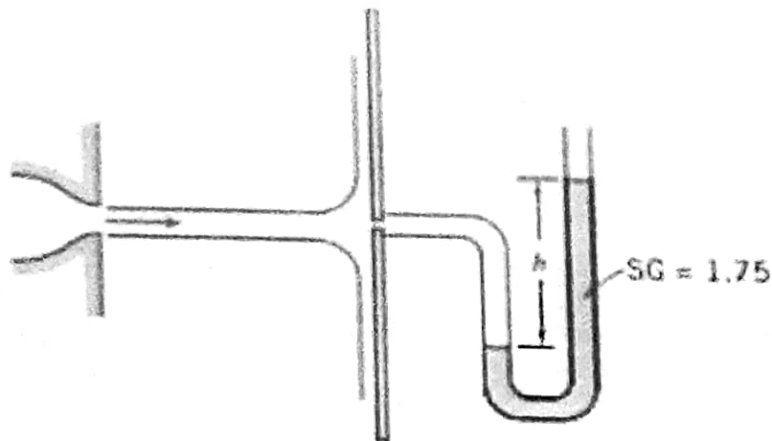


Figure 2: Problem 2a