

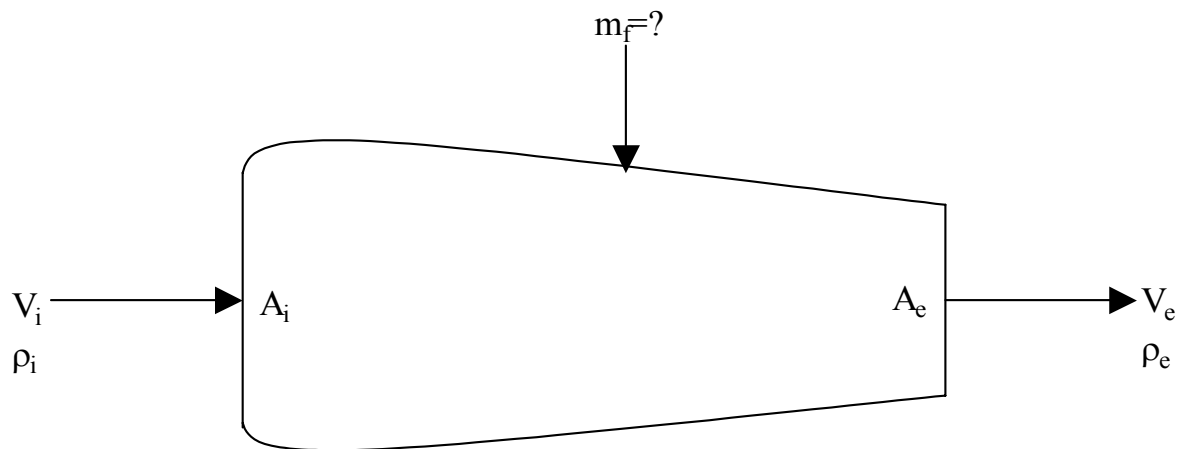
Fluid Mechanics

(2nd Exam)

Name:

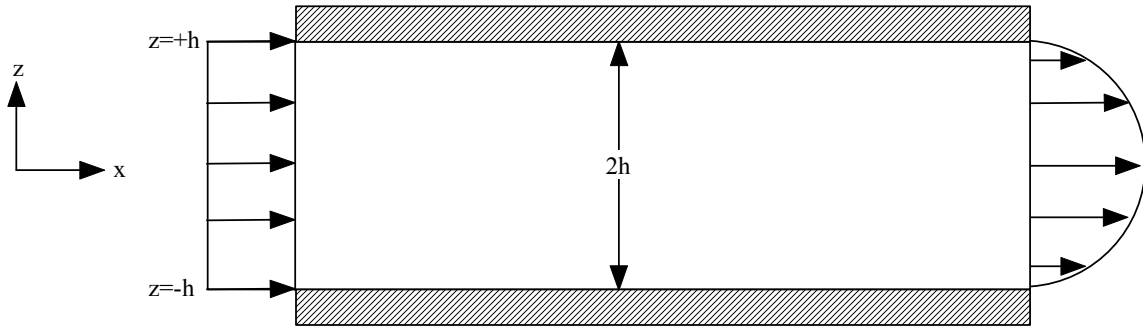
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1. (20 points) An airplane moves forward at a speed of V_a in air with a density of ρ_a . The areas of the airplane's engine intake and exhaust are A_i and A_e , respectively. The exhaust has a density of ρ_e and exits the engine at a speed V_e . Develop expressions for the mass flow rate of the fuel, m_f , in terms of V_a , V_e , ρ_a , ρ_e , A_i and A_e for V_e measured with respect to:
 - a. the engine
 - b. an observer standing on the ground

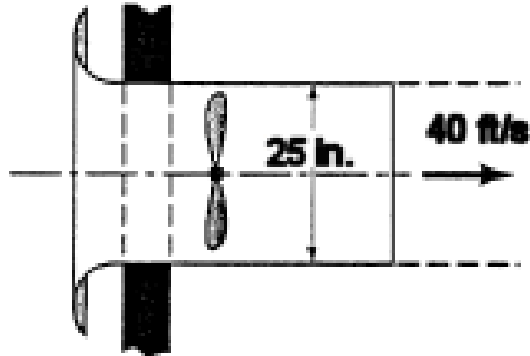


2. (20 points) The steady incompressible entrance flow between the two plates shown develops from uniform flow $u(z)=U_0$ to fully developed laminar flow $u(z) = u_{\max} \left(1 - \frac{z^2}{h^2} \right)$.

The fluid density is ρ and the static pressures at the inlet and exit are P_i and P_e , respectively. Develop an expression for the drag force on the plates in terms of U_0 , ρ , P_i , P_e , and h . Assume the top and bottom plates have a unit length in the y -direction.



3. (30 points) A 0.8-hp motor is required by a ventilating fan to produce a 25-in stream of air having a velocity of 40 ft/s. Estimate a) the efficiency of the fan and b) the thrust of the supporting member on the conduit enclosing the fan.



4. (30 points) In an air conditioning system, air flows without heat gain or loss through a horizontal pipe of uniform diameter. At section 1 the pressure is 150 psia, the velocity is 80 ft/s, and the temperature is 70°F ; at section 2 the pressure is 120 psia and the temperature is 50°F . Find (a) the change in kinetic energy of the air; (b) the head (mechanical energy) loss; (c) the change in enthalpy; all between section 1 and section 2. Assume the air to be a perfect gas.