Mechanical, Automotive and Materials Engineering
Fluid Mechanics I
MECH 3233-F23

Assignment Problems Set #1

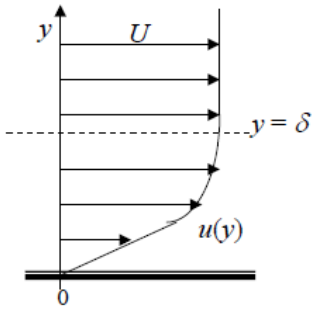
Due: Thursday, September 21, 2023 at 11:59 p.m.

Problem 1: (1 point) The information on the can of pop indicates that the can consists of 355mL. The mass of a full can of pop is 0.369 kg while empty can weighs 0.153N. Determine the specific weight, density and specific gravity of the pop.

Problem 2: (2 points) A newly produced pipe with diameter of 3 m and length 15 m is to be tested at 10 MPa using water at 15°C ($\rho_1 = 1000\ \text{kg/m}^3$). After sealing both ends, the pipe is first filled with water and then the pressure is increased by pumping additional water into the test pipe until the test pressure is reached. Assuming no deformation in the pipe, determine how much additional water needs to be pumped into the pipe. Take the coefficient of compressibility to be 2.10×10^9 Pa.

Problem 3: (4 points) An approximation for the boundary-layer velocity profile is given by the formula

$$u(y) \approx U \sin\left(\frac{\pi y}{2\delta}\right), \quad 0 \le y \le \delta$$



where U is the stream velocity far from the wall and δ is the boundary layer thickness, as shown in the Figure to the right. If the fluid is helium at 20°C and 1 atm (R = 2077 m^2/(s^2-K) and μ = 1.97E-5 kg/m-s), and if U = 10.8 m/s and δ = 3 mm, use the formula to (*a*) estimate the wall shear stress τ_w in Pa; and (*b*) find the position in the boundary layer where τ is one-half of τ_w.

Problem 4: (3 points) The tank contains air (R = 286.9 J/kg.K) at a temperature of 15°C and an absolute pressure of 210 kPa. If the volume of the tank is 5 m^3 and the temperature rises to 30°C, determine the mass of air that must be removed from the tank to maintain the same pressure.