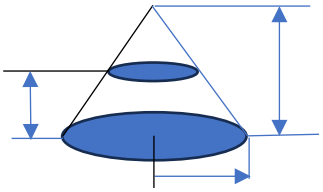
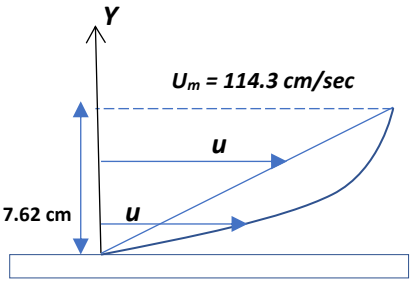
ULBM FSSA Dep. Of Mechanical Engineering the 10/09/2024
2nd year ST

Problems in Fluid Mechanics: Fluid properties

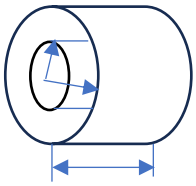
1. A tank containing glycerin with a mass of 1200 kg and a volume of 0.952 m^3. Find the weight of the glycerin (W), its density (ρ), and its specific gravity (γ).
2. Water with a volume of 0.02265 m^3 is injected into a conical tank with a height of h=0.508 m and a base radius R=h/2.
   - What is the vertical position (h_L) of the free surface of the water? How much water is needed to fill the entire tank?
   - For a thickness of 1 mm of the aluminum tank, find the overall density (ρ). What is the thickness for which the tank sinks in water if ρ_{al}=2700 kg/m^3?



3. A fluid with dynamic viscosity $\mu = 4.7875\ 10^{-2}\ \frac{Ns}{m^2}$ fills the space between two plates, the lower one fixed and the other moving with a velocity Um. We simultaneously take two velocity distributions, one linear and the other parabolic (see figure).
   - Calculate the velocity gradient and the shear stress at the points y=0 cm, 3, and 6 cm.



4. A cylinder of external radius R_1=12 cm rotates concentrically inside another fixed cylinder of radius R_2=12.7 cm. The two cylinders have a length of *l*=30 cm.
   - Calculate the viscosity of the fluid that fills the space between the two cylinders if a moment M=0.8812 Nm is necessary to maintain a rotation speed ω=60 rpm.



5. Water flows through a pipe, the velocity profile is given by:

$$v(r) = \left(\frac{\beta}{4\mu}\right)\left(\frac{d^2}{4} - r^2\right)$$

With μ the dynamic viscosity, β a constant, and d the diameter of the pipe.
   - Calculate the shear stress on the walls of the pipe,
   - What will this constraint be at r=d/4?
   - If this profile is constant for a length L of the pipe, what will be the drag force (overall friction) T?

6. A liquid is compressed in a cylinder; at the pressure P_1=1 MN/m^2, the volume of the liquid is 1*l*; at P_2=2MN/m^2, the volume becomes 995 cm^3. Calculate the overall modulus of elasticity K of this liquid. If the overall modulus of elasticity of water is K=2.2 GPa, what is the pressure necessary to reduce a volume of water by 0.6%?

8. At a depth of 7 km in the ocean, the pressure is P_2=71.6 MPa. If the specific weight at the surface is γ_1=10.05 kN/m^3, the overall modulus of elasticity K=2.34 GPa (for this pressure interval) and Patm= 1 atm. Calculate the mass volume, the density at a depth of 7 km, and the variation in the mass volume between the surface and the depth of 7 km.