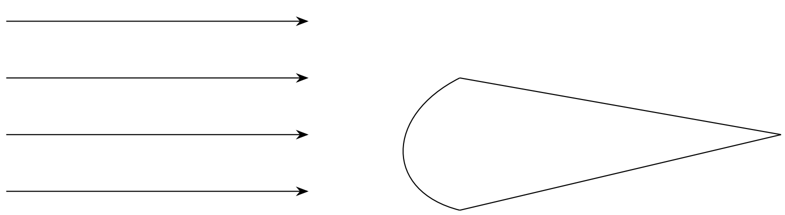
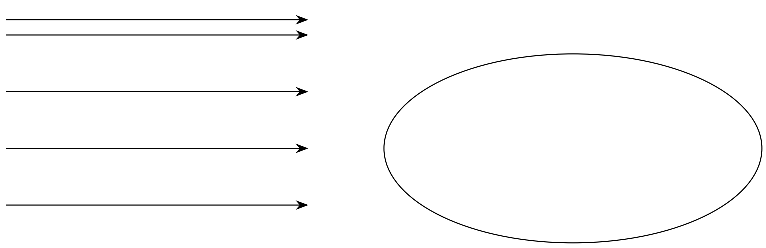
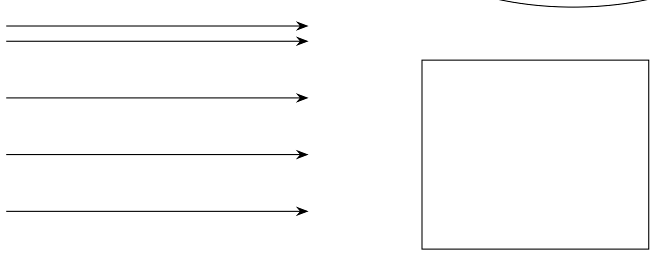
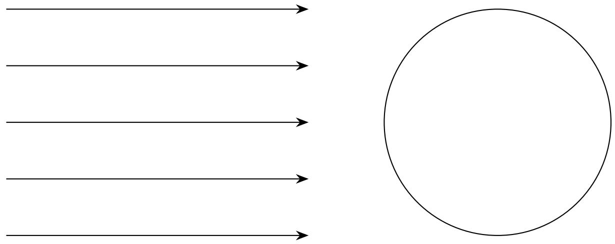
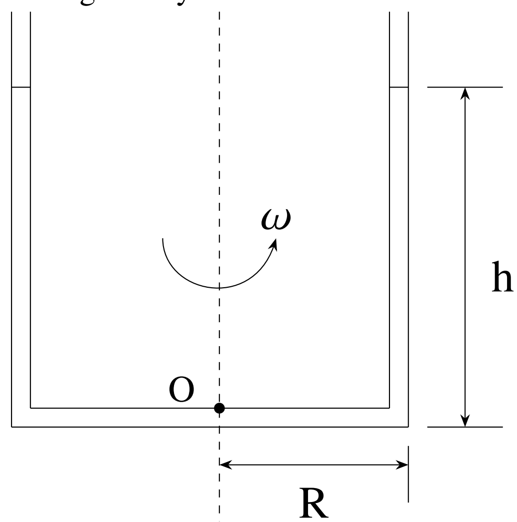
2013-XE-27-39

EE24BTECH11003 - Akshara Sarma Chennubhatla

1) Flow past a circular cylinder can be produced by superposition of the following elementary potential flows:
   a) Uniform flow, doublet
   b) Uniform flow, vortex
   c) Source, vortex
   d) Sink, vortex
2) Let δ, δ_1 and δ_2 denote respectively the boundary-layer thickness, displacement thickness and the momentum thickness for laminar boundary layer flow of an incompressible fluid over a flat plate. The correct relation among these quantities is
   a) $\delta < \delta_1 < \delta_2$
   b) $\delta > \delta_1 > \delta_2$
   c) $\delta > \delta_1 < \delta_2$
   d) $\delta < \delta_1 > \delta_2$
3) In the hydrodynamic entry region of a circular duct, the pressure forces balance the sum of
   a) viscous and buoyancy forces
   b) inertia and buoyancy forces
   c) inertia and surface tension forces
   d) inertia and viscous forces
4) Bodies with various cross-sectional shapes subjected to cross-flow of air are shown in the following figures. The characteristic dimension of all the shapes is the same. The cross-sectional shape with the largest coefficient of drag (i.e. sum of the pressure and skin-friction drags), at any moderately large Reynolds number, is
   a) 
   b) 
   c) 
   d)

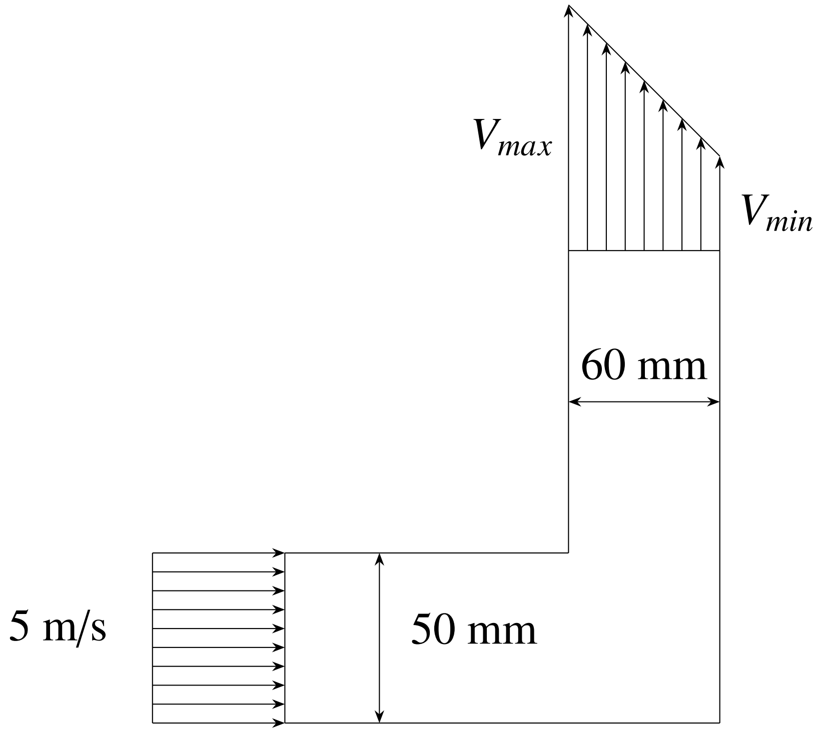


5) A U-tube of a very small bore, with its limbs in a vertical plane and filled with a liquid of density ρ, up to a height of h, is rotated about a vertical axis, with an angular velocity of ω, as shown in the Figure. The radius of each limb from the axis of rotation is R. Let p_a be the atmospheric pressure and g, the gravitational acceleration. The angular velocity at which the pressure at the point O becomes half of the atmospheric pressure is given by



a) $\sqrt{\frac{p_a+2\rho gh}{\rho R^2}}$
b) $\sqrt{\frac{2(p_a+\rho gh)}{\rho R^2}}$
c) $\sqrt{\frac{p_a+2\rho gh}{2\rho R^2}}$
d) $\sqrt{\frac{p_a+\rho gh}{2\rho R^2}}$

6) An incompressible fluid at a pressure of 150 kPa (absolute) flows steadily through a two-dimensional channel with a velocity of 5 m/s as shown in the Figure. The channel has a 90° bend. The fluid leaves the channel with a pressure of 100 kPa (absolute) and linearly-varying velocity profile. v_{max} is four times v_{min}. The density of the fluid is 914.3 kg/m^3. The velocity v_{min}, in m/s, is



a) 25
b) 2.5
c) 2.0
d) 0.2

7) The velocity vector corresponding to a flow field is given, with usual notation, by $\mathbf{V} = 3x\mathbf{i} + 4xy\mathbf{j}$. The magnitude of rotation at the point $(2, 2)$ in rad/s is
   a) 0.75
   b) 1.33
   c) 2
   d) 4
8) The stream function for a potential flow field is given by $\psi = x^2 - y^2$. The corresponding potential function, assuming zero potential at the origin, is
   a) $x^2 + y^2$
   b) $2xy$
   c) $x^2 - y^2$
   d) $x - y$
9) Fully developed flow of an oil takes place in a pipe of inner diameter 50 mm. The pressure drop per metre length of the pipe is 2 kPa. Determine the shear stress, in Pa, at the pipe wall.________
10) The Darcy friction factor f for a smooth pipe is given by $f = \frac{64}{Re}$ for laminar flow and by $f = \frac{0.3}{Re^{0.25}}$ for turbulent flow, where Re is the Reynolds number based on the diameter. For fully developed flow of a fluid of density 1000 kg/m^3 and dynamic viscosity 0.001 Pa.s through a smooth pipe of diameter 10 mm with a velocity of 1 m/s, determine the Darcy friction factor.________
11) Air flows steadily through a channel. The stagnation and static pressures at a point in the flow are measured by a Pitot tube and a wall pressure tap, respectively. The pressure difference is found to be 20 mm Hg. The densities of air, water and mercury, in kg/m^3, are 1.18, 1000 and 13600, respectively. The gravitational acceleration is 9.81 m/s^2. Determine the air speed in m/s.________

Common Data for Questions 12 and 13:

The velocity field within a laminar boundary layer is given by the expression:

$$\mathbf{V} = \frac{Bu_\infty y}{x^{\frac{3}{2}}}\mathbf{i} + \frac{Bu_\infty y^2}{4x^{\frac{5}{2}}}\mathbf{j}$$

where $B = 100m^{\frac{1}{2}}$ and the free stream velocity $u_\infty = 0.1$ m/s.

12) Calculate the x-direction component of the acceleration in m/s^2 at the point $x = 0.5$ m and $y = 50$ mm.__________

13) Find the slope of the streamline passing through the point $x = 0.5$ m and $y = 50$ mm.__________