UCE-305 FLUID MECHANICS
Tutorial No. 7 (Fluid Dynamics - Momentum Equation)

Q1: Find the kinetic energy and the momentum correction factors for the following cases:
(a) Laminar flow through a circular pipe: (Velocity distribution eq. [$\mathbf{u = u_{max}(1- r^2/R^2)}$]

(b) Turbulent flow through a circular pile: (Velocity distribution eq. [$\mathbf{u = u_{max}(y/R)^{1/7}}$]

Here **u** is the local velocity, $\mathbf{u_{max}}$ is the maximum velocity, **r** is any radius < **R**, **R** is the radius of pipe and **y i**s the distance from the pipe surface.

(c) Flow over the any surface with the velocity variation as: 0 at the surface to 4 m/s over a distance of 2 m and constant onwards for a distance of 1 m.

Q2: Calculate the ratio of kinetic energies in lamianr flow to the turbulent flow.

Q3: In a 45^o bend, a rectangular duct of 1 m^2 cross-sectional area is gradually reduced to 0.5 m^2 area. Find the magnitude and direction of force required to hold the duct in position if velocity of flow at 1 m^2 section is 10 m/s and pressure is 30 kPa. Take density of air = 1.16 kg/m^3.

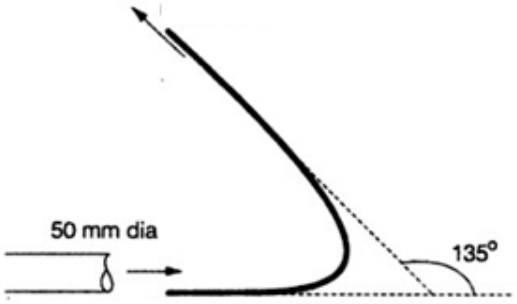
Q4: 360 lps of water is flowing in a pipe. The pipe is bent by 120^o. The inlet diameter is 360 mm and the outlet diameter is 240 mm. The volume of water in the bend is 0.14 m^3. The pressure at the entrance is 72 kN/m^2 and the exit is 2.4 m above the entrance section. Find the force exerted on the bend.

Q5: A 400 mm × 300 m, 90° vertical bend carries 0.5 m^3/s oil of specific gravity 0.85, with a pressure of 118 kN/m^2 at inlet to the bend. The volume of bend is 0.1 m^3 and water enters the bend at 45° to the horizontal. Find the magnitude and direction of force on the bend. Assume both inlet and outlet sections to be at same horizontal level.

Q6: A vertical jet of water 80 mm diameter leaving a nozzle with a velocity of 9 m/s, strikes a horizontal moveable disc of weight 160 N. Jet is deflected horizontally after striking. Determine the vertical distance above the nozzle at which the disc will be held in equilibrium.

Q7: A flat square plate weighing 8 kN is hinged at its top edge and is suspended vertically. A jet of water, 50 mm in diameter strikes the plate normally with a velocity of 50 m/s at its mid-point. Find (i) the horizontal force that should be applied to the plate at its bottom edge to keep it vertical and (ii) the angle of deflection where the plate stays in equilibrium.

Q8: Determine the resultant force and its direction on the vane shown in **Figure** if a water jet of 50 mm dia. and velocity 20 m/s strikes the vane tangentially and is deflected without friction.



Answers:

Q1: (i) 2, 1.33 (ii) 1.06, 1.02 (iii) 1.68, 1.25 **Q2:** 0.43 **Q3:** 22.2 kN, 28.8^{o} **Q4**: 11.6 kN, 24.9^{o} **Q5:** 18.6 kN, 76.4^{o} **Q6:** 3.5 m **Q7**: 2.45 kN, 31.5^{o} **Q8:** 1.45 kN, 22.5^{o}