四能二流體力學第二次期中考(考古題)

1. Consider steady flow of water through the device shown in Fig.1. The areas are A_1=0.2 m^2, A_2=0.5 m^2, and A_3=A_4=0.4 m^2. The mass flow rate out through 3 is given as 388 kg/sec. The volume flow rate in through section 4 is given as 1 m^3/sec, and $\vec{V}_1 = 10\,\vec{i}$ m/sec. If properties are assumed uniform across all inlet and outlet flow sections, determine the flow velocity at section 2.

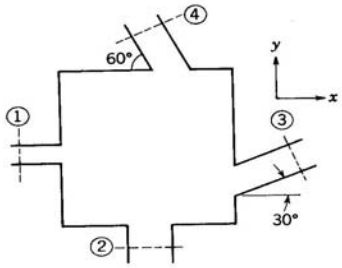

Fig. 1

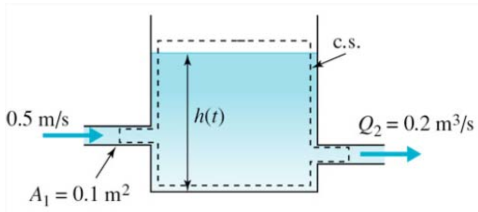

Fig. 2

2. Please determine the rate at which the water level rises (or falls) in an open container if the water coming in through a 0.10-m^2 pipe has a velocity of 0.5 m/s and the flow rate going out is 0.2 m^3/s, as shown in Fig. 2. The container has a circular cross section with a diameter of 0.5 m.

3. A nozzle is attached to a vertical pipe and discharges water into the atmosphere as shown in Fig. 3. When the discharge is 0.1 m^3/s, the gage pressure at the flange is 40 kPa. Determine the vertical component of the anchoring force required to hold the nozzle in place. The nozzle has a weight of 200 N, and the volume of water in the nozzle is 0.012 m^3. Is the anchoring force directed upward or downward? Assume that the density of water is 999 kg/m^3.

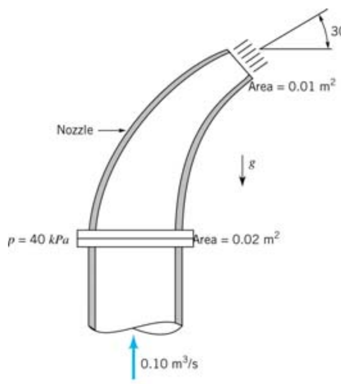

Fig. 3

4. For laminar flow in the entrance to a round pipe with the radius of r_0, as shown in Fig. 4, the entrance flow is uniform, $u=U_0$, and the flow downstream at location x is parabolic in profile, $u(r) = C(r_0^2 - r^2)$. Assume the pressure distribution at location 0 is P_0 and at location x is P_x. P_0 and P_x are constant. At steady state, please determine
   (a) the value of C.
   (b) the viscous drag force exerted on the pipe walls between 0 and x.

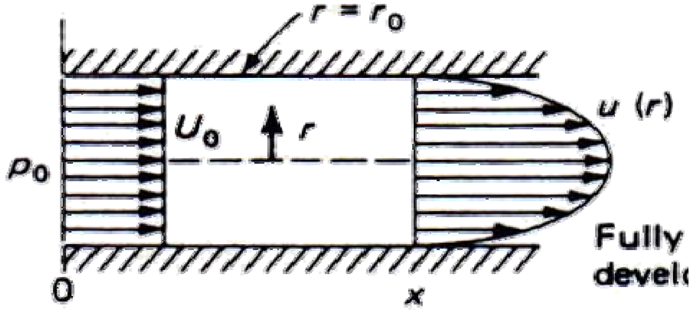

Fig. 4

5. Air flows into the atmosphere from a nozzle and strikes a vertical plate shown in Fig. 5. A horizontal force of 9 N is required to hold the plate in place. Determine the reading on the pressure gage. Assume the flow to be incompressible and frictionless. (Note: ρ_{air} =1.23 kg/m^3)

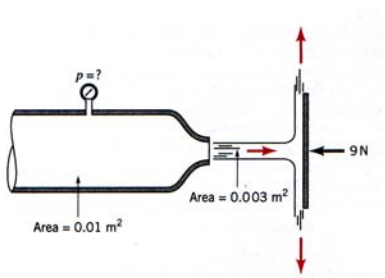

Fig. 5

6. As shown in Fig. 6, the radial variation of velocity at midsection of the 180^o bend is given by rV_θ= constant. The cross section of the bend is square and is on the same horizontal plane. Assume that the velocity is not function of z. Derive an equation for the pressure difference between the outside and the inside of the bend. Express your answer in terms of the mass flow rate $\dot{m}$, the fluid density ρ, the geometric parameters, R_1 and R_2, and the depth of the bend, h.

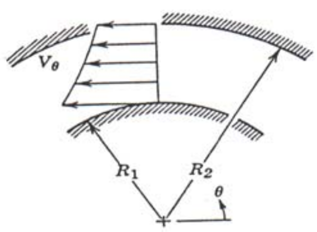

Fig. 6

7. Consider an experiment in which the drag on a two-dimensional body immersed in a steady incompressible flow can be determined from measurement of the velocity distributions far upstream and downstream of the body (see Fig. 7). Velocity far stream is the uniform flow U_∞, and that in the wake of the body is measured to be $u(y)$, which is less than U_∞ due to the drag of the body. Find the drag force per unit length of the body.

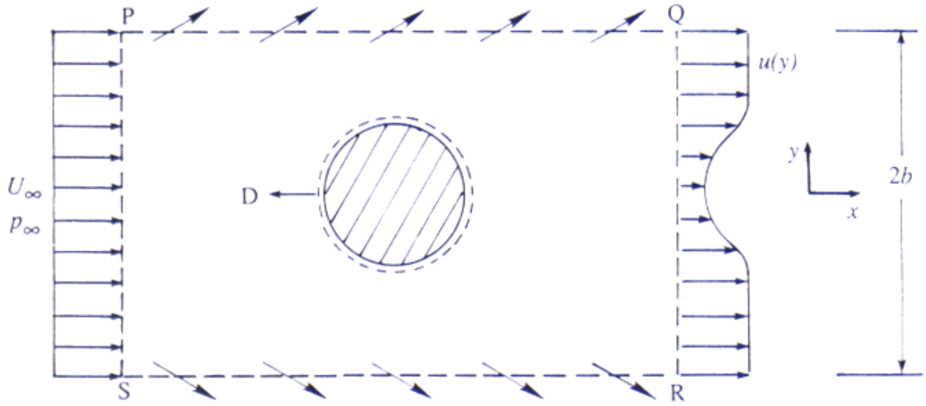

Fig. 7

8. Water flows steadily from a tank mounted on a cart as shown in Fig. 8. After the water jet leaves the nozzle of the tank, it falls and strikes a vane attached to another cart. The carts' wheels are frictionless, and the fluid is inviscid. (30%)
   (a) Determine the tension in rope A.
   (b) Determine the tension in rope B.

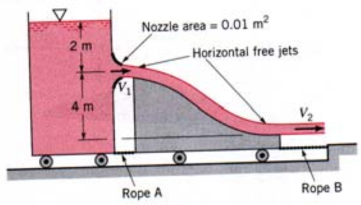

Fig. 8

9. A water jet pump is configured as shown in Fig. 3. The cross-sectional area of the jet is A_j= 0.01 m^2, and the jet velocity 35 m/s. The velocity of the secondary stream of water V_s= 4 m/s and the total cross-sectional area of the duct is 0.08 m^2. Assume that the jet and the secondary flows are mixed thoroughly and leave the pump at station (2) as a uniform flow. The pressure in the jet and secondary flows are equal at the inlet, station (1). Please determine the exit velocity, V_2, and the pressure rise, $P_2 - P_1$. (Neglect the effect of viscous forces.)

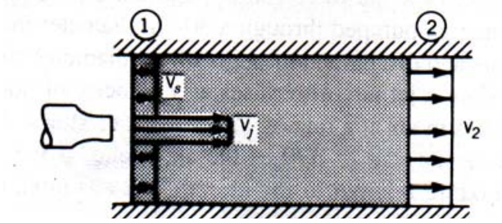

Fig. 9