國立虎尾科技大學 102 學年度第二學期博士班資格考試題

所別：動力機械系機械與機電工程博士班　　　　　　　　　　　　　第 1 頁　共 1 頁

科目：流體力學

注意事項：
（1）本試題共有 4 題，每題 25 分，合計一百分。(close book)
（2）請依序作答於答案卷上並註明題號，若未註明選答題號及超過規定題數時，謹採計作答順序較前之題目計分。
（3）禁止使用計算機

1. 請證明角變形率為 $\frac{d\gamma}{dt} = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}$, 其中 $\bar{V}$ =（u, v）m/s.

2. 請證明靜止的流體壓力為 P = γh, 其中 γ 為流體之比重量, h 為深度.

3. 請寫出 Navier-Stokes 方程式, 並說明每項之物理意義.

4. 請說明伯努力方程式, 並說明各項之物理意義.

國立虎尾科技大學 107 學年度第二學期博士班資格考試題

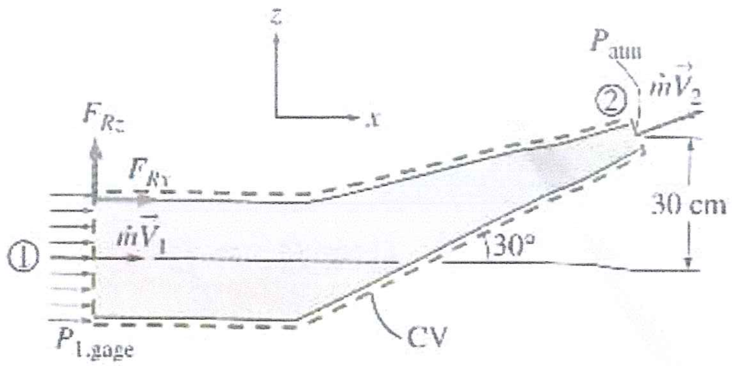
系別：動力機械工程系機械與機電工程博士班　　　　　　第 1 頁　共 1 頁
科目：流體力學

注意事項：
(1) 本試題共有 3 題，合計一百分。
(2) 請依序作答於答案卷上並註明題號，若未註明選答題號及超過規定題數時，謹採計作答順序較前之題目計分。
(3) 可使用計算機 close book

1. 解釋名詞：(30%)
   (a) 速度邊界層
   (b) 邊界層之位移厚度
   (c) 邊界層之動量厚度

2 在一水平圓管中，流體已經達到完全發展之穩態層流，試推導其速度分佈。(30%)

3. 收縮的肘管被用來使水平管中以 14kg/s 流動的水流向上轉向 30° 並加速，如圖所示。肘管排水至大氣中，其截面積在入口是 113cm²，在出口是 7 cm²。出口與入口的中心高度差是 30cm，肘管與其內水的重量被視為是可忽略的。試求(a)在肘管入口中心的表壓力，(b)將肘管夾著不動所需要的力。(40%)



國立虎尾科技大學 110 學年度第 2 學期博士班資格考試題

系別：動力機械工程系機械與機電工程博士班

科目：流體力學 Fluid Mechanics

注意事項：
（1）本試題共有 5 題，每題 20 分，合計一百分。
（2）請依序作答於答案卷上並註明題號，若未註明選答題號及超過規定題數時，謹採計作答順序較前之題目計分。
（3）閉書考/可使用計算機； close book, and regular calculator is allowed

1. Write Basic Definitions
   (a) Stream line, Path line, Smoke line, Particle line
   (b) Three types of the Bernoulli Equations, write them and describe their meanings of each part
   (c) What is the no-slip condition? What causes it? What condition cannot apply the assumption? Give an example.
   (d) What is forced flow? How does it differ from natural flow? Is flow caused by winds forced or natural flow?
   (e) What is a boundary layer? What causes a boundary layer to develop?

2. Some aeronautical engineers are designing an airplane and wish to predict the lift produced by their new wing design. The chord length Lc of the wing is 1.12 m, and its planform area A (area viewed from the top when the wing is at zero angle of attack) is 10.7 m^2. The prototype is to fly at V= 52.0 m/s close to the ground where T= 25 °C. They build a one-tenth scale model of the wing to test in a pressurized wind tunnel. The wind tunnel can be pressurized to a maximum of 5 atm. At what speed and pressure should they run the wind tunnel in order to achieve dynamic similarity?

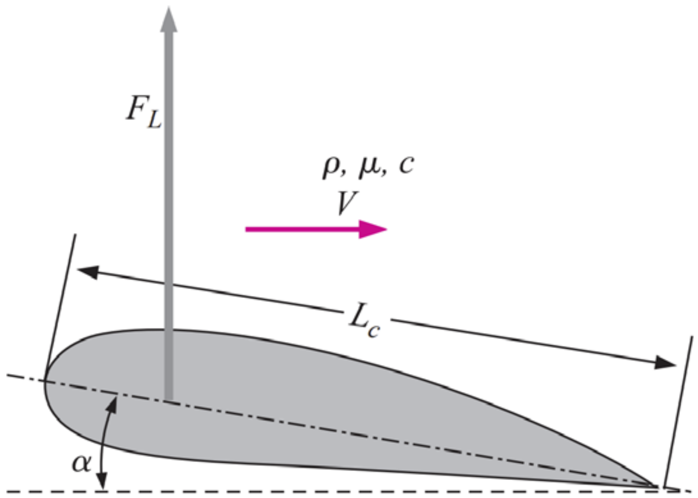


Fig. 1

3. The clutch system shown in Fig.2 is used to transmit torque through a 3-mm-thick oil film with μ = 0.6 N・s/m^2 between two identical 30-cm-diameter disks. When the driving shaft rotates at a speed of 3000 rpm, the driven shaft is observed to rotate at 2698 rpm. Assuming a linear velocity profile for the oil film, determine the transmitted torque and efficiency.

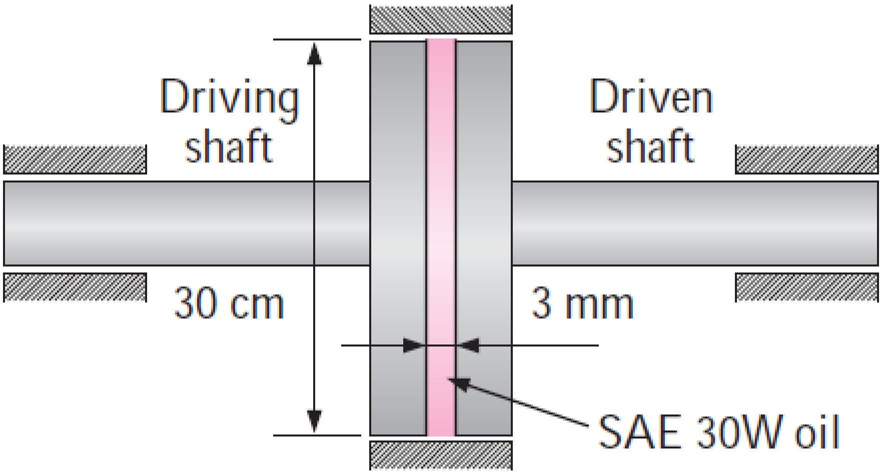


Fig. 2

科目：流體力學 Fluid Mechanics

4. A long, solid cylinder of radius 2 ft hinged at point A is used as an automatic gate, as shown in Fig.3. When the water level reaches 15 ft, the cylindrical gate opens by turning about the hinge at point A. Determine (a) the hydrostatic force acting on the cylinder and its line of action when the gate opens and (b) the weight of the cylinder per ft length of the cylinder.

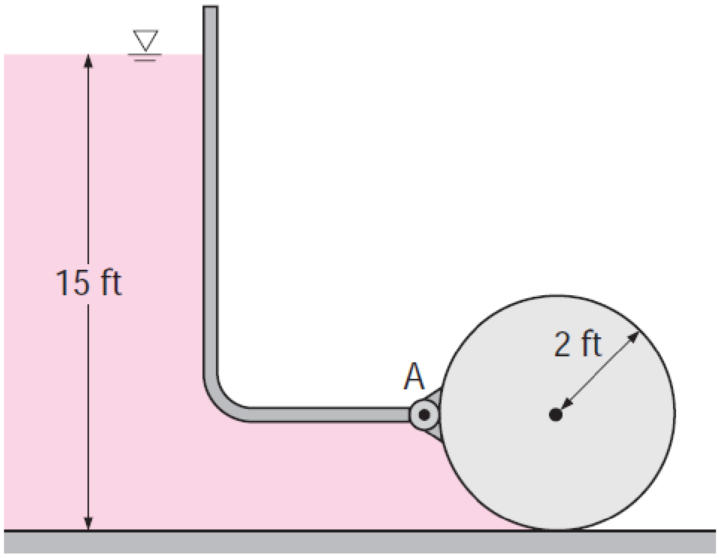


Fig. 3

5. A reducing elbow is used to deflect water flow at a rate of 30 kg/s in a horizontal pipe upward by an angle $\theta = 110^\circ$ from the flow direction while accelerating it. The elbow discharges water into the atmosphere. The crosssectional area of the elbow is 150 cm^2 at the inlet and 25 cm^2 at the exit. The elevation difference between the centers of the exit and the inlet is 40 cm. The mass of the elbow and the water in it is 50 kg. Determine the anchoring force needed to hold the elbow in place. Take the momentum-flux correction factor to be 1.03.

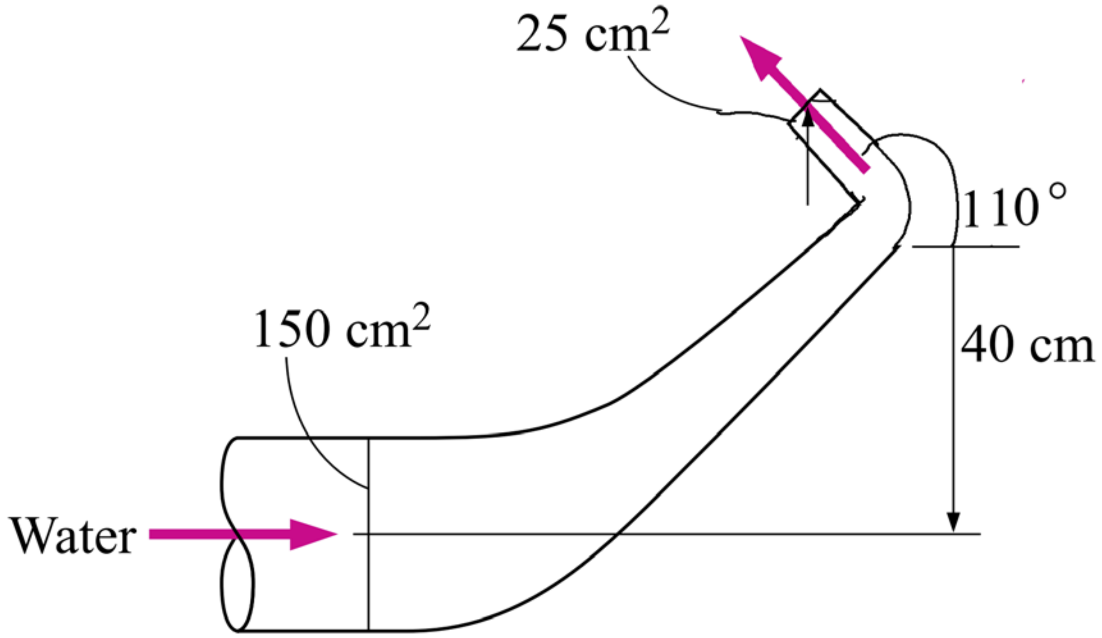


Fig.4

國立虎尾科技大學 111 學年度第 1 學期博士班資格考試題

系別：動力機械工程系機械與機電工程博士班　　　　　　

科目：流體力學 Fluid Mechanics

注意事項：
（1）本試題共有 5 題，每題 20 分，合計一百分。
（2）請依序作答於答案卷上並註明題號，若未註明選答題號及超過規定題數時，謹採計作答順序較前之題目計分。
（3）閉書考/可使用計算機； close book, and regular calculator is allowed

1. (a) Consider the following steady, two-dimensional velocity field:

$$\vec{V} = (u, v) = [a^2 - (b - cx)^2]\vec{i} + (-4cby + 3c^2xy)\vec{j}$$

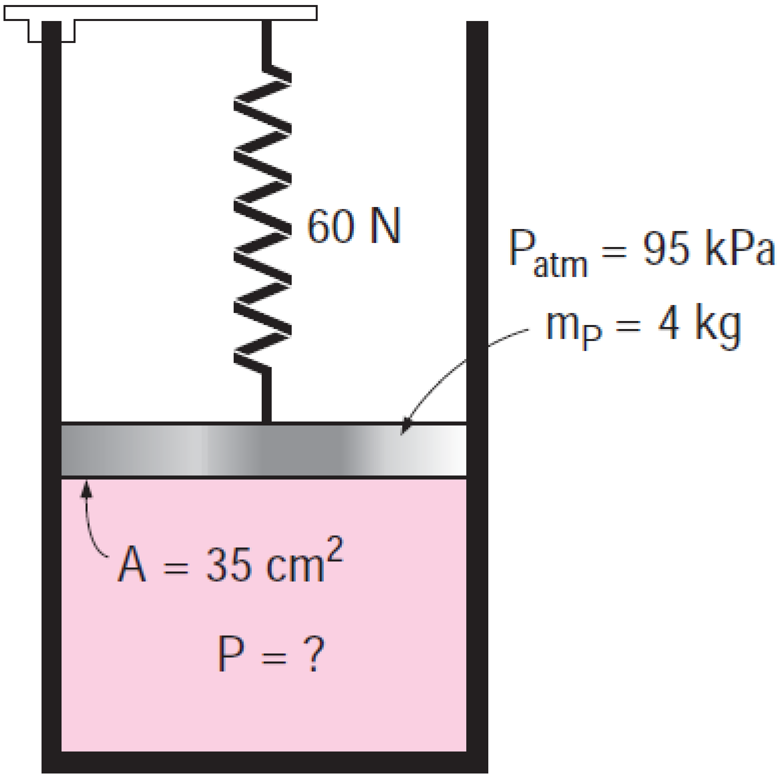
Is there a stagnation point in this flow field? If so, where is it?

(b) A steady, incompressible, two-dimensional velocity field is given by the following components in the xy-plane:

u=1.1+2.8x+0.65y; v=1.2-2.1x-3.2y

Calculate the acceleration field (find expressions for acceleration components a_x and a_y), and calculate the acceleration at the point (x, y)=(-3, 2).

2. A gas is contained in a vertical, frictionless piston – cylinder device. The piston has a mass of 4 kg and a crosssectional area of 35 cm^2. A compressed spring above the piston exerts a force of 60 N on the piston. If the atmospheric pressure is 95 kPa, determine the pressure inside the cylinder.



3. A frustum-shaped body is rotating at a constant angular speed of 300 rad/s in a container filled with SAE 10W oil at 20°C ($\mu = 0.1$ Pa· s), as shown in Fig.2. If the thickness of the oil film on all sides is 1.2 mm, determine the power required to maintain this motion. Also determine the reduction in the required power input when the oil temperature rises to 80°C ($\mu = 0.0078$ Pa· s).

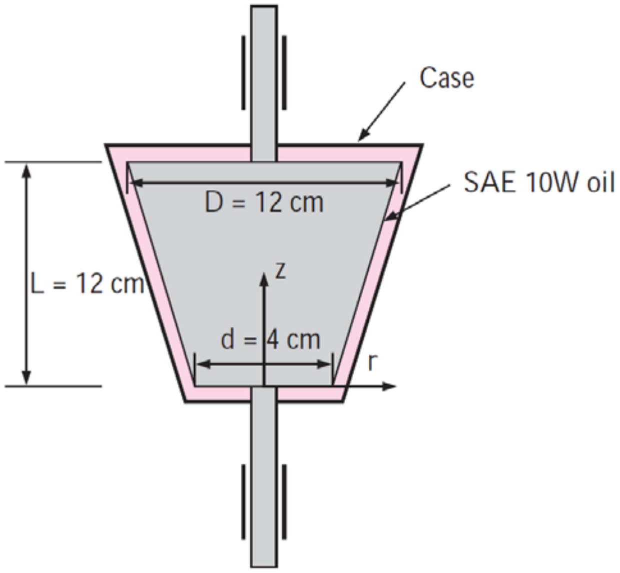


Fig.2

4. Water enters a centrifugal pump axially at atmospheric pressure at a rate of 0.12 m^3/s and at a velocity of 10 m/s, and leaves in the normal direction along the pump casing, as shown in Fig. 3. Determine the force acting on the shaft (which is also the force acting on the bearing of the shaft) in the axial direction.

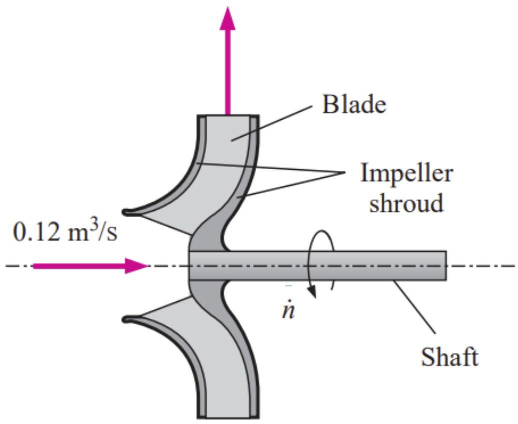


Fig. 3

5. The bathroom plumbing of a building consists of 1.5-cm-diameter copper pipes with threaded connectors, as shown in Fig.4. If the gage pressure at the inlet of the system is 200 kPa during a shower and the toilet reservoir is full (no flow in that branch), determine the flow rate of water through the shower head. (b) Determine the effect of flushing of the toilet on the flow rate through the shower head. Take the loss coefficients of the shower head and the reservoir to be 12 and 14, respectively.

   Assumptions : 1. The flow is steady and incompressible. 2. The flow is turbulent and fully developed. 3. The reservoir is open to the atmosphere. 4. The velocity heads are negligible.

   Properties : The properties of water at 20 °C are $\rho = 998$ kg/m^3, $\mu = 1.002 \times 10^{-3}$ kg/m·s, and the roughness of copper pipes is $\varepsilon = 1.5 \times 10^{-6}$ m.

   Equations :

$$\frac{P_1}{\rho g} + \alpha_1 \frac{V_1^2}{2g} + z_1 + h_{\text{pump}, u} = \frac{P_2}{\rho g} + \alpha_2 \frac{V_2^2}{2g} + z_2 + h_{\text{turbine}, e} + h_L$$

$$h_L = \left(f\frac{L}{D} + \sum K_L \right) \frac{V^2}{2g}$$

   <u>* Note : The problem is not necessary to solve all unknowns. But need to list all equations and write how to solve them.</u>

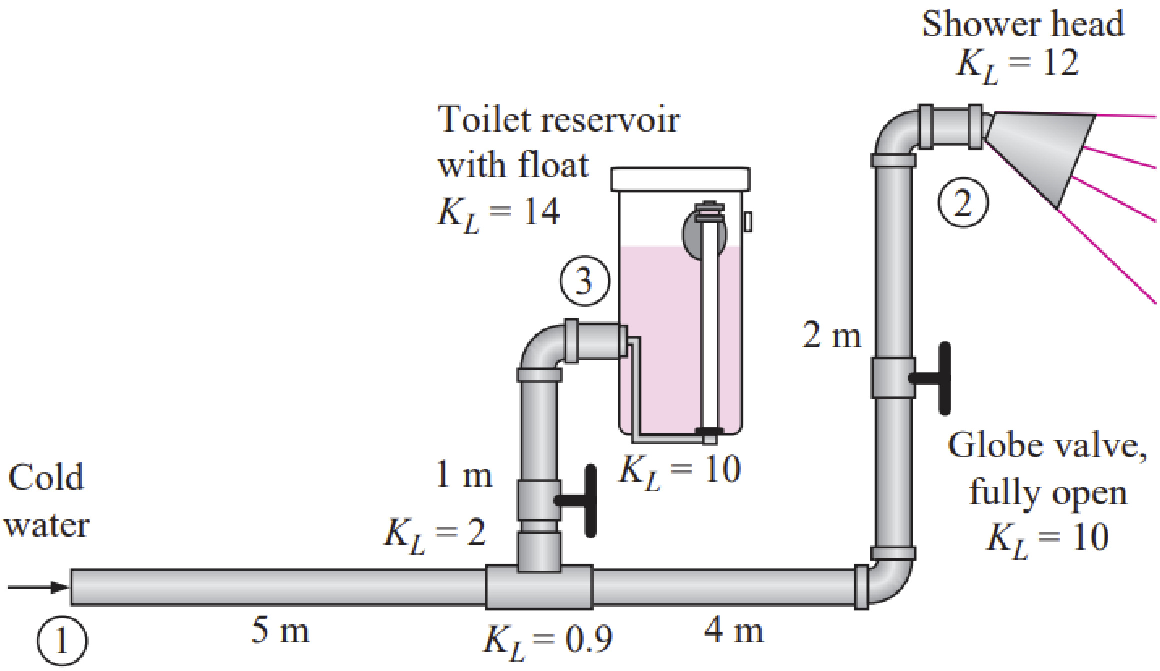


Fig.4

國立虎尾科技大學 111 學年度第 2 學期博士班資格考試題

系別：動力機械工程系機械與機電工程博士班

科目：流體力學 Fluid Mechanics

注意事項：
（1）本試題共有 5 題，每題 20 分，合計 100 分。
（2）請依序作答於答案卷上並註明題號，若未註明選答題號及超過規定題數時，謹採計作答順序較前之題目計分。
（3）閉書考/可 使用計算機
Close book and Engineering calculator is allowable.

1. Write the following definitions.
   (a) Stream Line
   (b) Unit and Dimension
   (c) Stagnation Point
   (d) Viscosity
   (e) Boundary Layer

2. The following equation is dimensionally homogeneous:

$$\mathrm{F} = \frac{4Ey}{(1-\nu^2)(Rd^2)}\left[(h-y)\left(h-\frac{y}{2}\right)A - A^3\right]$$

Where, E ≡ Young's modulus; ν ≡ Poisson's ratio; d, y, h ≡ distances; R ≡ ratio of distances; F ≡ force. What are the dimensions of A?

3. Two chambers with the same fluid at their base are separated by a piston whose weight is 125 N, as shown in Fig.1. Calculate the gage pressures in chambers A and B.

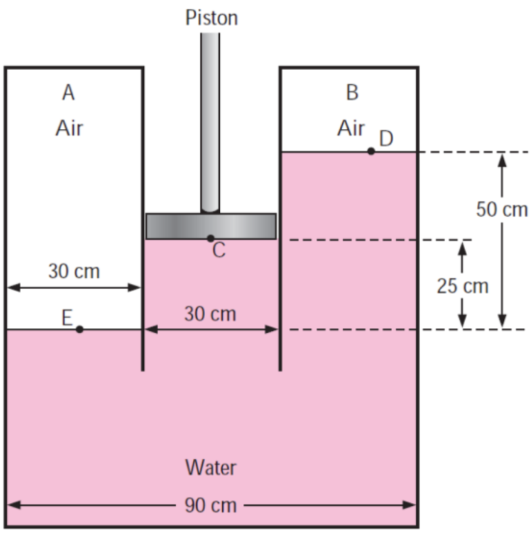


Fig.1

4. A cylindrical tank of water rotates in solid-body rotation, counterclockwise about its vertical axis at angular speed n = 200 rpm. Calculate the vorticity of fluid particles in the tank.

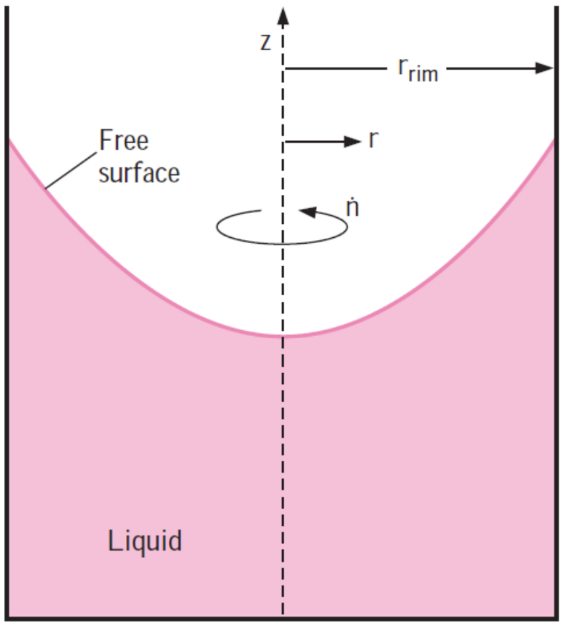


Fig.2

國立虎尾科技大學 111 學年度第 2 學期博士班資格考試題

科目：流體力學 Fluid Mechanics

5. Water is flowing through a 12-cm-diameter pipe that consists of a 3-m-long vertical and 2-m-long horizontal section with a 90° elbow at the exit to force the water to be discharged downward, as shown in Fig.3, in the vertical direction. Water discharges to atmospheric air at a velocity of 4 m/s, and the mass of the pipe section when filled with water is 12 kg per meter length. Determine the moment acting at the intersection of the vertical and horizontal sections of the pipe (point A). What would your answer be if the flow were discharged upward instead of downward?

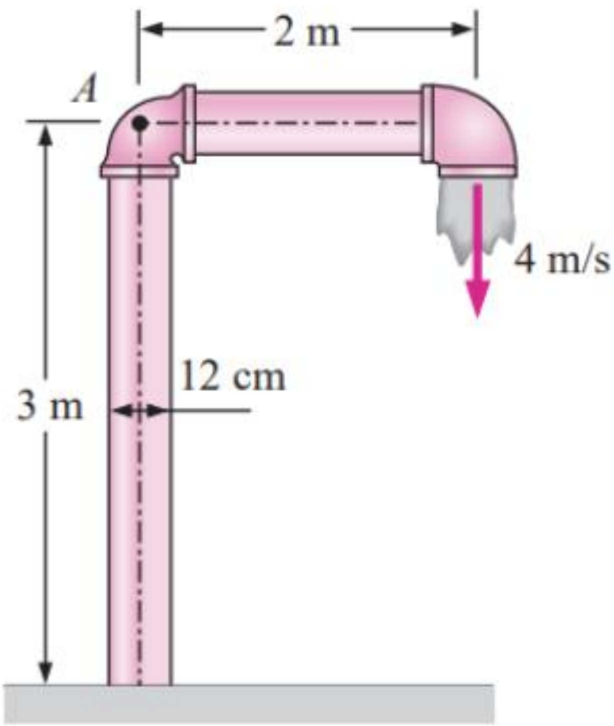


Fig.3