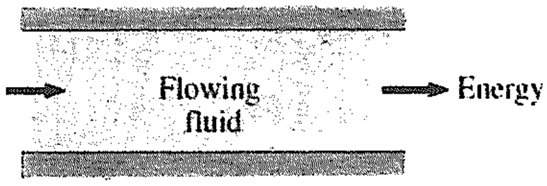
The density of water to be 1000 kg/m^3 and gravitational acceleration = 9.81 m/s^2

(1) (25)



(a) (10) Please show that the flow energy (or flow work) is equal to P/ρ which is the energy per unit mass needed to move the fluid and maintain flow.

(b) (15) Derive a relation for the capillary rise h of a liquid between two large parallel plates a distance t apart inserted into the liquid vertically. Take the contact angle, liquid density and surface tension to be ϕ, ρ and σ_s, respectively.

(2) (20) The two sides of a V-shaped water trough are hinged to each other at the bottom where they meet, as shown in Fig. P3–71, making an angle of 45° with the ground from both sides. Each side is 0.75 m wide, and the two parts are held together by a cable and turnbuckle placed every 6 m along the length of the trough. Calculate the tension in each cable when the trough is filled to the rim. The weights of the trough and cable are negligible.

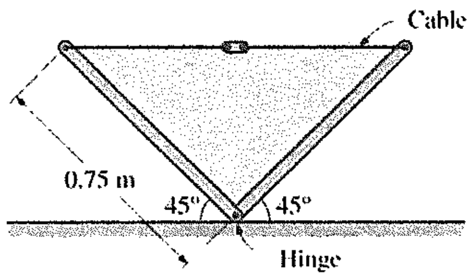
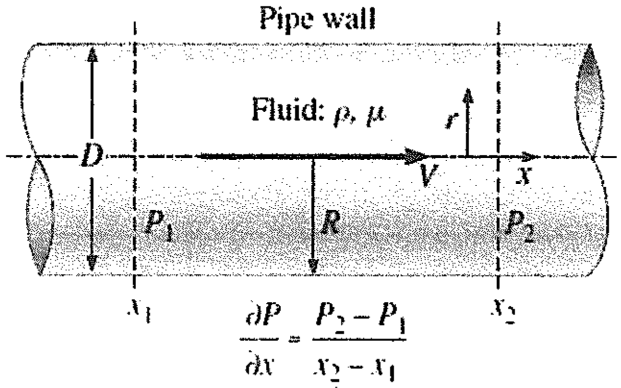


FIGURE P3–77

(3) (15) Derive the Bernoulli Equation along a streamline for steady, incompressible flow. Please define all the parameters you used in the derivation.

(4) (20) Use linear momentum equation and control volume to solve the problem followed. An orbiting satellite has a mass of m_{sat} = 5000 kg and is traveling at a constant velocity of V_0. To alter its orbit, an attached rocket discharges m_f =100 kg of gases from the reaction of solid fuel at a velocity V_f=3000 m/s relative to the satellite in a direction opposite to V_0. The fuel discharge rate is constant for 2 s. Determine (*a*) (10) the acceleration of the satellite during this 2-s period and (*b*) (10)the thrust exerted on the satellite.

(5) (20) Consider steady, incompressible, laminar flow of a Newtonian fluid in an infinitely long round pipe of radius R (Shown in the right figure). Ignore the effects of gravity since the pipe is horizontal. Pressure is a function of x only and pressure gradient $\partial P/\partial x$ is constant. u is the velocity component in x direction. Derive the velocity profile u(r) for fully developed laminar flow using Navier-stokes Equation given by



$$\frac{1}{r}\frac{\partial(ru_r)}{\partial r}+\frac{1}{r}\frac{\partial(u_\theta)}{\partial\theta}+\frac{\partial u}{\partial x}=0$$

$$\rho\left(\frac{\partial u}{\partial t}+u_r\frac{\partial u}{\partial r}+\frac{u_\theta}{r}\frac{\partial u}{\partial\theta}+u\frac{\partial u}{\partial x}\right)=-\frac{\partial P}{\partial x}+\mu\left(\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u}{\partial\theta^2}+\frac{\partial^2 u}{\partial x^2}\right)$$

試題隨卷繳回