October 5, 2009

1. The velocity distribution for the flow of a Newtonian fluid between two wide, parallel plates (See Fig. 1) is given by the equation

$$u = \frac{3V}{2}\left[1 - \left(\frac{y}{h}\right)^2\right]$$

where V is the mean velocity. The fluid has a viscosity of 0.04 lb·s/ft^2. Also, V = 2 ft/s and h = 0.2 in. Determine: (a) the shearing stress acting on a plane parallel to the walls and passing through the centerline (midplane), and (b) the shear-force $F = \tau \cdot A$ acting on the bottom wall when the area of the bottom wall is A =2 ft^2.

2. The water in a 25-m-deep reservoir is kept inside by a 150-m-wide wall whose cross section is an equilateral triangle, as shown in Fig. 2. Determine (a) the force F_R acting on the inner surface of the wall and its line of action y_R and (b) the magnitude of the horizontal component of this force, F_H. (γ= 9.81 kN/m^3; I_{xc} = ab^3/12)

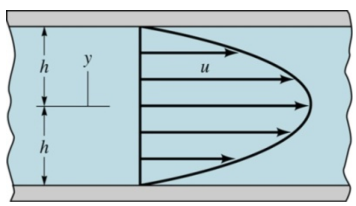

Fig. 1

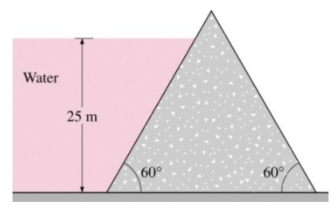

Fig. 2

3. Water flows under the sluice gate shown in Fig. 3. Determine the flow rate Q of the channel. In the figure, the contraction coefficient C_c = 0.61.

4. A fluid particle flowing along a stagnation streamline, as shown below, slows down as it approaches the stagnation point. The location of a particle is given approximately by s = 0.6$e^{-0.5t}$, where t is in second and s is in feet. (a) Determine the speed of the fluid particle at time t = 1 sec by using the relation $V_P(t) = ds/dt$. (b) By knowing that s = 0.6$e^{-0.5t}$, the fluid particle velocity $V_P(t)$ can be rewritten as a function of s such that $V(s) = -0.5s$. Determine the speed of the fluid at s = 1 ft. (c) Determine the fluid acceleration along the streamline a_s at s = 1 ft.

(Note: $\underline{a} = a_s\hat{\boldsymbol{s}} + a_n\hat{\boldsymbol{n}}$, where $a_s = V\frac{\partial V}{\partial s}$ and $a_n = \frac{V^2}{R}$)

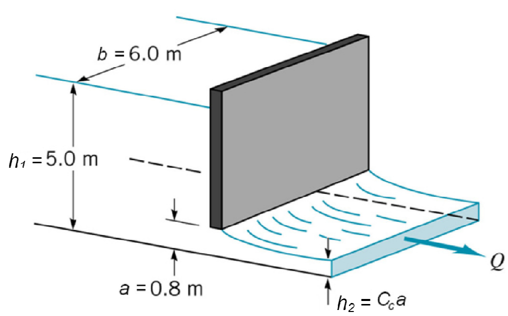

Fig. 3

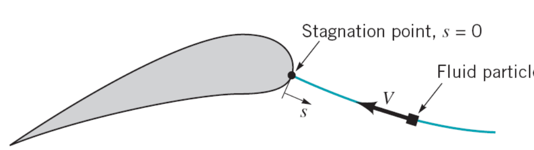

Fig. 4