**057:20 TEST # 1 Fall 2003**

**Prob. 1**

**Information and assumptions**

Provided in problem statement

From Table A.4, $\mu = 6.2\times10^{-1}\ N\cdot s/m^2$

**Find**

Velocity and shear stress at 12mm from wall;

Velocity and shear stress at wall.

**Solution**

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Velocity

$$u = -\frac{1}{2\mu}\frac{dp}{dx}\left(By - y^2\right)$$

$$B = 0.05m$$

$$\frac{dp}{dx} = -1600\ N/m^2$$ (Eqn. = 2)

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$$u_{12mm} = \left(1600/\left(2\times0.62\right)\right)\left(0.05\times0.012 - \left(0.012\right)^2\right)$$

$$u_{12mm} = 0.588m/s$$ (Inter. + Ans. = 1)

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$$u_{0mm} = \left(1600/\left(2\times0.62\right)\right)\left(0.05\times0 - \left(0\right)^2\right)$$

$$u_{0mm} = 0.0m/s$$ (Inter. + Ans. = 1)

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Shear stress

$$\tau = \mu\frac{du}{dy} = -\frac{1}{2}\frac{dp}{dx}\left(B - 2y\right)$$ (Eqn. = 4)

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$$\tau_{12mm} = \left(1600/2\right)\left(0.05 - 2\times0.012\right)$$

$$\tau_{12mm} = 20.8N/m^2$$ (Inter. + Ans. = 1)

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$$\tau_{0mm} = \left(1600/2\right)\left(0.05 - 0\right)$$

$$\tau_{0mm} = 40N/m^2$$ (Inter. + Ans. = 1)

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**Prob. 2**

**Information and assumptions**

Provided in problem statement
Neglect volume associated with bends

**Find**

Specific gravity of liquid in left leg

**Solution**

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Equating pressures at bottom of liquid in left leg

$$(34-10)\times 10^{-2}\times 9810 = 30\times 10^{-2}\times 9810\times S$$ (Eqn. + Inter. = 9)

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$$S = 0.8$$ (Ans. = 1)

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**Prob. 3**

**Information and assumptions**

Provided in problem statement

**Find**

Force acting on hinge

**Solution**

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$$F = \bar{p}A \qquad \text{(Eqn. = 3)}$$

$$= (3+4.5)\times 9810\times 9\times 9 = 5,960,000N \qquad \text{(Inter. + Ans. = 1)}$$

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$$y_{cp} = \bar{y} + \bar{I}/\bar{y}A \qquad \text{(Eqn. = 3)}$$

$$= 7.5+9\times 9^3/(12\times 7.5\times 9\times 9) = 8.40m \qquad \text{(Inter. + Ans. = 1)}$$

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$$F_{hinge} = F\left(d - y_{cp}\right)/h \qquad \text{(Eqn. = 1)}$$

$$= 5,960,000\times(12-8.40)/9$$

$$= 2,384,000N = 2,384kN \qquad \text{(Inter. + Ans. = 1)}$$

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**Prob. 4**

**Information and assumptions**

Provided in problem statement

A tank with one inflow and two outflows is described in the textbook.

**Find**

Is the tank filling or emptying?

Rate at which the tank level is changing.

**Solution**

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$$Inflow = 10 \times \pi \times 2^2 / 144 = 0.8727 cfs$$ (Eqn. + Inter. + Ans. = 2)

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$$Outflow = \left(7 \times \pi \times 3^2 / 144\right) + \left(4 \times \pi \times 1.5^2 / 144\right) = 1.571 cfs$$

(Eqn. + Inter. + Ans. = 2)

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**Outflow > Inflow, thus, tank is emptying** (Ans. = 2)

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$$\frac{dh}{dt} = Q / A$$ (Eqn. = 3)

$$= \left(1.571 - 0.8727\right) / \pi \times 3^2 = 0.0247 \ ft/s$$ (Inter. + Ans. = 1)

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