Biomedical Engineering Program
Midterm exam. In Fluid mechanics (MPE171) 2017-2018
Time Allowed 75 minutes (20 total marks)

Name : ....

Section : ....

Question (1) : For the piston-cylinder arrangement shown in Fig. 1, the lubricant has a kinematic viscosity of 3×10^{-5} m^2/s, and specific gravity of 0.9 . If the the power dissipated in friction is 200 Watt , what the mean velocity of the piston.

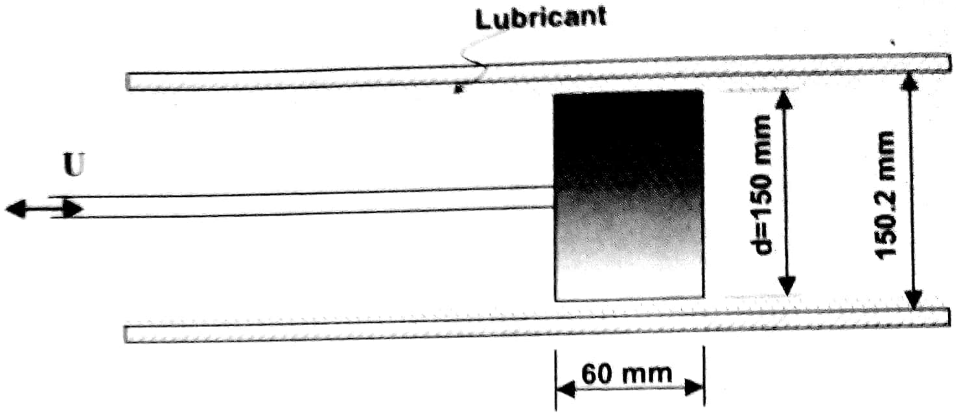

Fig. 1

Question (2) : A piston having a cross-sectional area of 0.1 m^2 is located in a cylinder containing water as shown in Figure 2. An open U-tube manometer is connected to the cylinder as shown. Calculate the height h if the mass of the piston is 1300kg.

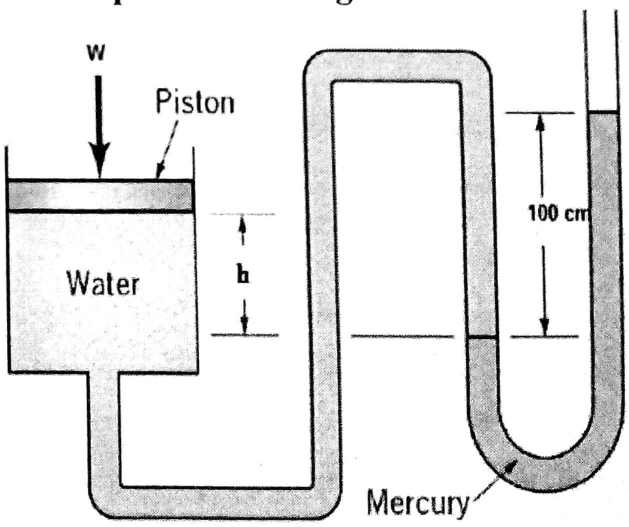

Fig.2

Question (3) : Circular gate ABC in the Fig. 3. is 6m in diameter and is hinged at B. Compute the force P just sufficient to keep the gate from opening.

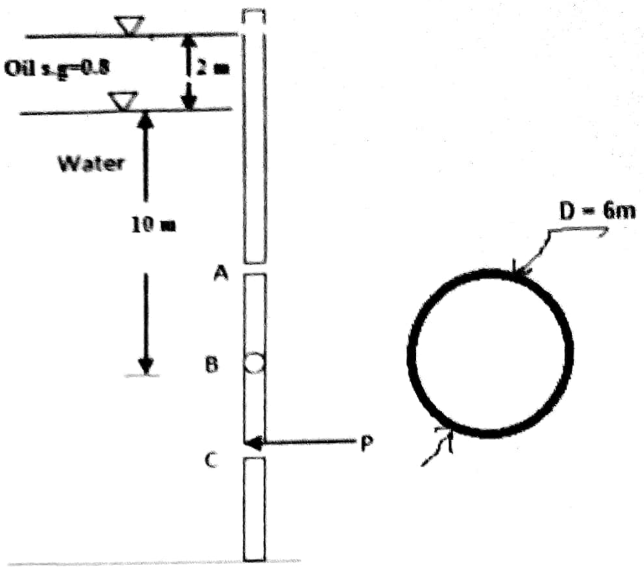

Fig.3

Question (4) : A uniform body (s.g=0.6) of size 6m × 3m × 1m floats in water. Determine the meta-centric height $\overline{GM}$ and check stability.

Program of Biomedical Engineering.
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Midterm exam 2017-2018
Fluid Mechanics

Question (1) :

Given:

$v=3\times10^{-5}$ m²/s, s.g=0.9

Power=200 W

Required: U

Solution:

$$\mu = \nu\rho = 3\times10^{-5}\times900$$
$$= 0.027\ Pa.s$$

$$A = \pi dL = \pi\times0.15\times0.6$$
$$= 0.3826\ m^2$$

$$y = \frac{0.1502-0.15}{2} = 0.0001m$$

$$F = \frac{\mu UA}{y} = \frac{Power}{U}$$

$$U^2 = \frac{200\times0.0001}{0.3826\times0.027}$$

U = 1.391 m/s

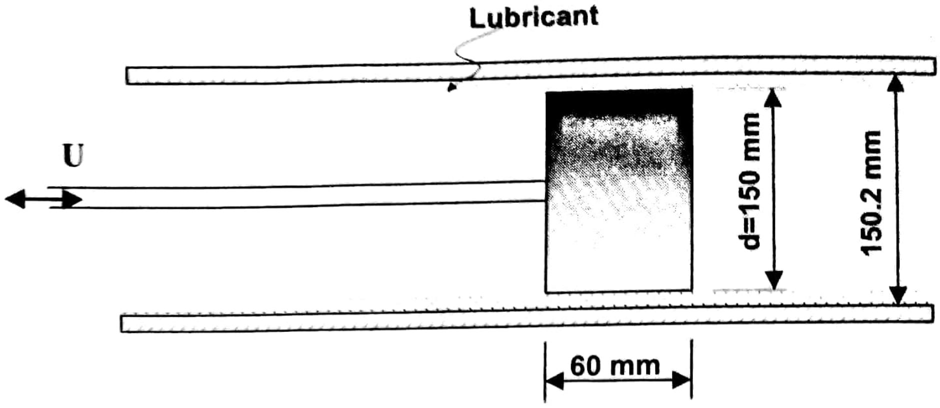


Fig. 1

Question (2) :

Given:

A=0.1 m², m=1300 kg

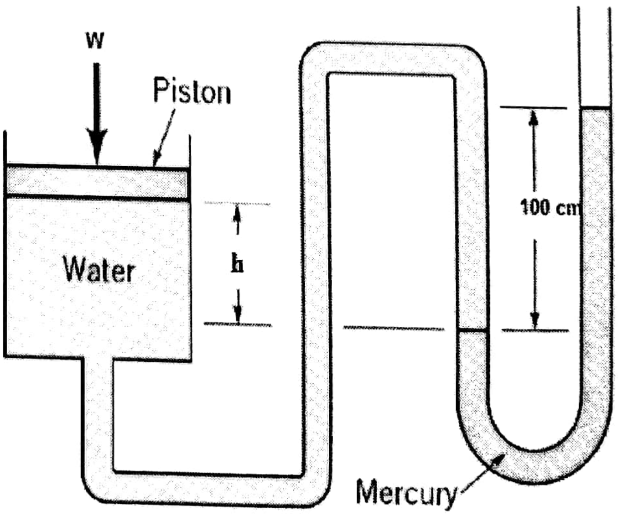
Required: h

Solution:

$$P_x = P_y = P_z = P_n$$

$$\gamma_{Hg}\times1 = \gamma_w(h) + \frac{mg}{A}$$

$$h = [\gamma_{Hg}\times1 - \frac{(mg)}{A}]\frac{1}{\gamma_w} = 0.6\ m = 60\ cm$$

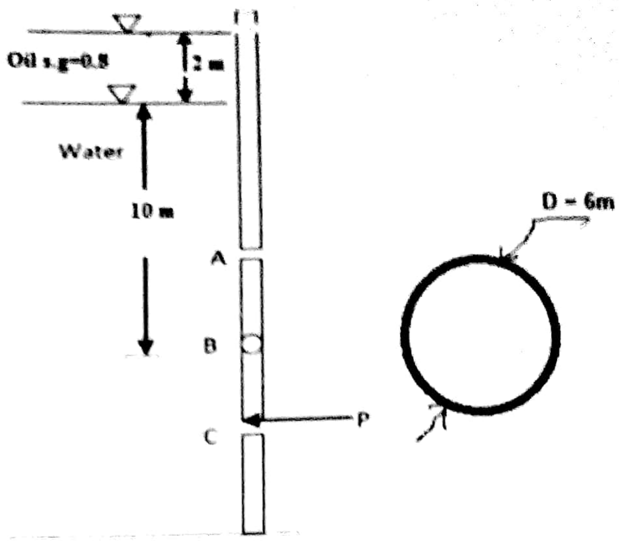


Question (3) :

Given: ho=2 m, D=6m

Required: P

Solution:



$$P_W = P_O$$

$$9810 \times h_{eq} = 0.8 \times 9810 \times 2$$

$$h_{eq} = 1.6\ m$$

$$h_c = 11.6\ m$$

$$F_W = \gamma_w A h_c = 3215.87\ kN$$

$$I_{cc} = \frac{\pi D^4}{64} = 63.59\ m^4$$

$$h_p = h_c + \frac{I_{cc}}{A h_c} = 11.97\ m$$

$$\sum_B \text{Moment} = 0$$

$$P \times 1 = F_W \times (h_p - h_C)$$

$$P = 1189.87\ kN$$

Question (4) :

Given: s.g=0.6

Required: $\overline{GM}$ and check stability

Solution:

$$h = s.g \times L = 0.6\ m$$

$$\overline{BG} = \frac{L}{2} - \frac{h}{2} = 0.2\ m$$

$$\overline{BM} = \frac{I_{cc}}{V_s} = \frac{\frac{b \times w^3}{12}}{b \times w \times h} = \frac{\frac{6 \times 3^3}{12}}{6 \times 3 \times 0.6} = 1.25\ m$$

$$\overline{GM} = \overline{BM} - \overline{BG} = 1.25 - 0.2 = 1.05\ m$$

The body is stable.