# Biomedical Engineering Program
## Midterm exam. In Fluid mechanics (MPE171) 2018-2019
**Time Allowed 60 minutes (20 total marks)**

**Name :** ..................................................................................................

**Section :** ..................................................................................................

**Question (1) :** For the shaft-bearing arrangement shown in Fig. 1, the lubricant has a kinematic viscosity of $3\times10^{-5}$ $m^2/s$, and specific gravity of 0.8. If the the power dissipated in friction is 515 Watt , what the rotational speed of the rotating shaft N, in rpm.

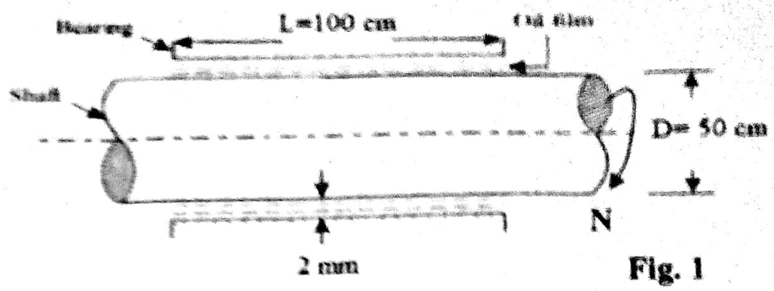


Fig. 1

**Question (2) :** Determine the mass of piston in the Fig. 2 if the piston area is 0.1 $m^2$.

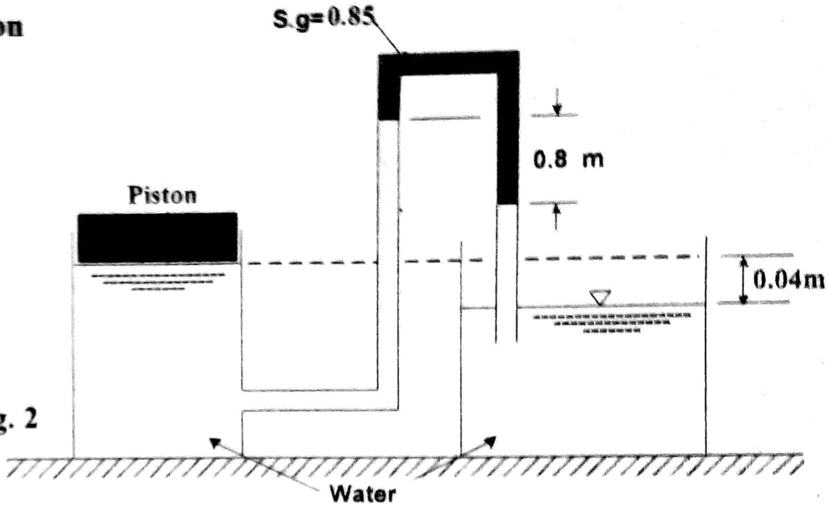


Fig. 2

**Question (3) :**

Draw the pressure distribution on the gate OA. Calculate the following:

a) the hydrostatic force on the gate (2 m wide) and the location of their line of action. b) the horizontal reaction P exerted by the wall at point A.

**Question (4) :** For the shown in Fig. 4, calculate the following: a) the specific gravity of the hollow cylinder. b) the metacenter height $\overline{GM}$ and show that is stable or not?

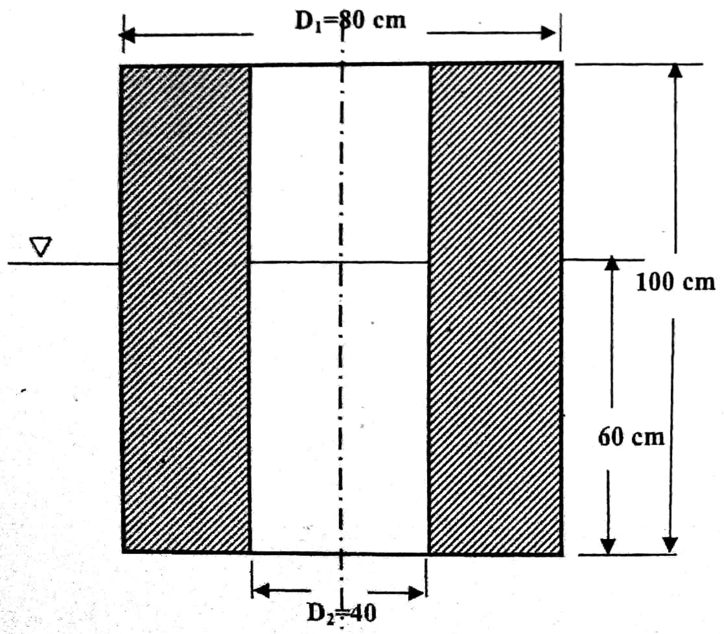


Fig. 4

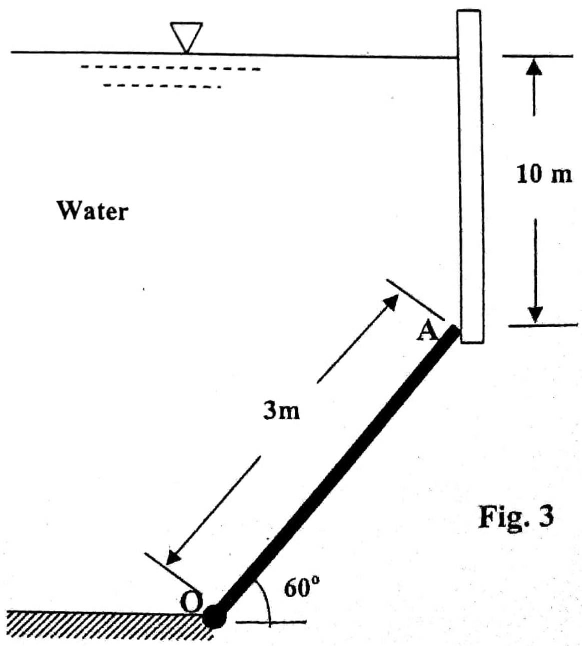


Fig. 3

*Good Luck* *Dr. Ahmed Abd Elsalam*

## Biomedical Engineering Program
## Model answer midterm exam. In Fluid mechanics (MPE171) 2018-2019

**Question (1)**

**Given:** L=1m, D=0.5m, y=0.002m , $v=3\times10^{-5}$ $m^2/s$, P=515 W

**Required:** N

**Solution:**

$$\mu = v \times \rho = 3 \times 10^{-5} \times 0.8 \times 1000 = 0.024\ Pa.s$$

$$A = \pi DL = 3.14 \times 0.5 \times 1 = 1.575\ m^2$$

$$P = F \times U = \frac{\mu AU}{y} \times U$$

$$515 = \frac{0.024 \times 1.57}{0.002} U^2$$

We get U= 5.228 m/s

$$U = \frac{\pi DN}{60}$$

$$5.228 = \frac{3.14 \times 0.5 \times N}{60}$$

N=199.79 rpm

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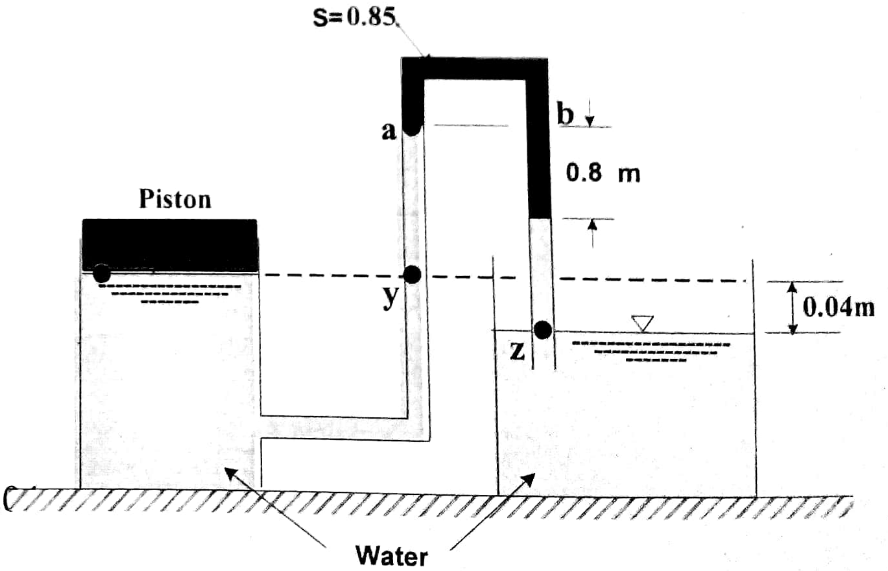
**Question (2)** :
**Given:** A= 0.1 $m^2$
**Required:** m




**Solution:**

$P_z = 0$

$P_y = \frac{mg}{A}$

$P_a = P_b$

$\frac{mg}{A} - \gamma_w \times 0.8 = 0 - \gamma_o \times 0.8 - \gamma_w \times 0.0$

$\frac{m \times 9.81}{0.1} - 9810 \times 0.8 = 0 - 0.85 \times 9810 \times 0.8 - 9810 \times 0.04$

m=8 kg

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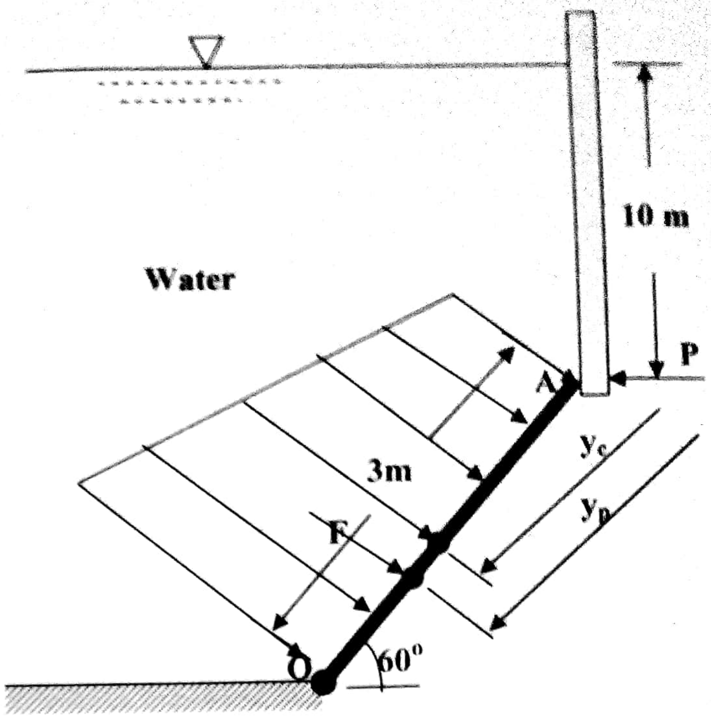
**Question (3) :**
**Given:** b=2 m
**Required:** F, P
**Solution:**




$A = 3 \times 2 = 6m^2$

$h_c = 10 + 1.5\ sin60 = 11.299m$

$F = \gamma_w A h_c = 665059.14\ N$

$I = \frac{2\times3^3}{12} = 4.5\ m^4\ ,\quad y_c = \frac{h_c}{sin60} = 13.047\ m$

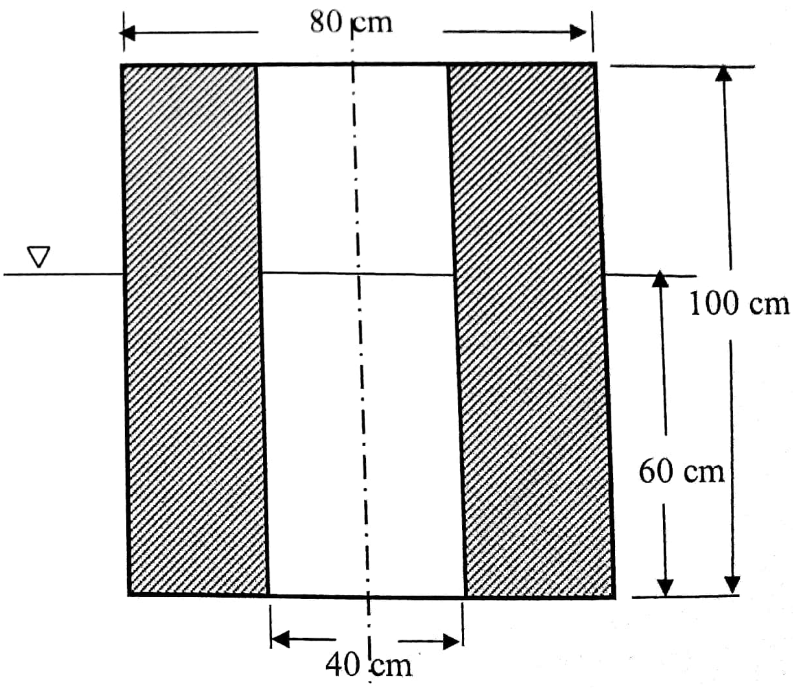
$y_p = y_c + \frac{I}{Ay_c} = 13.1044\ m$

$\sum_o M = 0$

$$P \times 3 \times sin60 = F \times (1.5 - (y_p - y_c))$$

*P=369278.74 N=369.28 kN*

**Question (4) :**
**Given:** L=1m, h=0.6 m, $D_1$=0.4m , $D_2$=0.8m
**Required:** s.g, GM
**Solution:**




$h = s.gL$

$s.g = \frac{h}{L} = \frac{0.6}{1} = 0.6$

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

$I = \frac{\pi}{64}(D_2^4 - D_1^4) = 0.01884\ m^4$

$V_{imm} = \frac{\pi}{4}(D_2^2 - D_1^2)h = 0.22508\ m^3$

$\overline{BM} = \frac{I}{V_{imm}} = 0.0837\ m$

$\overline{GM} = \overline{BM} - \overline{BG} = -0.1163\ m$

the cylinder is not stable