إجابة امتحان ميكانيكا موائع

ثانية مدني

ديسمبر ٢٠١٧

كلية الهندسة - جامعة كفر الشيخ

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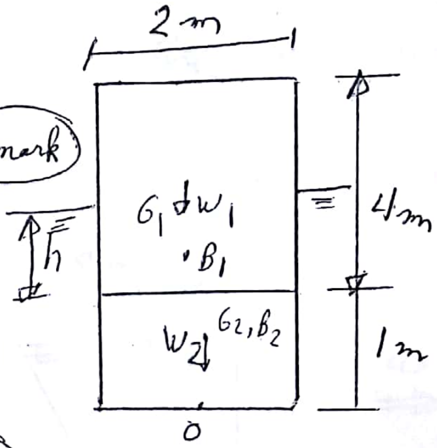
13 Marks

Q1



$W_1 = \pi(1) * 4 * 0.8 = 10.05\,t \rightarrow$ (1 mark)

$W_2 = \pi(1) * 1 * 1.2 = 3.77\,t \rightarrow$ (1 mark)

$W_T = W_1 + W_2 = 13.82\,t \rightarrow$ (1 mark)

$V_2 = 3.14\ m^3 = \pi(1)(1)$

$W_T = \gamma_L V_d$

$13.82 = 1 * V_d$, get $V_d = 13.82\ m^3 > V_2$

$\therefore 13.82 = 3.14 + \pi(1) h$, get $h = 3.40\ m \rightarrow$ (3 marks)

$OB_1 * V_{d_1} + OB_2 * V_2 = OB * V_d$

$\left(1 + \frac{3.4}{2}\right) 10.68 + 0.5 * 3.14 = OB * 13.82$

$OB = 2.20\ m \rightarrow$ (1 mark), $\boxed{\text{or } OB = \frac{3.4+1}{2} = 2.2\ m \text{ because the same cross sec}}$

$OG_1 * W_1 + OG_2 * W_2 = OG * W_T$

$\left(1 + \frac{4}{2}\right) * 10.05 + 0.5 * 3.77 = OG * 13.82$

get $OG = 2.32\ m \rightarrow$ (2 marks)

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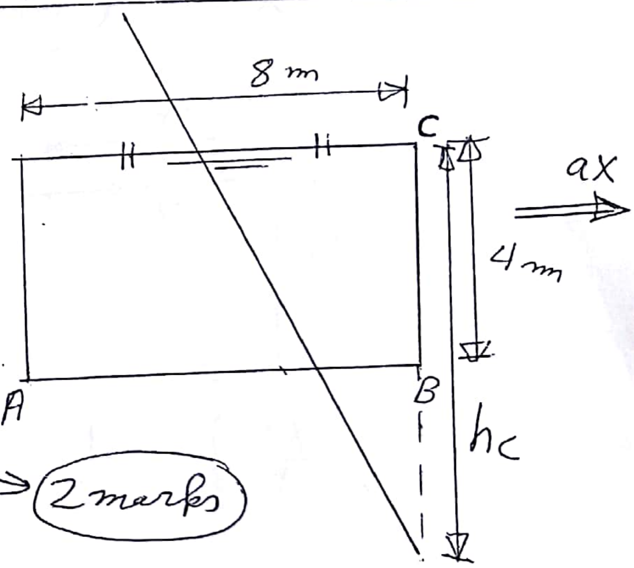
$BG = OG - OB = 2.32 - 2.20 = 0.12\ m \rightarrow$ 1 mark

$BM = \frac{I}{V_d} = \frac{\pi(1)^4/4}{13.82} = 0.06\ m \rightarrow$ 2 marks

$BM < BG$

M below G , The cylinder is unstable → 1 mark

Q2 $\boxed{13 \text{ Marks}}$



$P_{vap} = 0.75\ t/m^2$ (absolute)

$P_{vap} = -10.33 + 0.75$

$P_{vap} = -9.58\ t/m^2$ (gauge) → 2 marks

$P_C = -\gamma h_c = -9.58\ t/m^2$

get $h_c = 9.58\ m \rightarrow$ 2 marks

$\tan\theta = \frac{a_x}{g} = \frac{y}{x}$

$\frac{a_x}{g} = \frac{9.58}{4.0} = \frac{a_x}{9.81}$

get $a_x = 23.49\ m/sec^2 \rightarrow$ 2 marks

If $a_x \geq 23.49\ m/sec^2$, water changes to vapour

$\therefore a_x = 23.48\ m/sec^2$ is maximum acceleration which does not change water to vapour → 1 mark

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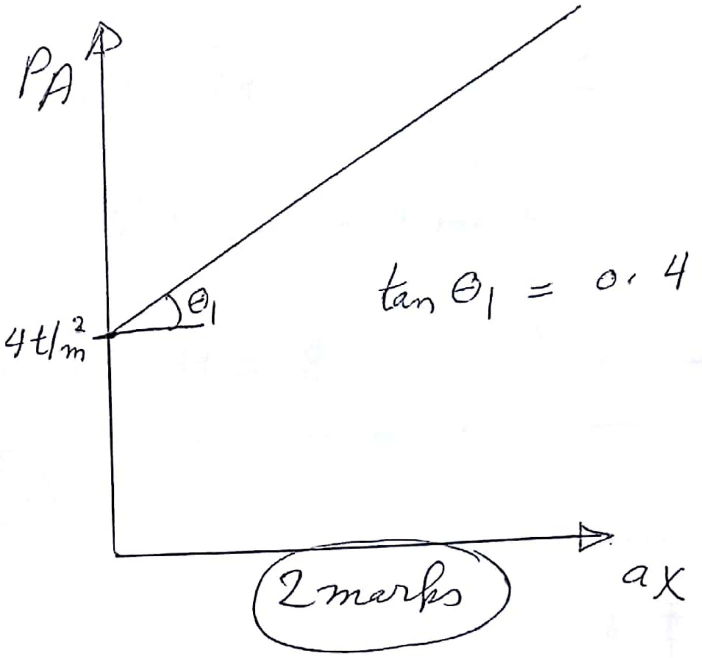
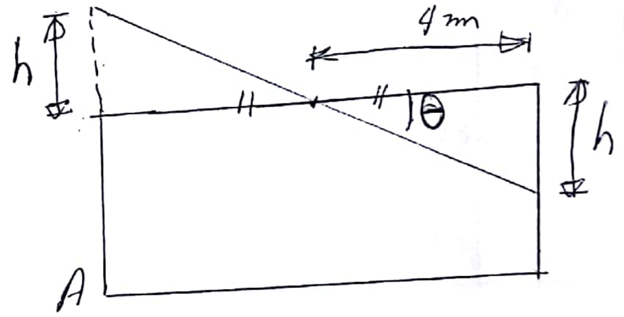


$\tan\theta_1 = 0.41\gamma \rightarrow$ 2 marks

2marks $\leftarrow$ $4\, t/m^2$

2marks



$\tan\theta = \frac{h}{4} = \frac{ax}{g}$

$h = \frac{4}{g}\, ax$

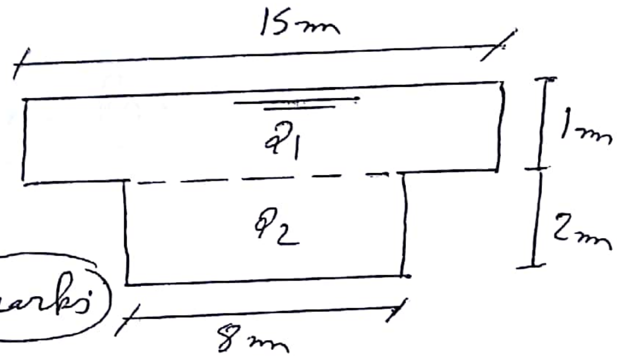
$h = 0.41\, ax$

$P = \gamma h$

$P = 0.41\, \gamma\, ax$

$\boxed{\tan\theta_1 = 0.41\gamma}$

Q3) a) 7 marks



$Q_T = Q_1 + Q_2$

$Q_1 = \frac{2}{3}\, Cd\, B_1 \sqrt{2g}\, H^{3/2} \rightarrow$ 2marks

$Q_1 = \frac{2}{3} * 0.62 * 15 \sqrt{2*9.81}\, (1)^{3/2}$

$Q_1 = 27.46\, m^3/sec \rightarrow$ 1 mark

$Q_2 = \frac{2}{3}\, cd\, B_2 \sqrt{2g} \left(H_1^{3/2} - H_2^{3/2}\right) \rightarrow$ 2 marks

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$Q_2 = \frac{2}{3} * 0.62 * 8 * \sqrt{2g}\ \left((3)^{3/2} - (1)^{3/2}\right)$

$Q_2 = 61.39\ m^3/sec \longrightarrow$ 1 mark

$Q_T = 27.46 + 61.39 = 88.85\ m^3/sec \longrightarrow$ 1 mark

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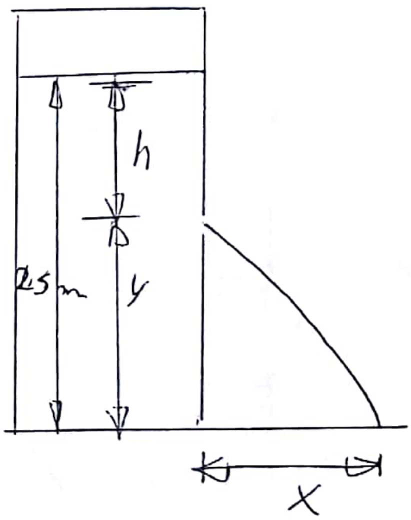
Q5: (b) 5 marks

$y = \dfrac{gX^2}{2V^2}$



$V = C_V\sqrt{2gh}$

$V^2 = C_V^2\,(2gh)$

$y = \dfrac{gX^2}{2C_V^2\,(2gh)}$, $C_V = 0.95$

$y = \dfrac{X^2}{4C_V^2 h}$

$X^2 = 3.61\,yh \longrightarrow$ 2 marks

$y + h = 2.5m$

$y = (2.5 - h)$

$X^2 = 3.61\,h\,(2.5 - h)$

$X^2 = 9.03\,h - 3.61\,h^2 \longrightarrow$ 1 mark

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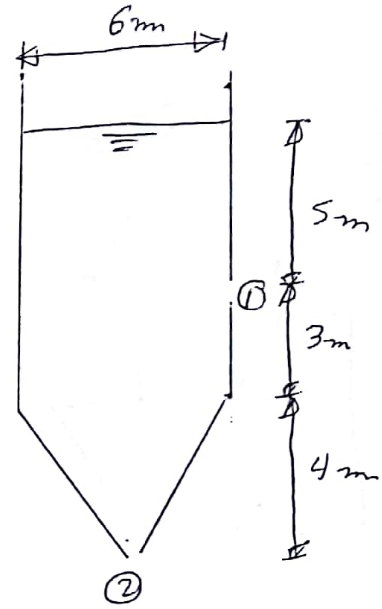
for X_{max}, $\frac{\partial X}{\partial h} = 0$ → 1 mark

$0 = 9.03 - 7.22h$

get $h = 1.25\,m$, $y = 1.25\,m$ → 1 mark

Q4 | 14 marks



$T_t = T_1 + T_2 + T_3$

$$T_1 = \int_0^5 \frac{A \cdot dh}{Q_1 + Q_2}$$

1 mark

$$T_1 = \int_0^5 \frac{\pi (3)^2 \, dh}{C_d\, a\sqrt{2gh} + C_d\, a\sqrt{2g(h+7)}}$$ → 2 marks

1 mark

$a = \pi (0.04)^2 = 0.005\ m^2$

$$T_1 = \frac{28.26}{0.61 * 0.005 * \sqrt{2g}} \int_0^5 \frac{dh}{\sqrt{h} + \sqrt{h+7}}$$

$$T_1 = 2091.8 \int_0^5 \frac{dh}{\sqrt{h} + \sqrt{h+7}} = 2091.8 \int_0^5 \Phi(h)\, dh$$

$$\Phi(h) = \frac{1}{\sqrt{h+7} + \sqrt{h}}$$

h	$\Phi(h)$	Area
0	0.38	0.74
2.5	0.21	0.49
5	0.18	

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$\therefore T_1 = 2091.8 * 1.23 = 2572.91$ sec → 2 marks

1 mark

$$T_2 = \int_4^7 \frac{A \cdot dh}{C_d\, a \sqrt{2gh}}$$

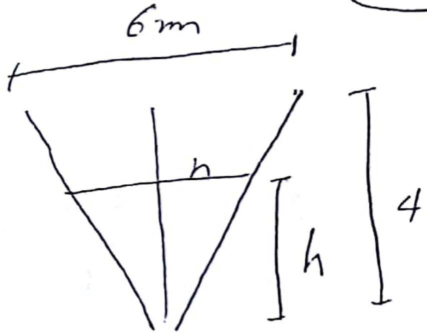
1 mark

$$T_2 = \frac{\pi (3)^2}{0.61 * 0.005 * \sqrt{2g}} \int_4^7 h^{-1/2}$$

1 mark

$$T_2 = 2093.33 * 2 \left[(7)^{1/2} - (4)^{1/2} \right] = 2703.55 \text{ sec}$$

1 mark



$$T_3 = \int_0^4 \frac{A \cdot dh}{Q}$$

$A = \pi h^2$

$$\frac{h}{4} = \frac{h}{3}$$

$h = .\ .h$

$A = \pi (0.75h)^2 = 1.77 h^2$

2 marks

$$T_3 = \int_0^4 \frac{1.77 h^2}{0.61 * 0.005 \sqrt{2g}\; h^{1/2}}$$

1 mark

$$T_3 = 131.02 \int_0^4 h^{3/2}$$

$$T_3 = 131.02 \left(\frac{2}{5}\right) (4)^{5/2} = 1677.06 \text{ sec}$$

$T_t = 6953.52$ sec $= 1.93$ hr → 1 mark

Q.5 (a) (12 marks)

$\lambda = 0.02$

$d_a = d_b = 50cm$

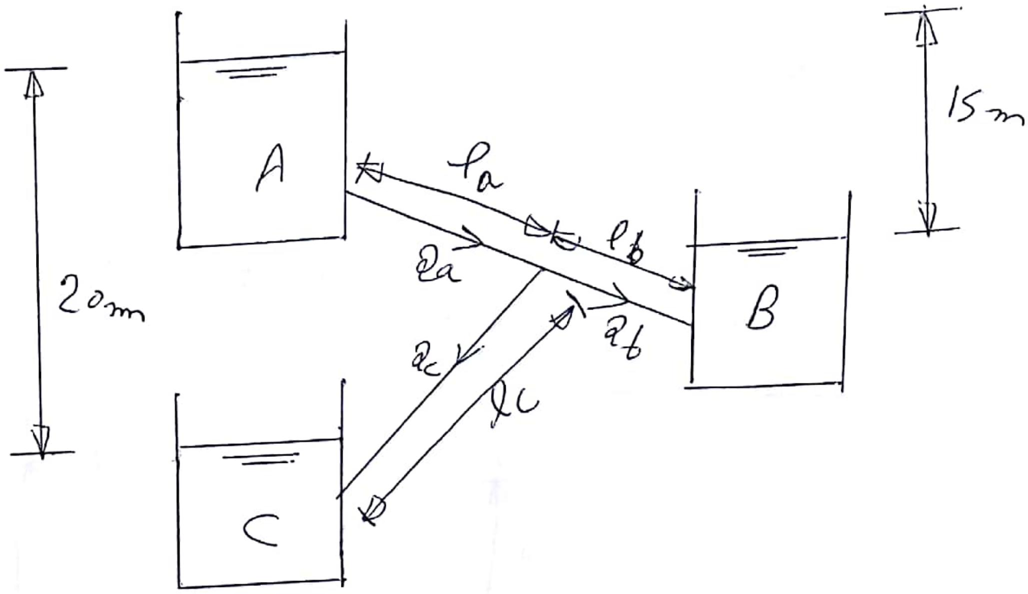
$l_a + l_b = 5000m$

$l_a = 2000 m$

$l_c = ...$

$l_b = 3000$

$d_c = 40cm$



$Q_a = Q_b + Q_c$

$Q_c = Q_b$

$Q_a = 2Q_b = 2Q_c$

$Q_a^2 = 4Q_b^2 = 4Q_c^2$ → 2 marks

$$H_A - H_B = 15 = \frac{8\lambda_a l_a (4Q_b^2)}{g\pi^2 d_a^5} + \frac{8\lambda_b l_b Q_b^2}{g\pi^2 d_b^5}$$

$$15 = \frac{8 \times 0.02 \times 2000 (4Q_b^2)}{9.81 \times (3.14)^2 (0.5)^5} + \frac{8 \times 0.02 \times 3000 \times Q_b^2}{9.81 \times (3.14)^2 (0.5)^5}$$ → 3 marks

$$15 = 423.48 Q_b^2 + 158.7 Q_b^2$$

$$15 = 582.18 Q_b^2$$

$Q_b = 0.16 \ m^3/sec$ → 2 marks

$Q_c = Q_b = 0.16 \ m^3/sec$

$$20 = \frac{8\lambda_a l_a Q_a^2}{g\pi^2 d_a^5} + \frac{8\lambda_c l_c Q_c^2}{g\pi^2 d_c^5}$$ → 3 marks

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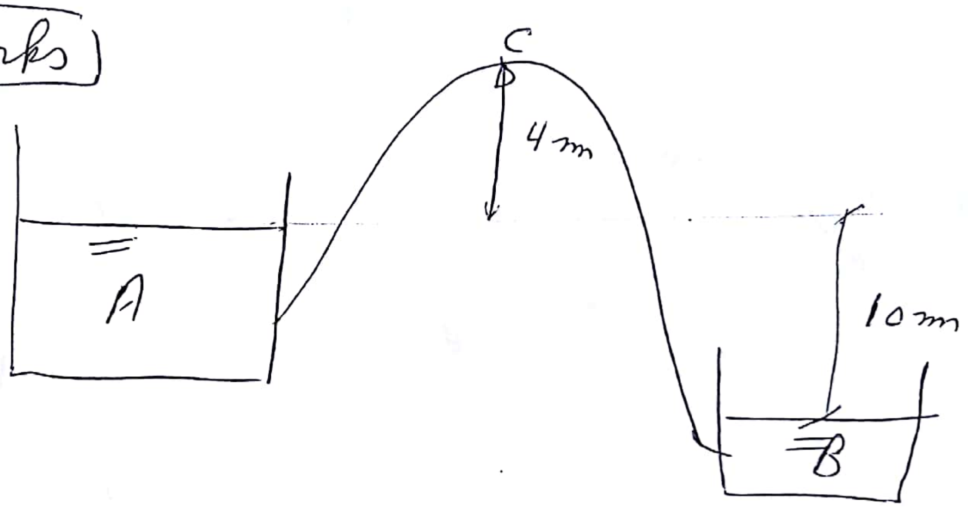
$$2 = \frac{8 * 0.02 * 2000 * (0.16)^2 * 4}{9.81 * \pi^2 * (0.5)^5} + \frac{0.02 * 8\, l_c\, (0.16)^2}{9.81 * \pi^2 * (0.4)}$$

get $l_c = 2234\ m$ → 2 marks

Qs (b) : $\boxed{13\ \text{Marks}}$



$$H_A - H_B = 10 = 0.5\frac{V^2}{g} + \frac{0.03 * 1500\, V^2}{2g * 0.2} + \frac{V^2}{g}$$ → 2 m

$$10 = 1.5\frac{V^2}{g} + 207.64\frac{\cancel{V^2}}{g} = 209.14\frac{V^2}{g}$$

$V = 0.97\ m/sec$

$Q = 0.97\left(\frac{\pi}{4}(0.2)^2\right) = 0.03\ m^3/sec$ → 1 mark

B.E between A and B

$$0 + 0 + 0 = Z_c + \frac{P_c}{\gamma} + \frac{V_c^2}{g} + \frac{0.5\, V^2}{g} + \frac{f\, l_1\, V^2}{g\, d}$$

$$0 = 4 + \frac{P_c}{\gamma} + 1.5\frac{(0.97)^2}{2 * 9.81} + \frac{0.03(400)}{0.2} * \frac{(0.97)^2}{2 * 9.81}$$

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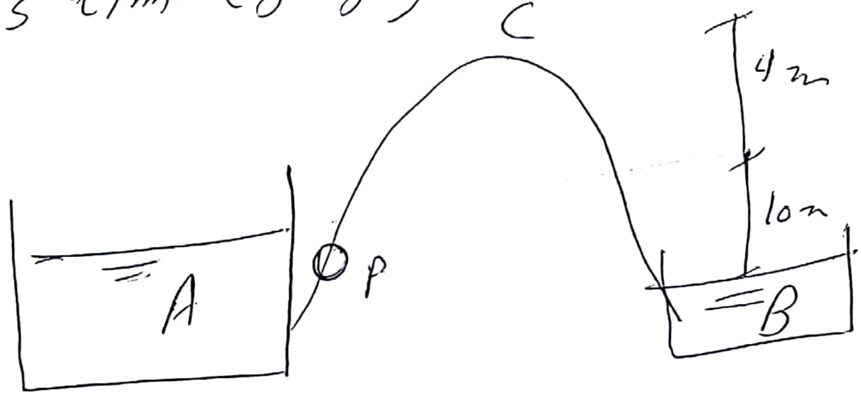
get $\frac{P_c}{\gamma} = -6.95$ m

$P_c = -6.95$ t/m² (gauge) → 3 marks



$H_p = 5$ m

$10 + 5 = 1.5 \frac{V_1^2}{2g} + 207.64 \frac{V_1^2}{2g} = 209.14 \frac{V_1^2}{2g}$ → 2 marks

get $V_1 = 1.19$ m/sec → 3 marks

B.E between A and C

$0 + 0 + 0 + 5 = 4 + \frac{P_{c_1}}{\gamma} + \frac{1.5 (1.19)^2}{2g} + \frac{0.03(400)}{0.2} * \frac{(1.19)^2}{2g}$ → 2 marks

get $\frac{P_{c_1}}{\gamma} = -3.44$ t/m² (gauge) → 2. marks

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