Notre Dame University. Department of Mechanical Engineering
Test #2-MEN101 (Dynamics) *Closed book: 1hr10 minutes*
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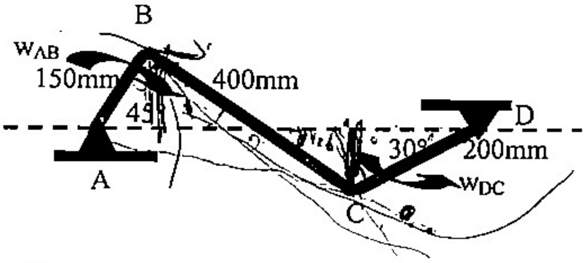
Problem#1

For the three bar linkage shown w_{DC} = 8rad/s; Find w_{AB} and w_{CB} at the instant shown.



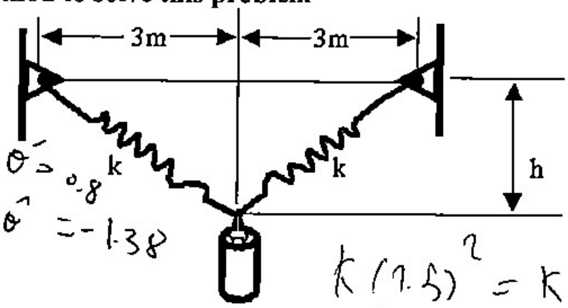
Problem#2

The cylinder has a mass of 30 kg and released from rest when h=0.

a) Find the required stiffness of each spring so that the motion momentarily stops when h = 1.5 m. The unstretched length of each spring is 1.5 m.

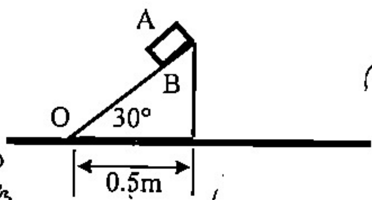
b) Find the cylinder speed when h = 1m.

Use energy method to solve this problem



Problem #3

Block A has a mass of 4kg and is placed on the smooth triangular block B having a mass of 40kg. System released from rest. Determine the distance B moves from point O when A reaches the bottom. Neglect size of block.



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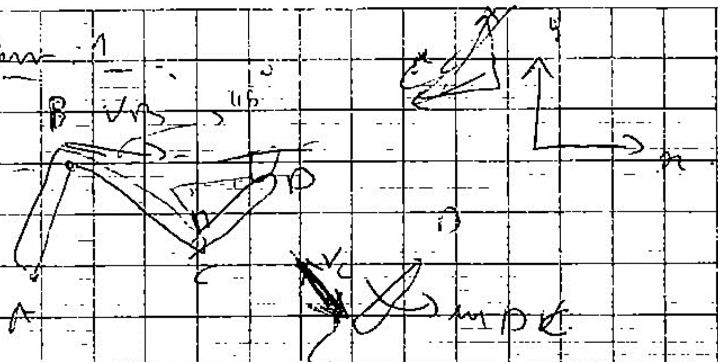
Zouk Mosbeh - Lebanon

Grade : [illegible]

Course No: Mec 101 Section : .... Date : ....

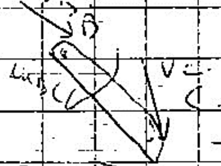
Problem 1



$V_C = \omega_{DC} \times 0.2 = 8 \times 0.2 = 1.6\ m/s$

$\vec{V_C} = 1.6 \cos 60 \vec{i} - 1.6 \sin 60 \vec{j}$

$= 0.8 \vec{i} - 1.38 \vec{j}$

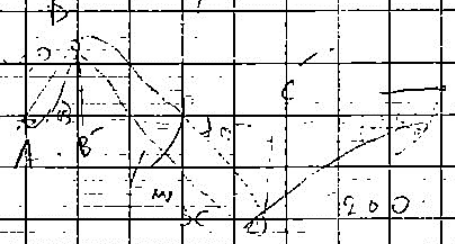


$\vec{V_B} = V_B \cos 45 \vec{i} - V_B \sin 45 \vec{j}$

-10

$V_B \cos 45 \vec{i} - V_B \sin 45 \vec{j} = \vec{V_B} = \vec{V_C} + \vec{V_{B/C}} = 0.8 \vec{i} - 1.38 \vec{j} + \omega_{BC} \times \vec{r_{B/C}}$

~~$= 0.8 \vec{i} - 1.38 \vec{j} + (\omega) \vec{k} \times (400$~~



0.2 ...

0 ... 5.37

Sol: $V_B \cos 45 \vec{i} - V_B \sin 45 \vec{j} = 0.8\vec{i} - 1.38\vec{j} + (\omega \vec{k}) \times (0.4 \cos\theta \vec{i} + 0.4 \sin\theta \vec{j})$

$V_B \cos 45 \vec{i} - V_B \sin 45 \vec{j} = 0.8\vec{i} - 1.38\vec{j} + 0.4\omega \cos\theta \vec{j} + 0.4\omega \sin\theta \vec{i}$

$V_B \cos 45 = 0.8 + 0.4\omega \sin\theta$ (1)

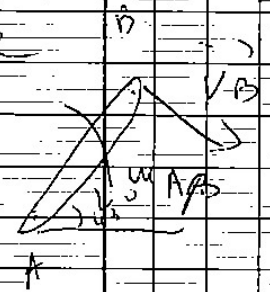
$-V_B \sin 45 = -1.38 + 0.4\omega \cos\theta$ (2)

$0 = -0.58 + 0.8\,\omega \cos\theta + 0.4\omega \sin\theta \Rightarrow \omega = \frac{0.58}{0.8 \cos 53.7} = 1.47$ rad/s

method

$V_B = 1.30$ m/s

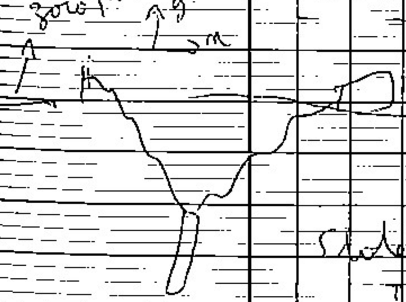
of



$V_B = \omega_{AB} \times 0.150 \Rightarrow \omega_{AB} = \frac{V_B}{0.15} = 8.66$ rad/s

(2 remains and more)

zero potential energy



Problem 2 : State 1 : Bungee at rest.

$E_1 = 0 + \frac{1}{2} K x^2 + \frac{1}{2} K x^2 + 0$

$= \frac{1}{2} K (1.5)^2 + \frac{1}{2} K (1.5)^2 = K (1.5)^2$

State 2 at $h = 1.5$

The length $l = \sqrt{9 + 1.5^2} = \sqrt{11.25} = 3.354$

So the stretch is $x = 1.854$

$E_2 = \frac{1}{2} K (1.854)^2 + \frac{1}{2} K (1.854)^2 - mg(1.5) + \frac{1}{2} m (v)$

a_3

Conservation of energy: $E_1 = E_2$

$$K(1.5)^2 = K(1.854)^2 - mg(1.5)$$

$$K = \frac{-mg(1.5)}{(1.5)^2 - (1.854)^2} = \frac{-441.45}{-1.1875} = 371.8\ N/m$$

$$K = 371.8\ N/m$$

b) Conservation of energy: $E_1 = E_2$ (when $h = 1$)

$$(371.8) \times (1.5)^2 = K(x'')^2 - mg(1) + \frac{1}{2}mV^2$$

at $h = 1$ The length is $l' = \sqrt{9+1} = \sqrt{10} = 3.1622$

$x'' =$ stretch $= 1.6622\ m$

$$836.55 = 371.8 \times (1.6622)^2 - 30 \times 9.81 + \frac{1}{2}mV^2$$

$$109.8 = \frac{1}{2}mV^2 \Rightarrow V^2 = 6.78$$

$$V = 2.6\ m/s \downarrow$$

Problem #3

Conservation of linear momentum along x:

$$-m_A V_{Ax} + m_B V_B = 0 + 0$$

$$m_B V_B = m_A V_{Ax} \quad (1)$$

$$\vec{V}_A = \vec{V}_B + \vec{V}_{A/B}$$

$$-V_{Ax} = V_B - (V_{A/B})_x \quad (2)$$

(2) in (1)

$$m_B V_B = m_A(-V_B + (V_{A/B})_x)$$

$$(m_B + m_A)V_B = m_A (V_{A/B})_x$$

$$(m_B + m_A)\,ds_B = m_A\,(ds_{A/B})_x$$

By integration:

$(m_A + m_B) S_B = m_A \times 0.5$

$S_B = \frac{0.5\, m_A}{m_A + m_B} = \frac{0.5 \times 4}{44} = 0.04545\, m$

$0 + 0 = 4 \times V_{A_x} +$

$4 V_{A_x} = 40 \times V_B$

$V_{A/B} = V_A - V_B$

$V_{A/B} = \frac{m\, 30}{0.5}$

$\Rightarrow A_x = -V_B = \frac{m\, 30}{0.5}$