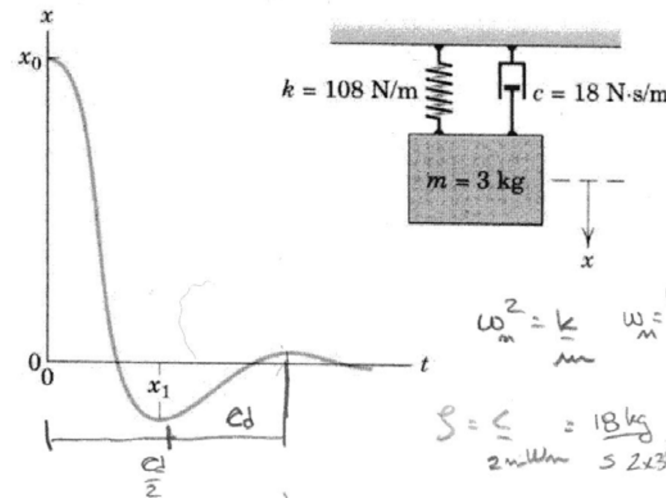
CIVE 261 - DYNAMICS
FINAL

Date: December 15, 2009
Time: 3:40 – 5:40 pm
Prof. P.Y. Julien

Name: P. Julien

(25 points)
The system shown is released from rest from an initial position x_0. Assume that the block m does not rotate and translates in the x-direction only. Determine the maximum overshoot displacement x_1 of the block.



$\omega_n^2 = \frac{k}{m}$ $\quad \omega_n = \sqrt{\frac{108\,N}{m\,3kg}} = 6\frac{rad}{s}$

$\zeta = \frac{c}{2m\omega_n} = \frac{18\,kg}{s}\frac{s}{2\times3kg\;6\,rad} = \frac{1}{2}$

$x = A e^{-\zeta\omega_n t} \underline{\sin(\omega_d t + \phi)}$
$+1, -1$

$\omega_d = \omega_n\sqrt{1-\zeta^2} = 6\frac{rad}{s} \times 5.19\frac{rad}{s}$

$\tau_d = \frac{2\pi}{\omega_d} = \frac{2\pi\ s}{5.19\,rad} = 1.209\,s$

$\frac{\tau_d}{2} = 0.6045\,s$

$x_1 = x_0\, e^{-0.5\times 6\frac{rad}{s}\times 0.6045\,s}$

$\boxed{x_1 = 0.163\,x_0}$

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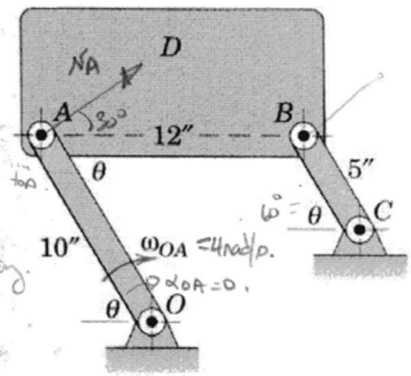
(50 points) $\alpha_{AB} = ?$

Calculate the angular acceleration of the plate D in the position shown when the control link *AO* has a constant angular velocity $\omega_{OA} = 4$ rad/s and $\theta = 60^\circ$ for both links.



$\omega_{OA} = 4$ rad/s CW

$\omega_{AB} = 0$

$\omega_{BC} = 8$ rad/s CW

$\vec{v}_A = \omega_{OA} r_{OA} = 4\frac{rad}{s} \times \frac{10''}{12''}ft = 3.33\frac{ft}{s}$ at 30° from horiz.

$\omega_{OA} = 4$ rad/s, $\alpha_{OA} = 0$.

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

3.33 ft/s ∠30° ?

$\vec{v}_A = 3.33\frac{ft}{s}$ ∠30°

$\vec{v}_B = 3.33\frac{ft}{s} = \omega_{BC} r_{BC}$

$\omega_{BC} = 3.33\frac{ft}{s}\ \frac{12''}{5''\ ft} = 8\frac{rad}{s}$ CW

$v_{A/B} = \omega_{AB} r_{AB} = 0$.

$\omega_{AB} = 0$

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

$\vec{a}_{Bn} + \vec{a}_{Bt} = \vec{a}_{An} + \vec{a}_{At} + \vec{a}_{B/An} + \vec{a}_{B/At}$

$\omega_{BC}^2 r_{BC} + \alpha_{BC} r_{BC} = \omega_{OA}^2 r_{OA} + 0 + \omega_{AB}^2 r_{AB} + \alpha_{AB} r_{AB}$

$64 \cdot \frac{5}{12}\frac{ft}{s^2}$ (60°) = $26.67\frac{ft}{s^2}$; ? (30°); $16 \times \frac{10}{12}$ (60°) = $13.3\frac{ft}{s^2}$; 0; 0; ↕

$\alpha_{BC} = 13.33\frac{ft}{s^2}\ \tan 30^\circ\ \frac{12}{5\ ft} = 18.5\frac{rad}{s^2}$

$\alpha_{AB} r_{AB} = 13.33\frac{ft}{s^2}\ \frac{1}{\cos 30^\circ}\ \frac{12}{10\ ft} = 18.5\frac{rad}{s^2}$ CW

$\vec{a}_{B/A} = 0\vec{i} - 30.8\frac{ft}{s^2}\vec{j}$

$\vec{a}_A$ 13.3; 26.67; $\alpha_{AB} r_{AB}$; $30.8\frac{ft}{s^2} = \vec{a}_{B/A t}$; $\alpha_{BC} r_{BC}$; $\vec{a}_B$

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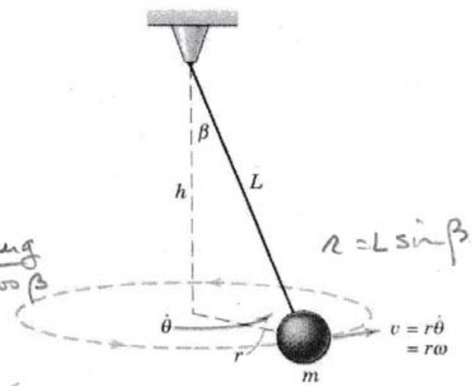
The small ball of mass m is attached to a light cord of length L and moves in a horizontal circle with a tangential velocity v. Determine the angle β and the elevation h of the planar motion. Also determine the tension in the cord.

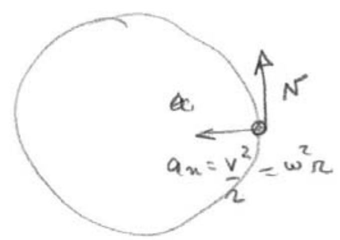


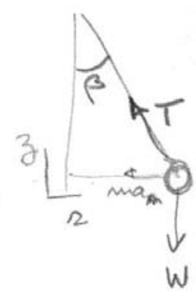
$r = L\sin\beta$

$\Sigma F_z = T\cos\beta - W = 0 \quad \text{or } T = \frac{mg}{\cos\beta}$

$\Sigma F_r = T\sin\beta = m\omega^2 r$

$\frac{mg}{\cos\beta}\sin\beta = m\omega^2 L\sin\beta$





$\cos\beta = \frac{g}{\omega^2 L}$

$$\boxed{\beta = \cos^{-1}\frac{g}{\omega^2 L}}$$

$h = L\cos\beta = \frac{Lg}{\omega^2 L} = \frac{g}{\omega^2}$

$$\boxed{h = \frac{g}{\omega^2}}$$

$T = \frac{mg}{\cos\beta} = \frac{mg\,\omega^2 L}{g} = m\omega^2 L$

$$\boxed{T = m\omega^2 L}$$