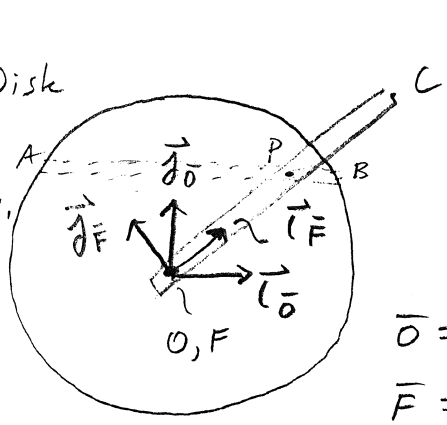
MAE 511 HW Set #3

(1a) Calculate ${}^{\bar{O}}\vec{v}_{P/O}$ and ${}^{\bar{O}}\vec{a}_{P/O}$ in terms of $\theta, \dot{\theta}$, and $\ddot{\theta}$ for the system in Problems 3 and 4 on P. 23 of the text by Thomson. Express your answer in the form

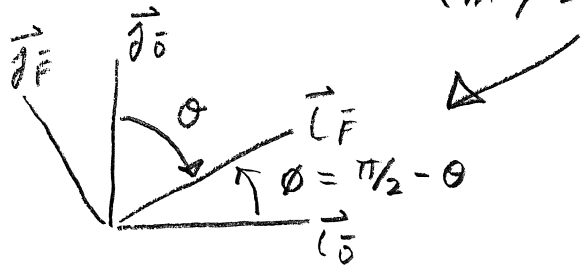
$${}^{\bar{O}}\vec{v}_{P/O} = (\quad)\vec{\imath}_{\bar{F}} + (\quad)\vec{\jmath}_{\bar{F}} + 0\,\vec{k}_{\bar{F}}$$

$${}^{\bar{O}}\vec{a}_{P/O} = (\quad)\vec{\imath}_{\bar{F}} + (\quad)\vec{\jmath}_{\bar{F}} + 0\,\vec{k}_{\bar{F}}$$

The $\bar{O}$ and $\bar{F}$ frames are described below. (Hint: $\phi = \theta - \pi/2$ may be useful.)



Note: Disk is stationary.



$\bar{O} = \{O, \vec{\imath}_{\bar{O}}, \vec{\jmath}_{\bar{O}}, \vec{k}_{\bar{O}}\}$ $\quad O = F$

$\bar{F} = \{F, \vec{\imath}_{\bar{F}}, \vec{\jmath}_{\bar{F}}, \vec{k}_{\bar{F}}\}$

$\vec{k}_{\bar{F}} = \vec{k}_{\bar{O}}$ $\quad \bar{O}$ is attached to disk.

$\bar{F}$ is attached to arm OC

(1b) Calculate ${}^{\bar{O}}\vec{v}_{P/O}$ and ${}^{\bar{O}}\vec{a}_{P/O}$ at the instant when $\theta = 30^\circ = \pi/6$ radians if we are given that $\dot{\theta} = 3$ rad/sec and $\ddot{\theta} = 4$ rad/sec^2. Express your answer using the $\bar{F}$ frame unit vectors (as in 1a).

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② Consider the equation (derived in class):

$$m_p \ddot{\ell} + (k - m_p \dot{\theta}^2)\ell = k\ell_0 - m_p g \cos\theta + m_p \ddot{x} \sin\theta$$

Now, let $m_p = 2\,kg$, $k = 18\,N/m$, $\ell_0 = 0.5\,m$ ["m" = meters]

and suppose $x(t) = 7t \Rightarrow \dot{x} = 7 \Rightarrow \ddot{x} = 0$

and suppose we have initial conditions $\begin{cases} \ell(0) = 0.75\,m \\ \dot{\ell}(0) = 0 \end{cases}$

Use matlab (ode45) to plot $\ell(t)$ versus time for $0 \le t \le 40$ seconds for the following cases:

a) $\theta(t) = 0$

b) $\theta(t) = 0.5t$

c) $\theta(t) = 1t$

d) $\theta(t) = 1.5t$

e) $\theta(t) = 2t$

f) $\theta(t) = 2.5t$

g) $\theta(t) = 2.9t$

h) $\theta(t) = 2.99t$

(i) $\theta(t) = 2.999t$

(j) $\theta(t) = 3.0t$

(k) $\theta(t) = 3.001t$

(l) $\theta(t) = 3.01t$

(m) $\theta(t) = 0.03t^2$

(n) $\theta(t) = 0.04t^2$

(o) $\theta(t) = 0.05t^2$