SideWork D2:

Converting Linear to Rotational Motion

It is common to convert linear motion of a piston to rotational motion of a shaft by the use of a connecting rod. In the schematic shown, a piston rides in a frictionless cylinder. One side of the piston is exposed to a load P. A connecting rod (BC) of length L connects the other end of the piston to a crank arm of length r.

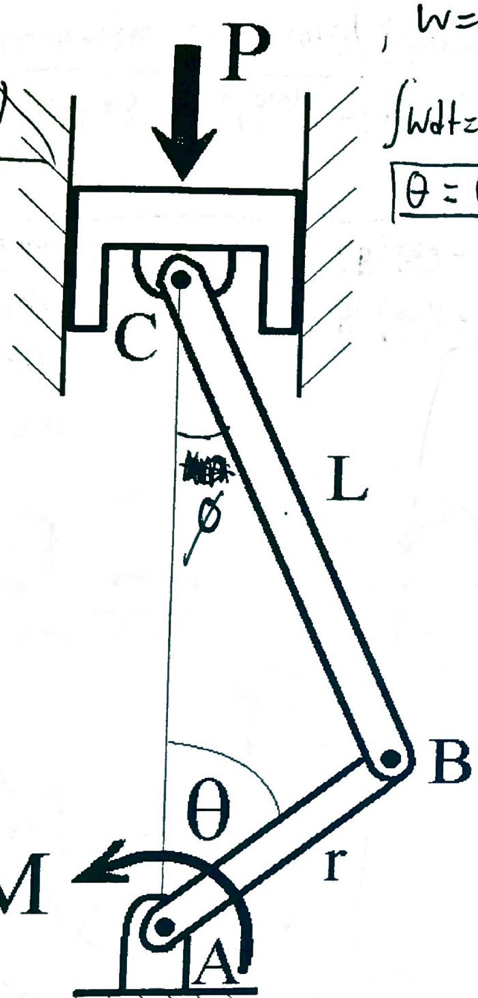
A counter-clockwise restraining moment or torque (M) is applied to the crank arm of length r, which has a crank angle θ with respect to the vertical angle at the instant shown. The crank rotates with a constant angular speed (ω = dθ/dt) clockwise. Treating all components as massless, analyze and determine as a function of time:

a) All reaction forces (at piston and A)
b) The applied torque (M)

EXTRA CREDIT:
Determine the speed and acceleration of the piston

WRITE A MATLAB SCRIPT THAT PRODUCES WELL-FORMATTED PLOTS. USE DEFAULT PARAMETER VALUES P = 1kN, L = 0.15m, r = 0.07m, ω = (2000rev/min)*2π

SUMBIT FILE TO TEAMS. Use the filename



$w = \frac{d\theta}{dt}$

$\int w\,dt = \int d\theta$

$\boxed{\theta = wt}$

$L\sin\phi = r\cos\theta$

$\boxed{\phi = \sin^{-1}\left(\frac{r}{L}\cos\theta\right)}$

$\sum F_x = 0$

$P - C\cos\phi = 0$

$C = \frac{P}{\cos\phi}$

$\sum F_y = 0$

$R_P = C\sin\phi$

$\boxed{R_P = P\tan\phi}$

$R_A = \sqrt{R_{A_x}^2 + R_{A_y}^2}$

$= C\cos(\theta+\phi)$

$= \frac{P\cos(\theta+\phi)}{\cos\phi}$

$\boxed{R_{A_x} = \frac{P\cos(\theta+\phi)}{\cos\phi}\cos\theta}$

$\boxed{R_{A_y} = \frac{P\sin(\theta+\phi)}{\cos\phi}\sin\theta}$

$\sum M_A = 0$

$M = C\sin(\theta+\phi)(r)$

$\boxed{M = \frac{P\sin(\theta+\phi)}{\cos\phi}r}$