Chapter 14 HW Hints (due April 16)

Problem 14.2. I did Problem 14.3 in class; this is the same mechanism. Now the force P on the slider is specified, and you are asked to find moment $\mathbf{M}_{12}$.

Pretty simple free-body diagrams for the analytical method; graphical method is similar. Result should be around 60 N-m.

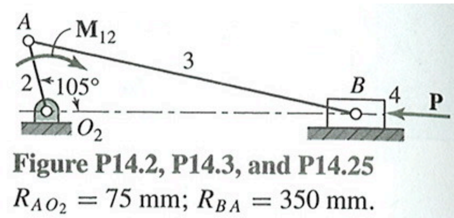

Figure 1: Slider-crank.

Problem 14.7 This is a "quick-return" mechanism. Solve the problem using the crank angle $\theta = 30°$ as stated. Note that there is **no friction** in this problem—this assumption makes the direction of some of the constraint forces easy to find.

For purposes of static force analysis note that you can really neglect body 3, since the force $\mathbf{F}_{23}$ that link 2 applies to 3 is "passed through" to link 4, so $\mathbf{F}_{34} = \mathbf{F}_{23}$. It's easier just to consider the force as going right from link 2 to 4, and using $\mathbf{F}_{24}$. You can do a similar thing with bodies 5 and 6.

You will have to use loop closure equations to solve for some of the angles in the problem; this can be a little tedious, but I've done it.

I use MATLAB to perform some of the cross product—not the Symbolic Toolbox, just the numerical `cross()` function. In fact, you can write a MATLAB script to solve the entire problem.

As a partial result, I found one constraint force to be

$$\mathbf{F}_{24} = -198.95\mathbf{i} + 59.41\mathbf{j} \text{ lb}$$

and crank moment to be in the range

$$\mathbf{M}_{12} \approx 350\mathbf{k}...400\mathbf{k} \text{ in-lb}$$

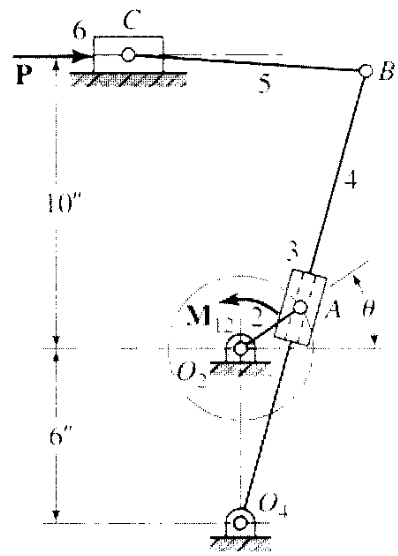

Figure 2: Quick-return mechanism.

Problem 14.15. This is Problem 14.7 with some static friction. The coefficients of Coulomb friction are

$$\mu_c = 0.20 \text{ between links 1 and 6}$$
$$\mu_c = 0.10 \text{ between links 3 and 4}$$

Following the discussion in text Sections 14.9 and 14.10, the presence of friction will "tilt" the contact forces by the friction angle given by text equation (14.11). These changes in angle will affect the final result for moment $\mathbf{M}_{12}$.

The procedure here is almost exactly the same as in Problem 7. The only difference is that friction is acting between links 1 & 6, and between links 3 & 4.

To determine the direction in which to "angle" forces $\mathbf{F}_{16}$ and $\mathbf{F}_{24}$ (As before, I "neglected" link 3, and assumed links 2 & 4 contact) you must examine the direction of "impending motion" caused by the *action of applied moment* $\mathbf{M}_{12}$. The contact forces will be angled so as to oppose the direction of impending motion.

The result for $\mathbf{M}_{12}$ will be higher than before; that makes sense since it requires a larger moment to "break through" the friction.