Chapter 3 HW I Hints (due Wednesday, September 7)

Problem 3.6: This is an interesting problem, although it's not a mechanism. I placed an xy coordinate system at a convenient point (origin doesn't really matter), then developed expressions for position vectors $\mathbf{r}_A(t)$ and $\mathbf{r}_B(t)$ (both are functions of time t).

The distance between A and B is the length (magnitude) of vector $\mathbf{r}_{AB}$, which is the vector from B to A (or the reverse; distance is the same). Then what you want to do is find the *minimum* value of the magnitude $|\mathbf{r}_{AB}|$. That's just a calculus problem; you will actually find the *time* when the minimum occurs, then substitute to find the distance (both are requested in (a) and (b)).

It is interesting to plot the distance *vs* time; I'll probably have this in my solution, although it's not required (I think it's nice to visualize things wherever possible). The plot can also confirm your analytical results.

Note that—even though I'd like you to do it analytically—you can also simulate this problem using ADAMS. If you use a "point-to-point" `MEASURE` to record the distance between planes, you can get the same plot of separation distance *vs* time as with MATLAB.

HINT: The time when the minimum distance $|\mathbf{r}_{AB}|$ occurs is the same as when the minimum of $|\mathbf{r}_{AB}|^2$ occurs—this makes the calculus a little easier.

ANSWER: I got the time in part (b) as approximately 6:40:30; that is, about 40.5 minutes after 6:00 p.m.

Problem 3.8: Do this problem **analytically**. This is a four-bar linkage with two translational joints and two pin joints. It can be solved using the "two points on a body" principle. The direction of both $\mathbf{v}_A$ and $\boldsymbol{\omega}_3$ are known.

Problem 3.9: Analyze this four-bar linkage **both** analytically and using ADAMS. Here are some suggestions.

(a) *Analytical Method.* Since this four-bar has only pin joints, it's solvable using only the "two points on a body" principle. You can find the velocity of A, then relate the velocity of B to that of A using $\boldsymbol{\omega}_3$. You can also express the velocity of B using $\boldsymbol{\omega}_4$. This will leave you with two equations and two unknowns, which is solvable. Note that you need two more angles; I solved for those in the figure below (you can thank me sometime ;-).

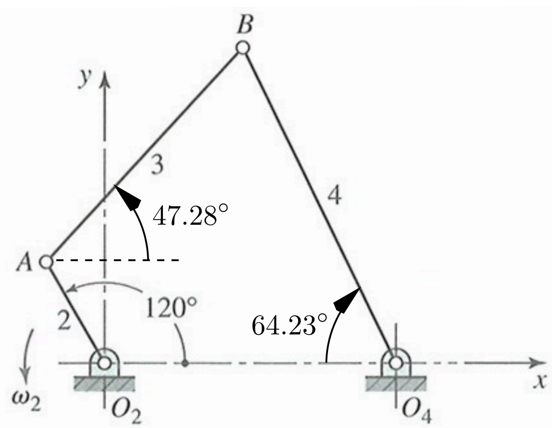

Figure P3.9 $R_{AO_2} = 4$ in, $R_{BA} = 10$ in, $R_{O_4O_2} = 10$ in, $R_{BO_4} = 12$ in.

(b) *Using ADAMS.* The ADAMS model is pretty straightforward, although the geometry might be a challenge. I'd suggest building the ADAMS model with link 2 initially at 0°, then letting link 2 move through one revolution (it satisfies Grashof's Law so it can continuously rotate). With link 2 at 0°, you will have to solve the geometry of triangle ABO_4 to place the links in ADAMS.

Plot ω_3 and ω_4 (on the same plot in rad/s) *vs* crank angle θ_2 (deg). The ADAMS results when link 2 is at 120° should be quite close to the analytical.