Your Name: ______________________________

Your TA name: ______________________________

Section day: ______________________________

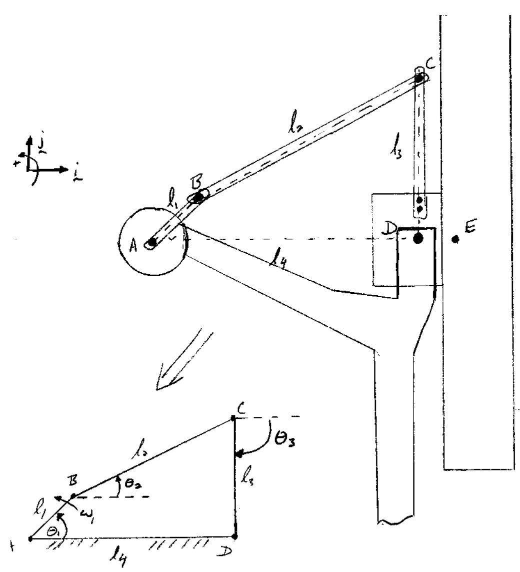
MAE325, Homework 8

(Due Wednesday, October 27, 1999, 9:04 AM)

Please follow the homework directions from the course WWW pages, the directions of the first homework, and the advice marked on your previously graded homework.

1. Norton 4-33a
2. Norton 4-34a
3. Norton 4-35a
4. This problem is a continuation of last weeks problem. We start with a restatement.

   It is hot and your roommate is hogging the only fan that you have – an industrial strength 10 kg job. Having recently taken MAE325, and having a motor and other parts handy, you decide to rig the fan so that it oscillates up and down, blowing air alternately on the upper and lower bunks of your bed. You rig up a linkage as shown below, but aren't sure whether or not the motor that you have is sufficient for the job. The motor is rated for 6 Newton-meters of torque. Ultimately you will want to figure out whether or not it is strong enough to make the fan oscillate.



   Assume:

   - $\omega_{AB} = 2\pi$ rad/s counterclockwise
   - $AB = 10$ cm, $BC = 40$ cm, $CD = 30$ cm, $AD = 40$ cm, $DE = 10\sqrt{3}$ cm
   - mass of the fan is 10 kg and the center of mass is at E
   - the links are attached to the fan so that lines CD and DE remain perpendicular
   - the moment of inertia of the fan is $\frac{md^2}{16}$ and the diameter of the fan, d, is 1 meter
   - the gyroscopic effects from rotating the spinning fan apply forces to the pins at D, but these forces do not contribute to the torque necessary at the motor (this can be shown, by a fun experiment or by considering how the forces act at D); do not ignore the forces from gravity or accelerating the fan!

- all links are massless
- initially, $\theta_1 = \arctan(3/4)$

Please follow the notation from the figure above figure in your own solutions.

Last week you wrote a `matlab` function to evaluate the angular velocities and numerically integrate to the the positions on the links over a full cycle. You plotted the positions of the pins in the linkage over the cycle (A, B, C, and D). You solved a geometry problem to get the initial values of angles. You also found approximately the greatest angle that the fan blades are tilted away from vertical over the course of a cycle.

If you did not get this all done correctly you need to do this first. Even if you did the first problem correctly all on your own, it may be worth checking out the solution that is on the web – some of the methods in that solution might give you ideas about how to do the acceleration calculation without too much more work!

For the second part of the fan problem, you are asked to do the necessary analysis of the accelerations in the problem. Recall from the initial problem description (in HW 7 and above) that the masses of the links are to be neglected. Thus, the only linear acceleration that you will need to find is that of point E, the center of mass of the fan. However, in order to find this linear acceleration, you must solve for the angular acceleration of the links.

Set up matlab files (starting from your solution to the first part of the problem or the solution files posted on the web) to calculate the angular accelerations and the linear acceleration of point E over a full cycle of the mechanism. That is, evaluate the accelerations at the configurations of the linkage returned by one of `matlab`'s ode integrators. Make a plot of the horizontal and vertical components of the linear acceleration of the fan's center of mass over a full cycle.

Approximately, what are the maximum magnitudes of the angular acceleration of the fan and of the linear acceleration of the center of mass of the fan? Would you expect these maxima to occur at the same time? Do they?

In the next part of the problem, not due this week, you will use the acceleration terms in the force/moment calculation to determine whether or not the motor that is to drive the linkage is powerful enough for the job.