Your Name: ____________________

Your TA name: ____________________

Section day: ____________________

MAE325, Homework 3

(Due Wednesday, September 15, 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 graded homework.

1. Two shafts AC and EG, which lie in the vertical yz plane, are connected by a universal joint at D, The bearings at B and E don't exert any axial force. A couple of magnitude 30Nm(clockwise when viewed from the positive z axis) is applied to shaft AC at A. At the instant shown shaft AC rotates at 10 rev/s and the arm of the crosspiece attached to shaft AC is vertical, determine

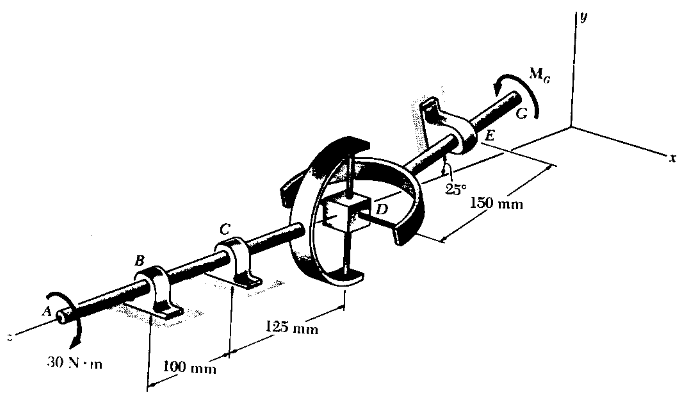
   (a) the magnitude of the couple M which must be applied to shaft EG to maintain equilibrium;

   (b) the reaction at B,C, and E;

   (c) the rotation rate of the output shaft as determined by power balance; and

   (d) the rotation rate of the output shaft as determined by kinematics (with no use of calculation of forces, moments, or the like).

   (e) After shaft AC has rotated 90 degrees, but the input torque and angular velocity are the same, what are the output torque and angular velocity (justify your answer clearly).

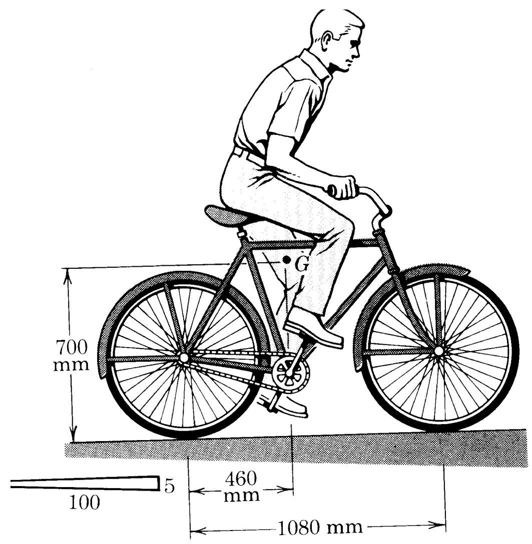


2. Problem 3-17 in the Norton text.

3. A person pedals a bicycle. Assume that when the pedals are horizontal all the rider's weight is on the front pedal. Assume the bike is massless compared to the person. Assume the wheel diameter is 26 inches. The cranks (the pieces that the pedals are attached to) are 8 inches long. Assume that the bike rider system is in equilibrium when going up a 5% grade at just this configuration. What is the ratio of the number of teeth in the front gear to the number in the gear at the wheel? [Hints, the radius ratio is equal to the tooth ratio. Draw lots of free body diagrams.]

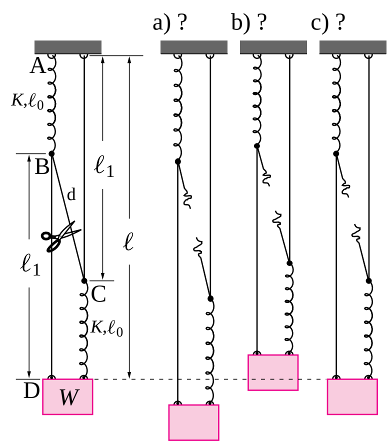
   (Note, this bike can't go far up hill like this. The rider would have to either shift down, or pull on the handlebars to make progress up the hill.)

4. A bicycle with no rider has the steering locked straight ahead and is balanced by being gently held. The cranks are vertical. A person walks up to the bike and pushes the bottom pedal backwards. Which way does the bike go? Justify your answer with a clear quantitative argument (clearly state any assumptions about the dimensions of any relevant parts).



5. This simple looking puzzle is suprisingly difficult. It may give you a chance to check your intuitions with experiment and more careful reasoning.

   Consider a weight hanging from 3 strings (BD,BC, and AC) and 2 springs (AB and CD) as in the left picture below. Point B is above point C and all ropes and springs are somewhat taught (none is slack).



   When rope BC is cut does the weight go (a) down?, (b) up?, or (c) stay put?

   In 15 minutes or so you can set up this experiment with 3 pieces of string, 2 rubber bands and a soda bottle. Hang the partially filled soda bottle from a door knob (or the top corner of a door, or a ruler cantilevered over the top of a refridgerator). Adjust the string lengths and amount of weight so that no strings or rubber bands are slack and make sure point B is above point C. The two points A can coincide as can the two points D. You might want to separate them a little with an erasor or small wad of paper, however, so you can see clearly which string is which.

   Looking at your experimental setup, but not pulling and poking at it, try to predict whether your bottle will go up down or not move when you cut the middle string.

   The solution you hand in should be a clear calculation, using free body diagrams and the laws of mechanics, that makes the correct prediction. Make and state any assumptions you make about any lengths, weights or stiffnesses.