

MIT OpenCourseWare
<http://ocw.mit.edu>

2.007 Design and Manufacturing I
Spring 2009

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.

2.007 Design and Manufacturing 1

Homework #1 Design Process & Machine Elements

NAME: _____

Date Issued: Tuesday 10 FEB, 11AM

Date Due: Tuesday 24 FEB, 11AM

Please answer the following 3 questions showing your work to the extent possible within the allotted time. Point allocations are listed for each question. The points sum to 100.

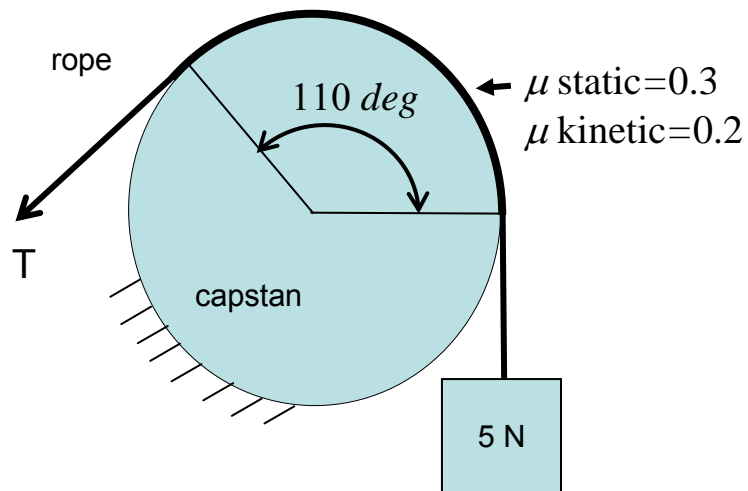
As described in the course policies document, this is one of four homeworks you will complete in this course. Each homework counts as 5% of your total grade. You will submit your work via the course web site.

1) (50 total) It is proposed to develop and market a bicycle including a new feature.

- A) (10 points) Make an annotated sketch of a standard bicycle. A side view could suffice. Ensure the ways parts are interconnected are accurate, that the proportions are roughly correct, and that key dimensions are labeled so that your functional understanding of the bicycle is evident.
- B) (20 points) Now consider a new feature. The bicycle should enable the rider to store energy from pedaling or from going down hill and later use that energy to aid in either acceleration from a stand still or else in hill climbing. Develop, at the conceptual level, three very different ways of implementing this function. Simple abstract descriptions and sketches will be enough.
- C) (20 points) Begin to set up a Pugh chart for selection among your alternatives from B. List at least three criteria by which you might choose among them. Choose a datum concept. Then fill out a single row, rating the two concepts against the datum (“+” indicates superior to, “-“ indicates inferior to, “S” indicates essentially the same as the datum). That would imply you need to make just two relative assessments. Below your Pugh chart, provide a few sentences of text, sketches, equations and so on that defend each of these ratings. Be quantitative in your exposition to the extent possible.

2) (20 total) Consider a capstan such as the one as depicted below.

- A) (5 points) How much tension, T , must be applied to raise the weight at a constant rate?
- B) (5 points) How much tension, T , must be applied to lower the weight at a constant rate?
- C) (5 points) How much tension, T , must be applied to hold the weight at a constant position?
- D) (5 points) Explain the differences in scenarios A, B, and C in a style that a bright ten-year-old would understand.



3) (30 points total) Consider a typical brushed DC permanent magnet motor

- A) (15 points) Let's say we connect the motor to a regulated 5V power supply. Further, let's say we have a means (such as a dynamometer) to apply a known torque to the shaft even as we allow the shaft to continue spinning. We observe its performance as a function of the applied torque. When no torque is applied, the motor operates at 10,000 rpm. When the motor is stalled, the torque on the shaft is 0.1 N*m. Draw a sketch of torque versus speed and (on the same graph) power versus speed and indicate on the graph the operating conditions for maximum power.
- B) (15 points) Let's say we remove the permanent magnets and put them in an oven. After the magnets cool back down to room temperature, we install them again and let's say we find that the magnetic field strength has dropped by a factor of two. Then we connect the reassembled motor to the 5V power supply and repeat the measurements as before. Estimate how the performance of the motor will be affected by the heat treatment of the magnets. Sketch the new torque speed curve and compare it to the previous one (from part 3A).