This exercise will give you a chance to practice more of the design process than last time: you will be designing some real parts. You will work in teams of three. Your reports are due at the beginning of the lab session after two weeks, on January 30.

The Problem
A drive belt inside an engine has been vibrating. This vibration causes excessive noise and wear on engine parts and needs to be stopped. It can be stopped by mounting an idler pulley in a location approximately halfway along the vibrating portion of the belt. The idler pulley is a pulley which does not transfer any power to and from the belt; it simply pushes on the belt, maintaining belt tension and preventing vibration. The pulley will be adjusted so that it pushes against the belt with a force of 120 pounds.

The idler pulley needs to be held in place by a support structure. The configuration of the structure is shown in the diagram above. Your design should probably not look just like the structure in the picture; it just supports the parts in the locations shown. The rod is 10 inches long from the baseplate to the back plane of the crank. The width of the crank is unknown and will be part of your design. The length of the crank from the centerline of the rod to the centerline of the composite bushing is 7.5 inches. The baseplate is part of the engine; it is made of 0.5 inch thick carbon steel which can be drilled into, tapped, and welded to. The pulley is supported by a shaft through the composite bushing (you do not have to design the shaft or pulley). This bushing has an outside diameter of 0.75 inches and is 0.5 inches thick. There must be some means by which the angle of the crank can be adjusted by at least 10 degrees; this is to allow the pulley’s position to be adjusted in order to maintain the correct tension on the belt.
The Objective
Your goal is to design a structure which holds the pulley safely in place, supporting the constant load of the belt. In this case, consider “safely” to mean that there is a factor of safety of at least 3 against yielding of the material from which the structure is built. If there are parts which rely on friction to hold them in place, there should be a factor of safety of at least 5 against these parts slipping. Use a factor of safety of at least 2 for manufacturer-supplied allowable loads on purchased components such as nuts and bolts. The structure should be as simple, inexpensive, and lightweight as possible. The whole system should be easily installed, and it should be easy for someone with ordinary tools to adjust the angle of the crank and so adjust pulley force.

The Assignment
You are to create a suitable design for this structure, and then prepare a design document which presents your work to the customer who is considering hiring your company to build these devices. This report will contain the following information:

- A clear technical description of the problem which your design is solving. This includes, for example, a complete set of free body diagrams which show the external forces acting on the structure.

- Brief descriptions of several design options which you should have considered in the course of your work. Sketches of the important features of these designs would probably be very helpful here.

- Results of the calculations which you used to compute the sizes of the parts used in the structure. It is usually best to show the results of the calculations in the body of your report, and include actual hand calculations in an appendix.

- A structural analysis of the design which you have chosen. This analysis should be complete enough that you can answer the question, “Will it break?” with a confident “No.” Your analysis may neglect considerations which have not been addressed in class, such as fatigue, many end effects, dynamic effects due to vibration, and so on.

- Design drawings should be made. These drawings should be drafted to scale (either by hand or by CAD is fine), not just sketched. You do not need to include information such as tolerances or surface finish, but you should show all relevant dimensions so that the parts could be fabricated from your drawings. An assembly drawing should be present which shows how the parts fit together.

As in the previous exercise, the format of the report is not fixed, but it should appear professional and well organized. Lists and tables help to organize your presentation. The report should be formatted using a word processor and spell checked.