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2.007 Design and Manufacturing I
Spring 2009

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2.007 Design and Manufacturing 1

Homework #3 Pneumatics, CAD, & Gears

NAME: _____

Date Issued: Tuesday 17 MAR, 11AM

Date Due: Tuesday 7 APR, 11AM

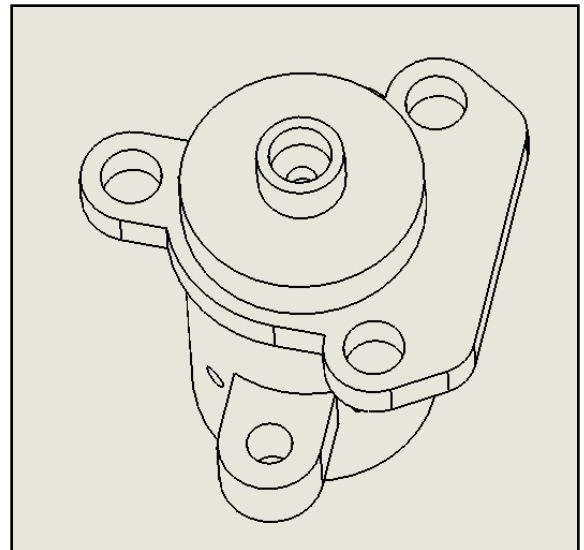
Please answer the following 5 questions showing your work to the extent possible within the allotted time. Point allocations are listed for each question. The points sum to 100.

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 at lecture by hardcopy or via the course web site (and your answers to question 1 are automatically recorded on the web site we have provided).

1) (25 points) Complete 25 questions on forces and accelerations from the Forces Concept Inventory.

2) (25 total) Get the solid model depicted below on the 2.007 web site (chamber08.sldprt).

- A) (15 points) Use Solidworks to make an engineering drawing of the part. Make a top, front, and side view and align them. Provide complete dimensions so that a machinist could make the part from the drawings alone without the solid model. Print out your drawing on 8.5"X11" paper.
- B) (10 points) In about one page of words and graphics, describe the procedures one might use to make this part on machines in the Papallardo lab (including mills and lathes). Pay careful attention to sequence of operations and means for holding the work in process. Are there any small design changes that will make the part much easier to fabricate (assume small quantities are to be made, say a dozen)?



3) (25 total) You fill a two liter container with air at 60 psi gauge pressure and plan to use it as a source of power for a machine.

- A) (10 points) How much energy will be required to fill the tank to 60 psi assuming that you pump the air slowly enough for the reservoir to be at thermal equilibrium (therefore $P \cdot V$ is constant) with the ambient air at a temperature of 20 degrees Centigrade and 1 atmosphere of pressure?
- B) (5 points) What will be the temperature of the air in the tank if we fill the tank assuming that you pump the air quickly enough so that heat transfer to the surrounding air can be neglected (therefore $P \cdot V^{1.4}$ is constant)?
- C) (5 points) Estimate the force applied if 60 psi air at 20 degrees C is released into a piston with a 1 inch internal diameter and a two inch throw?
- D) (5 points) How much energy will be released by the air if it is expanded very rapidly to ambient pressure (1 atmosphere) so that heat transfer to the surrounding air can be neglected (therefore $P \cdot V^{1.4}$ is constant)?

4) (25 total) Consider a set of spur gears of 24 pitch and 20° pressure angle and either 12, 24, or 48 teeth.

- A) (10 points) Make a sketch of a of 24 pitch gear with a 1 inch pitch diameter and about a 20° pressure angle. You can use Solidworks and can employ the DXF file on the 2.007 web site (24tooth.dxf) as a starting point.
- B) (5 points) A 12 tooth gear is mated with the 48 tooth gear. Make a drawing of the two gears with their pitch diameters tangent. You can use Solidworks and can employ the DXF files on the 2.007 web site (12tooth.dxf and 48tooth.dxf) A torque of 1 Nm is applied to the 12 tooth gear and the 48 tooth gear is prevented from rotating. Estimate the separation forces between the gears. Indicate on the drawing where the forces are applied and where a reaction force is generated to maintain the gears in static equilibrium.
- C) Using only 24 pitch gears with 12, 24, and 48 teeth and ¼ inch face width, design a compound spur gear train for a ratio of 32:1 Sketch the train to scale. (Note: there are many different solutions possible, you should make design decisions and explain your rationale.)
- D) Imagine the gear train from (part C) is driven by a servo motor with the manufacturer's specifications shown to the right. Estimate the factor of safety for the gear train assuming the largest load applied to it will be the stall torque of the servomotor. You can assume the gears are molded from Delrin.

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