Design Exercise #1. Design of Gear-Box
Assigned: 2/10/14, Due Date: 2/17/14

Grading:

10 points (style, grammar, organization),
0 points (quality of drawings),
90 points (Design Content: Calculations),
0 points (Design Content: Functional Requirement-Design Feature Mapping),
0 points (Design Content: Cost Estimates)
0 points (Design Content: Design Quality, Completeness, Buildability)

The second level functional requirements for your design will be

A) a container to hold the electronic control components (Vex microcontroller, Radio Shack circuit boards, electrical connectors, panel switches) allowing access to the components & viewing of the lights and protecting the components from environmental conditions (such as water, shock & vibration, and impact).
B) A frame to provide stiffness for the steering wheels, drive wheels, and to hold the controller box (A). Front and rear steering wheels must mount to either end of the frame. Pivots to attach drive wheels & suspension must be provided in the frame design.
C) **A gearbox to couple the drive motors to the drive wheel and which mounts to the suspension element in the Frame (B).**
D) A gearbox to steer the front/rear wheels. The design must accommodate a potentiometer to measure the position.

This design exercise is to develop a design to fulfill functional requirement C. This first step is to perform the basic calculations. The detailed design will come later.

The input is set by one or more FIRST CIM motors (for now, we'll design around 2). For specs on the motor, go to calliope.ualr.edu & look at the bottom of the mechanical design page under actuators.

The wheels are 9" in diameter and 2.5" wide. They have a 1/2" hex hole broached in the center.

The maximum load on the gearbox is set by the weight of the robot, the radius of the wheel, and the coefficient of friction. Presume that the weight born by each wheel is 500 lb and that the maximum coefficient of friction between wheel and surface is 0.2. Use these numbers to determine the maximum output torque. NOTE: this is the torque to use in failure calculations.

Available gears are 20 pitch, 20 pressure angle, with the following teeth: 60, 45, 30, 18, 15, 14. All gears are made from steel gear stock. See stock drive products (www.sdp-si.com) for gear stock specifications.

**Design a two stage gear box that won't stall the motor when subjected to maximum load.** The output of this step are the number of teeth on the motor pinion, the first stage gears (the gear that mates with the motor pinion and the gear that mates with the output gear), and the output gear. Four numbers. How hard can that be?

What are the gear spacings for this gearbox?

What is the output speed of the gear box at 3⁄4 no load speed? What does this say about the likely top speed of the robot? (i.e., multiply this number by the wheel radius ... that's the robot's top speed under load) This robot needs to maneuver around a (roughly) 30 ft x 20 ft stage with people on it. Speed can be limited in software but it cannot be increased. What do you think about this top speed?

Fill in the gear stress table for this gearbox using face widths of 1/2". Based on your stress calculations, set the face widths to insure that no tooth exceeds 0.3 Sy.

Design Output: Produce a brief (2 page maximum) report that summarizes your engineering calculations and provides your rationale for making your design choices.