

**Design Contest**  
**ME72 Engineering Design Laboratory**  
**Fall & Winter Terms, 2006-07**

**Analysis Assignment**

Assigned: **Tue 31-Oct**

Due: **Thur 9-Nov**

Individually (not as a team) perform one of the following analyses for the design contest. Describe the assumptions you make and briefly justify them. It is usually best to make *conservative* assumptions, *i.e.*, assume a coefficient of friction which is less than is likely, so that your results become a sort of worst case scenario, and your actual device will probably perform at least this well.

1. Analyze at what speed your device (or a device that you might consider building) can climb the mesh, and how much mass it can lift. A steady-state analysis is acceptable, but including the acceleration of the mass(es) would be better. What transmission ratio and wheel size (effective wheel radius) did you choose? Why? How long would it take for your device to travel from its start zone to its maximum height?
2. Analyze at what speed and with what force your device (or a device that you might consider building) can push an opponent device. A steady-state analysis is acceptable, but including the acceleration of the mass(es) would be better. What transmission ratio and wheel size (effective wheel radius) did you choose? Why? How long would it take for your device to travel from its start zone to reach an opponent's device?
3. For a range of devices masses and sizes, what force is required to eject an opponent device from the mesh? Consider both direct lifting, and tipping (assume a pivot location, and different centers of gravity). What transmission ratios are required to produce these forces. How fast can the ejection operation occur under optimum conditions (*i.e.*, your opponent is stationary and not fighting back)?
4. Analyze the forces and accelerations likely to occur during a fall your device might experience during the contest. Assume reasonable masses, and estimate the impact forces and accelerations on a padded floor surface using reasonable assumptions about the stiffness of the surface (e.g., similar to a mattress or bean bag) or the contact time. Since these values are not known with any certainty, vary them over a fairly wide range of reasonable values and determine the effect on your result. Based on this, determine what you believe to be a reasonable upper bound on the impact force and acceleration your device might experience. Based on this upper bound, does this specifically (quantitatively) limit the use of any materials from your kit?
5. Analyze the time needed for a hoist/winch type device to lift the chain to a desired height. Assume appropriate transmission elements for the hoist/winch. Remember

that the chain must be accelerated from rest and brought back to rest at the top. What overturning moment must be resisted by the hoist/winch support, assuming reasonable device dimensions? How does the choice of transmission ratios and winch drum diameters affect the time required to lift the chain? How do these choices and the resulting changing accelerations affect the overturning moment for the hoist/winch?

6. Analyze a vertical “scissors-jack” mechanism that is designed to extend up to a desired height, while lifting the chain. Determine the deployment distance as a function of time using a lead screw drive. What transmission ratio and lead-screw pitch did you choose? Why? How would you optimize your choice? What is the affect of adding additional stages? What is the affect of changing the link lengths? In your analysis use a material density that is appropriate to your material choice.