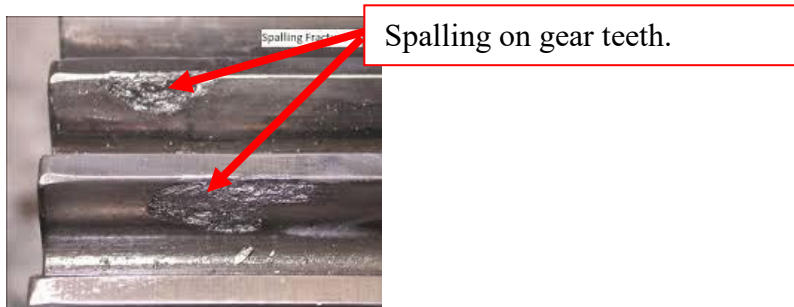


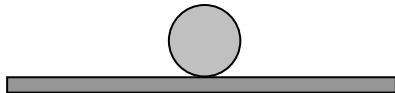
ME 328 – Machine Design
Assignment 4, Spring 2020

Grading will be based only on completion – but completion does include following the standard problem-solving format (and “top of page” information).

1. (5 pts) **Educational Purpose:** *develop a deeper understanding of what the Hertzian Contact stress equations “tell” engineers.* Using the information shown in graph on the course web page (<http://faculty.up.edu/lulay/me401/Hertzian-Cylinder-Stresses.pdf>) explain why bearings and gears may experience “spalling” failures as a result of Hertzian contact stress. Spalling example of a gear is shown here (spalling is also referred to as “pitting” failure – but it is not corrosion):



2. (10 pts) **Educational Purpose:** *apply Hertzian Contact stress equations to answer a simple design question.* A railroad car wheel runs on a track. The rail and wheel are both steel. There is a normal force (F_N) between them. The wheel has a 20 inch diameter and is 2 inches wide. For plots, use Excel, MatLab, or other program. $0 < F_N < 100,000 \text{ lb}$.



- a) With respect to b, where is the maximum shear stress due to Hertzian contact located? In other words, what is z/b for maximum shear stress? What is its normalized magnitude (max shear / P_{max})? You may use graphs mentioned in Problem 1.
 - b) Plot the maximum shear stress in the wheel as a function of F_N (hint, doing part c first might be easier).
 - c) Plot the maximum compressive normal stress in the wheel as a function of F_N .
 - d) Determine an appropriate yield strength for the wheel assuming a factor of safety of 5 against yielding with F_N of 50,000 pounds.
3. (5 pts) **Educational purpose:** *develop mechanical engineering jargon – ya gotta learn talk like an injuneer.* Define the following terms, use sketches if appropriate, and cite your sources (URL’s are acceptable): festoon, collet, clevis, gimbal, u-joint, CV joint (Rzeppa joint), flange, flange joint, solenoid, vibration damper.

No homework “credit” will be given for the next two “problems”. There is nothing to turn in. However, it should be both very educational and interesting (it’s nice when those go together). If you do not watch the videos, you will be missing out on important lessons learned.

4. (20 pts) *Educational purpose: the current generation of college students (aka ---- you) is living in a time of unprecedented technological change. These technological changes are*

having profound impact globally, economically, environmentally, and societally. And more change is imminent. It is not too far in the future before Amazon will employ very few delivery personnel as they will have fully autonomous distribution centers and delivery vehicles. Change is change – it is not inherently good or bad, but how we allow it to affect us can have profound implications. As 21st century engineers, we must have the ability to understand engineering responsibility and impact for the designs we create – if we don't, who will?

Submit this part (Problem 4) of the assignment on a separate sheet of paper – separate from the first 3 problems...an entire different stack of paper on the front desk...

A long time ago, on a continent far far away, a movie was produced that explored the impact of new technology on an isolated group in the Kalahari Desert in Africa (if you don't know where that is at, look it up) – at least part of the movie did that. Although this movie was filmed in Africa, it is in no other way related to the ME328 design project (the Kalahari is not near Uganda). Regardless, it is a movie worth watching – it may help you think a bit more creatively and broadly about the impact of engineering.

What's the movie? *The Gods Must be Crazy*

How do I find it to watch? *It is posted on the ME328 Moodle page, scroll down right side to Activities>Resources. Available for 2 weeks only. 1 hour, 45 minutes.*

What needs to be submitted for this assignment? *After watching the movie, you should have a different (hopefully better) ability to evaluate the potential impact of creating a motorized plow-pulling device (the ME328 design project). Write a few sentences (at least one sentence) for each of the following eight design considerations.*

*Discuss **impact** of the winch design on global, economic, environment, society. When discussing impact, you may discuss positive impacts and/or negative impacts. You may consider direct effects and indirect (what the winch is replacing)*

- *Globally: how may the “winch” device have different impact for farmers in Uganda than US farmers.*
- *Economically: how may the device impact economics for farmers in Uganda.*
- *Environmentally: how may the device affect the environment in Uganda.*
- *Societally: how may the device affect people or society in Uganda*

*Discuss **ethical and professional responsibilities** as an engineer associate with the context of global, economic, environment, society.*

- *Globally: What design features (criteria) may have more significant impact for Uganda farmers than US farmers.*
- *Economically: What economic criteria may be important for the Uganda “winch” project (initial cost, maintenance, effectiveness, etc.)*
- *Environmentally: what design factors can lead to a more positive, or less negative, impact on the environment.*
- *Societally: what design features you should consider that would affect society – this may include safety and health*

Then pick one of the above that you believe is most important. Write a brief paragraph explaining why you think it is the most important for this project (of the eight above considerations).

You may discuss this with friends, enemies, cats and dogs, but what you submit is **your** thoughts. **Submit this part of the assignment on a totally separate sheet of paper – separate from the rest of the assignment.**

On hw 5, you will be asked to watch a documentary. If you want a head start...here it is:

The video “Battle of the X-Planes” is a 2 hour documentary very well worth watching in regards to engineering design. **Pay attention to any discussion about “thermosetting vs. thermoplastic composites.”** Boeing bets the whole project on thermoplastic composites to save weight, but how can thermoplastic composites save weight? We’ll discuss that later, because it isn’t clear from the video.

Also pay attention to a meeting of a few dozen Boeing engineers trying to determine which of two different design they should pursue. **There are two important lessons demonstrated:** 1) the fact that engineers must often make decisions without having all the facts and data needed and 2) engineers need to have confidence in their professional opinions in order to make significant contributions to engineering decisions.

Don’t forget the popcorn: https://www.youtube.com/watch?v=Y_WPLLeDmU6o