# Aishwarya Ledalla

Mechanical Engineering Portfolio

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## Design Optimization of Brake Disk

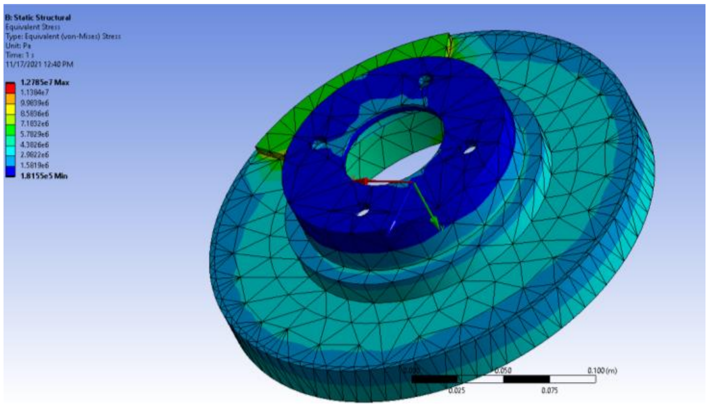


*Figure 1:* Static Structural Analysis

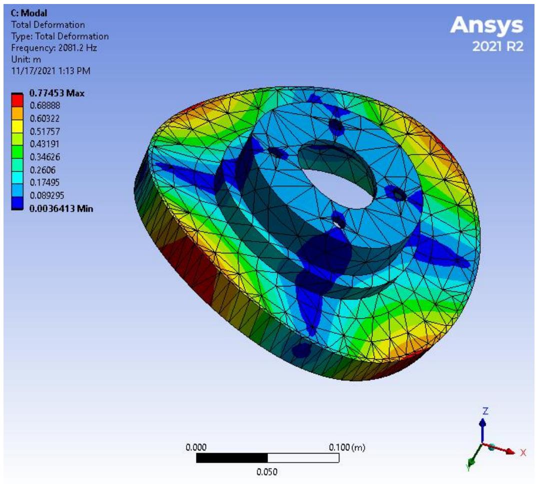


*Figure 2:* Model Analysis

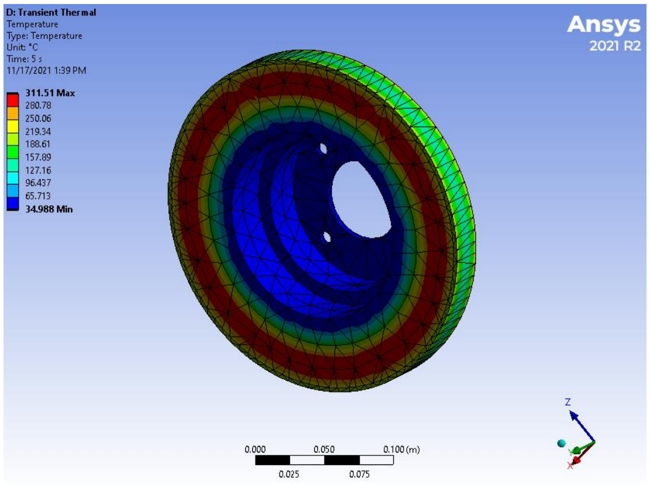


*Figure 3:* Transient Thermal Analysis

I improved the design of a generic brake disk model in ANSYS by minimizing the volume and optimizing the stress, natural frequency, and temperature. I performed a static structural analysis to minimize stresses in the brake disk caused by pressure from the brake pads, and centrifugal body forces on the disk. In addition, I performed a model analysis to maximize the natural frequency to avoid resonance, as well as a transient thermal analysis to minimize temperatures in the break disc to reduce wear and tear from high brake friction. I simulated a design of experiments (DOE) in ANSYS by varying the brake disk thickness, and outer and inner diameters. Using the results from the DOE, I performed an optimization on the designs using a Multi-objective Generic Algorithm in ANSYS. I chose the best design from three optimized candidates based on failure trade-offs between the stresses, natural frequencies, and temperatures. Overall, the maximum stress in the optimized design was reduced by 8.4% with no additional increase in temperature compared to the initial design.

## Senior Capstone Project: Firebreaker

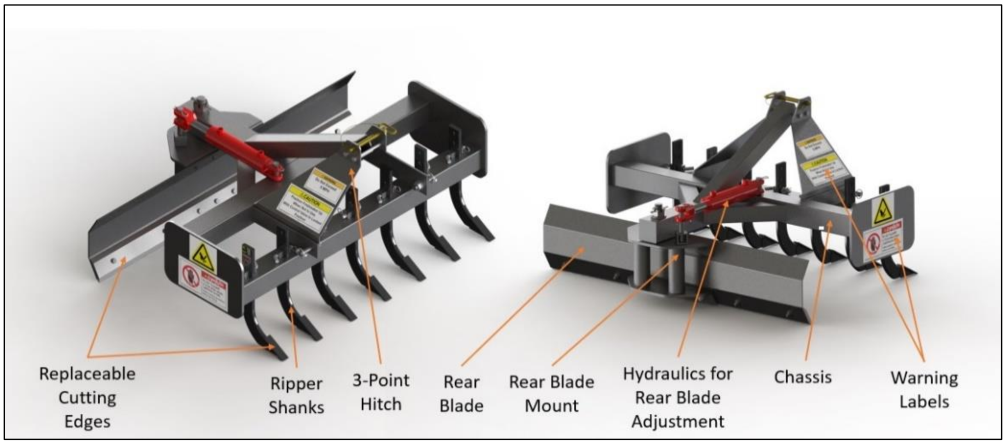


*Figure 4:* Firebreaker Rendered CAD Model

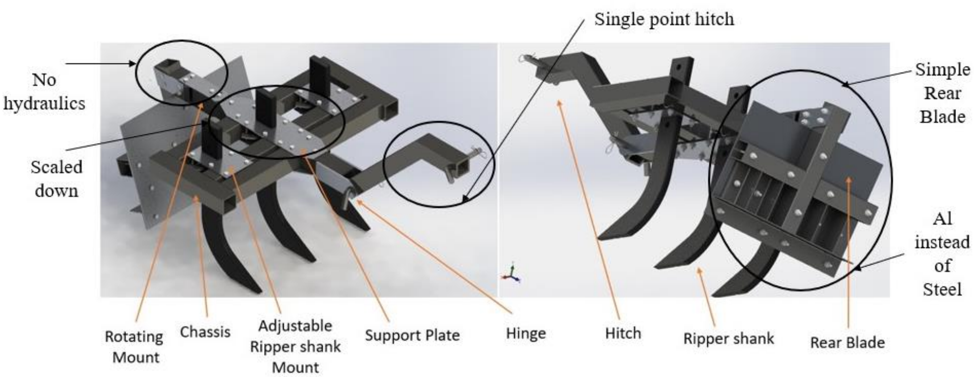


*Figure 5:* Firebreaker Prototype Rendered CAD Model

*Figure 6:* Firebreaker Prototype

In a team of 6 engineers, I developed, designed, and demonstrated a product to assist firefighters in creating firebreak lines to control wildfires. We designed the Firebreaker, a truck implement capable of plowing and clearing flammable debris. I managed the CAD main assemblies and sub-assemblies for the Firebreaker and prototype as well as oversaw validation testing for the prototype. To acquire load information for static and fatigue analyses, I researched soil properties and farm equipment. Using the gathered information, I wrote a MATLAB program to perform the analyses on the chassis which we used to compare against FEA results. I designed the chassis, and the rear blade and its mount with an additional team member. Working with two team members, I designed the prototype and selected materials and fasteners from standard material suppliers. I conducted a basic reliability analysis on the chassis with the assistance of an additional team member. Along with my team, I gave progress presentations to our sponsor. For our presentations and reports, I produced the CAD renders and animations. I provided CAD part drawings for the chassis sub-assemblies and main assemblies for the Engineering Drawing Packages for both the Firebreaker and the prototype. In the final report for the project, I wrote documentation on the design, DFMA, and budget sections along with my research.

## Windmill Gearbox Design

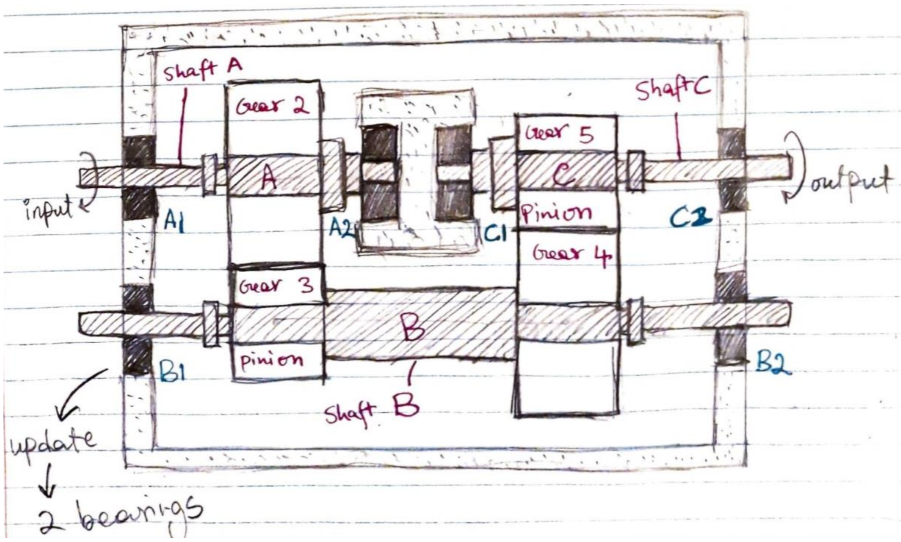


*Figure 7:* Gearbox Schematic

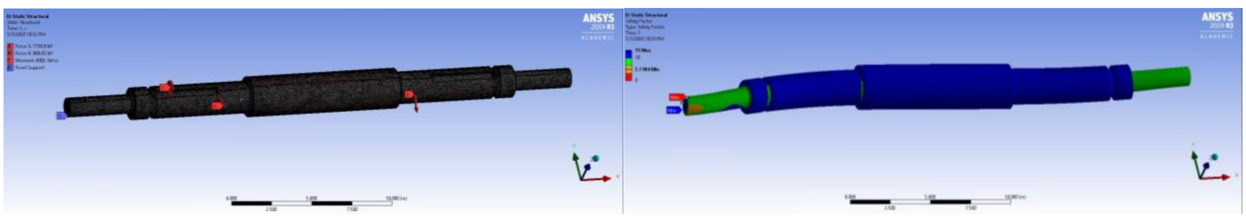


*Figure 8:* Shaft B Model and Stress Analysis

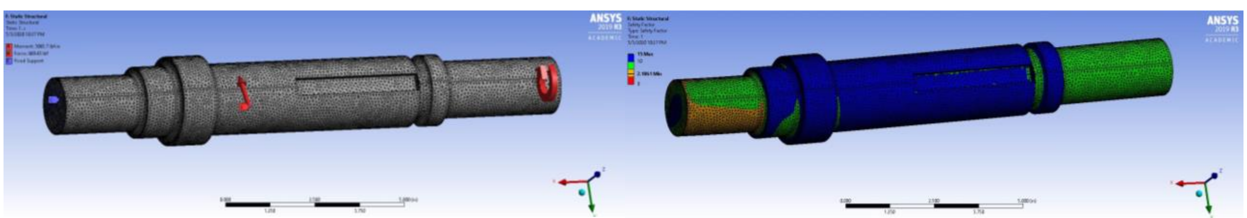


*Figure 9:* Shaft A/C Model and Stress Analysis

I designed a differential double-reduction gearbox for a wind powered electric generator. Given an overall gearing ratio of 3.6 and transmitted power of 175 HP, I designed the gears, shafts, bearings, and a basic enclosure for the gearbox. I wrote iterative programs in MATLAB for the design of each sub-component to assist me in choosing the best set of dimensions and materials for 4 gears, 6 bearings, and 3 shafts inclusive of keys. I performed a FEA on the shafts to validate my analytical results. For this, I CADed the basic models of the shafts in SOLIDWORKS and simulated the FEA in ANSYS. The shafts met yield and fatigue safety factors >2.0 with a 90% reliability.

## Speaker Controller Design

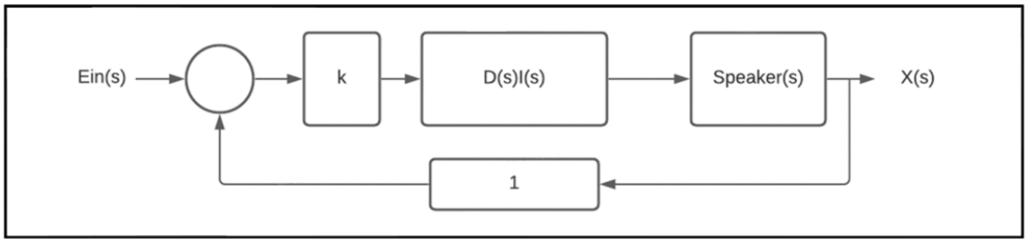


*Figure 10:* Compensated Speaker Block Diagram

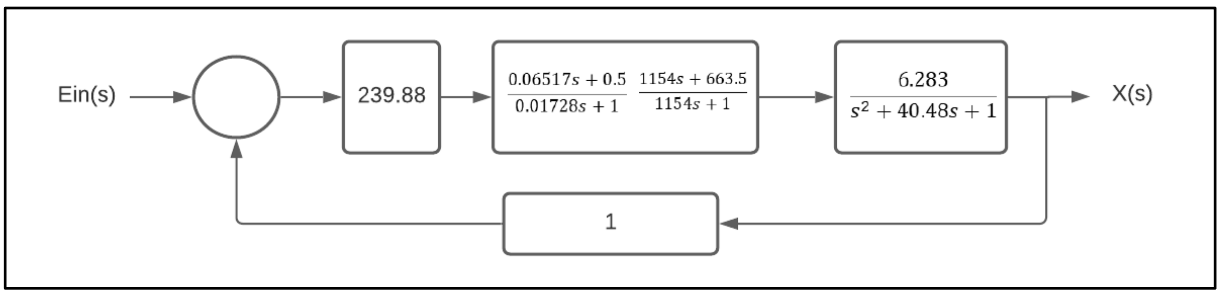


*Figure 11:* Block Diagram with Speaker and Compensator Transfer Functions

I designed a lag-lead controller/compensator for a generic speaker system. I set the requirements for the controller with a settling time of $T_s$ = 0.1s, an overshoot ≥ 5%, and a steady state error of $e_{ss}$ = 1 micron with unity feedback. I found the proportional gain K from a bode plot of the uncompensated transfer function of the speaker system to meet the settling time requirement. I found the lead compensator transfer function D(s) using the phase margin to meet the required overshoot and the lag compensator transfer function I(s) using the steady state error requirement. I wrote a MATLAB program to help iterate through these processes until the transfer functions yielded acceptable results.

## Underwater Robotics Club at ASU: ROV Detachable Hook System

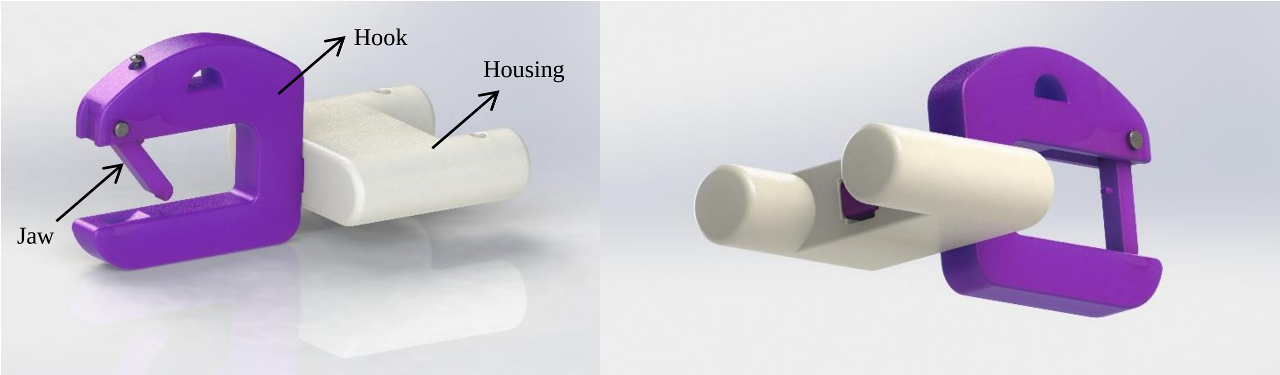


*Figure 12:* Detachable Hook System

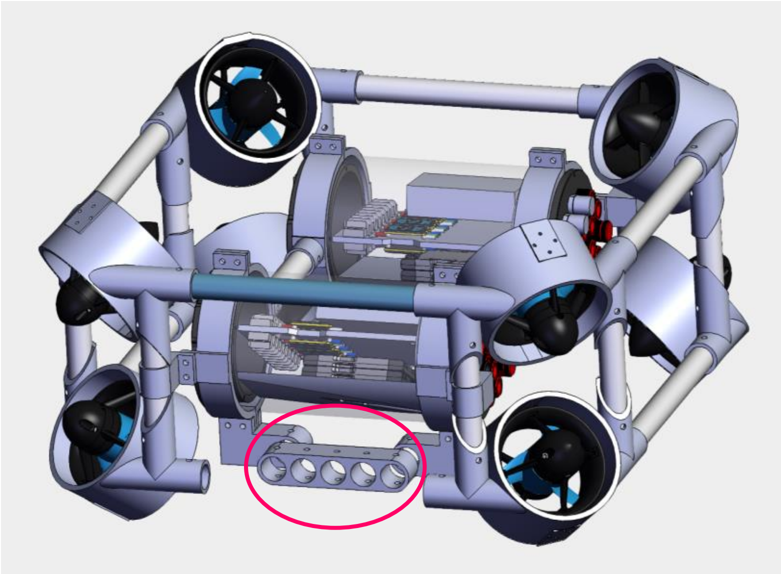

*Figure 13:* Location of Detachable Hook on the ROV

I was responsible for designing a hook system for our club's submission to the National Underwater Robotics Competition (NURC). The objective of the hook system was to pick up objects at the bottom of a pool and bring them to the surface during the competition. The system was required to be mountable to the ROV, modular, attachable to a rope, 3D printable, and easily detachable from the ROV. I designed a carabiner-like hook system in SOLIDWORKS with three main components as shown in *figure 12*: the jaw, the hook, and the housing. Once the hook self-locks onto an object, the ROV can disengage itself as the hook is magnetically attached to its housing and an operator can bring the hooked object out of the water using rope. To simplify the design, I chose to incorporate a rust-resistant rubber band instead of a spring to keep the jaw in place.