**ME 354**

Torsion Lab Write-Up

[Your Name]

Section [##]

Partners:

[Your Partner(s) Name(s)]

***Instructions:***

* Delete this page and complete/replace all the [##] prompts.

***Some notes on completing the lab write-up:***

* You don’t need to show your calculations, just the method (equations), the input, and the output. Someone should be able to take your numbers, plug them in using your methods, and produce your results. You do need to show all the equations you’ve used, either in the main text or the appendix.
* The results and discussion sections should not just be bulleted answers to the questions in the manual. Your answers should be integrated throughout the report, and you can indicate when you are answering a certain question, but writing should be done as a report in narrative form.
* Use descriptive words and sentences. “The results didn’t match,” or “the measurements were way off” are not proper scientific writing. “The numerical results overpredicted the experimental value by x%” is a better way to phrase your writing.
* Avoid filler words and statements such as “in order to”, “therefore”, etc, unless they are truly necessary to make a point. Writing concisely is a difficult skill to master, but one worth practicing.
* Double check formatting. Same font and spacing everywhere, table and figure legends are on the same page as the corresponding table or figure, consistent style throughout.
* Figures should be created such that they are readable in black and white.

***Big things to remember:***

* The experiments are always real, but there may have been issues with the measurements that prevented you from obtaining accurate results.
* The theory inherently lacks details; it is a model and is trying to match reality. The question you are trying to answer is whether it is a useful predictor of the behavior you’re observing.
* Your job is to investigate whether the theoretical analysis is a useful predictor of the experiments, given the measurement uncertainty for both. Just because they don’t match doesn’t immediately mean one or the other is wrong, and **just because they do match doesn’t mean they are correct**. Your job is to figure out why things do or don’t match up.

# Numerical Analysis

This lab involves experimentally and theoretically investigating the plastic yielding response of slender rod specimens of two different metals, 6061-T6 aluminum and A36 steel. In this, [briefly describe the experiment, important features for its setup, how the torsion is applied and measured, what model we are using to fit to the yielding data, and any other relevant information to the lab].

## Torsion Analysis

### Experimental Setup

[Describe the loading setup and any relevant details needed to understand the experiment]. A schematic of the torsion setup and the force measurement configuration are shown in Figure 1.

[Insert a schematic of the torsion setup and the load measurement setup (can be a simplified diagram). Note: this should be your own figure, not a copy/paste from the manual. Pro-tip: use Inkscape or Paint.net as free software alternatives to Photoshop]

**Figure 1**: Image of the testing setup and load measurement scheme.

**Table 1**: Relevant dimensions of the torsion setup and samples.

Insert a table of the torsion system dimensions

### Torsion Theory

Torsion leads to a state of nearly pure shear in the material and makes it possible to apply large strains prior to failure. Here we use an exponential hardening relationship to model the plastic deformation of the different rods under torsion.

[Include all the relevant equations to describe the theoretical analysis you are performing for the torsion experiments, as well as any equations you may be using for analyzing the experiments (e.g. for the applied torque in the rod). Hint: any equation you use in your data analysis (Python, excel, matlab or otherwise) should show up here.]

**Table 2**: Material properties of the 6061-T6 Aluminum and A36 Steel specimens used.

Insert a table with any material properties that you are using for your analysis, including the values of stiffness and strength you obtained from the tension lab that are being reused here. You can also include the H and n provided in the manual or that you have calculated yourself.

# Experimental Results

## 6061-T6 Aluminum Analysis

[Provide a brief explanation of the important results from the aluminum tests]

[Insert an image of the deformed specimen and the cross-section of the material after failure]

**Figure 2:** Aluminum specimen after failure

[Describe any observations from the aluminum torsion data. Note: this should be a description, not much critical analysis here.]

[Include a plot of the torque vs. twist angle for both aluminum data sets. Note: torque will be calculated using a moment balance on the schematic from Figure 4 in the manual.]

**Figure 3**: Aluminum torque vs twist angle results.

[Describe the results from the shear modulus fit and provide a value of the shear modulus and regression.]

[Describe the position of the yield radius of the material and at what twist the material should be theoretically plastically deforming.]

[Include a plot of the yield radius vs. twist angle for one of the aluminum data sets. This can be zoomed in to improve focus.]

**Figure 4**: Aluminum yield radius vs twist angle results.

[Describe the results of the exponential hardening fit to the experimental data. You should describe how well the theoretical torque data fits and what the effect of changing any parameters is.]

[Include a plot of both the experimental vs theoretical torque vs. twist angle for one of the aluminum data sets. On top of this you can superimpose the fits using different H and n values. Feel free to break this into multiple figures if you feel the data cannot be properly represented in one plot.]

**Figure 5**: Aluminum theoretical vs experimental torque vs twist angle.

## A36 Steel Analysis

[Repeat the above analysis for the A36 steel.]

# Discussion

[The discussion section can be formatted as you see fit. You should explain how and why the theoretical fits to the experimental torsion data do or don’t work, and what could be done differently to better model the behaviors. Be sure to include discussions on all of the points indicated in the manual.]

# Extra Credit

[Describe your method for calculating the H and n for the steel and aluminum. Include plots, equations, averages and variances as is needed to properly explain the results. You should be fitting to the experimental data in the tension lab. Include a brief discussion on how the variance in properties relates to your sensitivity analysis.]

# Appendix

[Include any code or materials use in your analysis of the data]