Week 1  Introduction to MAE150L – Objective of the course. Theory of strain gages and data acquisition

The learning objectives and all logistical details for the whole quarter are presented. The theory of strain measurements via strain gages is presented, alongside some fundamentals of electronic circuits and their application to signal processing.

Week 2  Strain gage application procedure

Demonstration of installation procedure. Strain gages will be installed on aluminum bars.

Week 3  Signal detection and conditioning

A Wheatstone bridge with signal amplification and offset correction will be implemented on a breadboard.

Week 4  Introduction to Arduinos

The Arduino micro-computers are introduced and set up as a data acquisition system / analog-to-digital converter for 1-channel and 2-channel readings. The circuit will be connected to the strain gage wires for strain measurement.

Group Report #1. Describe the operational principle of strain measurement via strain gages and discuss the practical implementation. Comment on the electronics aspects and discuss offset cancellation, amplification, etc... and their effect on the accuracy of the signal. How small of a strain can you reliably measure with your setup?

Week 5  Tensile Testing

An aluminum bar will be suspended at one end and loaded with variable weights on the other end. For each load magnitude, the strain will be measured. The Young’s modulus of aluminum will be extracted. The operation will be repeated on multiple instrumented bars.

Group Report #2. Describe the experimental setup for tensile testing. Discuss strain calibration procedures. Apply a series of well-known loads (verified with a scale) to an aluminum bar and extract the strain from the gage readings. Process the data to extract the Young’s modulus. Repeat the same activity on 2 more bars, and discuss accuracy and repeatability.
**Week 6**  
*Beam bending Test*

This is a cantilever beam-type bending test. One end of the bar will be clamped on a support and the other will be loaded with a transverse point load. A ruler will be installed behind the loaded end to measure the tip deflection. Two strain gages will be applied on the bar, at the midpoint, on the top and bottom sides respectively. The end load will be progressively increased to induce plastic deformation in the beam.

**Group Report #3.** Describe the experimental apparatus. Plot the experimentally measured end deflection as a function of the applied end load, and overlay the analytical prediction. How do the two curves compare? Plot the strain gage readings (top and bottom) as a function of the applied end load and overlay the analytical predictions for strain at those two points. Use the analytical equations and the experimental data to estimate the yield strength of the material.

**Week 7-9**  
*Buckling experiment using an INSTRON frame*

This lab will demonstrate elastic buckling of a single straight bar. The bar will be supported with two brackets at each end and will be compressed with the INSTRON machine. The buckling load will be extracted and compared with analytical predictions.

**Group Report #4.** Describe the experimental apparatus. Plot load VS cross-head displacement and strain (from the gage) VS cross-head displacement. Compare the experimentally measured critical load with the Euler load prediction. Comment on possible discrepancies.