ASE 375 Laboratory 7: Shake testing

Week of 25 March 2024

The goals of this laboratory are to:

- Learn how an electromagnetic shaker and a load cell work
- Amplify the output of the load cell using an instrumentation amplifier
- Perform shake testing on the built-up wing to obtain the frequency response function

Lab exercises:
You will explore the dynamic response of a built-up wing. You measured the static response of this wing in Lab 3 and performed rap testing on this wing in Lab 5 and Lab 6.

1. Calibrate the load cell by hanging known masses from it.

   NOTES:

   - Connect the output of the load cell to the AD623 instrumentation amplifier (see figure 1) and use the gain setting resistor provided for you. Measure the output of the instrumentation amplifier using the NI 9215. Also measure the gain setting resistor and calculate the gain of the amplifier.
   - Measure the output of amplifier for different masses hanging from it. Collect your data while loading and unloading the masses. Keep in mind that a larger number of data points will improve confidence in your calibration factor.

2. Use the shaker and the calibrated load cell to measure the frequency response function of the wing (tip bending displacement vs. input force). Compare the natural frequencies to those that you measured in Lab 5 and Lab 6.

   NOTES:

   - Attach the shaker to the front spar of the wing (near the wing root). Excite the shaker with a sinusoidal voltage at a constant frequency. Measure the force required to excite the wing and the tip acceleration (use the MEMS accelerometer). Do this for a frequency range between 5 Hz-100 Hz. Use a sampling frequency of 1 kHz.
   - Plot the magnitudes of tip acceleration, tip displacement and excitation force as a function of frequency. Since the excitation is sinusoidal, the magnitude of the displacement $|x| = |a|/\omega^2$ where a is the acceleration and ω is the frequency of excitation in rad/s.
   - Plot the magnitude of tip displacement divided by the magnitude of the excitation force at each frequency - this is the frequency response function (tip bending displacement vs. input force).

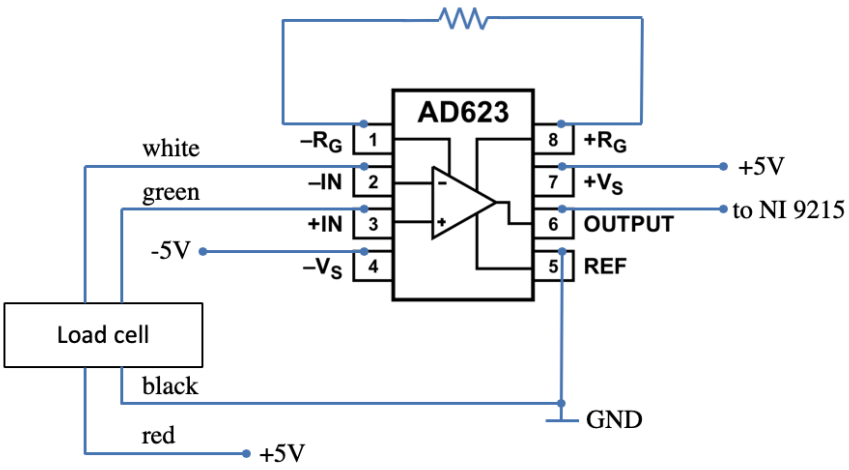

Figure 1: Load cell and instrumentation amplifier connections