ENGR 325	**Lab 6**	**Walla Walla University**
Winter 2021	**Measuring acceleration**	**Inst. Mark Haun**

The goal of this lab is to explore the usefulness of the FFT in analyzing vibration waveforms picked up by placing an accelerometer on the handle of a wooden softball bat. When a softball is hit with a bat, it may cause significant vibration in the hands of the hitter. In extreme cases, it causes pain. Hitters observe that vibration and pain level depend on where the ball hits the bat. There is a "sweet" spot where vibration is minimized.

Objectives:

- Use an accelerometer to measure vibration magnitude and frequency.
- Further your learning about data acquisition using A/D converters.
- Gain more practice using the FFT to analyze the frequency content of a signal.

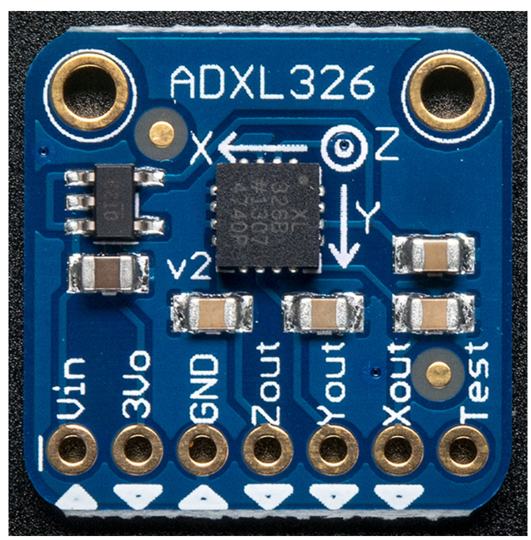
Equipment provided:

- Baseball bat, cantilever beam, and clamp
- Tape, rubber bands, and a "striking" device
- Accelerometer board and connection cables
- Windows PC with ADC and connection board

Procedure:

1. Use a C-clamp to clamp a cantilever rod to the top shelf of the workstation. Hang the bat vertically from the rod, handle end up, using a rubber band.
2. Use an ohmmeter and some pieces of wire to match up the connector holes at each end of the long blue ribbon cable. Hint: look for a faint triangle shape at one corner of the connector. The triangles at each end of the cable are connected together and they define "pin 1."
3. Make the necessary connections between one end of the ribbon cable and the A/D connection board:
   - Vin: connect to Vcc on A/D board
   - GND: connect to G0 **and** the GND pin next to the Vcc pin on the A/D board
   - Zout: connect to the S0 pin on the A/D board

   (One way not to make a mistake here is to use the connector hole with the triangle as Vin.) When you are done, have your instructor check your work.



4. Plug the blue ribbon cable into the accelerator board, being careful to match up the correct pins. **Be careful:** If you are wrong you could fry your accelerometer!

5. Test your setup by shaking the accelerometer while you collect A/D data in MATLAB, then plotting the results. (You do not need to include this in your report. Refer to past labs for code examples. This is easy to do at the command line using the `msgets0` function. Make sure you run `msstop` each time afterwards.)

6. Attach the accelerometer board to the side of the bat with some double-sided tape, about where a hitter would place their hands. You are using the Z-axis output from the accelerometer board so you are measuring transverse vibration (perpendicular to the length of the bat).

7. Tap the bat at various intervals and measure the magnitude of the vibration.

8. Determine the frequency components of the vibration, and a method to decide which point on the bat causes the least vibration.

9. Determine the "resonant" frequency of the bat. Compare to the numbers cited in the paper below [1], which is also on D2L.

Note:

The accelerometer board produces a voltage in the range of 0 to 3.3 volts, where 0V corresponds to -16g and 3.3V corresponds to +16g. Thus, 0g should read about 1.65V.

Report guidelines:

Include time-domain and frequency-domain plots for the case of least vibration, with correct axis labeling (actual time and actual frequency on the x axes). The y axis on the time-domain plot should be scaled and labeled in g's. You may leave the y axis of the frequency-domain plot as "relative amplitude."

References:

[1] Russell, Daniel A., Flexural vibration and the perception of sting in hand-held sports implements, in 41st International Congress and Exposition on Noise Control Engineering, INTER-NOISE 2012. New York, NY.

[2] Analog Devices ADXL326 aceelerometer data sheet