ASEN 3112 - Structures

Lab 3 - Airplane Shaker - Lab Procedure

Description of Apparatus:

The test article is a beam-model airplane comprised of six pieces, which are basic pieces of aluminum (6063-T5) stock. The pieces are assembled using simple nuts, bolts and lock washers. A separate piece is provided for a cantilever beam test used in another (senior elective) course in structural dynamics.

Nominal dimensions for each airplane piece (in inches) are as follows:

- Fuselage - 1 x 22 x 1/8
- Wing - 1 x 18 x 1/8
- Wingtip - 1 x 4 1/2 x 1/4
- Rudder - 1 x 5 x 0.040
- Elevator- 1 x 4 1/2 x 1/4
- Weights of each piece are as follows:
- Winget and stabilizer - 51 g
- Rudder - 12.2 g
- Fuselage - 125.3 g
- Wing - 103.8 g
- Gold bracket (ea) - 2.4 g
- Stop nut - 1.1 g
- Phillips style flathead screw - 0.7 g
- Slotted style flathead screw - 1.0 g
- All other screws - 1.1-1.2 g
- Lock washer - 0.1 g
- Fuselage/Wing center mounting plate - 19.2 g
- Mounting bolts and washers - 9.2 g

(All of these may be converted to English units for the FEM analysis described in Section III.)

Setup Procedure:

Before attempting any tests, please check the following:

1. Confirm Beam Model is securely attached to shaker table and all wires are correctly taped to surfaces and will not be damaged during vibration (Check with TA/LA).

2. Four accelerometers labeled 0–3 are available to test the airplane model. The accelerometers can be placed on points of largest displacement (using Bee's wax) along the beam model. One accelerometer is always placed on the shaker location to measure the forcing function.
3. The four accelerometers are connected with a BNC to the NI 9234 cDAQ module channels 0–3.
    a. Here is a list of accelerometers serial numbers per channel:
        i. CH 0 - SN 102548 - 9.55 mV/g
        ii. CH 1 - SN 101415 - 5.59 mV/g
        iii. CH 2 - SN 102547 - 9.70 mV/g
        iv. CH 3 - SN 101414 - 5.59 mV/g
4. A Polytec PDV 100 Laser vibrometer is connected to the NI 9215.
    a. Polytec PDV 100 recommended operating settings:
        i. Velocity: 20 mm/s
        ii. LP: 22 kHz
        iii. HP: N (no)
5. Ensure that the cDAQ module is on and connected to the computer through a USB cable and is powered.
6. Check all connections by comparing to Figure 1.

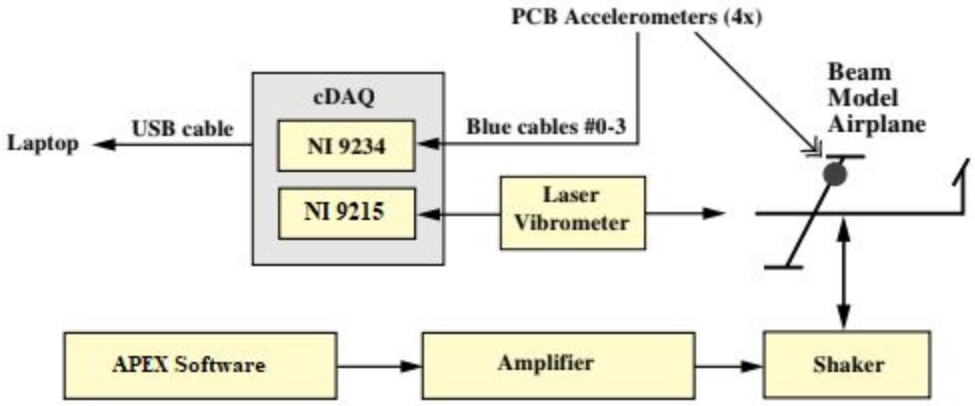

Figure 1: Wiring Diagram for Vibration of Beam Model Airplane

Operational Procedure:

Full Frequency Sweep

1. Open "Beam Model Airplane 2017 (Laser Vibrometer).vi".
2. Note that the LabVIEW VI displays are:
    a. Accelerometer waveforms (mm/s^2)

    b. Computed displacements (mm)
        i. Velocity waveforms (mm/s)
        ii. Vibrometer displacement (mm)
3. Run the VI and select where to start a datafile.
    a. The data will not be recorded until the ‘Data NOT Saving” button is pressed, examples given in Figures 2 and 3 below.
4. Add a comment to the comments section to help decipher the different data logs for later analysis
5. Measure each accelerometers distance from the reference accelerometer on the beam model mount and record those values for later analysis.
6. Ask the TA/LA to run the Beam model through the frequency sweep (2-50Hz) and ask them to ensure the amplifier is on and powering the vibe table.
    a. The first frequency sweep is at a higher displacement due to mode 1 needing a higher displacement to excite the mode.
7. Wait for the vibe table to ramp to the starting frequency of 2 Hz and click “Data NOT Saving” exactly when the Vibe interface shows “Sweeping”.
    a. Accuracy of starting the data log will make later analysis of the frequency sweep simpler.
8. Collect data for the entire sweep and stop the data collection immediately when the sweep is finished.

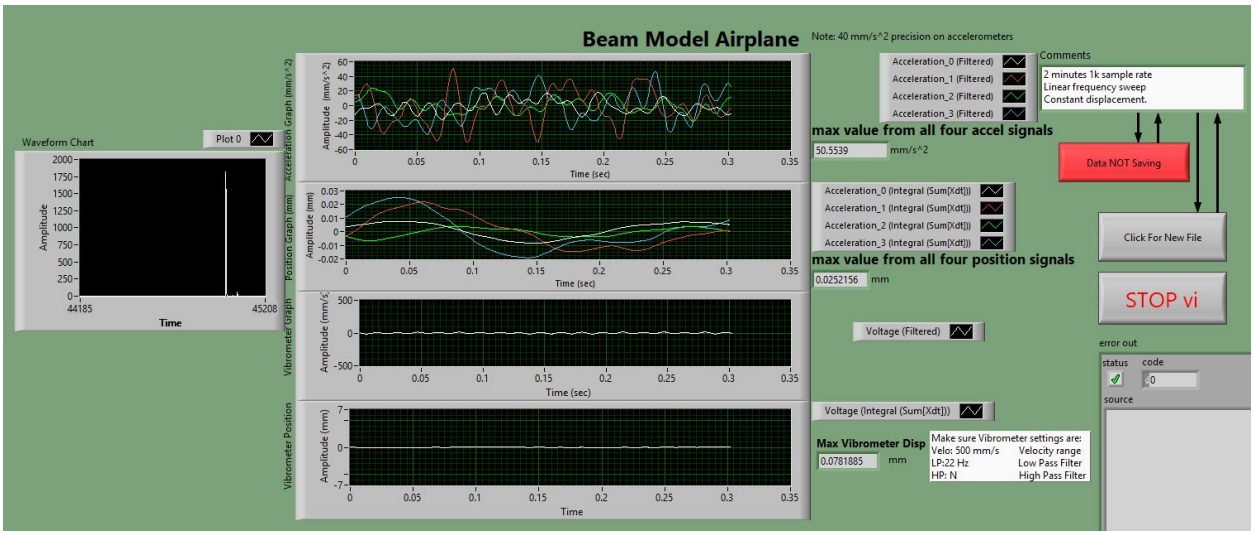

Figure 2: Beam Model Airplane VI with Data Not Saving

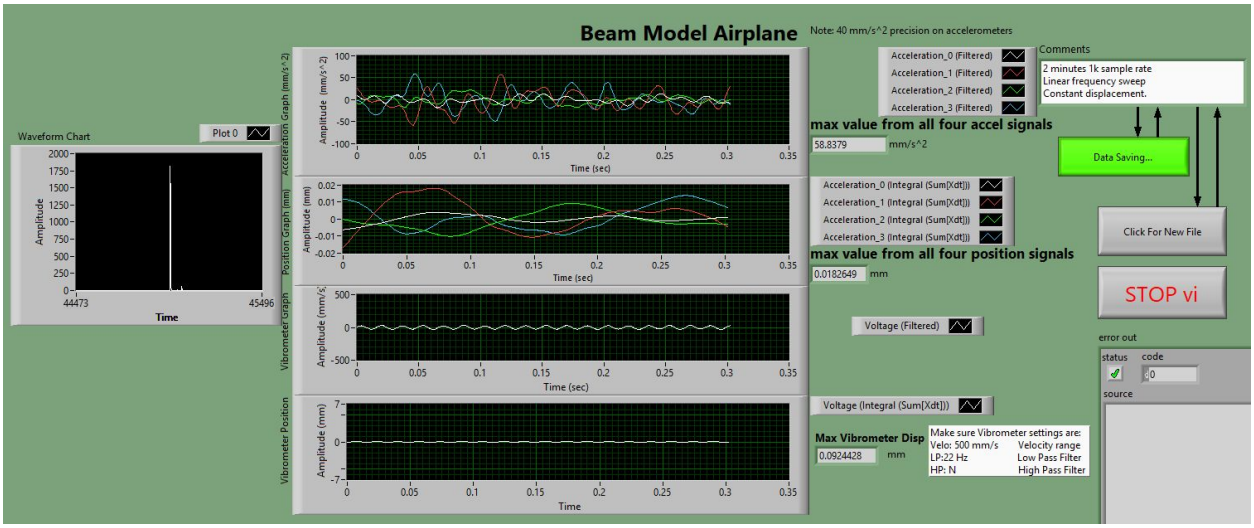

Figure 3: Beam Model Airplane with Data Saving

Mode 2 Examination

1. Start a new data file for the mode 2 examination.
2. Move the accelerometers (nose and wing) to locations that would result in data that will describe mode 2 and measure their distances from the reference accelerometer on the beam model mount.
3. Ask the TA/LA to open and start the mode 2 manual sweep.
4. Tell the TA/LA where you believe the mode 2 frequency to be and have them alter the frequency to find the exact location of the mode.
5. Repeat this adjustment process until the mode is found (accuracy only needs to be a tenth of a Hz).

6. Collect Data at this frequency for 3 seconds and record the frequency found on a separate document.
7. Have the TA stop the manual sweep

Mode 5 Examination

1. Start a new data file for the mode 5 examination.
2. DO NOT move the accelerometers. They will be moved once the mode shape is determined.
3. Ask the TA/LA to open and start the mode 5 manual sweep.
4. Tell the TA/LA where you believe the mode 5 frequency to be and have them alter the frequency to find the exact location of the mode.
5. Repeat this adjustment process until the mode is found (accuracy only needs to be a tenth of a Hz).
6. Use the strobe light to find the point of max deflection.
    a. If desired turn ON the Strobe light to aid in viewing the vibration amplitudes. Adjust the Strobotac frequency using the dial. Note: When the Strobotac frequency exactly matches that of the Vibe Table, the light will be in sync and you may not see any vibrations. By slightly detuning the Strobe light you will see full displacements.
7. Once the point of max deflection is found have the TA/LA stop the manual sweep so that the accelerometers can be moved to better describe mode 5.
    a. Once again, measure the distance of the accelerometers from the reference accelerometer.
8. Have the TA/LA go back to the frequency found in step 5.
9. Collect Data at this frequency for 3 seconds and record the frequency found on a separate document.
10. Have the TA stop the manual sweep.

Shut Down Procedure

1. Have the TA/LA shut the machine down.
2. Put Accelerometer 3 back at the initial location along the nose.
3. Return ear protection and safety glasses.

Additional Setup Notes

The following may be useful if it becomes necessary to do impromptu manual adjustments.

1. Instructions for attaching accelerometers.
    a. PCB accelerometers have been attached as needed using Bee's wax. If they need to be moved, they are pressed on firmly while twisting slightly onto airplane piece. Test attachment with a sideways force on accelerometer to confirm attachment is solid. Provide appropriate strain relief for all accelerometer cables by using electrical tape.
    b. NOTE: DO NOT DROP ACCELEROMETERS AS THEY WILL BE DAMAGED! PLEASE REPORT ANY ACCIDENTS TO THE SUPERVISING TA/LA FOR DOCUMENTATION.