ME/EID 465 – Musical Instrument Design

Spring 2020

Final Project: Acoustic Measurement and Model Calibration

The final project for ME/EID 465 consists of three parts. In the first part, you and a partner will conduct acoustic measurements of a space on campus. For the second part, you and your partner will model the same space in acoustic modeling software (CATT-Acoustics). You will need to calibrate / validate your model to match your measurements. Lastly, the final project also includes a presentation. For the presentation, you will be present your measurements and model, as well as provide recommendations for improving the acoustics of the space.

Part I: Model Creation and Calibration (Due 04/09/2020)

The objective for Part I is to create a realistic acoustical model of the Rose Auditorium. You and your partner will be responsible to:

1. Using the CAD program of your choice (e.g. AutoCAD, Sketchup, etc.) create a 3-D model of the space the Rose Auditorium.
    a. 2-D schematic and appropriate measurements are available on the Team page.
2. Import the model into CATT-Acoustics.
3. Assign absorption and scattering coefficients to the surfaces in your model based on their material. (Use the 'Material Data' .pdf available on Moodle.)
4. Use CATT-Acoustics to predict the room acoustics metrics at specified source and receiver positions. Your source position should be in the front-center of the stage and your 3 receiver positions should be placed in seats around the auditorium.
5. Write a technical report on the model, which includes:
    a. A detailed schematic of the space, source, and receiver positions
    b. Explanations for the materials you chose for each surface/group of surfaces.
    c. Plots of T_{30}, C_{80}, and EDT for the 125-4000 Hz octave bands. (Don't use CATT's plots. Export the data and re-plot yourself.)

Please upload your technical reports for Part I to the link on Moodle NO LATER than **11:55 P.M.** on **Thursday, April 9th, 2020**.

Part II: Acoustic Measurements (Due 04/30/2020) […if school reopens. Otherwise, there will be an alternate assignment.]

I will provide a detailed list of equipment and instructions (see pages 3-4). You and your partner will be responsible to:

1. Create a Matlab script to conduct and analyze the measurements.
2. Schedule a time to borrow the equipment and take measurements.
3. Write a technical report on the measurements, including:
    a. A detailed (2-D) schematic of the space, source, and receiver positions

b. Measurement analysis (i.e. plots and discussion of T_{30}, C_{80} and EDT)
c. Appendix with Code

While you are taking measurements, be sure to take pictures of the space and your equipment set-up to include in your report. The results of Part II should be added to the technical report that was started in Part I.

Please upload your technical reports for Part II to the link on Moodle NO LATER than **11:55 P.M.** on **Thursday, April 30th, 2020**.

Part III: Model Calibration and Recommendations (Due 05/15/2020)

The objective for Part III is to update your acoustical model to better reflect the measurements.

1. Compare the T_{30}, C_{80}, and EDT values from your model to those obtained from your measured data. Include this initial comparison in your technical report.
2. Adjust the absorption and scattering properties of the materials of your surfaces to change the T_{30}, C_{80}, and EDT values of your model to match your measurements. Include the final comparison in your technical report.

For the final part, your goal is to improve the space to help fulfill its intended purpose. For example, if you would like to use Rose Auditorium as a classroom, you may want to adjust it to improve speech intelligibility. If you feel that the space is already well suited for its intended purpose, provide recommendations on how to change it for a different purpose.

3. Adjust the absorption and scattering properties of the materials of your surfaces to improve the space for its intended (or unintended) purpose.
4. Include the recommendations in your technical report.

The final version of the technical report is due on 05/08/2020. Please upload your reports and presentations to the respective link on Moodle NO LATER than **12:00 P.M.** on **Friday, May 15th, 2020**.

Detailed Equipment List / Instructions for Part I:

Schematic:

Instructions:

1. Before you begin setting up the equipment, survey the room.
    a. Measure the room dimensions.
    b. Take note of surfaces (e.g. walls, floor, desks, lectern, etc.) and surface materials.
    c. Take pictures for later reference.
    d. Choose a source position and mark with tape. The source position should be placed at a typical lecturer / instrument / acoustic source location. Be sure to include some space between the speaker and the wall(s).
    e. Choose 3 receiver positions and mark with tape. The receiver positions should be at least 2 m (6 ft.) away from the speaker and should be representative of the entire room.
    f. Measure the distance between the source and the two nearest walls, as well as the receiver positions and the two nearest walls.
    g. Measure the distance between the source and each receiver position.
2. Take the BAS001 Omnidirectional Speaker and secure it on top of a tripod.
    a. Adjust the height of the tripod such that the middle of the speaker is positioned at a height of 5 ft.
3. Connect the speaker to the Crown Xli 2500 amplifier via the Speakon cable.
    a. Make sure that the dials on the amplifier are turned all the way to the left for both channels.
4. Plug the amplifier into the wall outlet.
5. Connect the amplifier to the NI USB 4431 DAQ device with the ¼" cable (and BNC adapter).
6. Connect the PCB ½" microphone to the DAQ with a BNC cable.
7. Place the microphone on the microphone stand with the "test tube" adapter and place at receiver position 1 (R1).
8. Connect the DAQ to the laptop and run your program to initialize IEPE power for the microphone.
9. Turn the amplifier up a few clicks (and take note of how many clicks you do).
    a. DO NOT GO PAST THE HALF-WAY POINT ON THE AMPLIFIER DIAL SO THAT WE DO NO RISK BLOWING OUT THE SPEAKER
10. Run a test measurement and data analysis to determine if the speaker is loud enough.
    a. Evaluate the noise floor in the room and adjust the amplifier as needed.
11. Set your number of averages for the measurement.
12. Turn off the amplifier and take a measurement of the noise in the room.
13. Turn back on the amplifier and begin your measurements at R1.
14. Repeat for R2 and R3, respectively.