



COMMUNICATION SCIENCES AND DISORDERS

## Electroacoustics and Instrumentation Calibration

CSD 854/5 | Fall 2021 | 2 (Theory) + 1 (Lab) Credits

<https://canvas.wisc.edu/courses/204952>

### What is this course about?

As audiologists, sound is your bread and butter! In this course we will take a deep dive into the world of sound and attempt to understand its various forms, shapes, and mediums. We will learn about how sound can be measured and manipulated to our benefit. Achieving these require brushing up on some fundamental physical concepts, and learning acoustics, basic electricity, and electronics. All these will be supplemented by implications for audiology and hearing science. I hope you will enjoy the course and appreciate the world of hearing.

### INSTRUCTORS AND TEACHING ASSISTANTS

#### Instructor Title and Name

Sriram Boothalingam, PhD, MSc Audiology

#### Instructor (Stevens Point)

Rebecca Henning, PhD

### Meeting Time and Location

	Day	Time	Location
Theory	Mondays	4:15 – 5:55 PM	GNH 412
Lab – Madison/SP	Wednesdays	3:00 – 5:00 PM	GNH B62

### Instructional Mode

Lectures, demonstrations, handouts, videos, and worksheets will supplement assigned readings in the text.

### How does this course meet the credit hour policy standard?

This class meets for one 1 hour 40 min class period and one 2-hour lab period each week over the Fall semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, watching posted video, etc) for about 3 hours out of classroom for every class period. The syllabus includes more information about meeting times and expectations for student work.

### Instructor Availability

Mondays, 2:30-4:00 PM by appointment; Goodnight Hall, Rm. 482 or remotely

### Instructor Email/Preferred Contact

Madison: [boothalingam@wisc.edu](mailto:boothalingam@wisc.edu)

Stevens Point: [rhenning@uwsp.edu](mailto:rhenning@uwsp.edu)

Please include "CSD854" in the subject line of all emails

## OFFICIAL COURSE DESCRIPTION

### Course Description

This course involves the systematic review of physical concepts of acoustics, electricity, and electronics underpinning the practice of audiology, as well as formally adopted standards by which clinical environments, instruments and procedures are calibrated.

### Requisites

None

## LEARNING OUTCOMES

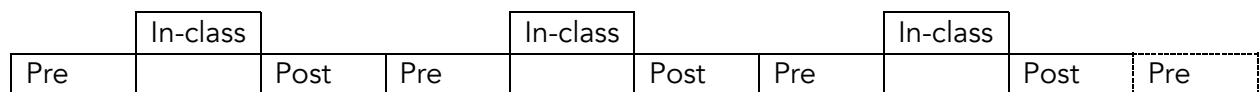
### Overall Course Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Describe sound, its characteristics, laws that govern its propagation, and its measurement and analysis
2. Describe the fundamentals of tools and clinical methods used in hearing science to study the auditory system
3. Describe the importance of calibration, knowledge of instrumentation, and electrical safety in the profession of audiology
4. Analyze and calibrate audiological equipment using calibration tools (e.g., sound level meter, couplers)
5. Evaluate clinical equipment, perform basic troubleshooting, and determine if instrumentation works according to manufacturer specifications and standards

### Course Structure

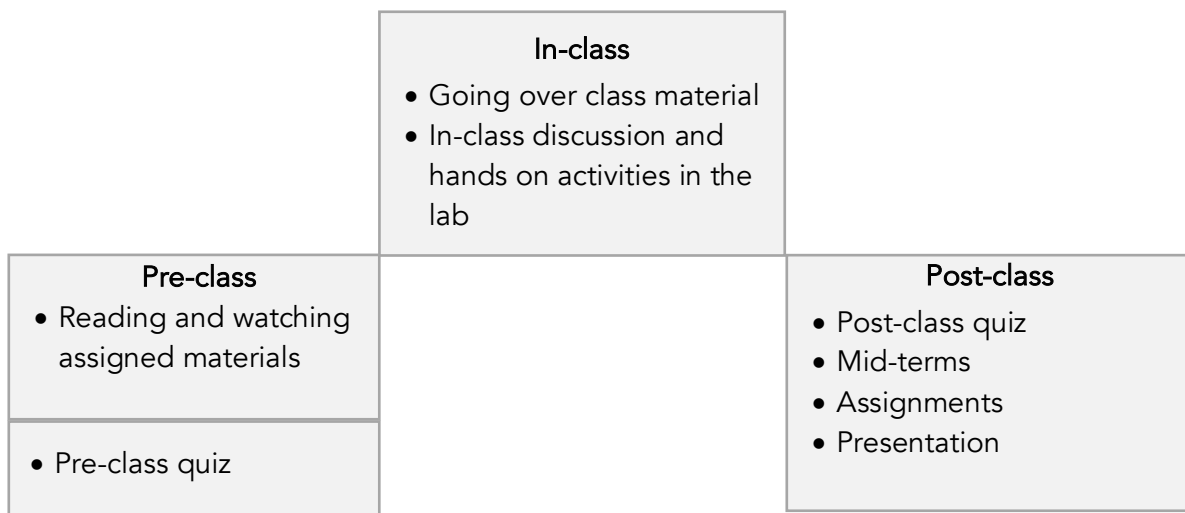
The course is presented in a quasi-blended format. Meaning, instructor-centered lectures are minimized when possible in lieu of classroom discussions and hands-on labs. Minimization of classroom lectures will be made possible by increasing the chances of self-directed learning. This course structure is called the 'Castletop activity model' and is schematized below for better visualization.



Pre-class: 'Absorb'	Course content will be presented as 'pre-class' reading, listening, and watching materials that you will have to complete before the scheduled class. This will allow you to <b>absorb</b> the material prior to class and be ready for classroom discussion on the same material rather than just listen to me for two hours. A pre-class quiz needs to be completed prior to class. Therefore, the success of this method of teaching depends on your motivation to learn the material and preparedness to engage and discuss in-class.
In-class: 'Do'	In the class, there will be further absorption, discussion, combined with hands-on <b>do</b> activities in the lab (CSD 855). Classroom activities will allow you think deeply about what you absorbed pre-class. This will be achieved by you talking individually or as

	small groups on the topic. Some talking points may include: what was easy? what was difficult? what is considered important? how does this apply to audiology? etc
Post-class: 'Connect'	Because the course is constructed into a few serial <b>units</b> (see below), where learning every successive unit requires mastery of the previous unit, (almost) every class will have a 'post-class' quiz. This quiz is taken outside of the classroom at your leisure. Quiz will open on Wednesday night and is due before the midday Saturday of each week – this allows for you to focus on the pre-class reading, listening, and watching for next week's content from Saturday to Monday. Apart from the post-class quiz, exams, assignments, labs and presentations will allow you to think critically about these topics, help solidify the knowledge, and connect theoretical and practical aspects learned in-class to audiology and the real-world. Weekly (or once in two-week) discussion sessions could be conducted based on student availability.

The actual course structure schematic is below:



The course content is divided into five **units** (see weekly class schedule for details on specific topic covered). Every unit is designed to introduce you to the basics of the respective topic and help you understand as well as evaluate the link between these fundamentals and clinical audiology, as well as real-life. Lab practicum (CSD 855) is coordinated such that theory from CSD 854 can be put into practice in the lab (see weekly lab schedule for details on specific topic covered).

### Unit 1: Acoustics

🎵 **Important note:** this unit is common for CSD 854 and CSD 850 but will only be included in the exams and quizzes of CSD 854.

This unit contains the most fundamental of topics to your understanding of everything in audiology as it involves understanding and analyzing sound itself, the laws that govern sound propagation, and the means by which sound and sound systems are measured.

As understanding and analyzing sound involves a basic knowledge in physical concepts such as mass, elasticity, and simple harmonic motion, we will devote a good chunk of time revisiting these topics.

#### Unit Outcomes

- Describe sound, its characteristics, and laws that govern its propagation

- Demonstrate knowledge in the measurement of sound and apply it in using audiological and calibration equipment
- *In the lab*, you will apply your theoretical knowledge of simple harmonic motion and sound to get a deeper understanding of sound and its measurement.

## Unit 2: Signals and systems

This unit will introduce you to linear and non-linear, and analog and digital systems on the systems end. We will learn how systems convert analog signals to digital signals and vice versa. On the signals end, we will learn about different kinds of audio signals used in audiology and how signals are represented in the time and frequency domains.

### Unit Outcomes

- Describe basic properties of general systems
- Apply your knowledge of sound and its measurement (unit# 1) to better understand the time (impulse) and frequency response of a system and ways in which we can go back and forth between the time and frequency domains
- Describe filters and apply this knowledge in measuring sound using a sound level meter
- Analyze the implications of signals and systems in audiology. For example, what kind of a system is the auditory system? what kind of a system does a hearing aid employ?
- *In the lab*, you will apply the knowledge of signals to synthesize, record, analyze, and evaluate various audio signals

## Unit 3: Electricity

As an audiologist, you will deal with electrical instruments on a daily basis. This unit will introduce you to the fundamentals of electricity and electromagnetism. Understanding how electrical instruments function at a basic level will help you realize the power of electricity and how to safely and effectively handle it for use in audiology and beyond.

Electricity is also the language of neurons in our body and the brain. Electricity carries information about sound to the brain. We can measure this electric potential to determine if a patient is able to hear sounds without the patient telling us if they hear or not – these are called auditory evoked potentials.

### Unit Outcomes

- Describe electricity, electromagnetism, and various electrical components
- Describe the importance of electrical safety in audiology and beyond
- Analyze the implications of electricity and electromagnetism for audiology and hearing science. For example, how does the coal/hydro/nuclear/solar/wind power plant generated electricity thousands of miles away allow you test your patient's hearing? and how can we measure brain potentials safely?
- *In the lab*, you will apply the knowledge of electricity and electrical components by building fun circuits and using instruments that measure electricity in different forms.

## Unit 4: Impedance

This unit will introduce you to the concept of impedance and will allow you to evaluate the implications of impedance for audiology and hearing science.

Impedance is the opposition to flow of energy. It has implications in mechanics, electricity, and

acoustics. You will apply your knowledge of acoustics and electricity to understand impedance.

### Unit Outcomes

- Describe impedance in its mechanical, electrical, and acoustical form
- Describe the role of impedance in the frequency response of the external and middle ear and its implications for hearing and hearing disorders
- Apply the knowledge of impedance in measuring sound conduction through external and middle ear (admittance)

### Unit 5: Transducers and standards

The final unit will introduce you to various transducers in use in audiology and current standards for calibration of audiological equipment.

### Unit Outcomes

- Describe the various audiological transducers and their uses in audiology
- *In the lab*, you will apply your knowledge of electricity and acoustics to build fun circuits. In addition, the last three labs will focus on calibration equipment and calibration for long and short duration signals.
- Identify factors that contribute to signals that may be out of calibration and troubleshoot audiological equipment
- Appropriately record the results of an acoustic and an electric calibration
- Identify and be able to use instruments to calibrate audiological equipment

**Lab exercises:** we will have a “live lab” every week where we will get to work hands-on with electrical and acoustic calibration instruments.

- Madison labs will either be in Goodnight Hall Rm. B62 and remotely depending on the type of content. See lab schedule (below) for more details.
- Stevens Point labs will be held in hearing aid lab 1 and remotely unless otherwise told to meet elsewhere.

### GRADING, EXAMS, QUIZZES, PAPERS & OTHER MAJOR GRADED WORK

**Points breakdown:** grades will be determined from a maximum of 100 points, i.e., 100%.

	<b>In-class</b> <ul style="list-style-type: none"><li>• Class participation 7.5 points</li></ul>	
<b>Pre-class</b> <ul style="list-style-type: none"><li>• Pre-class quiz 10 * 1 (point) = 10 points</li></ul>		<b>Post-class</b> <ul style="list-style-type: none"><li>• Post-class quiz 8 * 2.5 (points) = 20 points</li><li>• Exams 3 * 18 (points) = 54 points</li><li>• Assignments 3 * 2 (points) = 6 points</li><li>• Group presentation 1 * 2.5 (points) = 2.5 points</li></ul>

🎵 Important notes on points:

- There is a total of **11 pre-class quizzes**. Your best 10 will count towards the final grade
  - You get two attempts at the pre-class quiz. This quiz is not to test your knowledge but is a guide to help you keep-up with the pace of the class. Please take this quiz seriously as it is critical to your understanding and engagement in class.
- There is a total of **10 post-class quizzes**. Your best 8 will count towards the final grade
- Evaluation of **class participation** is subjective, and observation based. The best way to score points in participation is to come prepared for the class on the day's content and engage in genuine discussion.
- All **exams** will be open-book and will be taken on Canvas. Although exams are time-restricted, it will be available to be taken at any time on the exam day.
  
- **Group presentation: Know your instruments!**
  - Groups will be randomly assigned an audiological instrument. 3 groups in Madison, two groups in Stevens Point.
  - *Given the pandemic, you may have to do your work individually and merge your work within groups remotely*
  - Each group will research on the instrument type and gather specific details (explained below) about a physical instrument that they have access to. For example, if your group is assigned with an audiometer, your group will research about audiometers in general, and also gather specific details about an audiometer that you can access.
  - Specific details include (but not limited to): input/output ports, functions that the instrument can perform, comparison to standards, and calibration records.
  - Present your findings as a class presentation during the Madison lab hour (on 12/2/2019). Everyone from the group should take turns presenting their content.
  - Your group will get a score for the overall presentation and (possibly) a peer review method will be used to scale group points to individual points.
  - Presentation should have the following components:
    - i. Introduction to the instrument
    - ii. What are its features and what does it do?
    - iii. Description of the specific instrument that you had access to
    - iv. Calibration record
  - What am I looking for in the presentation?
    - i. Display of knowledge in the area of presentation
    - ii. Quality and clarity of content and depth of background research

Grade scale:

%	100-92	91.9-90	89.9-88	87.9-82	81.9-80	79.9-78	77.9-72	71.9-70	69.9-68	67.9-60	<60
UW-M	A	AB	AB	B	BC	BC	C	CD	CD	D	F
UW-SP	A	A-	B+	B	B-	C+	C	C-	D+	D	F

REQUIRED TEXTBOOK, SOFTWARE & OTHER COURSE MATERIALS

1. Required: Decker, T. Newell and Carrell, Thomas D. (2004). Instrumentation: An Introduction for Students in the Speech and Hearing Sciences, 3rd ed. Mahwah, NJ: Lawrence Erlbaum. ISBN-10: 0-

8058-4681-6

2. *Recommended:* Rosen, Stuart and Howell, Peter. (2013). Signals and Systems for Speech and Hearing, 2nd ed. Brill Academic Pub, ISBN-13: 978-90-04-25243-1
3. Readings will include other relevant materials not covered in the textbooks and will be posted in respective Modules and/or Files on Canvas.
4. For at least two labs, we will use a free software called Praat. Please [download](#) and install it on your computer that you will use for classes/labs.

## OTHER COURSE INFORMATION

### Important things to keep in mind:

- Let's build a community of learning and listening, where all students' voices are heard.
- Please feel free to ask any questions at any time. Every question and clarification attempt will get you closer to understanding the material better. So, there are no unwise questions, and nobody will judge you.
- Come to class prepared – this is important to success of both yourself and the learning model of this course.
- Leave social media out of the classroom and engage with what the class has to offer.
- Please see the course as a gateway to understanding your world better, and not to just get good grades.
- It is imperative that you understand the material and be able to apply the knowledge in real world, not just simply remember facts. This is the ultimate goal of any college education.
- I am delighted to be teaching this course. I hope you will enjoy the course and appreciate all the audiological equipment and the need for calibration better.

### Methods of communication:

Course website is on <https://canvas.wisc.edu/courses/204952>. All lectures and study guides will be available in "Pages" and redundantly in "Modules" and "Files" tabs. Lecture slides and videos of the class will be made available a few days before the class. Updates to course content will be made throughout the week; it is your responsibility to check for updates. All assignments have to be submitted via the respective "Assignments" tab on Canvas. All exams are open-book and will be taken on Canvas.

## RULES, RIGHTS & RESPONSIBILITIES

- Students are responsible for all material covered in class and for all reading assignments. Students are highly encouraged to ask questions and participate in class discussion.
- It's up to students to decide if they want to purchase a calculator for this course. Exams will not require calculators.

## ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be

forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to [studentconduct.wiscweb.wisc.edu/academic-integrity/](http://studentconduct.wiscweb.wisc.edu/academic-integrity/).

It takes a lot of work, time, and energy to make the lecture videos, and the McBurney Center professionals graciously provide captioning service for all these videos. These videos are made for your benefit and to encourage active learning in class. Please use the lecture videos and class materials responsibly and do not circulate these materials outside of this class. See the copyright statement below on university policy.

## COPYRIGHT STATEMENT – NOTE TAKING, RECORDING LECTURES, & POSTING CLASS CONTENT ONLINE

This syllabus and all lectures and materials are copyrighted in 2019 to Sriram Boothalingam, Assistant Professor, Dept. of Communication Sciences and Disorders. As a student in my course, you may take notes and use lecture videos solely your personal use. Students are prohibited from providing or selling notes to anyone else or being paid for taking notes by any person or commercial firm without my express written permission. Unless you are considered by the university to be a qualified student with a disability requiring accommodation, you are not authorized to record my lectures without my permission. [Regent Policy Document 4-1]. Unauthorized use of my copyrighted materials constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

## AUTHORIZED PRESENCE IN CLASSROOM

Only students who are officially registered for the course and in good standing may be present in the classroom. [UWS 18.11(6)(b) and the Family Educational Rights and Privacy Act (FERPA)]. In addition to protecting the privacy of your education record, the closed and smaller class structure is intended to create a trust-based environment conducive to open and intensive discussion of key issues that form the basis of the course.

## ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA."

<http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php>

## DIVERSITY & INCLUSION

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture,



background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.” <https://diversity.wisc.edu/>

## RELIGIOUS CONFLICTS

In accordance with University of Wisconsin policy, any potential conflict between class requirements and religious observance must be made known to an instructor within the first week of class. The student must notify the instructor of the specific day(s) or date(s) of specific religious observances for which the student seeks relief from academic requirements.

## COURSE CONTENT & SCHEDULE

Wk	Day	Date	Unit	Topic	Readings	Post-class quiz due	Assignment # due	
1	Wed	8-Sep		Course and lab introduction	Syllabus			
2.1	Mon – 9-10:15 AM	13-Sep	Acoustics	Physical concepts	Durant & Lovrinic (Ch 1.1-1.6)			
2.2	Mon – 4:15-5:55 PM	13-Sep		Simple Harmonic Motion	Durant & Lovrinic (Ch 1.7-1.9) and Rosen & Howell (Ch 3)		1	
2.3	Wed – 9-10:15 AM	20-Sep		Sound & its Quantification	Rosen & Howell (Ch 2 and 3)	19-Sep	2	
3*	Mon	27-Sep	Signals & Systems	Signals & Systems	Rosen & Howell (Ch 3 and 4) and Decker & Carrell (Ch 5)	3-Oct		
4	Mon	4-Oct		Filters	Rosen & Howell (Ch 6) and Decker & Carrell (Ch 6 and 9)	5-Oct		
5	Wed 4:15-5:15 PM	6-Oct	Revision (during lab hour)					
6	Mon	11-Oct	Exam-I (topics from 13-Sep to 4-Oct)					
7	Mon	18-Oct	Signal Processing & Electricity	Digital Signal Processing	Decker & Carrell (Ch 4)	24-Oct		
8	Mon	25-Oct		Electricity Basics	Decker & Carrell (Ch 1)	31-Oct		
9	Mon	1-Nov		Electromagnetism & Electrical Safety	Decker & Carrell (Ch 1, 2, 7, 10)	7-Nov		
10	Mon	8-	Revision					

		Nov					
11	Mon	15-Nov		Exam-II (topics from 18-Oct to 1-Nov)			
12	Mon	22-Nov	Impedance	Impedance	Decker & Carrell (Ch2, pg 18-24) and Durant & Lovrinic (Ch 1.11)	29-Nov	3
13	Mon	29-Nov	Transducers & Standards	Transducers	Decker & Carrell (Ch 3, 6)	5-Dec	
14	Mon	6-Dec		Standards	Decker & Carrell (Ch 5, 8)	12-Dec	
15	Wed 4:15-5:15 PM	8-Dec		Revision (during lab hour)			
16	Mon	13-Dec		Exam-III (topics from 22-Nov to 6-Dec)			

\* Back to regular CSD 854 class schedules

## CSD 855 LAB SCHEDULE

Five assessable labs are in bold; best four are worth 25% each for CSD 855

Date	Topic	Room
15-Sep	Sound level meters	B62
22-Sep	<b>Signal characterization and analysis using Praat</b>	402
29-Sep	Permissible ambient noise levels	B62
6-Oct	Revision for Exam 1 (4:15-5:15 PM)	412
13-Oct	No lab	-
20-Oct	<b>Digital Signal Processing (DSP)</b>	402
28-Oct	Snap circuits – fun w/ electricity <b>Multimeter</b>	B62
3-Nov	<b>Oscilloscopes</b>	B62
10-Nov	<b>Calibration of tone audiometer</b>	B62
17-Oct	Calibration of short duration signals – implications for AEPs and OAEs	B62
25-Nov	Thanksgiving week – no lab	-
1-Dec	Group presentations (combined Madison and SP session) – Know your instruments!	412
8-Dec	Revision for Exam 3 (4:15-5:15 PM)	412

KASA (Knowledge & Skills Acquisition)/CFCC (Council for Clinical Certification) 2020 Standards completed in this course.

A4. Principles, methods, and applications of acoustics, psychoacoustics, and speech perception, with a focus on how each is impacted by hearing impairment throughout the life span

Students in this course will demonstrate competency by obtaining a passing grade on pre- and post-class quizzes and final exam

A5. Calibration and use of instrumentation according to manufacturers' specifications and accepted standards

Students in this course will demonstrate competency by obtaining a passing grade on pre- and post-class quizzes, final exam, and the lab component of the course by performing and submitting reports on calibration of audiometers.

A6. Standard safety precautions and cleaning/disinfection of equipment in accordance with facility-specific policies and manufacturers' instructions to control for infectious/contagious diseases

Students in this course will demonstrate competency during all the lab components of this course by including specific safety and cleaning procedures undertaken before operating instruments.

B4. Utilizing instrument(s) (i.e. sound-level meter, dosimeter, etc.) to determine ambient noise levels and providing strategies for reducing noise and reverberation time in educational, occupational, and other settings

Students in this course will demonstrate competency by obtaining a passing grade on pre- and post-class quizzes, final exam, and the lab component of the course by conducting noise level surveys in and around the campus and submitting a report.

C7. Selecting, performing, and interpreting a complete immittance test battery based on patient need and other findings; tests to be considered include single probe tone tympanometry or multifrequency and multicomponent protocols, ipsilateral and contralateral acoustic reflex threshold measurements, acoustic reflex decay measurements, and Eustachian tube function.

Students in this course will demonstrate competency by obtaining a passing grade on pre- and post-class quizzes and final exam

F12. Evaluating acoustics of classroom settings and providing recommendations for modifications

Students in this course will demonstrate competency by obtaining a passing grade on pre- and post-class quizzes, final exam, and the lab component of the course by conducting noise level surveys in and around the campus and submitting a report.

### **Important note on grades**

A passing grade is a B or better. If a student fails to complete any of the tasks listed above, they will work with the course instructor to either redo the task or complete an additional task in order to demonstrate

competency. If a student is not able to successfully complete this task, then an improvement plan will be initiated to remediate the skill in question. See the handbook section on improvement plans.