



## COMMUNICATION SCIENCES AND DISORDERS

### Electroacoustics and Instrumentation Calibration

CSD 854/5 | Fall 2022 | 2 (Theory) + 1 (Lab) Credits

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

#### What is this course about?

Sound and its perception are the domain of the audiologist. One of the most important roles of the audiologist is the measurement, manipulation, and analysis of sound. Audiologists measure and analyze environmental sounds, the sounds humans can and cannot hear and process, the sounds that are output from a hearing aid and input to the ear, the sounds that are presented by a cochlear implant to the auditory nerve, how sounds are represented by the auditory brain, and more. Understanding how sound in the world is captured, represented, and manipulated by human and electronic systems is critical to our profession. The purpose of this course is to help you understand the details of how sound works and how we measure and manipulate it using technology. This course will follow sound from pressure waves in the outside world, to electric signals transduced by microphones, manipulated by signal processors, and transduced back to pressure waves by speakers.

#### Instructors

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

#### Reader/Grader

Regan Bolt

#### Meeting Times and Locations

	Day	Time	Location
Theory	Monday	2:30 – 4:10 PM	GNH 412
Lab – Madison	Monday	10:00 – 12:00 PM	GNH B62/B5
Lab-SP	Wednesday	2:30-4:20	HA Lab

#### Instructional Mode

In-person (Madison) and Remote (Stevens Point) lectures supplemented by labs, demonstrations, handouts, videos, and worksheets, and readings.

#### 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 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

Tuesdays, 1-2:30 PM by appointment; Goodnight Hall, Rm. 482 or remotely

## Official Course Description

This course involves the review of acoustics, digital signal processing, 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

## Overall Course Learning Outcomes

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

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

## Course Structure

This course is divided into four units (see weekly class schedule for details). Each 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).

### 1. Acoustics

This unit reviews fundamental of topics of sound and its propagation. **Unit Outcomes:** Describe sound, its characteristics, its basic measurement, and laws that govern its propagation. Demonstrate knowledge in the measurement of sound and apply it in using audiological and calibration equipment.

### 2. Systems and Signals

This unit will introduce you to system and signal theory. Topics covered include linearity and homogeneity, Fourier transforms, convolution, filtering, digital signal processing, and analog/digital conversion. **Unit Outcomes:** Describe basic properties of general systems. Apply your knowledge of sound and its measurement to better understand the time 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. In the lab, you will apply the knowledge of signals to synthesize, record, analyze, and evaluate various audio signals and assess implications for clinical practice in audiology.

### 3. Electricity

This unit will introduce you to the fundamentals of electricity and electromagnetism. Understanding how electrical instruments function at a basic level will help you understand how all the tools we use in audiology, both in assessment and intervention, function. It will also help you troubleshoot instrument problems in your practice or research. **Unit Outcomes:** Describe electricity, electromagnetism, various electrical components, circuits, and impedance. Describe the importance of electrical safety in audiology and beyond. Analyze the implications of electricity and electromagnetism for audiology and hearing science. 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.

### 4. Transducers, Calibration, 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 assess and calibrate audiological equipment and transducers.

## Final grade will be based on:

- 3 exams: 60%

- 8 labs: 15%
- 10 quizzes: 15%
- 3 check-ins: 5%
- Group presentation: 5%

**Exams**

All exams are open book and are taken on Canvas. Although exams will be time-restricted, it will be available to be taken any time during exam day.

**Labs**

We will have a lab (nearly) every week where we will get to work hands-on with electrical and acoustic calibration instruments. Madison labs will be in Goodnight Hall Rm. B62 or B5. Stevens Point labs will be held in Hearing Aid Lab 1 unless told to meet elsewhere. Each lab has a write-up. Please submit your write-ups within 72 hours of your lab time.

**Quizzes**

Each week (starting 9/19), you will have a short quiz. Quizzes are time-restricted and taken on Canvas. Quizzes will open after class every Monday and close Thursday at 11:59 PM The lowest quiz score will be dropped. The purpose of the quizzes is to help you guide your progress through the course. Quizzes will always cover material from that week. If you don't understand something from class, you have some time after class to get clarification before you start the quiz.

**Check-Ins**

Prior to each exam, we will have a review session during lab. To facilitate review, please come prepared with a "check-in," a question you have about something related to the course. The check-in can be about anything that touches on the course material, including clinical applications or how the material relates to something you've learned in another course.

**Group presentation: Know your instruments!**

Groups will be randomly assigned an audiological instrument. 3 groups in Madison, two groups in Stevens Point. 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 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 (see schedule). 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:

- Introduction to the instrument
- What are its features and what does it do?
- Description of the specific instrument that you had access to
- Calibration record

**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

## **Textbooks and Software**

- *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
- *Recommended:* Smith, Steven W. (2002). Digital Signal Processing: A Practical Guide for Engineers and Scientists, 1<sup>st</sup> ed. Boston, MA: Newnes. ISBN-10: 0-7506-7444-X.
- “Lessons in Electric Circuits” by Tony R. Kuphaldt, available online as free PDF files: <http://allaboutcircuits.com>
- Readings will include other relevant materials not covered in the textbooks and will be posted in respective Modules and/or Files on Canvas.
- For some labs, we will use a free software called Praat. Please download and install it on your computer that you will use for classes/labs. <https://www.fon.hum.uva.nl/praat/>

The course schedule is subject to change depending on the progression of the course.

## **TEACHING & LEARNING DATA TRANSPARENCY STATEMENT**

The privacy and security of faculty, staff and students' personal information is a top priority for UW-Madison. The university carefully reviews and vets all campus-supported digital tools used to support teaching and learning, to help support success through learning analytics (<https://teachlearn.provost.wisc.edu/learning-analytics/>), and to enable proctoring capabilities. View the university's full teaching and learning data transparency statement (<https://teachlearn.provost.wisc.edu/teaching-and-learning-data-transparency-statement/>).

## **STUDENT RECORDS & THE USE OF AUDIO RECORDED LECTURES STATEMENT**

View more information about FERPA (<https://registrar.wisc.edu/ferpafacstaff/>). Lecture materials and recordings for this course are protected intellectual property at UW-Madison. Students in courses may use the materials and recordings for their personal use related to participation in class. Students may also take notes solely for their personal use. If a lecture is not already recorded, students are not authorized to record lectures without permission unless they are considered by the university to be a qualified student with a disability who has an approved accommodation that includes recording. [Regent Policy Document 4-1] Students may not copy or have lecture materials and recordings outside of class, including posting on internet sites or selling to commercial entities, with the exception of sharing copies of personal notes as a notetaker through the McBurney Disability Resource Center. Students are otherwise prohibited from providing or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm without the instructor's express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

## **CAMPUS RESOURCES FOR ACADEMIC SUCCESS**

- University Health Services (<https://www.uhs.wisc.edu>)
- Undergraduate Academic Advising and Career Services (<https://advising.wisc.edu>)
- Office of the Registrar (<https://registrar.wisc.edu>)
- Office of Student Financial Aid (<https://financialaid.wisc.edu>)
- Dean of Students Office (<https://dosو.students.wisc.edu>)
- Graduate Student Services (<https://grad.wisc.edu>)

## **COURSE EVALUATIONS**

Students will be provided with an opportunity to evaluate their enrolled courses and their learning experience. Student participation is an integral component of course development, and confidential feedback is important to the institution. UW-Madison strongly encourages student participation in course evaluations.

## **DIGITAL COURSE EVALUATION**

UW-Madison uses a digital course evaluation (<https://kb.wisc.edu/luwmad/81069/>) survey tool. In most instances, students receive an official email two weeks prior to the end of the semester, notifying them that course evaluations are available. Students receive an email with a link to log into the course evaluation with their NetID. Evaluations are anonymous. Student participation is an integral component of course development, and feedback is important. UW-Madison strongly encourages student participation in course evaluations.

## **STUDENTS' RULES, RIGHTS & RESPONSIBILITIES**

Rights & Responsibilities (<https://guide.wisc.edu/undergraduate/#rulesrightsandresponsibilitiestext>)

## **DIVERSITY & INCLUSION STATEMENT**

Diversity (<https://diversity.wisc.edu>) 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.

## **ACADEMIC INTEGRITY STATEMENT**

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary sanctions (<https://conduct.students.wisc.edu/academic-misconduct/>) include, but are not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

## **ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES**

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 (UW-855) (<https://policy.wisc.edu/library/UW-855/>) require the university to provide reasonable accommodations to students with disabilities to access and participate in its academic programs and educational services. Faculty and students share responsibility in the accommodation process. Students are expected to inform faculty of their need for instructional accommodations during the beginning of the semester, or as soon as possible after being approved for accommodations. Faculty will work either directly with the student or in coordination with the McBurney Center to provide reasonable instructional and course-related accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: McBurney Disability Resource Center (<https://mcburney.wisc.edu/>))

## **ACADEMIC CALENDAR & RELIGIOUS OBSERVANCES**

Academic Calendar & Religious Observances (<https://secfac.wisc.edu/academic-calendar/>)

## **LAND ACKNOWLEDGEMENT**

The University of Wisconsin-Madison occupies ancestral Ho-Chunk land, a place their nation has called Teejop (day-JOPE) since time immemorial. In an 1832 treaty, the Ho-Chunk were forced to cede this territory. Decades of ethnic cleansing followed when both the federal and state government repeatedly, but unsuccessfully, sought to forcibly remove the Ho-Chunk from Wisconsin. This history of colonization informs our shared future of collaboration and innovation. Today, UW-Madison respects the inherent sovereignty of the Ho-Chunk Nation, along with the eleven other First Nations of Wisconsin.

## **ADDITIONAL RESOURCES FOR STUDENTS**

For additional resources, including mental health, food, and gender and sexuality support, visit <https://www.wisc.edu/student-life/student-services/>.

**COURSE CONTENT & SCHEDULE**

Week	Date	Unit	Topic	Reading
1	9/12/22	<b>Acoustics</b>	Syllabus/Intro/Acoustics Basics	Durant & Lovrinic (Ch 1.1-1.9)
2	9/19/22		Simple Harmonic Motion and Sound	Rosen & Howell (Ch. 2-3)
3	9/26/22		Sound Quantification	Rosen & Howell (Ch. 2-3)
4	10/3/22	<b>Signals and Systems</b>	Signals and Systems	Smith (Ch. 5, 8), Decker & Carrel (Ch. 5)
5	10/10/22		Filters	Smith (Ch. 14), Decker & Carrell (Ch. 9)
6	10/17/22	<b>Exam I</b>		
7	10/24/22	<b>Electricity</b>	Digital Signal Processing	Smith (Ch. 3), Schweitzer, C. 1997
8	10/31/22		Electricity Basics	All About Circuits Vol 1
9	11/7/22		Electromagnetism and Safety	All About Circuits Vol 1
10	11/14/22	<b>Exam II</b>		
11	11/21/22	<b>Instruments and Calibration</b>	Impedance	Decker & Carrell (Ch2, pg 18-24), Durant & Lovrinic (Ch 1.11), Margolis (1981)
12	11/28/22		Transducers	Decker & Carrell (Ch. 3, 6)
13	12/5/22		Standards	Champlin & Letowski (2014)
14	12/12/22	Group Presentations		

15	12/15/2022 (or TBD)	<b>Final Exam</b>		
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### LABS

<b>Date</b>	<b>Topic</b>
9/14/2022 (SP) 9/19/2022 (M)	Sound Level Meters
9/21/2022 (SP) 9/26/2022 (M)	Signal analysis using Praat
10/3/2022 (Or TBD)	Check-Ins 1 and Review
10/5/2022 (SP) 10/10/2022 (M)	Permissible ambient noise levels
10/12/2022 (SP) 10/17/2022 (M)	Digital Signal Processing
10/19/2022 (SP) 10/24/2022 (M)	Oscilloscopes
10/31/2022 (Or TBD)	Check-Ins 2 and Review
11/2/2022 (SP) 11/7/2022 (M)	Multimeter
11/9/2022 (SP) 11/14/2022 (M)	Transducers (Speaker Build)
11/16/2022 (SP) 11/21/2022 (M)	Audiometer Calibration
11/28/22	No Lab - Thanksgiving
12/5/2022	Dedicated time for group projects
12/12/22 (Or TBD)	Check-Ins 3 and Review



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.