



COMMUNICATION SCIENCES AND DISORDERS

Electroacoustics and Instrumentation Calibration

CSD 854 | Fall 2023 | 2 Credits

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

What is this course about?

This is the theory portion of the CSD 854/855 course sequence. This course is a combined didactic course for both UW-Madison and UW-Stevens Point students. The lab portion of this course (855) meets and is graded separately for each campus. For convenience, schedules and meeting times for both the theory course and lab components for both campuses are described on this syllabus. For details about the lab component for each 855 section, see the respective syllabus for each campus.

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.

Instructor

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

Meeting Times and Locations

	Day	Time	Location
Theory (854)	Monday	2:30 – 4:10 PM	GNH 412
Lab (855) – Madison	Monday	10:00 – 12:00 PM	GNH B62/B5
Lab (855)-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 each week over the fall semester. This course follows the UW-Madison Definition of Credit Hour. Generally, UW-Madison will follow the federal credit hour definition: one hour of classroom or direct faculty/qualified instructor instruction and a minimum of two hours of out of class student work each week for approximately fifteen weeks, or the equivalent engagement over a different time-period. Alternatively, a credit hour will be defined as the learning that takes place in at least 45 hours of learning activities, which include time in lectures or class meetings, in-person or online, laboratories, examinations, presentations, tutorials, preparation, reading, studying, hands-on experiences, and other learning activities; or a

demonstration by the student of learning equivalent to that established as the expected product of such a period of study. In all cases, learning in for-credit courses is guided by a qualified instructor and includes regular and substantive student-instructor interaction. For this course, the instructor will provide direct instruction, feedback on student work, and course content consistent with the information posted in this syllabus. The syllabus includes more information about meeting times and expectations for student work.

Instructor Availability

Tuesdays, 1-2:30 PM or by appointment.

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 audiologic equipment and transducers.

Final grade will be based on:

- 3 exams: 60%
- 11 quizzes: 20%
- 3 check-ins: 10%
- Group presentation: 10%

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.

Quizzes

Each week you will have a short quiz. Quizzes are time-restricted and taken on Canvas. Quizzes will open Monday at 6:00 PM 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!

Students will sign up for groups or be randomly assigned to groups. Groups will be assigned an audiological instrument. 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:

%	100-93	92.9-90	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

There is no required text for this course. Below are some recommended texts you may find useful.

There is a required (free) software package.

- *Recommended:* 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, 1st 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.

ACADEMIC CALENDAR & RELIGIOUS OBSERVANCES

[Academic Calendar & Religious Observances](#)

Establishment of the academic calendar for the University of Wisconsin-Madison falls within the authority of the faculty as set forth in [Faculty Policies and Procedures](#). Construction of the academic calendar is subject to various rules and laws prescribed by the Board of Regents, the Faculty Senate, State of Wisconsin and the federal government. For additional dates and deadlines for students, see the [Office of the Registrar's pages](#). Students are responsible for notifying instructors within the first two weeks of classes about any need for flexibility due to [religious observances](#).

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](#) 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](#)) 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](#))

COURSE EVALUATIONS

Students will be provided with an opportunity to evaluate their enrolled courses and their learning experience. Most instructors use AEFIS a [digital course evaluation](#) survey tool. In most instances, students receive an official email two weeks prior to the end of the semester, notifying them that anonymous course evaluations are available. Student participation is an integral component of course development, and confidential feedback is important. UW-Madison strongly encourages student participation in course evaluations.

DIVERSITY & INCLUSION STATEMENT

[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.

MENTAL HEALTH AND WELL-BEING STATEMENT

Students often experience stressors that can impact both their academic experience and personal well-being. These may include mental health concerns, substance misuse, sexual or relationship violence, family circumstances, campus climate, financial matters, among others.

Students are encouraged to learn about and utilize UW-Madison's mental health services and/or other resources as needed. Visit uhs.wisc.edu or call University Health Services at (608) 265-5600 to learn more.

PRIVACY OF STUDENT RECORDS & THE USE OF AUDIO RECORDED LECTURES STATEMENT

View [more information about FERPA](#).

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.

STUDENTS' RULES, RIGHTS & RESPONSIBILITIES

[Rights & Responsibilities](#)

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](#), and to enable proctoring capabilities. View the university's full teaching and learning [data transparency statement](#).

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 (854)

Week	Date	Unit	Topic	Reading
1	9/11/23	Acoustics	Simple Harmonic Motion and Sound	Durrant & Lovrinic (1.1-1.9)
2	9/18/23		Sound Quantification	Rosen & Howell (2-3)
3	9/25/23	Signals and Systems	Signals	Decker & Carrell (5); Smith (8, 9)
4	10/2/23		Systems	Rosen & Howell (4, 6); Smith (5); Chertoff (2001)
5	10/9/23		Filters	Decker & Carrell (9); Smith (14)
6	10/16/23	Exam I		
7	10/23/23	Electricity	Digital Signal Processing	Schweitzer (1997); Decker & Carrell (4); Smith (3)
8	10/30/23		Electricity Basics	All About Circuits (1-2)
9	11/6/23		Electromagnetism and Safety	Decker & Carrell (2, 7, 10); All About Circuits (3)
10	11/13/23	Exam II		
11	11/20/23	Instruments and Calibration	Impedance	Decker & Carrell (2 (pg 18-24); Durrant & Lovrinic (1.11); Margolis (1981)
12	11/27/23		Transducers	Decker & Carrell (3, 6)
13	12/4/23		Standards	Champlin & Letowski (2014); Frank (2000)
14	12/11/23	Group Presentations		
15	12/14/23 (or TBD)	Final Exam		

LABS (855)

Date	Topic
9/13/2023 (SP) 9/18/2023 (M)	Sound Level Meters
9/20/2023 (SP) 9/25/2023 (M)	Signal Analysis
9/27/2023 (SP) 10/2/2023 (M)	Permissible ambient noise levels
10/4/2023 (SP) 10/9/2023 (M)	Digital Signal Processing
10/11/2023 (SP) 10/16/2023 (M)	Check-Ins 1 and Review
10/18/2023 (SP) 10/23/2023 (M)	Oscilloscopes
10/25/2023 (SP) 10/30/2023 (M)	Multimeter
11/1/2023 (SP) 11/6/2023 (M)	Transducers
11/8/2023 (SP) 11/13/2023 (M)	Check-Ins 2 and Review
11/15/2023 (SP)	Audiometer Calibration
11/20/2023 (M) 11/22/2023 (SP)	No Lab - Thanksgiving
11/27/2023 (M)	Audiometer Calibration
11/29/2023 (SP) 12/4/2023 (M)	Dedicated time for group projects
12/6/2023 (SP) 12/11/2023 (M)	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 quizzes and exams. In the lab component of this course, students will demonstrate competency by analyzing signals used in clinical audiology and human speech.

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 quizzes and exams, as well as a group project detailing the components, specifications, and calibration standards of a specific instrument. In the lab component of this course, students will demonstrate competency by analyzing clinical and laboratory instruments and 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 quizzes, exams, 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 quizzes, exams, 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.