Syllabus

Course Name Acoustics I

Course Number ENG ME 520

Semester Fall 2024

Course Description Introduction to wave propagation and sound. Derivation of the linear wave equation with emphasis on its origins in the conservation equations of fluid media and fluid equations of state. Plane wave and spherical wave propagation. Initial value and boundary value problems, including normal modes and waveguides. General concepts such as acoustic impedance and intensity. Lumped elements. The wave equation in horns and stratified media. Other topics may include biomedical ultrasound, acoustic levitation, etc... as time permits.

Prerequisite ENG ME 302: Engineering Mechanics II

Prerequisite ENG ME 303: Fluid Mechanics

Prerequisite ENG ME 304: Energy and Thermodynamics

Required Course Materials *Fundamentals of Acoustics, 4th Edition*, Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens, James V. Sanders

Required Course Software MATLAB

Recommended Course Equipment 0.9 mm Pentel GraphGear 500 Automatic Drafting Pencil Gray (PG529N) with 2B lead

Lectures Lectures are held in 808 St. Mary's St PHO 202 on Tuesdays and Thursdays, 1:30 p.m. – 3:15 p.m.

Course Blackboard Site There is a Blackboard Site for the course.

Instructor Professor J. Gregory McDaniel

Instructor Email jgm@bu.edu

Instructor Office Location Room 406 of 110 Cummington Mall

In Person Office Hours Fridays 1:00-2:00 in Room 406 of 110 Cummington Mall. This time slot has been chosen to minimize conflicts with student class schedules.

Access to Live and Recorded Lectures You are expected to attend lectures in person. You are allowed to access 3 lectures remotely, either live, recorded or both. These are intended to support learning if you are ill or have other legitimate reasons for not attending in person. To access a live lecture on Zoom, simply join using the Zoom links on Blackboard. To access a recorded lecture, send a request by email to me. You are not required to state the reason in the email. If more than 3 are necessary, please email the instructor and explain the reason. You may not download or distribute any recorded lecture.

Recording by Students During Lecture Audio recordings, video recordings, and photographs by students during lecture are not permitted without my consent. All lecture notes displayed on screen will be scanned and available to students as pdf files.

Course Average The numerical course average will be an average of 10 assignments.

Course Grade The letter grade for the course will be determined from Table 1.

Percent Range	Letter Grade
92.5–100	A
90.0–92.5	A-
87.5–90.0	B+
82.5–87.5	B
80.0–82.5	B-
77.5–80.0	C+
72.5–77.5	C
70.0–72.5	C-
60.0–70.0	D
50.0–60.0	F

Table 1: Table used in determining a letter grade for the course.

Collaboration Policy on Assignments The Boston University Academic Conduct Code is strictly followed. Students are allowed to discuss the assignments with each other and help each other learn. However, each student must turn in a code that they wrote. Students are not allowed to share their codes in any way. If identical portions of codes are found, that will be considered a violation of the academic conduct code and referred to the university for investigation.

Grading Concerns All grading concerns must be reported to the professor within one week of returning the graded work.

Boston University Diversity Statement

Boston University's founders opened its doors to all students without regard to religion, race, or gender. Building and sustaining a vibrant community of scholars, students, and staff remains essential to our mission of contributing to, and preparing students to thrive in, an increasingly interconnected world.

We strive to create environments for learning, working, and living that are enriched by racial, ethnic, and cultural diversity. We seek to cultivate an atmosphere of respect for individual differences in life experience, sexual orientation, and religious belief, and we aspire to be free of intellectual parochialism, barriers to access, and ethnocentrism.

Success in a competitive, global milieu depends upon our ongoing commitment to welcome and engage the wisdom, creativity, and aspirations of all peoples. The excellence we seek emerges from the contributions and talents of every member of the Boston University community.

Accommodations for Students with Documented Disabilities If you are a student with a disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures.

Religious Observance As an instructor at Boston University, I welcome students of diverse religious backgrounds into my classroom as part of my larger commitment to educating whole persons. I also know that when students are able to bring all of themselves into the classroom, everyone benefits from the diversity of perspectives and backgrounds present, resulting in more robust scholarly engagement. Additionally, under Massachusetts law, students have the legal right to religious accommodation. Please let me know if a requirement for this course conflicts with your religious observance so that we can figure out a way for you to observe your religious practice and complete the requirements for this course. If at all possible, please contact me about any potential conflicts within the first two weeks of the course. The Boston University Policy on Absence for Religious Reasons is strictly followed.

State Authorization & Distance Education For Information regarding Boston University's State Authorization approval and related complaint resolution processes can be found on the State Authorization and Distance Education website at State Authorization & Distance Education.

Lecture Topics for 24 Lectures

5.1 Introduction

5.2 The Equation of State

5.3 The Equation of Continuity

5.4 The Simple Force Equation

5.5 The Linear Wave Equation

5.6 Speed of Sound in Fluids

5.7 Harmonic Plane Waves

5.8 Energy Density

5.9 Acoustic Intensity

5.10 Specific Acoustic Impedance

5.11 Spherical Waves

5.12 Decibel Scales

5.13 Cylindrical Waves

5.14 Rays and Waves

5.15 The Inhomogeneous Wave Equation

5.16 The Point Source

6.1 Changes in Media

6.2 Transmission from One Fluid t o Another: Normal Incidence

6.3 Transmission Through a Fluid Layer: Normal Incidence

6.4 Transmission fromOne Fluid t o Another: Oblique Incidence

6.5 Normal Specific Acoustic Impedance

6.6 Reflection from the Surface of a Solid

6.7 Transmission Through a Thin Partition: The Mass Law

6.8 Method of Images