ME 424/BME 424: Engineering Acoustics

Fall Semester, 2017

Instructor: Professor Karl Grosh: 3646 GG Brown, 764-9414, grosh@umich.edu.
Graduate Student Instructor: Amir Nankali: nankali@umich.edu.

Textbook: *Fundamentals of Acoustics*, Kinsler, Frey et al., John Wiley & Sons (2000).

Lecture Hours: T Th, 2:30PM-4:00PM 1003 EECS

Office Hours: Grosh: Tues. 9AM-10:30AM and Weds. 12:30-2pm in 3646 GGB
Amir: TBA

Homework: Graded homework/computer projects are an important part of the course. Homework will be assigned on a weekly basis and the lowest grade will be dropped in computing your final grade. No late homework will be accepted, except in documented cases of emergency. While you may discuss solution strategies for homework problems with your classmates and the instructor, the solutions you hand in must be your own original work.

Projects: Students are encouraged to work in teams of up to four people; individual reports are are acceptable. You are to work on a problem in acoustics that is of interest to you. The format of the project is flexible and can involve simulations (analytic or numerical), experiments, or a literature survey. Each team will give an oral presentation during the final week of classes. Written reports should be fully documented to include contributions from the individual team members and a reference list with citations. Project titles, descriptions and group lists are due on **October 5**. A progress report will be due on **November 9**. Final written reports are due on **December 12**. See attached sheet for more details on the Project.

Examinations: There will be two examinations. The first will be given in class and the second, non–cumulative exam will be given during final examination period.

Grading:

Homework	25%
Exam #1	25% in class **October 12 in class**
Exam #2	25% during final period **Wednesday, December 20, 1:30 pm - 3:30 pm**
Final Project	25%

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Course Outline

1. **Introduction:** Overview and motivation.
2. **Analogies for acoustics:** Lumped systems: single degree of freedom electrical and mechanical systems; free and forced solutions of damped and undamped systems.
3. **Governing Equations of One Dimensional Acoustics and Fundamental Quantities:** Derivation of the linear acoustic wave equation and underlying assumptions of the linear theory. Plane waves and spherical waves. Energy density; intensity; impedance. Decibel scales and measurement.
4. **Resonators, Ducts and Filters (low frequency elements):** Helmholtz resonator, low frequency waves in pipes, filter elements (e.g., muffler design and loudspeaker design).
5. **Governing Equations of Acoustics:** Three dimensional equations of acoustics. Plane waves and spherical waves. Energy density; intensity; impedance. Decibel scales and measurement.
6. **Transmission and Reflection of Plane Waves:** Normal and oblique incidence of plane waves at material boundaries and layers. Locally reacting impedance. Wave fronts and rays.
7. **Radiation and Reception of Acoustic Waves:** Simple sources, volume velocity/source strength, acoustic reciprocity, Continuous line source, baffled circular piston, Directivity factors. Multiple sources.
8. **Absorption of Sound:** Brief discussion of loss mechanisms for acoustic waves.
9. **Pipes, Cavities and Waveguides:** Propagation and radiation from pipes/ducts. Sound in cavities ("rooms"!).
10. **Other Topics:** Transduction (e.g., speakers and microphones). Mechanics of hearing and protection of hearing.