THE OHIO STATE UNIVERSITY
Department of Mechanical and Aerospace Engineering
ME 8260

ADVANCED ENGINEERING ACOUSTICS

Spring 2017, Class 31400
Course Syllabus

Lecture Meeting Times: Monday/Wednesday 2:20pm-3:40pm. Location: Scott Lab N044

Instructor: Prof. Ryan L. Harne. Office: E540 Scott Lab. Email: harne.3@osu.edu

Office Hours: Mondays 12:00pm-1:00pm, Fridays 12:00pm-1:00pm, or by email appointment

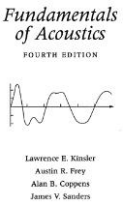
Prerequisites: (To be replaced in future) ME 5240, or Grad Standing or Instructor approval

Disability Information: Any student who feels s/he may need an accommodation based on the impact of a disability should contact the Instructor privately to discuss their specific needs. The Instructor will communicate with the Office for Disability Services (150 Pomerene Hall) to coordinate reasonable accommodations for students with documented disabilities.

Conduct: Students are expected to maintain professional and open-minded conduct throughout the course. All suspected cases of academic misconduct will be reported to the OSU Committee on Academic Misconduct. Information on academic misconduct is posted at http://oaa.osu.edu/coam.html

Objectives: The objectives of this course are to
1. Establish deep understanding of acoustic wave propagation physics and principles
2. Understand linear wave propagation characteristics, including radiation, absorption, and transmission of sound from and through structures/materials, along waveguides, and within enclosures
3. Acquire knowledge on computational tools used to investigate acoustic systems
4. Explore emerging areas of interest in the acoustical engineering community

Course Topics:
Mathematics review. Wave equation and solutions for simple structures and acoustic fluid. Wave propagation, absorption, transmission. Sound radiation from structures. Acoustic fields in enclosures and along waveguides. Structural-acoustic coupling. Computational methods.

Textbook and Course Notes:


The Textbook used for this course is: L.E. Kinsler, A.R. Frey, A.B. Coppens, J.V. Sanders, *Fundamentals of Acoustics*, Fourth Edition, Wiley, 1999. (KFCS). The course material will be derived from this Textbook. **Course Notes** will be posted on the Carmen course website. The Course Notes will be a valuable resource for study and review. Reading assignments in the Timetable refer to sections of KFCS.

Useful References:
D.T. Blackstock, *Fundamentals of Physical Acoustics*, Wiley, 2000.

Course Website: There will be a Carmen website for this course. On the website, Homework assignments, Course Notes, resource materials, occasional video lectures, and grades will be posted. Students are responsible for regularly checking the Carmen website for such material.

Homework: There will be six Homework assignments subject to following guidelines. Deviations from the guidelines will result in points deductions. **Guidelines**:
- Homeworks are individual efforts unless otherwise noted

- Homeworks must be prepared using word processing software, and must be submitted in printed form
- All Homework submissions must include (i) page numbering and (ii) a header on the top of every page that includes the following information: Name, name.#, Homework # (where the red text indicates the appropriate substitution)
- Show your work and indicate solutions by enclosing, **emphasizing**, or underlining the solutions
- All plots must be generated in MATLAB and include MATLAB code used to generate results
- Label all curves and axes on plots or sketches
- Late submissions will not be accepted without a valid reason.

Course Project: Students will complete a Course Project on a topic of current research relevance.

- The Projects are individual efforts, and will be completed in approximately three to four weeks, with due date about two weeks before the semester's end
- A list of suggested Project topics will be made available by the Instructor during the Course, while the students are also encouraged to propose Project topics
- The Instructor must approve the composition of the Project topics to be undertaken, and students must meet in advance with the Instructor to obtain the approval
- The Projects must be distinct with respect to the students' current graduate studies research
- The students will have access to the Instructor's research lab for acoustics equipment and facilities required to undertake the proposed Course Project
- If financial resources are needed to purchase materials/supplies in order to fabricate apparatus required for the Course Project, the student must meet with the Instructor in advance to discuss and justify financing opportunities. The Instructor will make available a small budget, as appropriate. All such apparatus fabricated and excess materials/supplies acquired in the undertaking of the Course Project, as financed by the Instructor, become property of the Instructor's research lab at the conclusion of the Course

Software and Computing: MATLAB will be used in lectures and will be necessary for many of the Homework assignments. MATLAB is available in the MAE Department. COMSOL Multiphysics may be used for the Course Project. COMSOL is available in the MAE Department. A calculator, such as the Texas Instruments TI-36X or the Texas Instruments TI-84, is permitted for use during the Midterm and Final Exam. Students are expected to acquire an approved calculator in order to complete these in-class evaluations. Cell phones are not approved for use during in-class evaluations.

Grading Policy:
Students will be graded using the following evaluations that will be developed from course material presented in lectures, from the Course Notes, on the course website, and from Homework and Reading assignment material. While the OSU Standard Grade Scheme will be used, the Instructor reserves the right to make appropriate grade adjustments according to class/student performance.

(30%) Homework. Six homework assignments

(25%) Midterm Exam

(25%) Course Project

(20%) Final Exam (Comprehensive. Take-home.)

TENTATIVE COURSE TIMETABLE

Month	Date	Weekday	Topics	KFCS
Jan	09	Mon	Mathematics review. Analysis of oscillations. Fourier's theorem.	1.1-11, 1.13-15
	11	Wed	Wave equation: Infinite string. D'Alembert general solution. Forced response. Complex exponential wave equation solution. Drive point impedance.	2.1-8
	16	Mon	No lecture: Martin Luther King Jr. Day	
	18	Wed	Wave equation: Finite string. Separation of variables. Normal modes, orthogonality. Relation between standing waves and travelling waves.	2.9-14
	23	Mon	Wave equation: Rod. Beam. Modal decomposition. Boundary conditions. Forced response.	3.1-12
	25	Wed	Wave equation: Membranes. Microphones. Plates.	4.1-11
	30	Mon	Wave equation: Impedance. Mobility. Modal summation.	
Feb	01	Wed	Acoustic wave equation: Derivation. Sound speed. Velocity, displacement potentials.	5.1-7
	06	Mon	Acoustic wave equation: Harmonic plane waves. Decibels. Shock in plane progressive waves. Energy. Intensity. Impedance.	5.7-10, 12. 16.1-4
	08	Wed	Acoustic wave equation: Spherical waves. Comparison of plane and spherical wave propagation. Point source. Source strength. Acoustic reciprocity. Helmholtz equation. Wave vector.	5.8-11. 7.1-2
	13	Mon	Reflection and transmission: Waves through fluid media. Continuity conditions. Cross-section changes.	6.1-3
	15	Wed	Reflection and transmission: Multiple fluid media. Impedance and transmission loss measurements.	6.1-3
	20	Mon	Reflection and transmission: Oblique incidence. Evanescent waves. Intromission.	6.4-6
	22	Wed	Reflection and transmission: Limp barriers: panels. Mass law. Method of images.	6.7-8
	27	Mon	Reflection and transmission: Acoustic metamaterials. Bloch wave analysis.	
Mar	01	Wed	Reflection and transmission: Acoustic metamaterials. COMSOL Multiphysics simulations.	
	06	Mon	Review	
	08	Wed	Midterm	
	13	Mon	No lecture: spring break	
	15	Wed	No lecture: spring break	
	20	Mon	Sound radiation from structures: Monopole. Dipole. Line source. Near, far fields. Directivity.	7.1-3
	22	Wed	Sound radiation from structures: Rayleigh's integral. Piston. Near and far field approximations.	7.4
	27	Mon	Sound radiation from structures: Radiation impedance. General source characteristics. Acoustic arrays. Product theorem.	7.5-6, 8, 9
	29	Wed	Sound radiation from structures: Plates. Radiation efficiency. Spatial Fourier transform. Beam-steering.	7.11
Apr	03	Mon	Cavities and waveguides: Acoustic modes. Standing and traveling waves. Constant cross-section waveguides. Introduction to pipes.	9.1-5, 10.1-2

	05	Wed	Cavities and waveguides: Impedance changes, terminations. Power radiation. Absorption. Pipe-driver coupling.	10.2-7
	10	Mon	Cavities and waveguides: Lumped acoustic elements. Acoustic filtering.	10.8-11
	12	Wed	Acoustic finite and boundary element modeling: Fundamentals. COMSOL and openBEM simulation.	
	17	Mon	Course project presentations	
	19	Wed	Course project presentations	
	24	Mon	Course review	
May	02	Tue	Final exam	