



Aalto University

General info and overview of the course

ELEC-E5610 Acoustics and the Physics of Sound

Ville Pulkki, Georg Götz, Stefan Wirler, Vasileios Bountourakis

*Department of Signal Processing and Acoustics
Aalto University School of Electrical Engineering*

October 24, 2023

Organizers & schedule

Organizers & schedule

Course objective

Course contents

Course material

How to pass the course

- Lecturers: Ville Pulkki & Georg Götz & Timo Lähivaara (UEF) & Stefan Wirler & Vasileios Bountourakis



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- Lecturers: Ville Pulkki & Georg Götz & Timo Lähivaara (UEF) & Stefan Wirler & Vasileios Bountourakis
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- Real-lfe lectures: Tuesdays at 12:15-14:00 and Thursdays at 14:15-16:00 (12 lectures in total)

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- Seminars: Fridays at 9:15-11:00 (homework solutions, Q&A session)

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How to pass the
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- Describe fundamental acoustic concepts (sound pressure, particle velocity, etc).



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How to pass the
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- Describe fundamental acoustic concepts (sound pressure, particle velocity, etc).
- Interpret the wave equation and Helmholtz Equation and their solutions under different conditions.



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- Describe fundamental acoustic concepts (sound pressure, particle velocity, etc).
- Interpret the wave equation and Helmholtz Equation and their solutions under different conditions.
- Interpret the behavior of vibrational and acoustical systems.



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- Interpret the wave equation and Helmholtz Equation and their solutions under different conditions.
- Interpret the behavior of vibrational and acoustical systems.
- Apply analogies between the mechanical (acoustical) and electrical domains.



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- Describe fundamental acoustic concepts (sound pressure, particle velocity, etc).
- Interpret the wave equation and Helmholtz Equation and their solutions under different conditions.
- Interpret the behavior of vibrational and acoustical systems.
- Apply analogies between the mechanical (acoustical) and electrical domains.
- Analyze wave propagation and sound radiation of simple sound sources (monopole, dipole, etc).



Course lectures

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How to pass the
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- 24.10 Course introduction, Basic oscillating systems (Ville)
 - 24.10 Vibrations of strings and membranes (Georg)
 - 31.10 Waves in fluids and rectangular enclosures (Georg)
 - 2.11 Plane and spherical waves, intensity (Ville)
 - 3.11 Seminar (Stefan)
 - 7.11 Reflection and refraction in fluid boundaries (Georg)
 - 9.11 Acoustic transmission lines (part 1) (Ville)
 - 10.11 Seminar (Stefan)
 - 14.11 Acoustic transmission lines (part 2) + Horns (Ville)
 - 16.11 Impedance, equivalent circuits (Stefan)
 - 17.11 Seminar (Stefan)
 - 21.11 Sound radiation from vibrating objects (Ville)
 - 23.11 Intro to FEM, BEM, (Timo Lähivaara, UEF)
 - 24.11 Seminar (Stefan)
 - 28.11 Introduction to COMSOL (Vasileios)
 - 30.11 COMSOL continued (Vasileios)
-



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How to pass the
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- T. D. Rossing and N. H. Fletcher: **Principles of Vibration and Sound**
- F. Fahy: **Foundations of Engineering Acoustics**
- J. Blauert and N. Xiang: **Acoustics for Engineers**
- Lecture notes

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All necessary parts of textbooks + lecture notes available on MyCourses.



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Equation notation on the lecture slides:

- R&F p. 102 = Rossing and Fletcher's book, page 102
- FF 1.09 = Fahy's book, Equation (1.09)
- B&X 8.48 = Blauert and Xiang's book, Equation (8.48)



How to pass the course

- Do the 4 homework:
 - 3 problems (20 pts) + 1 bonus (5 pts)
 - max total 20 pts per homework

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- Use the LaTeX template provided on MyCourses



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- Use the LaTeX template provided on MyCourses
- If you have to solve an equation in a problem, do it **analytically**
- Allocate sufficient time to complete each homework
- Reserve at least one day (>8 hours) per week to work on the homework!!!



Homework

Week $N \in (1, 2, 3, 4, 5)$

- Week N Thursday: Homework uploaded

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How to pass the
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Homework

Week $N \in (1, 2, 3, 4, 5)$

- Week N Thursday: Homework uploaded
- Week N Thursday — Week $N + 1$ Thursday: Try to solve the homework

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- Week N Thursday: Homework uploaded
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- Week $N + 2$ Thursday evening: Deadline for homework

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- Course assistant will not generally answer to email questions: Q&A session and Zulip channel are the place for it

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- Week $N + 2$ Friday: Solutions session
- Course assistant will not generally answer to email questions: Q&A session and Zulip channel are the place for it
- Fair for everybody in the course, the work load of the assistant also controlled

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COMSOL homework

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How to pass the
course

- COMSOL: powerful and widespread multiphysics simulator
- Used widely in industry



COMSOL homework

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How to pass the
course

- COMSOL: powerful and widespread multiphysics simulator
- Used widely in industry
- A COMSOL homework will be given



COMSOL homework

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How to pass the
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- Arni: a varechoic chamber with 55 openable absorption panels
- Possibility to change the reverberation time from 0.3 s to about 1.5 s



COMSOL homework

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How to pass the
course

- Arni: a varechoic chamber with 55 openable absorption panels
- Possibility to change the reverberation time from 0.3 s to about 1.5 s
- Room modes btw 30-100 Hz

COMSOL homework

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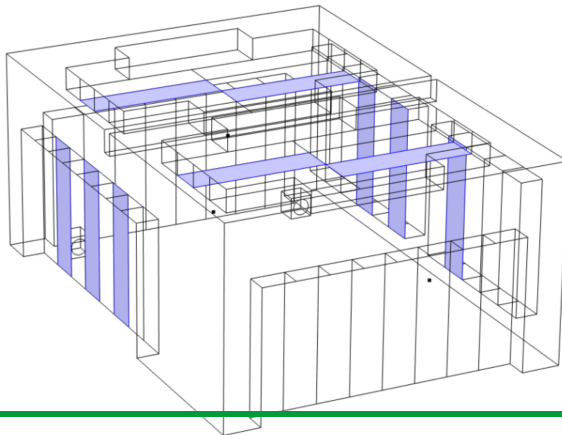
How to pass the
course

- Arni: a varechoic chamber with 55 openable absorption panels
- Possibility to change the reverberation time from 0.3 s to about 1.5 s
- Room modes btw 30-100 Hz
- Common task for acoustical engineers: where to place the absorptive material to control the modes



COMSOL homework

- open exactly 10 absorptive panels to best control the modes in the room



Organizers & schedule

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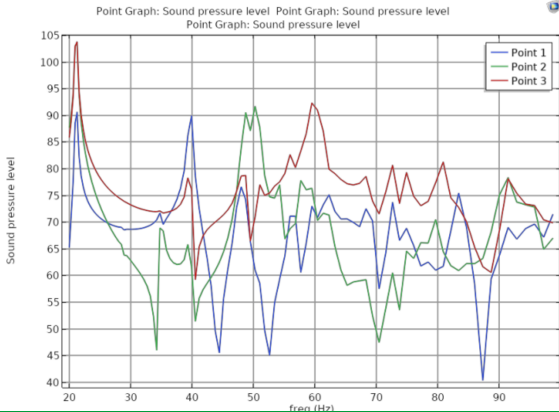
Course material

How to pass the course

COMSOL homework

- simulated modes

10 panels open



These slides

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Latex sources evolved along a long time [curr affiliation]

- Jyri Pakarinen (abt 2007-11) [Huawei]
- Henna Tahvanainen [A-insinöörit]
- Alessandro Altoe [U. South California]
- Archontis Politis [Tampere University]
- Julie Meyer [Aalto]
- Ville Pulkki (2018–) [Aalto]
- Georg Goetz (2020–)[Aalto]
- Stefan Wirler (2021–)[Aalto]

