Chalmers University of Technology
Division of Applied Acoustics
2020-08-28

Course PM: **Sound and Vibration Measurement (SVM)**, VTA073, 1st and 2nd quarter 2020, 7.5 ECTS credits

Aim
To work as an expert in noise control engineering requires the capability to design and carry out experimental work in a proper way. The course aims at giving the student insight in and understanding of acoustical measurement methods and the concepts associated with the methods. This also concerns the basics of practical signal processing.

Learning outcomes *(after completion of the course the student should be able to)*
Work experimentally in the field of sound and vibration including:

- The calibration of equipment both for air-borne and structure-borne sound measurements
- Applying standardized experimental methods, such as the determination of sound power, sound insulation, etc.
- Design of experiments fulfilling to standardization
- The application of signal processing techniques, such as FFT, correlation, etc.
- Carrying out measurement of subjective human response to sound and vibration
- Work successfully with a partner on the experimental task as team
- Develop a critical attitude to experimental approach which allow for correctly interpreting results; to critically treat, relate, and evaluate the methodology and the results.
- Summarize and communicate the results in an appropriate way by reports.

Organisation: The organisation and content of lectures and laboratory works are shown below. Please note that lecture attendance is compulsory! All lectures will be given remotely (using Zoom). Time and location of lab work will be announced as the course progresses.

Lecturers: Wolfgang Kropp, Jens Ahrens and other lecturers, including for each lab (see below).

Course administrator and examiner: Jens Forssén (t: 031 772 8604, jens.forssen@chalmers.se).

Course literature: The course material consists of the lab-instructions, standards and additional materials provided via the course website http://www.ta.chalmers.se/education/course-materials/sound-and-vibration-measurements/. The needed measurement standards are found on e-nav (https://enav.sis.se) via a Chalmers connected computer. Useful introduction material by B&K (Brüel & Kjær) can be downloaded from *www.bksv.com* (*Primers and Handbooks*, *Knowledge center*).

Requirements for obtaining a passing grade, or grade 4 or 5:

- Attend the lectures
- Study the appropriate course material and lab notes prior to the lab work
- Carry out the Pre-Study (see separate document, "The Pre-Study", which explains what this means) and send it in at least one day before the start of the lab (for all labs except lab 4)
- Actively participate in the work, i.e. practical laboratory work, data processing, analysis, etc.

- Write a report. The reports should follow *Applied Acoustics' guidelines for report writing.* (See more about reporting and feedback below.)
- The grading is on a quarter scale (0, 0.25, 0.5, ..., 5.5), where ≥2.5 is a passing grade, grade 4 is between 3.5 and 4.5, and grade 5 is from 4.5 and above
- For passing the course, each lab report must reach a passing grade
- The total grade on the course is the rounded average of the lab reports. (Lab 5/6 counts as two labs.)

Reporting and feedback
The laboratory work is normally made in groups of four persons and the reports are normally written in groups of two, including the Pre-Study. (Except for lab 4 which is made individually.) The reports are submitted on the Canvas course web.

The planned process of reporting and feedback is as follows.

- One day before the start of the lab (or earlier), the students submit their Pre-Studies.
- Before the group starts their lab work, the lab assistant and the lab group will have a feedback meeting about their Pre-Study reports
- One week after the lab (except for the last lab, which is counted as two labs and allows two weeks), the group submits a *Results and Analysis Report,* which concerns the results and analysis of the measurements carried out.
- One week thereafter, a feedback meeting is held about the Results and Analysis Report.
- One week after the feedback meeting, the FINAL lab report is to be handed in. This report shall be complete and contains two parts. Part 1 is the Method part (which is essentially the Pre-Study, in revised form) and Part 2 is the Results and Analysis part, in revised form. In terms of our guidelines for report writing, Part 1 corresponds to Chapters 1–3 of the guidelines and Part 2 corresponds to Chapters 4–7 of the guidelines.
- Thereafter the final report is graded. (Check our guide to grading of lab reports.)

At the feedback meetings, the lab group will be informed by the assistant on the quality of the report (not the grade) and given an indication on the possible grade after improvements.

Participation
If a student is unable to participate in a mandatory part of the course, due to extraordinary causes, they should contact the examiner as soon as possible. In such cases, an alternative way of participation or extra tasks can be provided. Due to the current pandemic situation, additional possibilities to participate remotely will be made available.

Lectures (see common schedule for lecture times)

Quarter 1

Week 1 Lecture: Introduction. Principles of acoustic measurements. Guidelines for writing measurement reports (WK).

Week 1 Lecture: Measurement technique: microphones, loudspeakers, measurement environments (JA).

Week 1 Lecture: Measurement technique: microphones, loudspeakers, measurement environments, continued (JA).

Week 2 Lecture for lab 1: Measurement of sound outdoors (JF).

Week 2 Lecture: Report writing (JT).
Week 3 Lecture lab 2: Measurement of airborne and impact sound insulation (WK).
Week 4 Lecture on uncertainty estimates (JF).
Week 5 Lecture lab 3: Measurement of sound power (CA).

Quarter 2
Week 1 Lecture lab 4: Signal processing (JA).
Week 3 Lecture lab 5/6: Basic vibration measurements & Vibration measurement using a laser Doppler vibrometer (JT).

Lab work

Quarter 1
Lab 1: Measurement of sound outdoors (JF)
Lab 2: Measurement of airborne and impact sound insulation (WK)
Lab 3: Measurement of sound power (CA)

Quarter 2
Lab 4: Signal processing (JA)
Lab 5/6: Basic vibration measurements & Vibration measurement using a laser Doppler vibrometer (JT)

Teachers
WK Wolfgang Kropp <wolfgang.kropp@chalmers.se>
JA Jens Ahrens <jens.ahrens@chalmers.se>
JF Jens Forssén <jens.forssen@chalmers.se>
CA Carl Andersson <carl.andersson@chalmers.se>
JT Jannik Theyssen <jannik.theyssen@chalmers.se>

Recent course improvements
The following changes were made to improve the course, influenced by the student evaluation work.

- Upgrading the Home-task prior to the lab into a more substantial Pre-Task, with the purpose to increase the understanding and final take-home knowledge. The Pre-Task shall explain the *Purpose*, the *Method* (Theory/Setup/Implementation) and something about the expected results and how the method is chosen to answer the *Purpose*.
  Even though the Pre-Task text is recyclable in the lab report, there is an expected added workload. Therefore, the *Uncertainty Estimates* was cancelled from the report demands.
- Updating the lecture on report writing to include good and bad examples as well as an introduction to writing in Latex, which is not mandatory but generally appreciated by the students (eventually ;-).
- Randomising the participants of the lab groups.
- Making sure that at least one student per group is experienced in Matlab, mainly for the first lab. In general, students are expected to rotate on tasks and equipment handling.
- Additional amendments to the lab instructions.
- Note also that the previous lab on human response to sound and vibration is removed and instead we have the one on signal processing.