Experimental measurement techniques, 7.5 credits

Experimentella mättekniker, 7.5 högskolepoäng

Course code:	FOES020
Third-cycle subject:	Energy and Environmental Engineering
School:	EST
Valid from:	240222
Established by:	EST
Decision date:	240222
Last modified:	
Level of education:	Third cycle level
Language:	English
English version:	Yes

Course objective

The course comprises modules for introduction to experimental methods and theoretical frameworks, measurement uncertainty and repeatability, advanced flow visualization methods to state-of-the-art instrumentation for temperature, pressure, and velocity measurements used in Energy and in Environmental research. The course discusses how to start an experiment, which techniques to use, intrusive and non-intrusive measurement techniques with their advantages and disadvantages will be discussed. Particular focus is given on the fundamental phenomena on which the measurement techniques are based for data analysis and post-processing.

Course content

The first module of the course aims to introduce experimental measurements, the design of experimental facilities, and introduction to design of experiments (DoE) approach. It also addresses the importance of reliable experimental measurements and their characteristics with measurement uncertainty and repeatability, and the risk assessment of an experiment. The second module of the course will focus on measurements of the flow field in fluids. This will discuss devices such as pressure probes, hot-wire probes, optical methods with the use of lasers. The third module will focus on measurements in energy with temperature and heat transfer, and in environmental research with physiochemical analysis. The fourth module will

focus on post-processing and the use of experimental data in simulations, and process control. It will emphasize the importance of responsible research practices, including proper handling of equipment and data integrity.

Intended learning outcomes.

- Describe the basics of experimental measurements and the design of experiments approach with the ability to prepare a risk assessment document for a specific experiment.
- Argue for the importance of experimental measurements and measurement uncertainty and repeatability.
- Describe the optimal approach for describing commonly used fluid flow, heat transfer or environmental measurement techniques. Compare the fundamental phenomena behind these techniques.
- Explain the challenges and limitations of different measurement techniques and rank parameters in order of measurement accuracy.
- Formulate effective experimental plans, including selection of appropriate instruments, calibration procedures, and data acquisition strategies, on thermo-fluid mechanics research questions.
- Determine the requirements for an experiment depending on the purpose and the planned use of the experimental data.
- Acquire skills in presenting experimental findings effectively through comprehensive reports and presentations. Emphasize the importance of clear, concise, and scientifically rigorous communication.

The intended qualitative targets in relation to the Higher Education Ordinance, appendix 2.

Knowledge and understanding

For the Degree of Doctor, the doctoral student shall demonstrate:

- A1: broad knowledge and systematic understanding of the research field as well as advanced and up-to-date specialised knowledge in a limited area of this field, and
- A2: familiarity with research methodology in general and the methods of the specific field of research in particular.

Competence and skills

For the Degree of Doctor, the doctoral student shall demonstrate:

- B1: the capacity for scholarly analysis and synthesis as well as to review and assess new and complex phenomena, issues, and situations autonomously and critically,
- B2: the ability to identify and formulate issues with scholarly precision critically, autonomously, and creatively, and to plan and use appropriate

methods to undertake research and other qualified tasks within predetermined time frames and to review and evaluate such work,
- B5: the ability to identify the need for further knowledge, and

Teaching formats

Examination

OBN1: 1.5hp, Participation in the course lectures and assessment.

LAB1: 2hp, Participation in the lab visits and manipulate experiment with data.

INL1: 4hp, Individual mini project.

Grade

Examinations included in the course are assessed according to a two-grade scale, fail or pass.

Grades are to be decided by a teacher specially appointed by the university.

A person who has not passed the regular examination shall be given the opportunity to retake the test.

Requirements

To participate in the course and the examinations included in the course, the applicant must be admitted to doctoral studies. Exceptions can be made at the discretion of the course responsible and course examiner for industry professionals holding a relevant MSc degree or equivalent experience in the subject.

Specific entry requirements

The course has a practical orientation and does not require any specialized professional background in experimental methods. The training will be individually adapted to the needs of each participant. The course is suitable for all PhD students under energy, aerospace, controls, and production system optimization as well as embedded system applications. PhD students and post-docs working on experiments, simulations, control and optimization analysis of energy systems, production systems and environmental experimentation.

Selection criteria

Doctoral students admitted to other subjects at Mälardalen University may be admitted to the course, subject to availability. The same applies to doctoral

students admitted to other higher education institutions within and outside of Sweden.

1. Doctoral students in Energy and Environmental engineering.

2. Doctoral students at Mälardalen University

3. Doctoral students at other universities in Sweden

4. Doctoral students at other higher education institutions outside Sweden

5. Industry professionals holding a relevant MSc degree or equivalent experience in the subject.

Transitional and other provisions