SE2145 Reliability, Optimization and Design 9.0 credits

Tillförlitlighet, optimering och dimensionering

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for SE2145 valid from Autumn 2019

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Mechanical Engineering

Specific prerequisites

Basic course in Solid mechanics, SE1010, SE1020, SE1055 or the equivalent and basic course on FEM, SE1025 or the equivalent. Furthermore the course presuppose that the content in the courses SE2132 Applied elasticity with FEM and SE2126 Material mechanics are well known.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

During the course a participant should acquire experience and become able to:

- explain the role of solid mechanics modeling and computation in the product development process, in particular in relation to a multitude of failure modes.
- consider also hidden failure modes in the above mentioned situation;
- identify mechanical requirements on components and structures and translate them into a mechanical model that is suitable for computations;
- select appropriate FE-meshes, elements, boundary conditions, material models, etc, for efficient problem solving;
- describe the purpose and ideas of different design strategies;
- use advanced methods for FE-based fatigue design (LCF, HCF and TMF);
- describe different forms of uncertainty and estimate the scatter of stochastic variables;
- illustrate and explain how uncertainty in a problem spread to uncertainty in the system response;
- select an appropriate method for exploration of the design space;
- perform probabilistic design with FEM based on direct Monte Carlo simulation or with a surrogate model;
- solve an advanced product development problem and communicate the solution in the form of a poster, an oral presentation and a technical report.

Course contents

The course is based on advanced, higher level, use of solid mechanics theory and modeling. This is added to the already acquired knowledge of the participants. The course is mainly experiential. The course includes a lecture series, including guest lecturers from industry. There are individual design exercises as well as a larger final project to be solved in a small group.

Lectures:

Product development and the role of solid mechancis, design space, failure modes, force flow in structures, modeling of joints, load transfer, tapering, warping, membrane states, non-linear materials, elastoplastic stress cycles, Woehler diagrams for materials and products, multiaxial high- and low cycle fatigue, fatigue criteria, structural optimization, topology optimization, contact mechanics and contact fatigue, slip and wear, fretting. Load typas, instability and buckling, large deformation analysis of buckling. The necessity of knowing the product, residual stresses, fractography and accident investigations. Simulations, dynamics and alternatives to the FEM. Satistics, distributions, estimation, sampling with the Monte Carlo method, Lating Hypercube Sampling. Regression, response surfaces and surrugate modeling, sensitivities and design of experiments. Main- and interaction effects. Probabilistic design and computation of probability for complex problems. Robustness,

quality. Taguchi´s method. Reliability theory, including FORM and SORM. Reliability based design optimization in theory and application. About 4 guest lectures on FE-based product development, optimization, MDO.

Hemuppgifter:

About 6 Design Exercises based on computational mechanics. They illustrate all parts of the course; product development by design, optimization and probabilistic design combined with optimization.

Course literature

Handouts.

Examination

- HEM1 - Home assignments, 3.0 credits, grading scale: P, F
- PRO1 - Project work, 6.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

The examiner, in consultation with the KTH Disability Coordinator (Funka), decides on any adapted examination for students with documented permanent impairment. The examiner may grant another examination form for reexamination of single students.

Other requirements for final grade

Approved home assignments and project.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.