SYLLABUS

Simulations in tribology 7.5 credits M7024T

Simulering av tribologiska processer

Course syllabus admitted: Autumn 2018 Sp 1 - Autumn 2019 Sp 2

DECISION DATE
2018-02-15

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LULEÅ TEKNISKA UNIVERSITET

Simulations in tribology 7.5 credits M7024T

Simulering av tribologiska processer

Second cycle, M7024T

Education level	Grade scale	Subject	Subject group (SCB)
Second cycle	G U 3 4 5	Maskinelement	Mechanical Engineering

Entry requirements

Foundation level courses in Mathematics, Numerics, Physics Mechanics and Fluid Mechanics.

Selection

The selection is based on 30-285 credits

Examiner

Andreas Almqvist

Course Aim

Divided into 3 categories below, you as a student should after completing the course:

1. Knowledge and Understanding

- Know about some selected state-of-the-art models and simulation methods in contact mechanics, lubrication theory and wear problems, including the main concepts and underlying assumptions.
- Understand the concept of the linear complementarity problem (LCP) and the possible application to contact mechanics.
- Understand the concept of fast Fourier techniques (FFT) and the application to solve the elastic deformation problem.
- Understand the concept of the finite difference method (FDM) and how it can be used for example to solve partial differential equations describing thin film flow problems.
- Understand the concepts of verification and validation in the context of scientific computations.
- Understand the advantage of a dimensionless model formulation for subsequent numerical analysis.

2. Skills and Abilities

- Be able to programme numerical solution methods in a structured and conceivable way facilitating simulations of physical processes, particularly in tribology.
- Be able to apply the LCP formulation to solve the contact mechanics problem.
- Be able to apply the FFT to accelerate the numerical calculation of integral equations, particularly the one describing the elastic deformation problem in contact mechanics.Be able to apply the FDM to solve partial differential equations, particularly the Reynolds equation governing the pressure build-up in the thin film flow problem in a thrust bearing.
- Be able to discretize Archard’s wear equation and solve it numerically.
- Be able to verify numerical methods and to validate mathematical models.
- Be able to utilize the models and simulation methods to carry out parameter studies.
- Have developed your abilities in writing technical reports in English and your skills in oral presentation in English.
- Be able to present the obtained results in a clear and comprehensible manner to other engineers.

3. Judgement and Assessment Ability

- Be able to assess accuracy and precision of the implemented simulation methods.
- Be able to assess and judge the relevance of the results obtained with the help of models and numerical simulation methods.
- Be able to adapt new models suitable to study related problems, with application in Tribology and in other fields.
- Use common models and simulation methods to facilitate the development of machine elements and other applications exhibiting tribological contacts.

Contents

Contact mechanics

- The complementarity problem (Either Contact <=> No gap or Gap <=> No contact)
- Modelling elastic deformation
- Discretization of integral equations (Elastic deformation problem)
- Linear complementary problem (LCP) formulation of the contact mechanics problem
- Fast Fourier Techniques (FFT) for calculation of derivatives and integrals

Lubrication theory

- The thin film approximation (N-S => Reynolds equation)
- Finite difference method (FDM) for Poisson’s type of PDE, in particular Reynold’s equation
- Simulation of flows in bearings by means of the Reynolds equation
- Predicting load carrying capacity (LCC) and minimum film thickness by means of fixed point iteration techniques

Modelling and simulation of wear

- Boundary lubrication
- Archard’s wear equation
- Numerical solution procedure for abrasive/adhesive wear

Multiphysics modelling

- COMSOL multiphysics
- Modelling fluid structure interaction (FSI) in a thrust bearing

It is not a prerequisite to have taken the course C0004M, neither is the Mechanical Engineering Programme, Computational Mechanics specialisation course Numerics for optimisation and PDE (Numerik för optimering och PDE). Prior experience of programming in MATLAB is not requirement but facilitates course work.

Realization

Each course occasion´s language and form is stated and appear on the course page on Luleå University of Technology's website.
Lectures, Computer based labs, Hand-in assignments.

Examination

If there is a decision on special educational support, in accordance with the Guideline Student's rights and obligations at Luleå University of Technology, an adapted or alternative form of examination can be provided. Hand-in assignments presented in technical reports in English and during oral presentation in English. Oral examination. Alternative forms of examination may occur.

Overlap

The course M7024T is equal to M7033T

Literature. Valid from Autumn 2015 Sp 1

Selected book chapters, papers and hand-outs.

Course offered by

Department of Engineering Sciences and Mathematics

Items/credits

Number	Type	Credits	Grade
0001	Assignments	5	TG U G#
0003	Oral examination/alternative examination	2.5	TG G U 3 4 5

Study guidance

Study guidance for the course is to be found in our learning platform Canvas before the course starts. Students applying for single subject courses get more information in the Welcome letter. You will find the learning platform via My LTU.

Last revised

by Mats Näsström 2018-02-15

Syllabus established

by Mats Näsström 2014-02-14