COURSE SYLLABUS

Applications of Computational Fluid Dynamics and Heat Transfer, 7.5 credits

Tillämpningar i beräkningsströmningsdynamik och värmeöverföring, 7,5 högskolepoäng

Course Code:	TTBS22	**Education Cycle:**	Second-cycle level
Confirmed by:	Dean Mar 1, 2022	**Disciplinary domain:**	Technology
Valid From:	Aug 1, 2022	**Subject group:**	MA2
Version:	1	**Specialised in:**	A1F
		Main field of study:	Product Development

Intended Learning Outcomes (ILO)

After a successful course, the student shall:

Knowledge and understanding

• show familiarity with general Navier-Stokes equations and solution methods employed in computational fluid dynamics, including heat transfer phenomena.
• demonstrate comprehension of heat transfer mechanisms and fluid flow regimes and types in the scope of components, materials and manufacturing processes studied in the course, and insight into current research and development in the area.
• display knowledge of how computational fluid dynamics (CFD) simulations address technical requirements to the product/component and contribute to the component reliability, being integrated into the component design process.

Skills and abilities

• demonstrate ability to critically and independently formulate problems in the scope of studied engineering applications involving heat transfer and fluid dynamics as well as ability to contribute to knowledge creation.
• demonstrate the ability to create, analyze and critically evaluate different engineering solutions as well as motivate the choice of materials, based on CFD simulation results and analytic estimations.
• demonstrate skills to produce written calculations with mathematical models of different physical phenomena involved in the scope of selected engineering applications.
• demonstrate ability to systematically integrate knowledge and create and solve static and dynamic models by applying commercial CFD simulation tools.

Judgement and approach

• demonstrate ability to independently and critically suggest solution methods and tools for a scope of engineering problems all involving heat transfer and fluid dynamics.

• demonstrate understanding of trade-off nature of the multidisciplinary engineering problems involving fluid dynamics and heat transfer, taking into account reliable component performance, manufacturing process, human needs and various sustainability aspects.

Contents

The course treats fundamentals of CFD and heat transfer, and methodologies for solving a broad range of multi-disciplinary engineering problems in the context of manufacturing process and component design, via application of CFD and thermal simulation tools in design analysis. The effects of different fluid flow regimes and thermo-physical properties of materials are studied. The course includes simulation laboratory sessions (e.g. COMSOL, Flotherm) with experimental support, e.g. for model validation/input parameter generation.

The course includes the following elements:
- Steady state and transient heat transfer, heat transfer modes and thermal resistance network applications.
- Overview of Navier-Stokes equations, and numerical solution methods.
- CFD model validation and virtual prototyping methodology.
- Fluid flow in porous media, including local thermal non-equilibrium conditions, and applications.
- Flow and heat transfer simulation in the context of the methods, materials, and components for thermal management of automotive and telecom assemblies.
- Heat transfer models for heat treatment process design (e.g. annealing) of large metallic components.
- Simplified phase transformation models and their application to manufacturing processes, e.g. laser cladding.
- Applications of fluid flow and heat transfer models for polymer component manufacturing.

Type of instruction

Lecture, exercises and laboratory sessions.

The teaching is conducted in English.

Prerequisites

Passed courses at least 90 credits within the major subject Mechanical Engineering, 15 credits Mathematics included multivariable calculus, Thermodynamics and completed course in Numerical Analysis, 7,5 credits and Polymer and Composite Technology, 7,5 credits, proof of English proficiency is required (or the equivalent).

Examination and grades

The course is graded 5,4,3 or Fail.

For grade 3 it is required to get passed both the written home assignments and the labs. For a grade higher than 3, it is required additionally to pass a written exam.

Registration of examination:

Name of the Test	Value	Grading
Written examination[I]	4 credits	5/4/3/U
Laboratory work and assignments	3.5 credits	U/G

[I] Determines the final grade of the course, which is issued only when all course units have been passed.

Course literature

The literature list for the course will be provided eight weeks before the course starts.

Course compendium distributed during the course.