COURSE SYLLABUS

Mathematical Modeling of Casting, 7.5 credits

Matematisk modellering av gjutning, 7,5 högskolepoäng

Course Code:	FTMMG33	**Education Cycle:**	Graduate level
Confirmed by:	Dean Jan 24, 2013	**Research subject:**	Materials and Manufacturing
Valid From:	Jan 24, 2013		
Version:	1		

Intended Learning Outcomes (ILO)

On completion of the course, the doctoral student must:

Knowledge and understanding

- have a good understanding of different simulation methods related to the production of shape castings
- have a good understanding on how simulated thermo-physical and thermo-mechanical properties can be transferred to simulation programs for strength calculations and other calculations related to the functionality of a casting component

Skills and abilities

- have the skills to formulate and program numerical models that analyze phenomena occurring during casting
- have the ability to relate numerical models that calculate solidification, segregation, crystallization, properties and defect formation, thermal induced stresses and deformation of simulated basic thermal processes

Judgement and approach

- be able to evaluate how thermo-physical and thermo-mechanical properties and bounday conditions used in the simulation affects the simulation results

Contents

The course aims to give the student background on how the calculation models are formulated for the simulation of phenomena associated with the casting of technical alloys (eg, Fe- Al- and Mg-based alloys). The basic heating transport problem and the coupled models are solved using the control volume-based finite difference method (FDM CV) method.
Simulation of solidification and solid phase transformation is formulated with enthalpy and kinetic methods. The results of the solidification process are linked to both microstructure and defect formaton and furthermore linked to material properties. The course provides training in the calculation of phase diagrams and thermo-physical properties for input data in casting simulation. From solidification to room temperature, the cast material undergoes thermally induced deformation. Deformation and variation of the stress state is calculated by thermo-mechanical models.

The course provides training in the transmission of the simulated material properties and the stress state to simulation programs calculating tensile strength associated with the use of cast components.
The course includes the following topics:

- Introduction of the course and outlook to research and development trends in casting simulation
- Calculation of phase diagrams and thermo-physical properties
- Formulation of kinetic models for solidification and solid phase transformation
- Formulation of the phenomena associated with solidification leading to defects (shrinkage and gas)
- Coupling of the microstructure and properties to defects
- Thermo-mechanical calculations (stress and deformation)
- Transfer of material properties, residual stresses and calculated solid models to simulation programs for strength-related calculations

Type of instruction

Lecture, laboratory assignements.

The teaching is conducted in English.

Prerequisites

Admitted to third level education or equivalent qualification and the course in modeling and simulation of casting, TMSS20, 7,5 hec (or equivalent).

Examination and grades

The course is graded Fail (U) or Pass (G).

For the grade "Pass" six different homework assignments to be submitted and approved.

Registration of examination:

Name of the Test	Value	Grading
Home assignments[I]	7.5 credits	U/G

[I] Home assignments 6 x 1,25 hec

Course literature

Mathematical Modeling of Casting
Fundamentals of Numerical Modeling of Casting Processes by Jesper Hattel and distributed literature from a special reading list.