

# **CASTING DOCTORATE COURSE**

**(7.5 hp)**

**Fall 2012**



**SCHOOL OF ENGINEERING**  
JÖNKÖPING UNIVERSITY

# COMPONENT CASTINGS (TGKG12)

## LECTURES AND SUPERVISION

Anders Eric Wollmar Jarfors, course leader                      036 – 10 16 51  
(anders.jarfors@jth.hj.se)  
Nils-Eric Andersson    036 – 10 16 65  
(nils-eric.andersson@jth.hj.se)

## INTRODUCTION

Products tend to be more and more complex with higher demands on performance, energy consumption, environment load and costs. Casting of components shows an increasing interest due to good characteristics.

Integrated and concurrent product developments are well recognized methods for industrial products. Important keywords in product development are: customer value, technical height, short lead time, quality, cost and environment.

Casting is the most used manufacturing method for the manufacture of components in the world. The engineering- and industrial design of cast components require integration of a large part of the process chain to be successful.

What is important for the industrial- and engineering designer, is to know about casting, material selection, manufacturing and simulation!

Some key topics are,

- Which casting methods are available?
- What materials can be cast and what properties can be obtained in a component?
- Design of cast components; plenty of design freedom, but also restrictions.
- How does the choice of casting process influence the concept of a good design?
- Which phenomena can be studied / predicted by means of casting simulation?
- Can we trust the simulation results?
- How to make prototypes and what virtual prototyping methods are available?
- What types of products are frequently produced by casting?

## AIM

The aim of the course is to give basic understanding of engineering and industrial design of components manufactured by casting. The students should be able to use simulation tools to study phenomena relevant for the casting process (e.g. heat flow, fluid flow and thermal stresses), as an aid in the product development process. A basic understanding of the physics and mathematics of casting should be mastered.

## SCOPE

### PRODUCTION TECHNOLOGY

Overview of casting methods, usefulness and product areas. Development trends. Different manufacturing methods and their characteristics. Machine and hand-moulding, shell-moulding, lost wax methods, lost foam, high pressure die cast methods, gravity die castings, low pressure die castings, squeeze-casting and new and special casting methods. Overview of mould and core materials. Product planning, pattern, dimensional tolerances and surface roughness.

### CASTING MATERIALS

Overview of casting materials. Phase diagrams. Solidification of casting alloys. Metallurgical treatment. Use of alloying elements in cast irons and light alloys. Relation between microstructure

and properties in cast materials. Shrinkage and gas porosity formation. Casting of new materials and composites. Melting and pouring.

## COMPUTATION AND SIMULATION OF THE CASTING PROCESS

Computation and simulation of

- mould filling
- solidification time
- feeding
- residual stresses and deformations.
- local material properties

## DESIGN OF CASTINGS AND CASTING DEFECTS

Design rules, related to filling and solidification phenomena

## SIMULATION LABORATIONS

Course participants will work in pairs during the mandatory laborations. Each pair will be given tasks which should be treated during the laboration. The tasks could be to analyse, simulate and if possible to investigate an already prepared cast component with some specific problems or demands. Information about the component, process and material will be available. The laboration results will be documented in Word documents with pictures and comments. In some cases animations will be made from the simulation results. These reports should be handed in to the teacher/assistant at the end of the laboration.

Before each laboration the student should read the recommended pages in the book.

## COURSE PLAN

The course contains lectures where different areas will be treated.

Mandatory laborations.

Mandatory home assignments

## COURSE MATERIALS

The book "Component castings and simulations" – in English 300 SEK.

The book will be sold at the first lecture and at the Department of Mechanical Engineering / Component Technology. Level 2 in the Engineering building.

The book "Materials processing during Casting" Frdriksson and Åkerlind, Wiley

Handouts and papers

## EXAMINATION

During the course 3 short quizzes will be given. Each can give 10 points for the final exam.

The exam consists of 100 points with grade 3 is 50 and above, 4 is 75 and above and 5 is 85 and above. The extra points can be used during the first exam.

The simulation-laborations have to be passed. To pass the course, it is necessary that the student actively has participated in all (5) mandatory laborations.

3 mandatory home assignments to be solved and discussed in 3 seminars

Student course points: final examination 2.5p, and simulation labs 1.5p, Home assignments 3.5p.

**Program: Component Castings, 2012****Week 34**

**To read:**     **Chapter 1** CASTING OF COMPONENTS  
                   **Chapter 2** PRODUCTION TECHNOLOGY

23 Aug E1022	13.00- 14.45	Introduction of course program Production methods (non permanent moulds) and examples of castings	JARAND
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**Week 35.**

**To read:**     **Chapter 3** FUNDMENTALS OF MOULD FILLING AND INGATE SYSTEMS

27 Aug E2326	08.00 -08.15	Test 1 (15 min) Content: <b>Chapter 1, Chapter 2</b>	JARAND
	08.15 -09.45	Fluid flow, mould filling and in-gate technology	JARAND

**Week 36**

**To read:**     **Chapter 4** FUNDAMENTALS OF SOLIDIFICATION DYNAMICS

3 sep E2326	08.00 - 08.15	Test 2 (15 min) Content: <b>Chapter 3</b>	JARAND
	08.15 - 09.45	Heat transfer and solidification in sand moulds and metal moulds	JARAND

5 sep E1105	10.00 - 12.00	Laboration preparatory lecture	ANNE
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7 sep E1303	8.00- 11.45	Simulation Laboration 1 Drawing in pre-processor Importing CAD / STL files Enmeshment Solvers Post processing	ANNE
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**Week v37****To read: Chapter 5 FOUNDRY OF CAST IRON: PROCESSING AND SIMULATION**

10 sep E2326	08.00 -08.15	Test 3 (15 min) Content: <b>Chapter 4</b>	JARAND
	08.15 -09.45	Cast Irons; Grey, vermicular and ductile cast irons	JARAND

**To read: Chapter 6 FOUNDRY OF LIGHT ALLOYS: PROCESSING AND SIMULATION**

12 sep E1105	10.00 -11.45	Aluminium alloys and Magnesium alloys	JARAND
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**To read: Chapter 7 FOUNDRY OF STEELS: PROCESSING AND SIMULATION**

13 sep E1022	13.00 -14.45	Steels and other cast materials	JARAND
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14 sep E1303	08.00- 11.45	Simulation Laboration 2 Mould filling and gating Feeding Calculation of hotspots Transport of melt at solidification Demonstration on castings	ANNE
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**Week 38****To read: Chapter 8 DESIGN ASPECTS OF CAST COMPONENTS**

17 sep E2326	08.00 -09.45	Design of castings Preparation, pattern and rapid prototyping	JARAND
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20 sep E1022	13.00 - 14.45	Casting defects	JARAND
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21 sep E1303	08.00- 11.45	Simulation Laboration 3 Simulation of microstructure and properties in aluminium alloys. Properties dependent on wall thickness and cooling conditions in grey and ductile cast irons . Demonstration on castings	ANNE
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**Week 39****To read:** Handed out materials on THERMAL STRESSES AND DISTORTIONS

24 sep E2326	8.00 - 9.45	Thermal stress, distortion and hot tears and cold cracks	JARAND
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24 sep E3105d	13.00- 14.00	Introduction to home assignment 1	JARAND
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28 sep E1303	08.00- 11.45	Simulation Laboration 4 Development of cast product from given requirements	ANNE
	13.00- 16.45	Unsupervised work to finish laboration if necessary	

**Week 40****To read:** Chapter 9 CASE HISTORIES  
Chapter 10 FUTURE CASTING DEVELOPMENTS

3 okt E1105	10.00- 11.45	Case histories	JARAND
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3 okt E3105d	13.00- 16.00	Introduction to home assignment 2 Presentations of home assignment 1	JARAND
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4 okt E1022	8-10	Course review	JARAND
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5 okt E1303	08.00- 11.45	Simulation laboration 5 Simulation of stresses and distortions Pressure die casting and stress calculation	ANNE
	13.00- 16.45	Unsupervised work to finish laboration if necessary	

**Week 41**

12 okt E1303	10.00- 14.45	Support lab Unsupervised work to finish laboration if necessary	
	13.00- 16.45	Unsupervised work to finish laboration if necessary	

**Week 43**

5 Nov E3105d	13.00- 14.00	Introduction to home assignment 3 Presentations of home assignment 2	JARAND
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**Week 45**

19Nov E3105d	13.00- 14.00	Presentations of home assignment 3	JARAND
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## WRITTEN EXAMINATION

### Week 42, Written examination

TGKG12	16 okt	Component casting	jarand
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