



## Casting Processing, MH2252, 6hp H23

### Aim

The course gives an overview over both component casting and processes such as ingot casting, continuous casting and direct casting and describe and explain the problems that can arise during metal casting, solidification and cooling.

### Intended learning outcomes

After passing the course the student should be able to:

- LM1 Give example of and justify for the use of common casting processes for manufacturing of components, as well as blanks (TEN2)
- LM2 Apply and calculate fluid dynamic processes for metal flow at tapping and filling of a casting system for manufacturing of components, as well as blanks (TEN2)
- LM3 Explain principles and justify adopted models for heat transport at the moulding and solidification of metals (TEN2)
- LM4 Explain and justify for structure and structure formation in casted materials and the appearance of micro and macro segregations during solidification (TEN2)
- LM5 Explain the origin of casting defects such as shrinkage, gas porosity, slags, secondary phases and cracks and methods and processes to control and minimise these (TEN2)
- LM6 Dimension and simulate a casting system with the purpose of minimising casting defects and maximising yield, and present this in a scientific context (PRA1)
- LM7 Describe and give examples of the complexity of a real industrial process chain for casting of components or blanks and present this during a seminar (STU1)

### Specific prerequisites

- Good knowledge of the production process for casting of metals corresponding to the course MH1024 Fundamentals of Materials Science - Metallic Materials, or the equivalent
- Good knowledge in fluid dynamics of melts corresponding to the course MH1018 Transport Phenomena, or the equivalent.

### Literature

Materials Processing during Casting. Hasse Fredriksson, Ulla Åkerlind, Wiley, March 2006, ISBN: 0-470-01514-4. Freely available by Wiley Online Library.

### Examination

PRA1 - Practical training, 1.5 credits, Grading scale: P, F

STU1 - Study visit, 0.5 credits, Grading scale: P, F

TEN2 - Written exam, 4.0 credits, Grading scale: A, B, C, D, E, FX, F

### Examiner:

Anders Eliasson

08-790 7255

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### **Lectures and exercises/home assignments**

The aim of the lectures in the course is to highlight the vital parts of the course. The major part of the material is to be studied individually.

Lecturer: Anders Eliasson, [anderse@kth.se](mailto:anderse@kth.se)

The exercises/home assignments will give opportunity to learn applications of theory and to solve problems. Problem solving should be done by the students and will be valued and commented by the assistant. The students are recommended to solve and to hand in solutions in canvas to the exercises noted in the Home assignment list.

Assistant: Aravind Senan Vasanthasenan Reji, [asvr@kth.se](mailto:asvr@kth.se)

### **Computer assignment (PRA1: 1,5 credits)**

A computer assignment should be solved by help of the numerical simulation program MagmaSoft.

Assistant: Aravind Senan Vasanthasenan Reji, [asvr@kth.se](mailto:asvr@kth.se)

### **Study visit (STU1: 0,5 credits)**

A mandatory study visit is planned to a foundry. The students are requested to in groups prepare questions, write a visit report and present it at a seminar.

Responsible: Anders Eliasson, [anderse@kth.se](mailto:anderse@kth.se)

Isak Hollinger, [isak.hollinger@scania.com](mailto:isak.hollinger@scania.com).

### **Examination (TEN2: 4,0 credits)**

The examination is in two parts. The first part is answered without any aids, while during the second part of the exam the use of handed out course material (Summary pages) is allowed.

Responsible: Anders Eliasson, [anderse@kth.se](mailto:anderse@kth.se)

## Course schedule H23

Date	Time	Place	#	Topic	Chapter
29/8	15-17	Blå	L1-2	Information and introduction. Component casting. Cast house processes. Chapter 1-2	1.1-1.2 2.1-2.6
30/8	10-12	Blå	L3	Casting hydrodynamics. Chapter 3.	3.1-3.7
5/9	15-17	Blå	E1/HA1	Component casting. Cast house processes. Casting hydrodynamics.	Chapter 1-3
6/9	10-12	Blå	L4a+b	Heat transport at sand mould casting - good contact Chapter 4-5	4.1-4.4 5.1-5.7
12/9	15-17	Blå	E2/HA2	Heat transport at component casting.	Chapter 4-5
13/9	15-17	Blå	L4c	Heat transport at component casting - poor contact. Chapter 4-5	4.1-4.4 5.1-5.7
14/9	09-12	M122	CL1	Computer lab – Introduction to MagmaSoft	
19/9	15-17	Blå	E3/HA3	Heat transport at component casting - poor contact.	Chapter 4-5
20/9	10-12	Blå	L5+6	Structure and structure formation in cast materials. Micro-segregation and solidification processes in alloys. Macro-segregations. Chapter 6, 7, 11.	6.1-6.11 7.1-7.9 11.1-11.9
21/9	09-12	M122	CL2	Computer lab – Introduction to assignment	
26/9	10-12	Blå	E4/HA4	Structure and structure formation in cast materials. Microsegregation and solidification processes.	Chapter 6-7, 11
27/9	09-12	M122	CL3	Computer lab – Work with assignment	
28/9	10-12	Blå	L7a+b	Precipitation of pores and slag inclusions at casting processes. Chapter 9.	9.1-9.9
3/10	15-17	Blå	E5/HA5	Reaction kinetics and precipitation of gas pores and non-metallic phases during solidification.	Chapter 9
4/10	15-17	Blå	L8a+b	Solidification and cooling shrinkage of metals. Chapter 10 Information about the study visit.	10.1-10.7
5/10	09-12	M122	CL4	Computer lab – Final work with assignment	
6/10	13-17	Scania	Field trip	Study Visit at Scania AB, Södertälje	
10/10	15-17	Blå	E6/HA6	Solidification and cooling shrinkage.	Chapter 10
11/10	08-10	Blå	L9	Repetition: Casting and solidification. Information about the exam.	
12/10	10-12	Blå	E7	Repetition	
13/10	13-15	Blå	Sem	Seminar – Presentations of Study visit groups	
27/10	08-13	Blå	TEN2	Examination.	
20/12	08-13	Blå	TEN2	Re-examination	

L = Lecture, E=Exercise (ev), HA = Home assignment (Canvas)

## Literature: Materials Processing during Casting by Hasse Fredriksson and Ulla Åkerlind

<u>Chapter</u>	<u>Chapter</u>	<u>Activity</u>	<u>Exercises</u>	
1. Component Casting	Whole chapter	Carefully	-	-
2. Cast House Processes	2.1 – 2.4	Carefully	-	-
	2.5 – 2.6	Browse		
3. Casting Hydrodynamics	3.1 - 3.3.2	Carefully	3-1	3-6
	3.3.3 - 3.3.4	Browse	3-2	<b>3-7</b>
	3.4	Carefully	<b>3-3</b>	3-8
	3.5	Browse	<b>3-4</b>	3-9
	3.6 - 3.7	Carefully	<b>3-5</b>	3-10
4. Heat Transport during Component Casting	Whole chapter	Carefully	4-1	<b>4-7</b>
			4-2	4-8
			<b>4-3</b>	<b>4-9</b>
			4-4	<b>4-10</b>
			<b>4-5</b>	4-11
			<b>4-6</b>	
5. Heat Transport in Cast House Processes	5.1 - 5.3	Carefully	5-1	5-7
	5.4	Browse	<b>5-2</b>	5-8
	5.5	Carefully	5-3	<b>5-9</b>
	5.6	Browse	<b>5-4</b>	<b>5-10</b>
	5.7	Carefully	<b>5-5</b>	<b>5-11</b>
	5.8	Browse	<b>5-6</b>	5-12
6. Structure and Structure Formation in Cast Materials	6.1 - 6.4	Carefully	6-1	6-6
	6.5 - 6.6	Browse	<b>6-2</b>	<b>6-7</b>
	6.7 - 6.9	Carefully	<b>6-3</b>	6-8
	6.10 - 6.11	Browse	6-4	6-9
			6-5	6-10
7. Microsegregation in Alloys – Peritectic Reactions and Transformations	7.1-7.3	Carefully	<b>7-1</b>	<b>7-6</b>
	7.4	Browse	<b>7-2</b>	7-7
	7.5	Carefully	<b>7-3</b>	7-8
	7.6-7.9	Browse	7-4	7-9
			<b>7-5</b>	
8. Heat Treatment and Plastic Forming	8.1 – 8.4	Browse	8-1	8-6
	8.5	Carefully	8-2	8-7
	8.6	Browse	8-3	8-8
			<b>8-4</b>	8-9
		8-5	8-10	
9. Precipitation of Pores and Slag Inclusions during Casting Processes	9.1-9.7.5	Carefully	<b>9-1</b>	<b>9-6</b>
	9.7.6-9.7	Browse	9-2	9-7
	9.8	Carefully	<b>9-3</b>	9-8
	9.9	Browse	9-4	9-9
			<b>9-5</b>	9-10
10. Solidification and Cooling Shrinkage of Metals and Alloys	10.1-10.5.1	Carefully	<b>10-1</b>	<b>10-6</b>
	10.5.2-10.6	Some Browse	<b>10-2</b>	10-7
	10.7	Browse	10-3	<b>10-8</b>
		-	<b>10-4</b>	10-9
			<b>10-5</b>	<b>10-10</b>
Macrosegregation in Alloys	11.1 – 11.5	Browse	11-1	<b>11-6</b>
	11.6 – 11.9	Carefully	11-2	<b>11-7</b>
			11-3	11-8
			<b>11-4</b>	<b>11-9</b>
			11-5	

**Bold: recommended exercises. Yellow home assignments**