KTH Industriell teknik
och management

EXAM IN MH2252 CASTING PROCESSING

PART I

Date: **2020-10-16**
Time: **08.00 - 13.00**
Location: **Digital**

Means of assistance, part 1

- **Calculator (without text information regarding the course content)**
- **Dictionaries (as well electronic ones)**

Information

- The written examination is divided into two parts. The first part (Part I) is handed out when the examination starts. The second part (Part II) is handed out when Part I is handed in. No time limit exists between the two parts of the examination.

- The exam consists of assignments on the course's learning objectives. To pass the exam, grade E, a basic / sufficient level of knowledge corresponding to approximately 50% correct answers of each ILO. Higher grades are given at good (C) / very good knowledge (A) of the learning objectives. Completion grade Fx can be offered when a basic / sufficient level of knowledge has not been shown in all learning objectives.

Examiner: Anders Eliasson, tel. 08-790 7255, anderse@kth.se
Responsible teacher: Anders Eliasson, tel. 073 614 95 73

Submission

You should handwrite the exam on paper; you will need to scan the handwritten text with the app ScanPro. The app converts the picture file to a PDF document. After scanning your paper, you need to transfer the PDF file to your computer and upload it to the Canvas assignment!

Obs, det går även bra att svara på Svenska.

Both results and the assessed examinations are published approximately 15 correcting days after the examination, latest by 2020-11-09.

Appeal of reassessment and completion of the exam (Fx) should take place within 3 weeks from the date of notification. In case of reassessment, contact the ITM's student office, and by completion of the exam (Fx), the course responsible.

Note, this cover sheet should be separated and not scanned

Name:.. Personal number:..

Problem 1 (20p) Component casting and cast house processes (LM1)

Foundry production of components are done either in non-recurrent moulds or in permanent moulds. There exist a number of different methods with their own advantages and disadvantages.

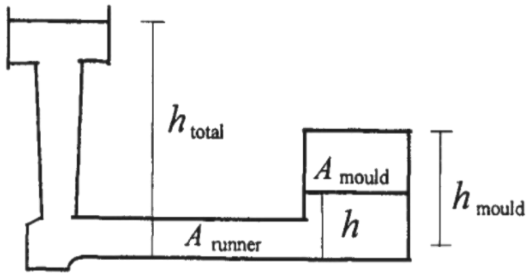
- Give and motivate the main reasons for selecting either to cast in a non-recurrent mould or in a permanent mould.
- Select and describe by your own choice; by a sketch and in text with its specific characteristics and ad-, and disadvantages one casting processes of each group. Give as well a typical cast component from each selected casting method!

Name:.. Personal number:..

Problem 2 (10p) Casting hydrodynamics (LM2)

Below is a sketch of a standard gating system for component casting – uphill casting.

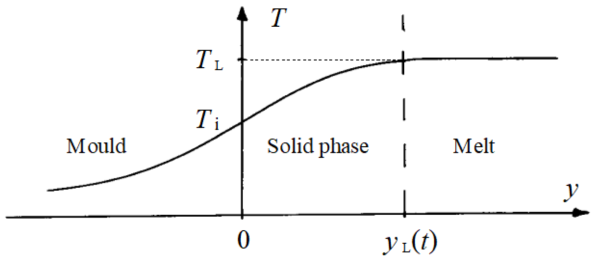
- Give the main reasons for using a gating system; why not pour directly into the mould cavity?
- Derive by help of basic hydrodynamic laws an equation for the filling time, t_f of the mould cavity.



Name:.. Personal number:..

Problem 3 (10p) Heat transport and solidification of metals (LM3)

During casting, the melt solidifies and cools mainly by heat transport by the mould. Consequently, the mould material affects the temperature distribution and solidification processes. Below are an ideal temperature/distance distribution described.



- Make some schematic temperature distribution drawings for each of non-recurrent moulds (one model) and permanent moulds (one model). Describe and explain your estimated solidification models, border conditions and simplifications.

Name:.. Personal number:...

Problem 4 (10p) Structure formation and macro segregation (LM4)

In steel ingots appears many different types of macro segregations. One result in a channel formation called A-segregations or "ghost lines", see picture.

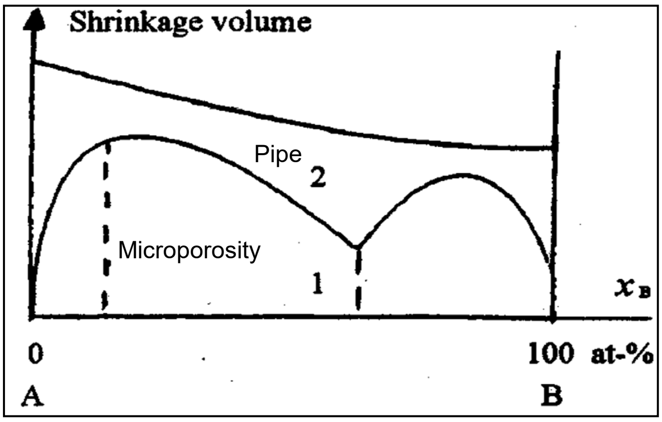
- Describe/explain the principle for A-segregations in large ingots. Please make use of both text, sketches and a simple schematic phase diagram in your explanation (mandatory).

Name:... Personal number:..

Problem 5 (10p) Casting defects, shrinkage porosity (LM5)

At solidification, one normally get both macro-and micro porosity in cast materials. In the figure below, the upper curve shows the total volume of shrinkage, while the middle area the volume of pipe/macro porosity and the bent curve the volume of micro porosity.

- Briefly explain what macro-and micro porosity is for kind of porosity.
- Explain in depth why the relations of these kinds of porosities vary by the alloy composition.



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EXAM IN
MH2252 CASTING PROCESSING

PART II

Date: 2020-10-16
Time: 08.00 - 13.00
Location: Digital

Means of assistance

- **Handed out "Summary sheet" from the textbook "Materials Processing during Casting" by Hasse Fredriksson and Ulla Åkerlind.**
- **Formula/table collection like "Beta Mathematics handbook"**
- **Calculator (without text information regarding the course content)**
- **Dictionaries (as well electronic ones)**

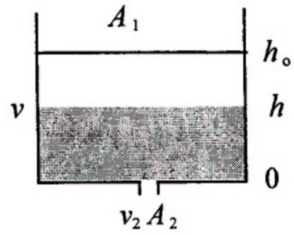
Note: Exercise documents, solved or unsolved are *not allowed, nor* any Casting and solidification textbook.

Note, this cover sheet should be separated and not scanned

Name:.. Personal number:…..

Problem 6 (10p) Casting hydrodynamics (LM2)

A bathtub (see cross-section in figure) is filled to a height of h_0 = 30 cm, and then it contains 300 l (dm^3) of nice hot water (density 998 kg/m^3). You enter it, but suddenly your cell phone ring and you rush up and accidentally unplug the bathtub.



- What is the maximum time for your telephone conversation before the bathtub is emptied? The bottom-hole diameter is 40 mm.
- Will there be any difference in the time for emptying if the bathtub instead is a ladle by the same dimensions and the water is molten steel (density 7036 kg/m^3)? Motivate your answer!

Name:.. Personal number:…...

Problem 7 (15p) Heat transport, solidification and micro segregation in metals (LM3+LM4)

A die-casting foundry cast components in aluminium for precipitation hardening. No eutectic θ-phase (Al_2Cu) should be found in the as-cast structure but by practice 1,5 % eutectic fraction are accepted.

- Calculate the maximum content of Cu in the cast Al-Cu alloy, by assuming:
  - Complete equilibrium conditions during solidification (the Lever rule valid)
  - Negligible diffusion in the solid metal (the Scheil's model valid).

- Motivate for which of these models that will give the most reliable answer about the as-cast composition of Cu. Note, the correction term B might give you some clues about the validity of the models.

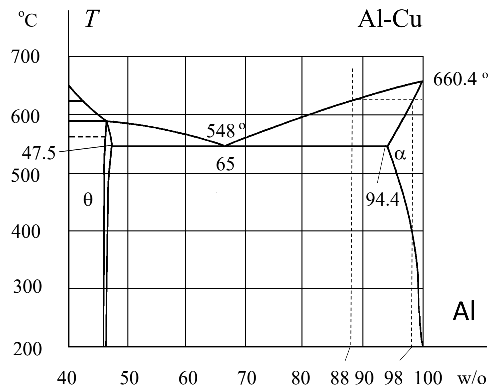


Figure: Part of the phase diagram Cu-Al

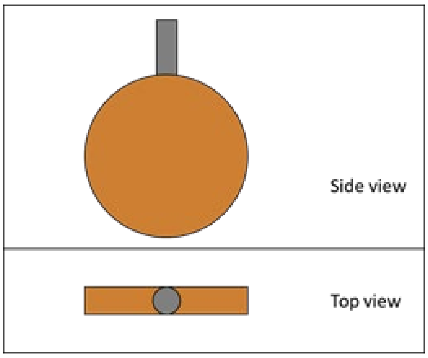
Name:.. Personal number:…...

Problem 8 (15p) Casting defects, shrinkage porosity, gas porosity, slag inclusions and macro segregation during solidification (LM3+LM5)

A medal in brass by a diameter of 3 cm and a thickness of 5 mm is cast in sand. The casting was suggested to be done with a standard cylindrical feeder by the dimensions: 5 mm diameter and 5 cm height (can be used if task feeder dimension below not is solved).

Note, state necessary assumptions to solve the problems!

- Calculate the solidification time of the medal.
- Calculate a more accurate feeder dimension by taking into account the CFR-value as well. Note; use the H = 1,5D relationship.
- What amount of copper in gram is needed for each medal containing 63%Cu-37%Zn (weight-%)?



The medal and the feeder

Material constants

ρ_{CuZn} = 8730 kg/m^3
k_{CuZn} = 109 W/mK
Cp^{CuZn} = 0,92 kJ/kgK
T_L(CuZn) = 1228 K
CFR = 26 %
$-\Delta H_{CuZn}$ = 164,8 kJ/kg
β (CuZn) = 5 %
k_{sand} = 0.63 W/mK
ρ_{sand} = 1610 kg/m^3
c_p^{sand} = 1,05 kJ/kgK
