

**Master examination**

**„Material Science of Steel“ – Pt. II**

**„Steel Design“**

**24.02.2015**

**Name:**

**Matrikelnummer:**

**Signature:**

Task	Maximum Points:	Points (achieved):	Review: (only additional Points)
18	1		
19	2		
20	1		
21	4		
22	2,5		
23	1,5		
24	2		
25	2		
26	2		
27	2		
28	3		
29	2,5		
30	2		
31	1,5		
32	1		
Sum	30		

75% of the final mark will be calculated from the written examination “Material Science of Steel – Pt. I” and the result of the oral examination.

The remaining 25% of the final mark can be achieved in the written examination “Steel Design”.

**Task 18** **Advanced High-Strength Steels I** **1 Point**

What is the difference between Advanced High Strength Steels and conventional high strength steels (1 Point)?

**Task 19****Advanced High-Strength Steels II****2 Points**

The special properties of TRIP-steels are related to the presence of approximately 10% retained austenite in the microstructure. Explain what makes it possible to have retained austenite present in a 0.2 wt.-% C steel. Is the retained austenite thermodynamically stable? Is it mechanically stable? (2 Points)

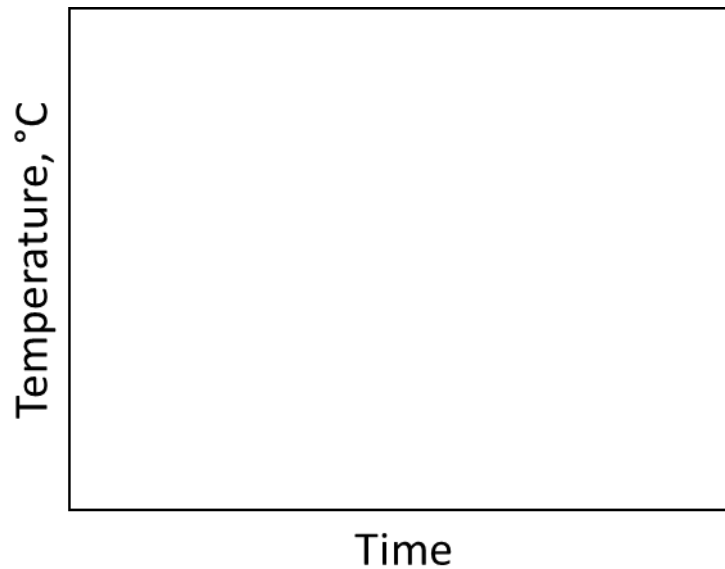
**Task 20** **Advanced High-Strength Steels II** **1 Point**

In Dual Phase steels, there is usually 5 to 30 vol.-% martensite present in the microstructure. Explain the lower and the upper limit of the martensite content considering the mechanical properties. (1 Point)

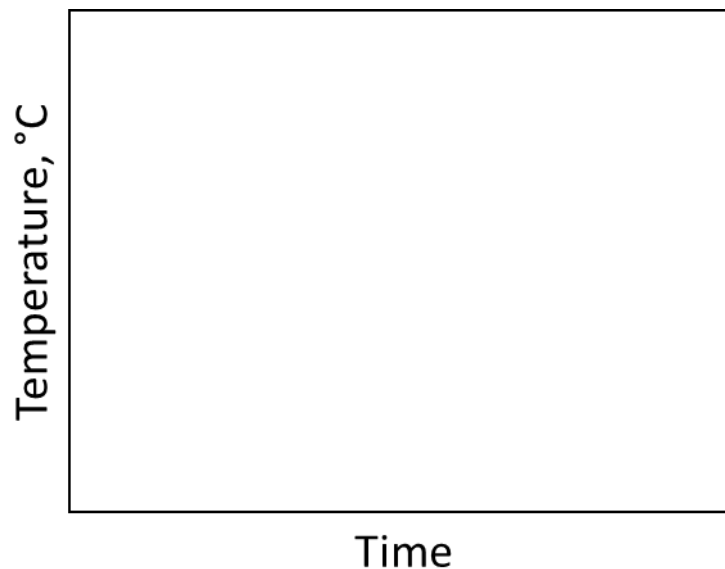
**Task 21****Advanced High-Strength Steels III****4 Points**

Sketch the cold rolled and hot rolled strip production of a DP-steel using the TTT-diagram in attachment 1. What microstructure does the steel have before cooling (4 Points)?

a) Hot rolled DP-steel:



b) Cold rolled DP-steel

**Attachment 1**

**Task 22** **Advanced High-Strength Steels III** **2,5 Points**

There are different mechanisms of plastic deformation that may be activated in high Manganese-steels.

- a) Name three of these mechanisms (1.5 Points)
- b) Which physical value determines the forming mechanism? (0.5 Points)
- c) Which unit is used for this physical value? (0.5 Points)

**Task 23****Seamless tubes****1,5 Points**

Give the three basic pre-processing steps which have to be carried out to manufacture seamless tubes (1.5 Points).

**Task 24****OCTG****2 Points**

Steels grades which are used as oil country tubular goods (OCTG) are used under severe corrosion conditions.

- a) Name 2 kinds of corrosion damage which can occur in OCTG-Steels (1 Point).
- b) Which chemical element is responsible for these kinds of corrosion damages (1 Point)?



**Task 25****Boiler tubes****2 Points**

What are the demands on boiler tube steels ...

a) ... in general (0.5 Points)?

b) ... on the inside of a tube (0.5 Points)?

c) ... on the outside of a tube (0.5 Points)?

d) What can be done to increase the effectiveness of boilers (0.5 Points)?

**Task 26****Rail steels****2,5 Points**

There are three ways, which are typically used to influence rail's properties. Name all of them. Describe the main strengthening mechanisms for each way briefly (2,5 Points).

**Task 27**

**Rail steels**

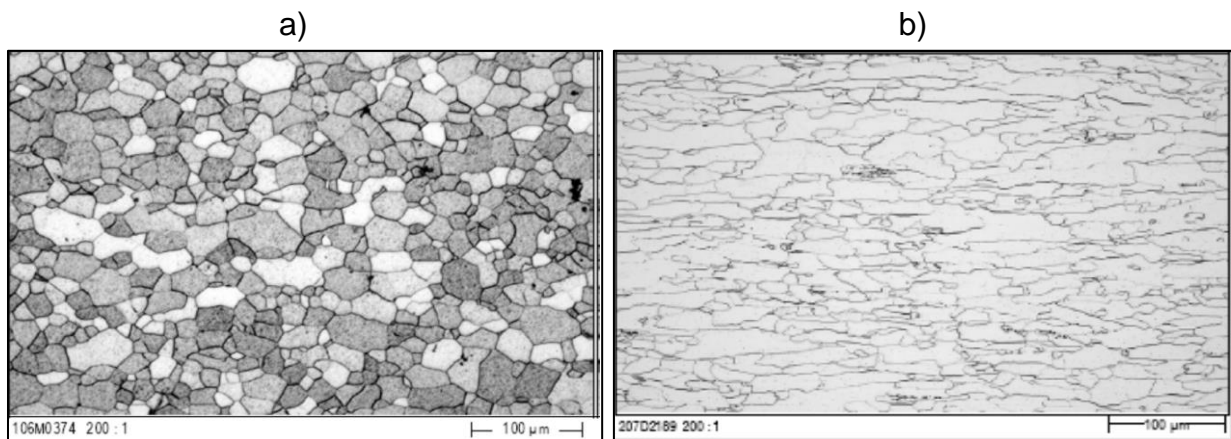
**2 Points**

What are the demands on rails? Name at least 4 (2 Points).

**Task 28****EDDS I****3 Points**

There are two common categories for deep drawing steels. A representative microstructure for each kind is given in Attachment 1.

a) Which kind of deep drawing steel can be seen in Attachment 1? Explain your answer briefly (2 Points).



Attachment 1

b) In table 1 there are 2 chemical compositions given. Which chemical composition belongs to which kind of deep drawing steel? Explain your answer briefly (1 Point).

c) The properties of both steels are strongly dependent on the coiling temperature. Give the requirements on the coiling temperature for each kind of deep drawing steel (1 Point).

Table 1

Vol. %	Steel 1	Steel 2
C	0,02 – 0,05	0-0,005
Mn	0,2-0,3	0,1-0,15
Al	0,02 – 0,05	0,02 – 0,04
N	0,001 – 0,01	0 – 0,005
Ti, Nb, V	0 – 0,001	0,05 – 0,1



**Task 29****EDDS II****2 Points**

The r-value is commonly used to classify the material behavior during deep drawing.

- a) Give a short explanation of the r-value using your own words (1 Point).
- b) Give the equation to calculate the r-value (0,5 Points).
- c) Tensile tests on two different materials have been carried out. Material 1 has a r-value of 1.4 and material 2 has a r-value of 2.3. Which material is favorable for deep drawing applications (0.5 Point)?

**Task 30** **special alloyed and stainless steels** **2 Points**

- a) Sketch, beginning from forging, the processing steps for a “heat treatable steel” (quenched & tempered steel) and a so-called “AFP”-steel in a time-temperature diagram (1 Point).
- b) What kind of microstructure do these two steel grades have after processing (1 Point)?

**Task 31****Tool steels****1,5 Points**

Ingot casting is a frequently used method to produce tool steels. Describe the influence of the ingot sizes on the microstructures of tool steels (1.5 Points).



**Task 32****HSS****1 Points**

Which property is most important for wear-resistant steels? What kind of microstructure is used in wear-resistant steels (1 Point).