

**Master Examination**  
**„Materials Science of Steel“**  
**Part 2**  
**“Steel Design”**  
**2<sup>nd</sup> September `13**

**Name:**

**Matriculation number:**

Question	Maximal erreichbare Points:	Erreichte Points:	Einsicht: (nur neue TeilPoints angeben, <b>nicht</b> neue Gesamtpunktzahl pro Question)
Part I / 1-14	70		
16	1.5		
17	2.0		
18	4.0		
19	4.0		
20	2.0		
21	4.0		
22	2.0		
23	2.0		
24	2.0		
25	2.0		
26	1.5		
27	2.0		
Summe	100		

**Task 16****AHSS I****1.5 P.**

Dual Phase steels show low ratio ( $R_{p0.2}/R_m$ ) ratio and high initial strain hardening rate when strained in a tensile test. Explain this material behaviour on the base of crystal lattice defects.

(1,5P)

**Task 17****Steel Design – AHSS II****2 P.**

Explain the phenomenon “Delayed Cracking”:

- a) Which element is considered to be decisive for Delayed cracking? (0,5P)
- b) How is this element brought into the steel? (give at least 2 causes) (1P)
- c) Is delayed cracking observed in deep drawing steels as well? (0,5P)

**Task 18**

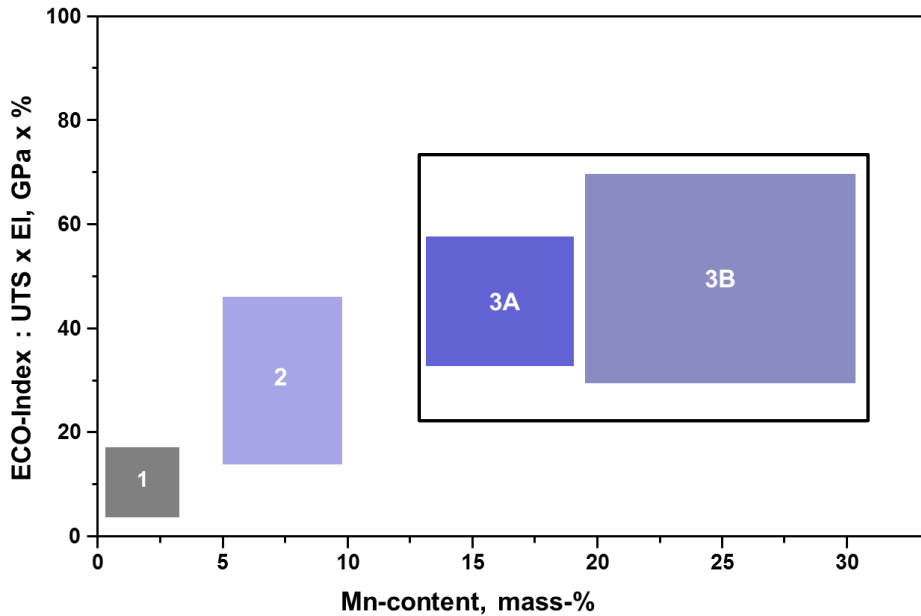
**Steel Design – AHSS III**

**4 P.**

The following diagram gives the mechanical properties of new steel concepts on Mn-Basis.

- a) Use the given table to assign the right generation, a representative steel for this generation and the right magnitude of  $\gamma$  phase within these generation.

(Correct column 1P.- if one answer within the column is wrong max. score is reduced to 0.5P)



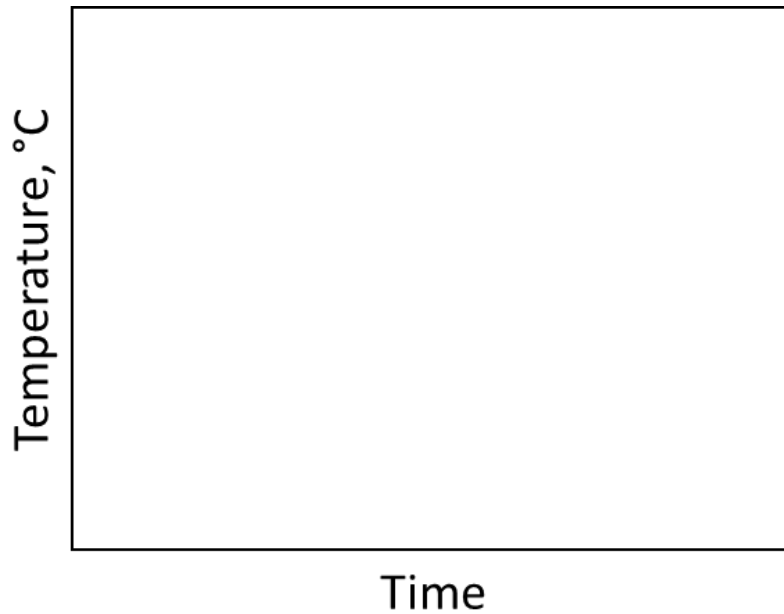
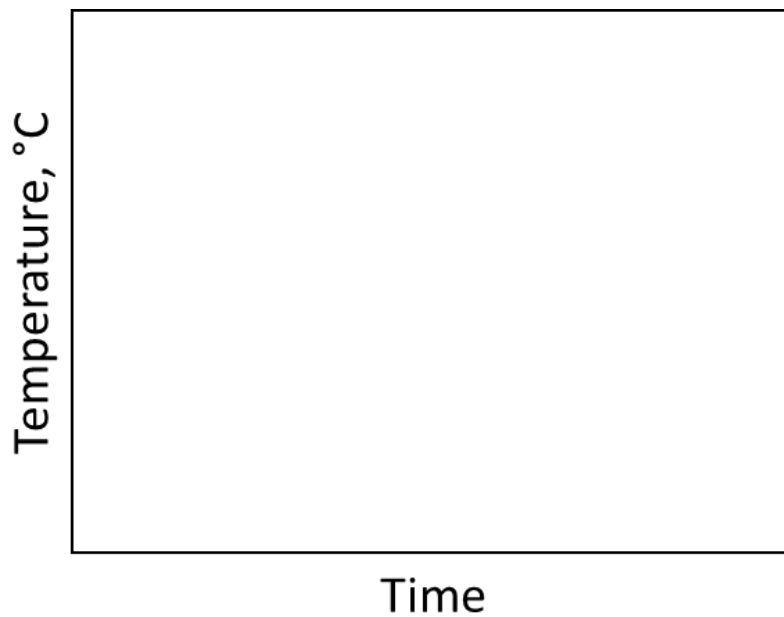
Feld	X. Generation AHSS	Stahlklassenbezeichnung (z.B. HSLA)	$\gamma$ - Phasenanteil (Größenordnung in %)
1			
2			
3A			
3B			

- b) What kind of AHSS generation has the biggest stacking fault energy? What metal physical effect is supported by high SFE values? (1P.)



**Task 19****AHSS****4.0 P.**

Using a TTT-diagram, show schematically the hot rolled strip and the cold rolled strip production of a DP-steel. What is the microstructure before cooling? (4P)

**Hot rolled****Cold rolled**

**Task 20****HSS****2.0 P.**

Why is the treatment of the crude steel in the secondary metallurgy and especially the treatment of the sulfide shape of great importance for the production of heavy plates? How is the sulfide shape typically modified? (2P)

**Task 21****HSS****4.0 P.**

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- a) Which physical-metallurgical mechanisms determine the microstructure development during rolling and heat treatment of high-strength structural steels? (2)
- b) Which mechanism allows blocking the recrystallization in austenite? (1P.)
- c) Name two of usually used alloying elements, which have an effect on the blocking of the recrystallization! (1P)



**Task 22****Tube steels****2.0 P.**

- a) What is the first basic processing step used in the production of seamless tubes broadly called?
- b) What is meant by the term UOE if you think about the manufacturing of welded pipes. Give the meaning of each letter and give a short explanation.

**Task 23****Rail steel****2.0 Punkt**

There are three ways typically used to influence rail's properties. Name these and choose one of them and explain it! (2P)

**Task 24****Tool steels****2.0 Punkt**

- a) Give the three most important names of tool steels.
- b) What material property is the main difference between these three steels if you have to make a material choice?

**Task 25****Tube steels****2 P.**

What is meant by SSC? What negative boundary conditions are necessary to cause SSC?  
What metallurgical concept is used to reduce or avoid the negative effect of SSC on the material?

**Task 26****Extra Deep Drawing Steels****1.5 Punkt**

Which parameter obtained from a tensile test describes the deep-drawability? What does this parameter mean and how does it enable us to make conclusions on the deep-drawability? (1,5 P.)

**Task 27****Boiler tubes****2 P.**

Which chemical element is mainly responsible for oxidation resistance of ferritic/martensitic steels for power plants? (2P)