

**Master Examination**  
**„Materials Science of Steel“**  
**Part 2**  
**“Steel Design”**  
**25th February 2014**

**Name:**

**Matriculation number:**

Question	Maximal available Points:	Points:	Review: (additional points)
Part I / 1-17	70		
18	2		
19	3.5		
20	4.5		
21	2		
22	3		
23	4		
24	2		
25	2		
26	2		
27	2.5		
28	2.5		
Sum	100		

**Task 18****AHSS I****2 P.**

What is the maximum achievable yield stress of heavy plates used for steel structures? Which manufacturing process step is used to achieve this high yield stress? What is the typical application field of such heavy plates? And what are the risks related to the application of heavy plates with higher yield strength (*2 Points*)?

**Task 19****Steel Design – AHSS II****3.5 P.**

- a) Describe the microstructural constituents and their typical volume fractions in DP-steels. Which two groups of dislocations can be distinguished (*2.5 Points*)?
- b) Compare the engineering stress-strain curves of a DP-steel and a hot rolled HSLA steel (*1 Point*).

**Task 20****Steel Design – AHSS III****4.5 P.**

Complete the given chart (4.5 Points)

Steel	DP	CP	TRIP
Micro structure Constituents			
Yield ratio			
Hole expansion			

Constituents:  $\alpha_B$  bainite  
 $\alpha_M$  martensite  
 $\alpha$  ferrite  
 $\gamma_R$  retained austenite

Hole expansion: + = good  
0 = moderate

Yield ratio: + = high  
0 = low

**Task 21****AHSS IV****2.0 P.**

The special properties of TRIP-steels are related to the presence of approximately 10% retained austenite in the microstructure. Explain what it makes 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 22****Steel Design – Tool Steel****3.0 P.**

a) Tool steels are subdivided into three main groups. Name these groups. What property is used to distinguish between the different classes (*2 Points*).

b) Which two production methods are given to produce fine grain tool steels (*1 Point*)?

**Task 23****HSS****4.0 P.**

- a) Which physical-metallurgical mechanisms determine the microstructure development during rolling and heat treatment of high-strength structural steels (*2.5 Points*)?
- b) Which mechanism allows blocking the recrystallization in austenite (*1.5 Points*)?

**Task 24****Line Pipe****2.0 P.**

- a) What is the first processing step of the seamless tubes production line (*0.5 Points*).
- b) What is meant by UOE during the processing of welded line pipes. Give a rough explanation of each letter (*1.5 Point*).



**Task 25****Line Pipe****2.0 P.**

The general striving for higher degrees of efficiency of coal power plants requires an optimization of the steam parameters. Which parameters are meant and which requirements can be derived for the materials to be used for pipes of the steam generator (*2.0 Points*)?

**Task 26****Line pipe****2 P**

Give three impact factors of the environment to sulphide stress cracking (SSC) resistance.  
How does the materials yield strength change the SSC-sensitivity (*2 Points*)?

**Task 27****Rail steels****2.5 P.**

- a) What can be done to minimize contact fatigue damage? Is it possible to extend rail's life time (0.5P)?
- b) What are the demands on rails? Name at least 4! (2P)

**Task 28****Extra Deep Drawing Steels****2.5 P.**

The coils A, B, C and D have been manufactured according to the process parameters listed below. Which of the four coils possesses the best deep-drawability properties? Explain why the other three coils are less suitable for deep-drawing i.e. have worse deep-drawability properties (2.5 Points).

Process parameters	Coil A	Coil B	Coil C	Coil D
Al in wt%	0,031	0,042	0,025	0,035
N in wt%	0,0029	0,0041	0,0019	0,0033
acc. to the chem. analysis				
coiling temperature (°C)	550	580	570	600
Cold rolling degree of deformation (%)	58%	69%	71%	75%
Recrystallisation annealing (-)	batch annealing	batch annealing	continuous annealing	continuous annealing