

# Advanced Master Course Process Technology of Metals (Part: Ferrous Process Metallurgy)

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(2/2010)

Hörsaal H223, Intzestraße 1, IEHK

Time: 10:00-11:00

Last name, first name:

Register No. (Matrikel-Nr.):

Signature: \_\_\_\_\_

Task	Points (max.)	Points	Signature	Approval date	Final points (total)
1	7				
2	7				
3	8				
4	6				
5	6				
6	8				
7	8				
<b>Total:</b>	<b>50</b>		<b>Total after approval:</b>		

**Task 1: Pelletizing and Sintering** **7 Points**

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1.1 Give a schematic sequence for an integrated steel mill and a minimill. *(1.0 point)*

1.2 Describe the process of green pellets formation.  
(Give 6 steps) *(3.0 points)*

(i)

(ii)

(iii)

(iv)

(v)

(vi)

1.3 Which factors are determining the quality of sinter and pellets?  
(Give at least 3 factors) *(1.5 points)*

1.4 What is the difference between fluxed sinter and acidic sinter? *(1.0 point)*

1.5 What is the source of heat used in the sintering process of iron ore? *(0.5 point)*

## **Task 2: Blast Furnace**

**7 Points**

2.1 Give the definitions of the following terms: (1.5 points)

(i) “Coke windows”:

(ii) “Cohesive zone”:

(iii) “Tuyeres”:

2.2 What are the most important functions of coke in the blast furnace?  
(Give at least 3 items) (1.5 point)

2.3 Is direct reduction possible at temperature lower than 1000°C? Why?  
(1.0 point)

2.4 Give the chemical compositions and temperature of the raceway gas?  
(1.0 point)

2.5 What is PCI in blast furnace operation? What is the main influence of PCI on the blast furnace process? (1.0 point)

2.6 What is

(a) the typical temperature

(b) carbon concentration

of hot metal produced from blast furnace? (1.0 point)

**Task 3: Oxygen Steelmaking** **8 Points**

3.1 What is the principle of the Laval nozzle? (Illustrate by diagram) (1.0 point)

3.2 What are the tasks of lime in steelmaking? (1.0 point)

3.3 Why is lime preferred than limestone in the LD converter process? (1.0 point)  
(Give at least 2 items)

3.4 What are the advantages and disadvantages of OBM compared to the LD- BOF process? (1.0 point)

3.5 What is the influence of CO bubbling on the [N] in the melt? (1.0 point)  
(Illustrate by scheme diagram)

3.6 What are the benefits of AOD converter in stainless steel production?  
(Give at least 2 items) (1.0 point)

3.7 Which factors determine the amount of scrap charged into BOF?  
(Give at least 2 items) (1.0 point)

3.8 What is the source of heat which is developed in BOF?  
(Give example) (1.0 point)

**Task 4 : Slags and Fluxes** **6 Points**

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4.1 What are the reactions take place between hot metal and slag during de-sulphurisation? *(1.0 point)*

4.2 (a) Why  $\text{CaF}_2$  is sometimes used in iron- and steelmaking processes? *(0.5 point)*

(b) What is a disadvantage of fluorine? *(0.5 point)*

4.3 Which factors can increase the viscosity of molten slag? *(1.0 point)*  
*(Give at least 2 factors)*

4.4 What are the tasks of the ladle top slag? (Give at least 2 items) (1.0 point)

4.5 FeO- containing slag from EAF or BOF processes must be reduced after tapping in terms of oxygen activity. By which method can that be done?

(Give the chemical reaction formula) (1.0 point)

4.6 Give equation represent the formation of:

(a) di-calcium silicate (0.5 point)

(b) alumina slag (0.5 point)



**Task 5: Electric Steelmaking** **6 Points**

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5.1 What are the advantages of steelmaking using an electric arc furnace in comparison to BOF- Converter?

(Give at least 2 items)

*(1.0 point)*

5.2 How can you diminish the consumption of graphite electrodes in EAF process?

(Give at least 2 items)

*(1.0 point)*

5.3 Explain the procedure and also write down chemical reactions for generation of foaming slags in electric arc furnace process.

*(1.0 point)*

5.4 Give a proper sketch to represent the difference between AC-EAF and DC-EAF.  
(1.0 point)

5.5 What are benefits of DRI applied to the electric arc furnace process?  
(Give at least 2 items) (1.0 point)

5.6 What is post combustion? and When is it useful in EAF process? (1.0 point)

**Task 6: Secondary Metallurgy (Ladle Metallurgy) 8 points**

6.1 What is Vacher-Hamilton equilibrium? (0.5 point)

6.2 What is Sieverts law? (0.5 points)

6.3 Complete the following comparison between de-S and de-P: (7.0 points)

		De-Sulfurization	De-Phosphorization
1	Main sources of S or P		
2	Chemical equation		
3	Place to be apply in the production chain		
4	Materials used for De-S or De-P		
5	Effect of temperature		
6	Effect of oxygen		
7	Effect of C and Si		

**Task 7: Continuous Casting** **8 points**

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7.1 Give the definitions for the following: *(1.0 point)*

(a) Non-metallic inclusions

(b) Macro-segregation

7.2 What is primary dendrite arm and secondary dendrite arm? *(1.0 point)*

(Make a sketch and mark the position of precipitate)

7.3 What are the tasks of continuous casting mould powder (Casting Flux)? *(1.0 point)*  
(Give at least 2 items).

7.4 What are the main components of Casting Flux powder? *(1.0 point)*  
(Give at least 2 components)

7.5 What is the influence of air gap and mould taper on the heat transfer during  
Continuous Casting? *(1.0 point)*

7.6 What is the “Leidenfrost” phenomenon? *(0.5 point)*

7.7 Give the relation between superheat and solidification structure. (1.5 points)

(Make a sketch and explain)

7.8 What is the difference between liquid core reduction and soft reduction? (1.0 point)