



**GWANDA STATE UNIVERSITY**  
**FACULTY OF ENGINEERING AND ENVIRONMENT**  
**DEPARTMENT OF METALLURGICAL ENGINEERING**  
**PYROMETALLURGY - FERROUS**  
**EMG 3105**  
**Part III First Semester Examination Paper**  
**November 2023**

This examination paper consists of 4 printed pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Mr Tinashe Mabikire**

**INSTRUCTIONS**

1. Answer **ALL** questions in **Section A** and any **TWO** from **Section B**
2. Each question carries 25 marks
3. Use of calculators is permissible

**Additional Requirements**

**MARK ALLOCATION**

Section A	50 Marks
Section B	50 Marks
Part Questions	As shown in each part question
Total Attainable	100

## SECTION A (50 MARKS)

### ANSWER ALL QUESTIONS

#### Question 1

Zimbabwe had a blast furnace operating in the city of Kwekwe producing pig iron of the composition Carbon - 2%, Silicon - 2% and the rest being Iron.

The burden of the furnace consisted of iron ore from Ripple Creek mine with the composition  $\text{Fe}_2\text{O}_3$  - 76%,  $\text{SiO}_2$  - 14%,  $\text{Al}_2\text{O}_3$  - 9%  $\text{MnO}$  -1%.

Coke from Hwange with C - 88%  $\text{SiO}_2$  - 12%, Amount 1100Kg per tonne of pig iron produced.

Limestone had  $\text{SiO}_2$  - 10% the rest pure  $\text{CaCO}_3$ .

The exit gases analyse 26% CO, 13%  $\text{CO}_2$  and 61%  $\text{N}_2$ .

Assuming no losses of carbon to slag

- a. Calculate the weight of iron per tonne of pig iron [10]
- b. Weight of limestone per tonne of pig iron required to produce slag containing 36% CaO [15]

#### Question 2

A new furnace for the Zimbabwe iron-making industry is to be erected in Mvuma. As a metallurgist tasked with the revival of the national iron and steel-making industry, what factors will you consider in:

- i. choice of the type of furnace to rejuvenate the industry [5]
- ii. choice of the location for a new furnace to rejuvenate the industry [10]
- iii. debate the pro and cons of re-commissioning the old Kwekwe blast furnace against erecting a new furnace [10]

**SECTION B (50 MARKS)**

**ANSWER ANY TWO QUESTIONS**

**Question 3**

- a. List the properties you would consider in the procurement of coal for coking purposes to use in a blast furnace [5]
- b. Highlight the significance of these properties in the coking process and later performance of the blast furnace. [10]
- c. What factors would you consider in deciding feed for the blast furnace with either raw ore, pellets, sinter or briquettes? [10]

**Question 4**

The ironmaking and steelmaking process pollutes the environment

- a. In what ways does this industry pollutes the environment [5]
- b. Highlight design considerations that can be used to reduce the pollution from the blast furnace. [10]
- c. Highlight operational ways that can be used to reduce pollution from the blast furnace. [10]

**Question 5**

- a. What are the advantages and disadvantages of a top-blown BOF over a bottom-blown one? [5]
- b. What factors would guide the decision of using an EAF or BOF in secondary steel making of your pig iron? [5]
- c. Which impurities would you check for in quality control of liquid steel in the refining stage? [5]
- d. What methods can be used to remove interstitial elements like oxygen, nitrogen or hydrogen from liquid steel in the refinery stage? [10]

### **Question 6**

Describe any direct reduction method used in iron making. Describe in detail its

i. Equipment, [9]

ii. chemical processes and [8]

iii. Its suitability over blast furnace [8]

in pig iron production.

**END OF QUESTION PAPER**