



NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT
DEPARTMENT OF CIVL, MINING AND PROCESS ENGINEERING

QUALIFICATION : BACHELORS OF ENGINEERING IN MINING ENGINEERING	
QUALIFICATION CODE: 08BMEG	LEVEL: 8
COURSE CODE: FFR820S	COURSE NAME: FUELS FURNACES AND REFRACTORIES
SESSION: JUNE 2023	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 60

SECOND OPPORTUNITY QUESTIONS	
EXAMINER(S)	Maweja Kasonde
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INSTRUCTIONS
<ol style="list-style-type: none"> 1. Answer all questions. 2. Read all the questions carefully before answering. 3. Marks for each question are indicated at the end of each question. 4. Please ensure that your writing is legible, neat and presentable.

PERMISSIBLE MATERIALS

1. Examination paper.
2. Calculator

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Including this front page)

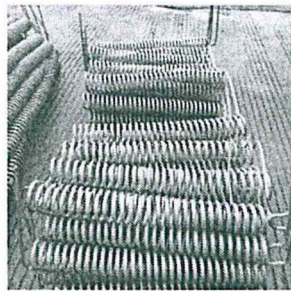
Question 1**(max 8)**

Basic furnace control strategies are based on either the product temperature control or the fuzzy logic and rule-based systems. Give summary principles of the two control strategies.

Question 2**(max 8)**

Consider resistance heating in furnaces.

- a) Explain why coiled heating elements, sometime tape form elements are preferred to straight round wires (or rods) heating elements.



- b) Explain the failure of heating elements by "hot spot". What are the other causes of failure of heat elements?
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Question 3**(max 9)**

Consider the physics of combustion.

- What are the stages of the combustion of a fuel with oxygen. Which is the slowest stage?
 - What would be the consequences of insufficient fuel/air mixing in a diffusion burner? How do you design the air supply to the furnace to avoid such risks?
 - Explain the occurrence of jet entrainment in furnaces.
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Question 4**(max 10)**

Refractory bricks rarely fail under compression, however they can fail under strain loading due to internal forces, such the volume thermal expansion (contraction) due to heating (cooling). How do you design the refractory construction to avoid this failure mode of the bricks.

Question 5**(max 10)**

Discuss the effect of the electric current frequency on the coreless and cored designs and operation conditions of induction furnaces. Fully explain the effect on the heating depth.

$$p = \frac{1}{2\pi} \sqrt{\frac{\rho}{\mu f}} \text{ cm}$$

Question 6**(max 6)**

Consider the wear of refractories by dissolution (corrosion) and by penetration by liquid slag. Fill in the table below.

	Rate factors	Control	Worse conditions
Dissolution (corrosion)			
Penetration by liquid slag			

Question 7**(max 9)**

Good instrumentation is an essential component of furnace control. The most important parameters are temperature, heat input and excess air. Give short summary of measurement of these parameters in industrial furnaces.