NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

MINERALS ENGINEERING IB

TCE 3203

Final Examination Paper

March 2025

This examination paper consists of **five** pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph Paper

INSTRUCTIONS

1. Answer **ALL** questions in **SECTION A**
2. Answer **ANY THREE** questions in **SECTION B**
3. Each question carries 20 marks
4. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
A1	**20**
A2	**20**
B1	**20**
B2	**20**
B3	**20**
B4	**20**
TOTAL ATTAINABLE MARK	**100**

SECTION A

ANSWER ALL QUESTIONS

QUESTION A1

a) Identify **five** mineral properties that are exploited in the separation of valuable minerals from gangue and give a brief description of how the valuable mineral and gangue are separated in each case. **[10]**

b) Collectors are types of reagents used in froth flotation to render mineral surfaces hydrophobic. Illustrate how collectors render mineral surfaces hydrophobic. **[5]**

c) Discuss the principles of gravity concentration. **[5]**

QUESTION A2

a) A sand deposit has the following composition shown in Table A2. Use your understanding of processing routes and suggest a flowsheet (using a block diagram) which could be used to separate values from each other and the gangue. The maximum grain size is approximately 500 µm. **[10]**

Table A2

Mineral	Mass (%)	Value/Gangue	Magnetic Susceptibility	Density (kg/m^3)	Conductivity	Flotation Characteristic
A	0.8%	Value	Paramagnetic	5200	Not conductive	Does not float
B	1.6%	Value	Paramagnetic	5000	Not conductive	Floatable
C	5.8%	Gangue	Ferromagnetic	5500	Conductive	Does not float
D	91.8%	Gangue	Diamagnetic	2600	Not conductive	Does not float

b) The Wet Drum Type (Low Intensity) Magnetic separator is widely used in the coal industry for the recovery of magnetic media from coal slurry. With the aid of a well annotated diagram describe the operation of a Wet Drum Type separator. **[10]**

SECTION B

ANSWER ANY THREE QUESTIONS

QUESTION B1

a) A nickel ore initially contains 4.5% nickel. After carrying out a froth flotation separation, the products are as shown in the table (Table B1) below;

Table B1 Froth flotation test results

Stream	Flowrate (tons/hr)	% Ni Assay
Feed	100	4.5
Concentrate	10	20
Tailings	90	0.1

Calculate;

(i) Ratio of concentration **[2]**

(ii) % Metals recovery **[2]**

(iii) % Metal loss **[2]**

(iv) % Yield **[2]**

(v) Enrichment ratio **[2]**

b) Geologists have reported that the copper ore discovered at a site 5km from Bulawayo consists of two main minerals i.e. pyrite with a specific gravity. of 5.0 and chalcopyrite with a specific gravity. of 4.3. Is it possible to use gravity concentration techniques to separate these minerals? Justify your answer. **[5]**

c) State <u>two</u> uses of each of the following metals: copper, iron, lead, zinc and platinum. **[5]**

QUESTION B2

a) (i) With the aid of a diagram describe the operation of a flotation column. **[7]**

(ii)What are the benefits of using flotation columns over conventional cells? **[3]**

b) Jigs are widely used in the mineral processing industry for concentrating fairly coarse material, with the aid of clearly labelled diagrams, give a detailed description of the four stages of a jigging cycle. **[10]**

Table B4

Specific Gravity Range	Mass Percentage (%)	Ash Content (%)
-1.4	15	5
-1.6 + 1.4	35	15
-1.8 + 1.6	20	43
-2.0 + 1.8	20	57
+2.0	10	78

b) Differentiate the following terms/phrases that are used in mineral processing:

(i) recovery and grade **[2]**

(ii) direct flotation and reverse flotation **[1]**

(iii) collector and frother **[2]**

(END OF PAPER)