NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

DEPARTMENT OF CIVIL, MINING AND PROCESS ENGINEERING

QUALIFICATION : BACHELORS OF ENGINEERING IN METALLURGICAL & CHEMICAL ENGINEERING	
QUALIFICATION CODE: BMET & BCHEM	**LEVEL: 7**
COURSE CODE: PPD710S	**COURSE NAME: PROCESS PLANT DESIGN & ECONOMICS 315**
SESSION: JUNE 2023	**PAPER: THEORY**
DURATION: 3 HOURS	**MARKS: 100**

SECOND OPPORTUNITY EXAMINATION	
EXAMINER(S)	**Prof Vusumuzi Sibanda**
MODERATOR:	**Prof Godfrey Dzinomwa**

INSTRUCTIONS

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. Two Graph Papers
3. Mathematical Instruments

THIS MEMORANDUM PAPER CONSISTS OF 5 PAGES (Including this front page)

SECTION A [50 MARKS]

Question 1 [5 marks]

Modelling and simulation is now established in process engineering as an invaluable tool of the trade. What are the main benefits of Modelling in Process Design? [5 marks]

Question 2 [5 marks]

Process flow diagrams (PFDs) are among the key deliverables of a process design. What key information can be obtained from a PFD? [5 marks]

Question 3 [10 marks]

Write a short essay discussing the critical issues that must be given attention when developing an integrated minerals processing circuit to concentrate an ore with more than one mineral of value. [10 marks]

Question 4 [5 marks]

"Reducing particle size of ores in comminution generally increases the degree of liberation".

i. What do you understand by the "degree of liberation" in this context? [2 marks]

ii. What is the effect of or texture on liberation [3 marks]

Question 5 [10 marks]

Why do smaller particles

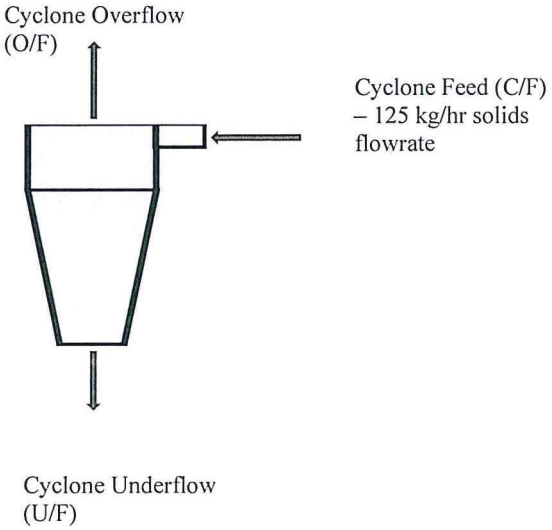
i. have larger surface area than larger ones per unit volume? [2 marks]

ii. require more unit energy for breakage than larger ones? [3 marks]

iii. Which of the ore breakage mechanism results in a bi-modal distribution of progeny particles and why? [5 marks]

Question 6 [10 Marks]

The cyclone shown below was used to classify material produced by a Rod mill prior to a flotation process at a Cu-Zn concentrator plant. The particle size analysis of a 67g sample obtained from the Rod mill product is as given in the table below. During the test-work on the cyclone the solids Feed-Rate was set at 125kg/hr.



Screen Size (μm)	Mass retained on screen (g)
250.0	4.1
125.0	21.6
62.5	23.4
31.3	12.6
Pan	5.2

You are given that classification behavior of the cyclone is given by the equation:

$$R_{ui} = 1-\exp(-(d/d_{50})^{1.2}),$$

where R_{ui} – is the recovery of each size class to the cyclone underflow (U/F), and the d_{50} size is given as 125μm.

Use this information to calculate the following:

(i) Flowrate to the underflow [7 marks]

(ii) d_{50} of the cyclone overflow [4 marks]

(iii) Describe briefly how a cyclone achieves the desired classification [4 marks]

SECTION B [50 MARKS]

Question 1 [10 Marks]

Show from 1st principles that the total recovery of a component A in a continuously stirred flotation tank is given by;

$$Rec = 1 - \frac{1}{(1 + k\tau)}$$

Where

Rec – is the total conversion of component A

K - is the reaction rate constant

τ – is the residence time

Question 2 [20 marks]

The copper-zinc ore from the milling circuit discussed in Section A- Question 6 was fed into a flotation plant at the rate of 250 t/h. The final products were a copper concentrate and a zinc concentrate and tailings. Analysis of each stream were:

	Assay	
Stream	% Cu	% Zn
Feed	25	3.1
Copper Conc.	78.2	6.3
Zinc Conc.	2.1	55.4
Tailngs	0.7	0.8

Determine the mass flows in the two concentrate streams and the recovery of metal in each product stream. [20 marks]

Question 3 [10 marks]

What do you understand by the following in the context of economic evaluation of a mineral beneficiation project.

a. Contingency [2 marks]
b. Cost of Capital [2 marks]
c. Working capital [2 marks]
d. Return on Investment (ROI) [2 marks]
e. Profitability index [2 marks]

Question 4 [10 marks]

The Koeberg nuclear power station in South Africa has process design project A and B which are expected to have the cash flows presented in the table below. The capital cost of each project is $1 000 000. Answer the following questions:

(a) Calculate the return on investment (ROI) for design project A. [3 marks]

(b) Determine the internal rate of return (IRR) for design project B by using a graphical method within a discount rate of 5% to 30%. Use a discount rate interval of every 5% in your calculations. [7 marks]

Table 1: Cash flows for two competing projects

Year	Cash Flows $1000	
	Design Project A	Design Project B
0	-1000	-1000
1	150	500
2	250	450
3	350	300
4	400	200
5	400	100

THE END