UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

# SCHOOL OF ENGINEERING

## MAIN EXAMINATIONS: JUNE 2023

**COURSE AND CODE:** OIL AND MINERAL PROCESSING ENCH2OM

**DURATION:** 2 HOURS

**TOTAL MARKS:** 100

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**INTERNAL EXAMINERS:** Prof Amir H. Mohammadi
Dr. N. Malusi Mkhize

**INTERNAL MODERATOR:** Dr. Jonathan Pocock

**EXTERNAL MODERATOR:** Dr. Lakesh Maharaj

**INSTRUCTIONS:**

1. **ALL** questions should be attempted.
2. Any programmable or non-programmable calculator may be used provided it has been cleared of any information that would subvert the purpose of the examination.
3. Calculations must be shown in sufficient detail to illustrate your understanding of the procedure.
4. **Two answer books are provided. Label them Book A and Book B. Answer Section A in Book A and Section B in Book B.**
5. This examination paper, together with all associated diagrams **MUST BE HANDED IN TOGETHER WITH YOUR SCRIPT.**

**Student Number:**

# SECTION A

## QUESTION 1

*a)* Sketch a typical process flow diagram (PFD) of a fluidised bed catalytic cracking (FCC) unit and show typical feeds and typical products on the diagram.

(12)

*b)* What are the three units that are used in a crude oil refinery to separate acid gases, mercaptans, and complex sulphur, nitrogen, oxygen and metal compounds from hydrocarbon streams?

(3)

**TOTAL/15/**

## QUESTION 2

*a)* Compare two main thermal cracking units in terms of their functions, typical feed(s), and typical products (main products and by-products).

(8)

*b)* Compare a steam reforming unit and a catalytic reforming unit in terms of their typical functions, their typical feeds, typical catalysts and typical products.

(8)

**TOTAL /16/**

## QUESTION 3

Calculate the RVP of a blend of Naphtha, Reformate, Isomerate and Hydrocracking Gasoline. Properties and available quantities of the gasolines are given in the following table:

| Gasoline | Quantity/Volume (Barrel per day) | RVP (psi) |
|---|---|---|
| Light Naphtha | 5000 | 10.2 |
| Reformate | 4000 | 2.40 |
| Isomerate | 4000 | 4.91 |
| Hydrocracking Gasoline | 6000 | 4.12 |

Considering:

$BI_{RVPi} = RVP_i^{1.25}$ and $BI_{RVP,Blend} = \Sigma X_{vi} \times BI_{RVPi}$

$BI_{RVPi}$ : RVP blending index for gasoline i
$RVP_i$ : Reid vapour pressure (psi) for gasoline i
$X_{vi}$ : volume fraction of gasoline i

**TOTAL/19/**

## SECTION B

### QUESTION 4

The objectives of comminution (size reduction) include i) to achieve liberation, ii) to create a surface area (floatation), iii) to create size and shape, etc. However, they are various equipment, and materials (to be fed in the comminution equipment). Also, they are all different when it comes to reduction techniques, reduction ratio, feed size, etc. Therefore, they have to be combined in the optimum way to reach or come close to the requested size interval for the end product.

As a professional metallurgist working for one of the leading mining and mineral ore refining companies in South Africa, advise on the following aspects at your company operations:

4.1. Typical feed and discharge sizes at your company operations? NB: You are required to select one mineral ore of your choice. Thus the feed and discharge sizes must be related to the mineral ore of your choice.

(2)

4.2. Discuss the operating conditions required for the comminution of the mineral ore from Question 4.1. Comment on the wet or dry communitors in your process.

(4)

4.3. List comminution stages associated with the mineral of your choice from Question 4.1. What are the suitable equipment required in each comminution stage and why these equipment are preferred over the others? Describe how these equipment operate?

(8)

4.4. Draw and discuss a process flow diagram showing the stages and listing the equipment used, as mentioned in Questions 4.1 – 4.3.

(4)

4.5. Why this is the optimum combination of the comminution stages (equipment).

(2)

**TOTAL /20/**

## QUESTION 5

A hydrocyclone is fed at the rate of 31 ton/h of dry solids. The hydrocyclone feed (F) contains 26% solids, the underflow (U) 54% solids, and the overflow (V) 17% solids by weight. Calculate the tonnage of the solids per hour in the underflow.

$$F = U + V$$

**TOTAL /10/**

## QUESTION 6

The feed to a floatation plant assays 0.65% iron. The concentrate produced assays 18% iron, and the tailings 0.11% iron.

Calculate the recovery of the iron to the concentrate.

(7)

Calculate the ratio of concentration.

(7)

Calculate the enrichment ratio.

(6)

**TOTAL /20/**

Formulae:

**Recovery =(100c(f-t))/(f(c-t))**

**Ratio of concentration =(c-t)/(f-t)**

**Enrichment ratio =c/f**

**F = U + V**