UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *CHEMICAL ENGINEERING*
SUBJECT	:	**CHEMICAL PLANT 3A**
CODE	:	**ACPA 321**
DATE	:	WINTER EXAMINATION 11 JUNE 2019
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100
EXAMINER(S)	:	MISS NOXOLO SIBIYA
MODERATOR	:	DR. A. MAMVURA
NUMBER OF PAGES	:	4 PAGES
REQUIREMENTS	:	Use of scientific (non-programmable) calculator is permitted (Only one per candidate)

HINTS AND INSTRUCTIONS TO CANDIDATE(S):

- Purpose of assessment is to determine not only if you can write down an answer, but also to assess whether you understand the concepts, principles and expressions involved. Set out solutions in a logical and concise manner with justification for the steps followed.
- **ATTEMPT ALL QUESTIONS**. Please answer each question to the best of your ability.
- Write your details (module name and code, ID number,student number etc.)on script(s).
- Number each question clearly; questions may be answered in any order.
- Make sure that you read each question carefully before attempting to answer the question.
- Show all steps (and units) in calculations; this is a ‘closed book’ test.
- Ensure your responses are legible, clear and include relevant units (where appropriate).

QUESTION 1 **[20]**

1.1. Discuss and give the examples of ceramic materials [4]

1.2. Show for the body-centered cubic crystal structure that the unit cell edge length [a] and the atomic radius [R] are related through $a = 4R/ 3$ [8]

1.3. An elastomeric bearing pad is subjected to a shear force V during a static loading test. The pad has dimensions: breadth = 150 mm, length = 225 mm, and thickness = 55 mm. The lateral displacement of the top plate with respect to the bottom plate is 14 mm under a load V = 16 kN. Calculate the shear modulus of elasticity of the elastomer. [8]

QUESTION 2 **[19]**

The copper pipe and the steel pipe were held together by a steel nut, and later it was discovered that the connecting nut was having an acidic solution leak. Initially the nut was designed to withstand corrosion for a minimum of 30 years lifespan.

Figure 1: Corrosion of two pipes

a) Describe what form of corrosion is occurring in this case. [3]

b) Use a diagram to show the mechanism and the flow of electrons on the sketch. [8]

c) How can it be prevented from happening [8]

QUESTION 3 [20]

3.1. Other than the conversional water treatment process, name other four(4) water purification techniques that can be used to clean water in a small scale [4]

3.2. Explain what is meant by sedimentation and its working principle. Figure or sketch should be used to clarify your explanation. [8]

3.3. Discuss the following forms of pollution: Air pollution, Land pollution, Water pollution, Noise pollution. [8]

QUESTION 4 [22]

4.1. Name two (2) advantages of wet grinding over dry grinding [4]

4.2. Distinguish the differences between ball mills and autogenous (AG) mills [6]

4.3. A material consisting originally of 25 mm particles is crushed to an average size of 6.5 mm and requires 20.5 kJ/kg for this size reduction. Determine the energy required to crush the material from 25 mm to 3.5 mm assuming (a) Rittinger's law, (b) Kick's law and (c) Bond's , [12]

QUESTION 5 [19]

5.1. Name four (4) types of conveyors. [4]

5.2. A screw conveyor is used to convey sugar of bulk density 0.75 t/m^3 horizontally for a distance of 20 m. The screw rotates at 38 rev/ min, and the loading factor is 15 %. Calculate the capacity of the conveyor and estimate the power required if the coefficient of friction of the material on the trough is 0.6, and the diameter of the screw is 0.6 m. [15]

END OF EXAM **TOTAL MARKS = 100**

FULL MARKS= 100

FORMULA SHEET

STRENGTH OF MATERIALS

$$\sigma = E \cdot \varepsilon \qquad \sigma = \frac{F}{A}$$

PARTICLE SIZE REDUCTION

Kick's Law $\boldsymbol{E} = K_K \cdot f_c \cdot \log_e\left(\frac{L_1}{L_2}\right)$ *or* $\boldsymbol{E} = K_K \cdot f_c \cdot \ln\left(\frac{L_1}{L_2}\right)$

Rittinger's Law $\boldsymbol{E} = K_R \cdot f_c \cdot \left(\frac{1}{L_2} - \frac{1}{L_1}\right)$

Bond's Law $\boldsymbol{E} = E_i \cdot \left({}^{100}/_{L_2}\right)^{1/2} \cdot \left(1 - {}^{1}/_{q^{1/2}}\right)$ with $q = \frac{L_1}{L_2}$

Specific surface area $V_{\mathbf{P}} = p \cdot D_{\mathbf{P}}^3$ $A_{\mathbf{P}} = 6 \cdot q \cdot D_{\mathbf{P}}^2$ **Shape factor** $\lambda = \frac{q}{p}$

MATERIAL HANDLING

Tensions ratio for a flat conveyor belt $T_1 = T_2 e^{\mu\theta}$

Tensions ratio for a v-conveyor belt $T_1 = T_2 e^{\frac{\mu\theta}{\sin(\frac{\phi}{2})}}$

Effective belt tension $T_e = T_1 - T_2 = \frac{P_T}{v}$

Maximum belt tension $T_1 = T_e \frac{e^{\mu\theta}}{e^{\mu\theta} - 1} \Rightarrow T_1 = T_e \frac{e^{\mu\theta}}{e^{\mu\theta} - 1}$ with $n = e^{\mu\theta}$

Maximum permissible belt stress $\sigma = \frac{T_1}{W \cdot p}$

Power required at the driving drum $P_T = T_e v = (T_1 - T_2)v = T_1\left(1 - \frac{1}{e^{\mu\theta}}\right)v$ & $P_T = P_e + P_m \pm P_r$

Motor power $P = \frac{P_T}{\eta}$

Power required to drive the empty belt $P_e = F_e v = m_i(l + 45)g\mu_e v$

Power required to convey material $P_m = m_m g l \mu_m v$

Power required to raise material $P_r = (Cap)gh$