UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *CHEMICAL ENGINEERING*
SUBJECT	:	**CHEMICAL PLANT 3A**
CODE	:	**ACPA 321**
DATE	:	WINTER SSA EXAMINATION 2015 15 JULY 2015
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40: 60
TOTAL MARKS	:	100
FULL MARKS	:	100

EXAMINERS	:	MR ISHMAEL RAMATSA
MODERATOR	:	DR. HILARY RUTTO
NUMBER OF PAGES	:	SIX (6) INCLUDING THIS COVER PAGE AND APPENDICES

INSTRUCTIONS	:	ANSWER ALL QUESTION : NUMBER ALL QUESTIONS IN ANY ORDER : UNIVERSITY EXAM RULES APPLY
REQUIREMENTS	:	NON PROGRAMEBLE CALCULATOR

QUESTION 1: CORROSION [19]

1. A steel nut used to hold two components together and it was discovered that there was an acidic dripping from a store tank onto the bold and the nut. The nut was designed for corrosion allowance for a lifespan of 30 years.

Figure 1: Corrosion of a tank

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

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

iii. How can it be prevented from happening [8]

QUESTION 2: STRENGTH OF MATERIALS [21]

A pipe has an outside diameter of 30 mm, an inside diameter of 15 mm and length 0.45 m and it supports a compressive load of 45 kN. The pipe shortens by 0.7 mm when the load is applied. Determine:

a) The compressive stress [10]

b) The compressive strain in the pipe when supporting this load. [11]

QUESTION 3: PREVENTION OF CORROSION [20]

3.1 With the use of a diagram, describe how you would protect an underground cast iron from corrosion using cathodic protection. Which material will you use as a sacrificial anode and why?

Show a complete diagram with balanced electro-chemical equations and indicate/show the flow of electrons in your sketch.

QUESTION 4: ENVIRONMENTAL PROTECTION [20]

4.1 Define pollution. [8]

4.2 Give any of the three forms of pollutions and discuss them. [12]

QUESTION 5: CONVEYOR BELT APPLICATION [20]

A belt conveyor 915 m long and 0.9 m wide is loaded with ore of bulk density 1.2 t/m^3 at two points. 350 t/h at the tail end of the conveyor, and 250 t/h at a point 305 m from the tail end. The gradient of the conveyor is 1 in 50 against the loads. The idler friction coefficient is 0.03 for both empty belt and material, and the two-drum drive-head has a total angle of wrap of 440°, with a coefficient of grip of 0.25. The average material section is one twelfth of the belt width squared and the mass of the moving part per meter is taken to be 60 times the belt width. An efficiency of 90 % for the gearing at the drive head is to be considered.

Determine the following;

a) The capacity of the belt in kg/s. [2]
b) Speed of the belt m/s. [3]
c) Power (in kW) required to drive empty belt across the entire length. [3]
d) Power (in kW) required to convey the material across the entire length. [6]

e) Power (in kW) required to raise the material to the required height across the entire length of the belt. [6]

f) Power (in kW) required at the motor. [2]

g) The non-slip ratio of the belt. [3]

h) The maximum belt tension in kN. [3]

i) Maximum permissible stress (in kN/m) if the belt has 5 plies. [2]

END OF EXAM

++++++++++++++++++++++++++++++++++=================================++++++++++++++++++

FORMULA SHEET

STRENGTH OF MATERIALS

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

PARTICLE SIZE REDUCTION

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

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

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

Specific surface area $V_P = p \cdot D_P^3$ $\quad A_P = 6 \cdot q \cdot D_P^2$ **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 $P_r = (Cap)gh$

GALVANIC SERIES: The following is the galvanic series for stagnant (that is, low oxygen content) water. The order may change in different environments.

CATHODIC OR MOST NOBLE(PROTECTED END)
Graphite
Palladium
Platinum
Gold
Silver
Titanium
Stainless steel 316 (passive)
Stainless Steel 304 (passive)
Silicon bronze
Stainless Steel 316 (active)
Monel 400
Phosphor bronze
Admiralty brass
Cupronickel
Molybdenum
Red brass
Brass plating
Yellow brass
Naval brass 464
Uranium 8% Mo
Niobium 1% Zr
Tungsten
Stainless Steel 304 (active)
Tantalum
Chromium plating
Nickel (passive)
Copper
Nickel (active)
Cast iron
Steel
Lead
Tin
Indium
Aluminum
Uranium (pure)
Cadmium
Beryllium
Zinc plating (see galvanization)
Magnesium
ANODIC OR LEAST NOBLE (CORRODED END)