NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part One Supplementary Examination 2014

TCE 1202 Materials and Containment 1B

Duration of Examination 3 Hours

Instructions to Candidates

1. Answer **Question One** and any other **Three** questions.
2. Show all your steps clearly in your calculation.
3. Start the answers for each question on a new page.

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1. a) Explain what is meant by 'the free energy of an electrochemical cell. [4]

   b) Calculate the pressure (fugacity) of hydrogen required to stop corrosion of iron immersed in 0.1M of $FeCl_2$ and pH =3? [5]

   c) Compare and contrast elastomers and thermoplastics. [10]

   d) Summarize the differences between direct and indirect costs associated with corrosion damage. [6]

2. a) Evaluate the process of microbial corrosion and analyze the extent of damage it results in. [4]

   b) Determine the corrosion potential and corrosion rate of zinc in 1M of hydrochloric acid. Assume that all the zinc surface acts as cathode, that Tafel slopes are +/- 0.100V, and that the exchange current densities for zinc and for hydrogen are 0.1 and 10^{-4} A/m^2? [6]

   c) Assess the conditions under which activation polarization rate is controlling and the one where concentration polarization is controlling. [5]

   d) Arrange the following ions in order of their thermodynamic ease of plating out of a solution: Cu^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, Na^{+}, Pb^{2+}, Cu^{+}. [6]

e) Compute the theoretical tendency of nickel to corrode (in volts) in dearated water of pH = 7. Assume the corrosion products are H_2 and $Ni(OH)_2$ the solubility product of which is 1.6×10^{-6}. [4]

3. a) Explain the main differences between the ohmic drop in an aqueous environment and the ohmic drop in an electrical conductor. [5]

   b) What do you understand by the following terms?

   i) concentration cells [1]

   ii) accelerated low water corrosion [1]

   iii) galvanization [1]

   iv) anodizing [1]

   v) passivation [1]

   c) Justify the need for chemical engineers to study corrosion. [5]

   d) What are the pros and cons of the use of plastics? [4]

   e) What is the best technique for stress corrosion protection? Justify your answer. [6]

4. a) Chemical composition of glass determines the category it falls under. State the five categories of glass and explain each category in detail? [10]

   b) Justify the need to use a separator between the anodic and cathodic half cells of a Daniell cell? [3]

   c) Fill in the table below

Rubber	**Production method**	**Weakness**	**Uses**
Polychloprene		Higher resistance to oils	
			Tyres, tubes, adhesives
Nitrite rubbers	Copolymerization of cryolonitrite and butadiene		

[7]

d) The ISO 9223 standard indicates that there should be no corrosion at temperature below 0^{o}C. Independent researchers have however proposed to lower the minimum temperature stated in the standard to lower values in order to account for the actual corrosion observed in Nordic climates. Provide a detailed explanation for the observed corrosion at temperatures below the freezing point? [5]

5. a) Define an inhibitor and explain the possible mechanisms that account for their effectiveness? [5]

b) Corrosion problems can rarely be attributed to single forms of corrosion. Provide some examples to justify your answer. [5]

c) Why would pitting corrosion be much more prone to provoke a catastrophic failure than uniform corrosion generally does? [5]

d) Explain why some metals, such as titanium for example, which are relatively easy to oxidize can still be found at the top of a galvanic series in seawater? [5]

e) Evaluate the statement that “cold-worked metals are more susceptible to corrosion than non-cold-worked metals”? [5]

END OF EXAM