UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING : METALLURGY*
SUBJECT	:	**CORROSION III**
CODE	:	**TKR31-1**
DATE	:	SUMMER SSA EXAMINATION 2014 1 DECEMBER 2014
DURATION	:	(SESSION 2) 11:30 - 14:30
WEIGHT	:	60 : 40
TOTAL MARKS	:	125
FULL MARKS	:	125

EXAMINER	:	MR GA COMBRINK
MODERATOR	:	MR J PROZZI 5070
NUMBER OF PAGES	:	3 PAGES

INSTRUCTIONS

1. ALL THE ANSWERS MUST BE COMPLETED IN THE EXAMINATION SCRIPT.
2. ONE POCKET CALCULATOR ALLOWED.
3. **NO** CORRECTION FLUID SHALL BE USED.

2/...

INSTRUCTIONS TO STUDENTS

PLEASE ANSWER ALL THE QUESTIONS.

QUESTION 1

1.1. How does relative humidity affect the rate of corrosion on clean (un-polluted) steel?

1.2. Explain what effect air pollution will have on the rate of corrosion. Make a drawing to help you explain.

[10]

QUESTION 2 Inhibitors

2.1. What is the difference between an ordinary corrosion inhibitor and a vapour-phase corrosion inhibitor (VCI)? (6)

2.2. Draw an Evans (E vs Log i) diagram showing how an anodic inhibitor works. (4)

2.3. You have a metal that is easily passivated under normal atmospheric conditions (such as grade ASTM 316 L stainless steel or grade AA 5086 aluminium) submerged in salty water that is well oxygenated (i.e. it is saturated with dissolved oxygen.) Depict both the anodic and cathodic reactions polarization curve on the same axis (i.e. superimposed viz. draw both the anodic curve as well as the cathodic curve on the exact same drawing). (10)

[20]

QUESTION 3 Electrochemical Nature of Metallic Corrosion

3.1. Explain what a corrosion cell is a make a labelled sketch of it. Explain what processes occur at the various regions described in the cell. Give a typical example of the half reactions that take place under the following conditions: -

3.1.1. The environment is deaerated water

3.1.2. The environment is oxygenated aqueous solution (water) with a pH of 3

3.1.3. The environment is oxygenated aqueous solution (water) with a pH of 8.5

3.1.4. Draw the Evans Diagram of steel submerged in oxygenated aqueous solution (water) with pH of 3

3.1.5. Draw the Evans diagram of steel submerged in oxygenated aqueous solution (water) with a pH of 9

[25]

QUESTION 4

4.

4.1. You drop a piece of bare steel metal into a solution of carbonic acid (carbon dioxide dissolved in water forms carbonic acid) with a pH of around 5.2. Thinking about the Pourbaix diagram of Iron in Water what do you expect will happen to the steel? Explain how much confidence you

have regarding what you expect to happen. What can influence the reactions as opposed to what the Pourbaix diagram indicates will happen at the low pH.

4.2. Draw the Pourbaix diagram of iron in water. On the diagram identify the various regions and indicate where corrosion occurs, where passivity may occur and also where the iron does not react.

[25]

QUESTION 5

5.1. When referring to half reactions of a corrosion cell explain what is activity control. Make a sketch and label it to assist you with your explanation.
5.2. Draw an Evans (E vs Log i) diagram of a completely activity controlled cell and indicate where i_{corr} is and also where E_{corr} is.

[10]

QUESTION 6

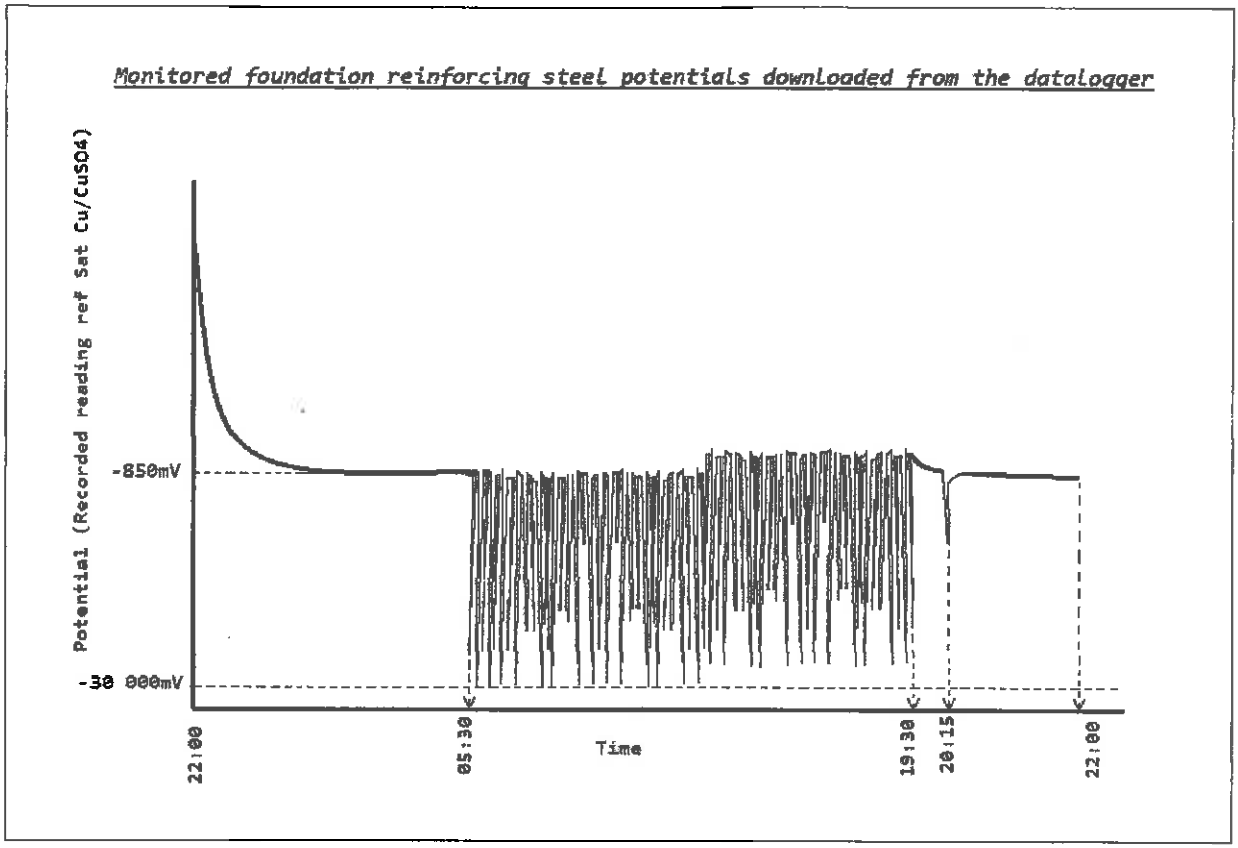
6.
6.1. Explain what : -
6.1.1. Fretting corrosion is and what causes it.
6.1.2. Stress corrosion cracking is and what causes it.

6.2. Make a sketch showing exactly what happens with crevice corrosion.

[20]

QUESTION 7 ECSA ELO: Problem identification and solving:

7.1. Explain using Evans diagrams how Cathodic protection (CP) works.
7.2. They are going to switch on the CP system on the Nelson Mandela bridge in Johannesburg for the very first time and you are asked to measure the potential of reinforcing steel in the concrete foundations of the Nelson Mandela bridge. The Bridge crosses over the Johannesburg train station where PRASA's electric trains run. You select a single point on the bridge foundation where you can do the measurement and you use a Copper /Copper Sulphate reference electrode and a data logger that records the potential (voltage) that is measured every 10 seconds for a 24-hour period. You start the recording at 22:00 in the evening. When you download the recorded data the next day and review it you find that the potential recorded was stable at -850mV from just after 22:00 until 05:30 the following day and then it varied between -850mV and -30000mV (30V) throughout the day until 19:30. The last train runs at 20:15. See the sketch below. Explain how this fluctuation can occur and also what can be done about eliminating it. Also say whether the bridges reinforcing is protected or not explaining why you say so. What happens to the bridges reinforcing when the potential goes to -30000mV?



7.3. What is impressed current cathodic protection and how does it differ from sacrificial anode cathodic protection

7.4. Name and describe three different situations where you would use cathodic protection to fight corrosion.

[30]

TOTAL MARKS = 140
FULL MARKS = 140