Instructions to students:

- Enter your student number **not** your name on all answer books.
- Answer **all** questions and include sketches and diagrams where asked or appropriate.
- All questions are equally weighted. Where a question has more than one part the division of marks is stated.
- Begin each question in a separate answer book; label each answer book clearly with the number of the question you are answering.
- Neither books nor notes may be taken into the examination.
- The use of a non-programmable calculator is permitted.
- Students are permitted to remove this examination paper at the end of the examination.
Answer all questions.

Question 1

Describe an electrochemical test procedure that could be used to assess either general corrosion or an organic coating.

a. Produce a fully labelled diagram of the test equipment and corrosion cell (10 marks)

b. Explain how the test is conducted and the parameters used (10 marks)

c. Relate what you are measuring to your understanding of corrosion or corrosion protection and degradation mechanisms (5 marks)

(Total 25 marks)

Question 2

a. Name and give examples of the four categories of people identified as secondary mechanisms in corrosion control. How does each of these groups influence the management and control of a system? (20 marks)

b. The probability of materials failure $P_m$ is 0.02 due to stringent inspection and quality control procedures. The probability of the environment changing to produce a corrosive environment ($P_e$) is 0.15. What is the probability of failure ($P_{sf}$), when there is an aggravating factor rated at 1.5? Show all working. (3 marks)

c. Comment on the answer you arrived at as your probability of failure (2 marks)

(Total 25 marks)
Question 3

This question is based around common corrosion protection methods you have studied; Anti-corrosion coatings and Cathodic protection.

Part 1

a. Name the three main constituents of a typical paint coating prior to application and give an example of each (6 marks)  
   (you can use a simple diagram to help explain this) (2 marks)

b. What two important functions do the pigments in the primer coat fulfill? (3 marks)

c. What are the mechanisms by which these functions operate? (4 marks)

Part 2

a. Why is -850 mV SSC (electrode potential) used for the cathodic protection potential for many steel structures? (3 marks)

b. What are the dangers of using greater negative potentials with regards to the effects on the metal? (4 marks)

c. Why does reducing the potential to (for example) -300 mV not reduce the corrosion rate by half of that produced by a potential of -150 mV? (3 marks)

(Total 25 marks)
Question 4

a. If the cathode in a corrosion cell has an area of 480 cm\(^2\) and the current density is 20 µA/cm\(^2\), what will be the total electrical current flowing in the corrosion cell? What will be the **current density** on the anode assuming an active anode area of 0.5 cm\(^2\)? Show all working.  
(6 marks)

b. Calculate the rate constant \(K_{\text{corr}}\) for a corrosion reaction at 15\(^\circ\)C, where the free energy of activation = 43 kJ mol\(^{-1}\) (ignoring constant “C”) Show all working.  
(6 marks)

\[
K_{\text{corr}} = C \cdot e^{\left(-\frac{\Delta G^\ddagger}{RT}\right)}
\]

c. Why is the surface profile produced by grit blasting so important with regards to coating life? (You can use a diagram to help explain this answer)  
(6 marks)

d. If salt compounds form beneath a coating that has poor adhesion explain the mechanism by which failure occurs?  
(4 marks)

e. Why would the pH of a solution within a coating blister become very high?  
(3 marks)

(Total 25 marks)