



# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 3 Examination in Engineering: August 2015

Module Number: ME 3302

Module Name: Metallurgy for Engineers

[Three Hours]

[Answer all questions, each question carries 12 marks]

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- Q1. a) Define following terms,  
i) Metallic corrosion  
ii) Anode and cathode  
[2 Marks]
- b) Briefly discuss the differences between corrosion science and corrosion engineering.  
[2 Marks]
- c) A machine component made of stainless steel (340SS: C-0.08% max, Cr-18% and Ni 8%) joined by welding was observed to have crack at a point very closed to the weld after few years.  
Identify the type of corrosion and briefly explain the reason for cracking.  
[4 Marks]
- d) State the major differences in Weld-Decay and Knife Line Attack (KLA).  
[4 Marks]
- Q2. a) TTT diagrams are useful to understand the microstructure of carbon steel during non-equilibrium cooling. Figure Q2 shows the TTT diagram for medium carbon steel.  
Draw the cooling curves on the diagram (Figure Q2) that will result in the transformation of austenite ( $\gamma$ ) to the following structures.  
i) 100% fine pearlite  
ii) 50% bainite + 50% martensite  
[2 Marks]
- b) How would you transform medium carbon steel sample of 100% pearlite at room temperature to the 100% bainite. Briefly explain each heating and cooling step.  
Draw the cooling curve on the given TTT diagram (Figure Q2).  
[3 Marks]
- c) Sketch the Iron -Iron carbide (Fe-Fe<sub>3</sub>C) equilibrium phase diagram and show following phases on it.  
i) Ferrite  
ii) Austenite  
iii) Pearlite  
[3 Marks]

- d) Explain briefly the differences between **pearlite**, **bainite** and **martensite** referring to the microstructure and mechanical properties.

[4 Marks]

- Q3. a) List the major factors to be considered before the heat treatment of any steel component.

[2 Marks]

- b) Discuss in details on different types of annealing and compare with normalizing as applied to the steel.

[4 Marks]

- c) Surface hardening processes of steel can be classified into **diffusion** and **localized hardening** processes. Briefly discuss the differences between above two processes.

[2 Marks]

- d) Describe the **carburizing** and **flame hardening** processes.

[4 Marks]

- Q4. a) Pig iron is produced by using the blast furnace.

i) What are the basic raw materials used to produce pig iron?

ii) Sketch a named diagram of the blast furnace.

iii) What are the reactions which can be taken place inside the furnace during the pig iron production?

[5 Marks]

- b) Metals are often alloyed in engineering applications to impart different properties. Describe briefly the effects of following alloying elements in steel.

i) Magnesium (Mg)

ii) Nickel (Ni)

iii) Chromium (Cr)

[3 Marks]

- c) Write brief descriptions on followings,

i) Copper-Zinc alloys

ii) Cast irons

[4 Marks]

- Q5. a) Nondestructive tests can be used to detect the defects in materials. Using a proper sketch, explain a suitable nondestructive test method for the detection of **open to surface flaws** in a **non-porous** material.

[4 Marks]

- b) What do you mean by **Stress Corrosion Cracking (SCC)**? How it is differ from **normal corrosion**?

[2 Marks]

- c) Briefly describe the **direct cost** and **indirect cost** associated with corrosion.

[2 Marks]

- d) "A steel nail used to hold the copper plates in position fails rapidly by wet corrosion. However, a copper nail used to fix steel plates will lead to little or no corrosion".

Explain above observation applicable to corrosion. Use suitable diagrams to illustrate your answer whenever possible.

[4 Marks]



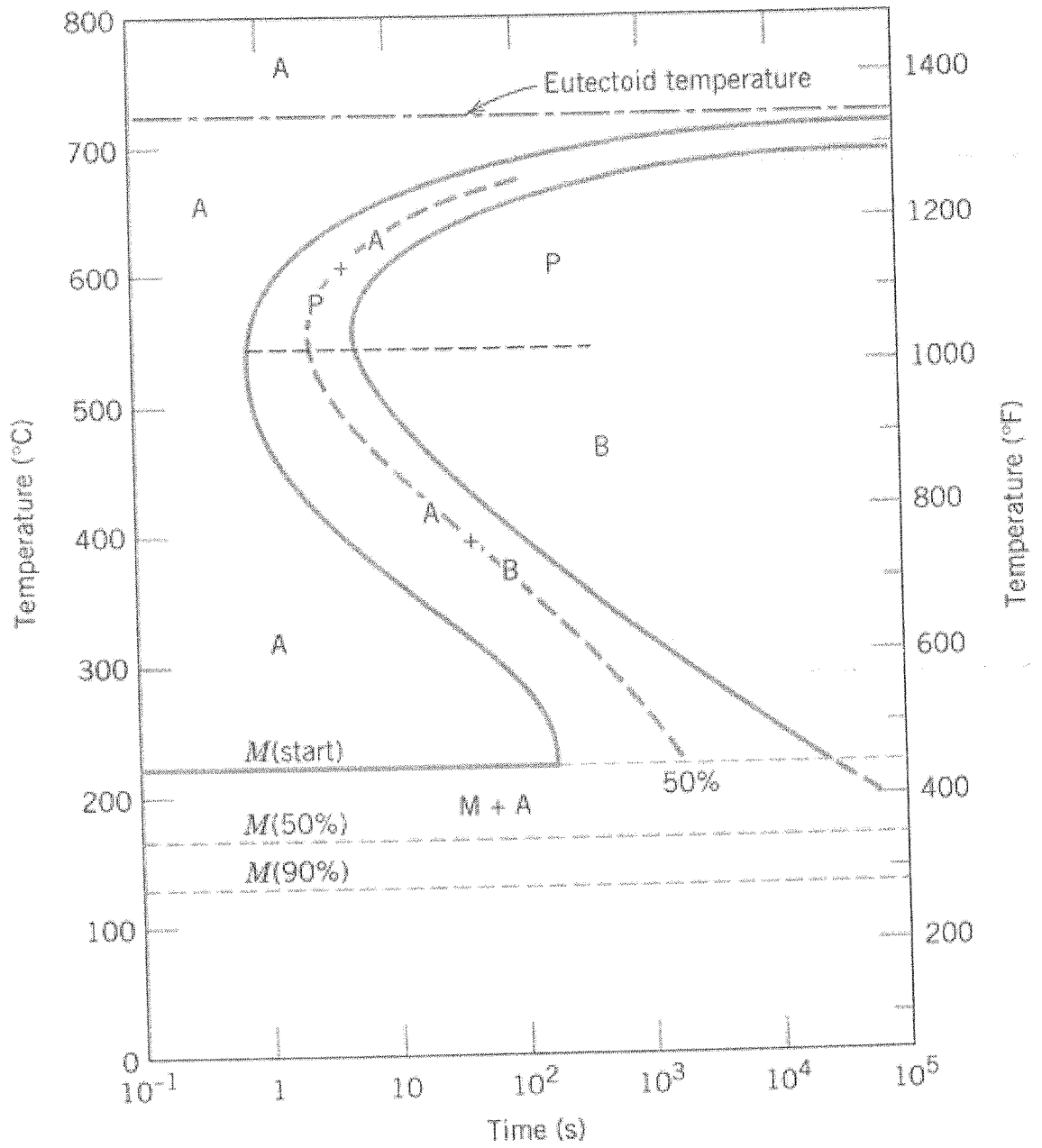


Figure Q2