# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

## **Faculty of Industrial Technology**

# **Department of Industrial & Manufacturing Engineering**

**BEng. Degree in Industrial and Manufacturing Engineering** 

### Materials Technology II -TIE2204

## 2<sup>ND</sup> SEMESTER EXAMINATIONS - AUGUST 2009

### Instructions To Candidates

1. Examination length is **3hrs**.

- 2. Each question carries twenty (20) marks and there are six (6) questions in total.
- 3. Attempt the whole of Section A and three questions from Section B.

# Section A

### **Question 1**

Below is the Iron–Iron Carbide (Fe–Fe<sub>3</sub>C) Phase Diagram. Use it to answer the a) questions that follow.



What is the distinction between hypoeutectoid and hypereutectoid steels? [2] iii)



v) Distinguish between steels and cast iron.

- b) With reference to the diagram in (a) above describe the cooling of the following alloys:
- (i) 3.40% C
- (ii) 1.50% C
- (iii) 0.26% C

### **Question 2**



Figure Q2 is an isothermal transformation diagram for a steel of eutectoid composition. Using it as a reference, describe the following heat treatment processes.

a)	Normalising anneal.	[4]
b)	Ausforming	[4]
c)	Martensitic hardening	[4]
d)	Tempering	[4]
e)	Austempering	[4]

# Section B

#### **Question 3**

a)	Give typical compositions, mechanical properties and applications	of low-carbon
	steels.	[10]
b)	Low-carbon steels are non-hardenable unlike high-carbon steels.	

- (i) Define hardenability.
- (ii) Describe in detail, the standard test employed to measure hardenability. [8]

- [3] [3]
- [3]

[2]

### **Question 4**

a)	Martensitic hardening can only be used for allotropic metals and a like copper and aluminium together with their alloys have to be age	alloys. Metals nardened.
b)	Explain why this is the case. Using a suitable example outline the process of age hardening.	[4] [15]
Oue	stion 5	

- a) Define the term corrosion in relation to metals. [4]
- b) Discuss some of the measures used to prevent or minimise general corrosion. [6]
- c) One-half of an electrochemical cell consists of a pure nickel electrode in a solution of Ni<sup>2+</sup> ions; the other half is a cadmium electrode immersed in a Cd<sup>2+</sup> solution.
- (i) If the cell is a standard one, write the spontaneous overall reaction and calculate the voltage that is generated.
- calculate the voltage that is generated. [5]
  (ii) Compute the cell potential if the Cd<sup>2+</sup> and Ni<sup>2+</sup> concentrations are 0.5 and 10<sup>-3</sup> M respectively. Is the spontaneous reaction direction still the same as for the standard cell? [5]

### **Question 6**

- a) Briefly describe the steps that are used to ascertain whether or not a particular metal alloy is suitable for use in an automobile valve spring. [6]
- b) A continuous and aligned glass fiber-reinforced composite consists of 40 volume % of glass fibers having a modulus of elasticity of 69 GPa and 60 volume % of a polyester resin that, when hardened, displays a modulus of 3.4 GPa.
- (i) Compute the modulus of elasticity of this composite in the longitudinal direction.
- (ii) If the cross-sectional area is 250 mm<sup>2</sup> and a stress of 50 MPa is applied in this longitudinal direction, compute the magnitude of the load carried by each of the fibre and matrix phases.

[3]

(iii) Determine the strain that is sustained by each phase when the stress in part (b) is applied. [6]

#### End of exam