NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

MATERIALS TECHNOLOGY I -TIE 2104

1ST SEMESTER EXAMINATION APRIL 2009

Instructions To Candidates

1.Examination length is **3hours**.
2.Each question carries twenty (**20**) marks and there are six (**6**) questions in total.
3.Attempt the whole of Section A and select any other three questions from Section B.
4.Pay attention to the instructions on the cover page of your answer booklet.

Section A

Question 1

a) Define a phase. [2]

b) Draw a typical eutectic phase diagram with the eutectic composition at 60%B and 10% limited solubility at bother ends. Identify the phase fields. Indicate the composition ranges for hypoeutectic and hypereutectic alloys. [10]

c) For the phase diagram you have sketched calculate the relative proportions of phases in an A-B alloy of eutectic composition below the eutectic temperature. [5]

d) Calculate the theoretical density of nickel if the lattice parameter is $3.52*10^{-8}$ cm and the molecular weight is 58.71g. Nickel has a face-centred cubic structure. [3]

Question 2

a) The following load-elongation data was obtained from a sample 50 mm in length and 12.8 mm in diameter. (kN = kilonewtons and 1 MPa = 1 N/mm^2)

	Load (kN)	Elongation (mm)
Start	0	0.0
	10	0.010
	20	0.020
Yield	25	0.025
	30	11.2
Maximum load	38	18.7
Fracture	18	24.5

(i) What is the engineering ultimate tensile strength (UTS)? [2]

(ii) What is the engineering strain at the yield point? [2]

(iii) Determine the engineering fracture stress. [2]
(iv) Estimate E for the sample. [4]
b) Define a substitutional solid solution. [2]
c) A steel is to be used in the construction of an offshore oil-drilling platform. What test would you recommend for quick checks on its susceptibility to brittle fracture? [2]
d) In the construction industry, either steel or reinforced concrete is used in many applications where tensile stresses are generated. What method of testing would you recommend to establish the safe tensile stress for steel and that for concrete? [2]
e) Explain why we study the crystal structure of metals. [4]

Section B

Question 3

a) Define the following terms
(i) Hardness [2]
(ii) Fatigue [2]
(iii) Melting point [2]
(iv) Creep [2]
(v) Ductility [2]
b) What is the difference between recovery and recrystallisation? [4]
c) A cold worked bar of metal has been recrystallised, but when tested is found to be anisotropic. Explain the probable reason. [2]
d) What effect does grain growth have on the mechanical properties of metals? [4]

Question 4

a) Draw sketches of FCC and BCC unit cells and for each give a metal of that structure. [6]
b) Define allotropic transformation. [4]
c) Calculate the density of packing for the face-centred cubic unit cell. [4]
d) Two physical properties that have a major influence on the cracking of work-pieces or dies during thermal cycling are thermal conductivity and thermal expansion. Explain why. [6]

Question 5

a) Using the x, y, z coordinate system show the planes that have the following Miller Indices.
(i) (1 2 3) [3]
(ii) (2 –1 4) [3]
(iii) (-2 4 3) [3]
b) Why do different crystal structures exhibit different strengths and ductilities? [4]
c) A paper clip is made of wire 1.5 mm in diameter. If the original material from which the wire is made is a rod 20 mm in diameter, calculate the diametrical engineering and true strains that the wire has undergone during processing. [4]

d) Justify the widespread use of ceramics. [3]

Question 6

a) A copper specimen is elongated to twice its original length while a similar specimen is deformed to half its original length. Show that engineering strain is an incorrect measure of strain. [5]

b) State the two general types of material failure. [2]

c) Distinguish between ductile and brittle fracture. [4]

d) List the measures commonly taken to increase the fatigue strength of metals. [4]

e) What are point defects? [5]

End of Examination