Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	MATERIALS SCIENCE
COURSE CODE	:	BDA 1602
PROGRAMME	:	1 BEE
EXAMINATION DATE	:	JUNE 2014
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS OUT OF FIVE (5) QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) The results of tensile test of a sample of stainless steel with 12.8 mm diameter and 50.8 mm gauge length are given in Table **Q1**. Plot the engineering stress versus engineering strain curve of the sample and find;

(i) Young Modulus
(ii) Yield stress at 0.2% deformation
(iii) Tensile strength
(iv) Ductility
(v) Working stress, given the factor of safety is 2 and the yield stress in (ii).

(20 marks)

(b) Explain in details a typical creep curve for a metal which is subjected to a constant load at a relatively high temperature.

(5 marks)

Q2 (a) Sketch the crystallographic directions and planes in Figure **Q2**. Please enclose Figure **Q2** with your answer script.

(6 marks)

(b) The atomic packing factor for face-centered cubic structure is 0.74. Prove the statement by using an appropriate sketches.

(10 marks)

(c) Calculate the linear density of atom along [111] for nickel crystal (FCC). Given that the value of atomic radius, r = 0.125 nm.

(4 marks)

(d) State **FIVE (5)** system of unit cell for metallic crystal structures.

(5 marks)

Q3 (a) An FCC iron-carbon alloy initially containing 0 wt% C is carburized at 950°C and in an atmosphere where in the surface carbon concentration is maintained at 0.25 wt%. If the concentration of carbon is 0.1 wt% at a position of 0.1 mm below the surface, determine the time, t for diffusion by referring to Figure **Q3** and Table **Q3**. The diffusion coefficient for carbon in iron at this temperature is 1.6×10^{-11} m^2/s.

(10 marks)

(b) Describe and illustrate the Frenkel imperfection and the Schottky imperfection.

(6 marks)

(c) Mr Shafaai has done the experiment for the diffusivity of iron atoms in the BCC metals. Iron diffusivity are 4.5×10^{-23} m^2/s at 400 °C and 5.9×10^{-16} m^2/s at 800°C. Calculate the activation energy in kJ/mol for the given temperature range in this case. (R=8.314 J/(mol.K))

(5 marks)

(d) State **FOUR (4)** factors that determine the degree of solvent dissolved in solid solution condition.

(4 marks)

Q4 (a) Define eutectic reaction and peritectic reaction. Identify the temperature of eutectic and peritectic reactions in the Iron-Carbon phase diagram in Figure **Q4(a)**.

(4 marks)

(b) By refering to the Lead-Tin phase diagram in Figure **Q4(b)**, make the phase analysis of point **(A + ΔT)** and **(A – ΔT)**. The analysis must include:

(i) Phases.
(ii) Chemical composition of each phase.
(iii) Amount of each phase (portion of each phase).

(12 marks)

(c) Define a heat treatment.

(3 marks)

(d) Describe briefly the process and the purpose of normalizing in heat treatment.

(6 marks)

Q5 (a) Explain in details the difference in electrical conductivity for metals, semiconductors and insulators in terms of their electron energy band structures. Use a suitable sketch.

(10 marks)

(b) Give **TWO (2)** differences between intrinsic and extrinsic conduction.

(5 marks)

(c) A wire of 0.40 cm in diameter must carry a 25 A current.

(i) If the maximum power dissipation along the wire is 0.025 W/cm, what is the minimum allowable electrical conductivity of the wire (give answer in SI units)?

(5 marks)

(ii) What is the current density in the wire?

(5 marks)

- END OF QUESTIONS –

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TABLE Q1(a)

Load (N)	Length (mm)	Load (N)	Length (mm)
12700	50.825	119400	51.562
25400	50.851	128300	51.816
38100	50.876	149700	52.832
50800	50.902	159000	53.848
76200	50.952	160400	54.356
89100	51.003	159500	54.864
92700	51.054	151500	55.880
102500	51.181	124700	56.642 (failure)
107800	51.308		

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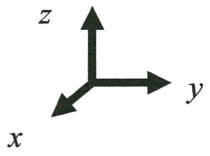

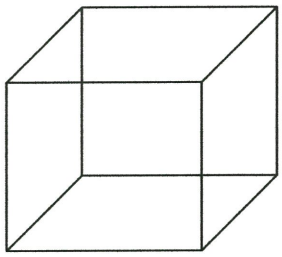

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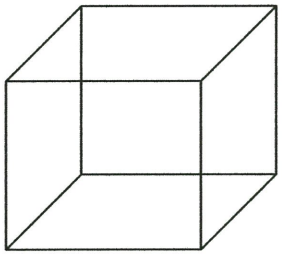
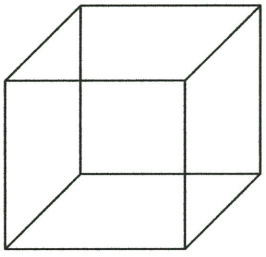
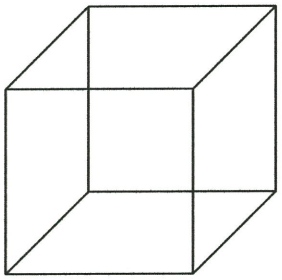


[$\bar{1}$ 3 0]



[6 2 $\bar{3}$]



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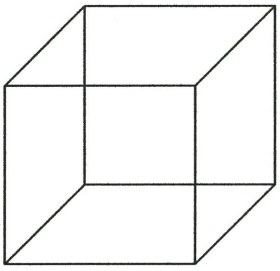
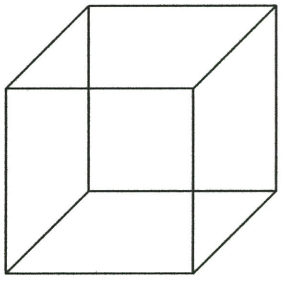


(3 2 $\bar{1}$)



(2 0 2)

FIGURE Q2

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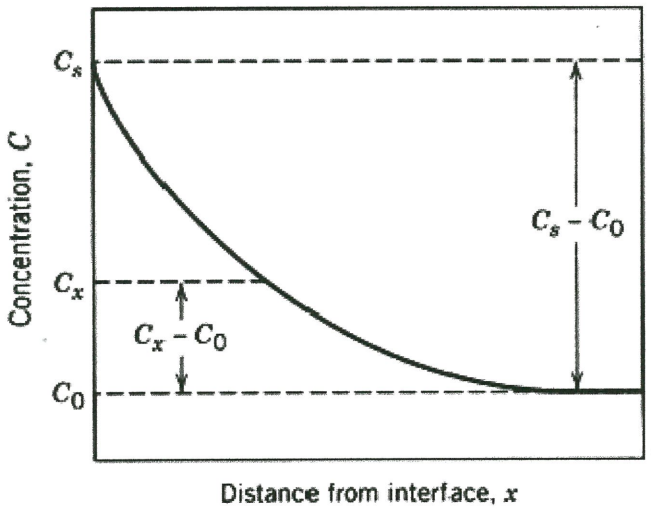

Given:
$C_s = 0.25\ \%$
$C_x = 0.10\ \%$
$C_o = 0\ \%$
$x = 0.1$ mm
$D = 1.6 \times 10^{-11}\ m^2/s$

FIGURE Q3

TABLE Q3

TABULATION OF ERROR FUNCTION

z	*erf(z)*	*z*	*erf(z)*	*z*	*erf(z)*
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9253
0.5	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

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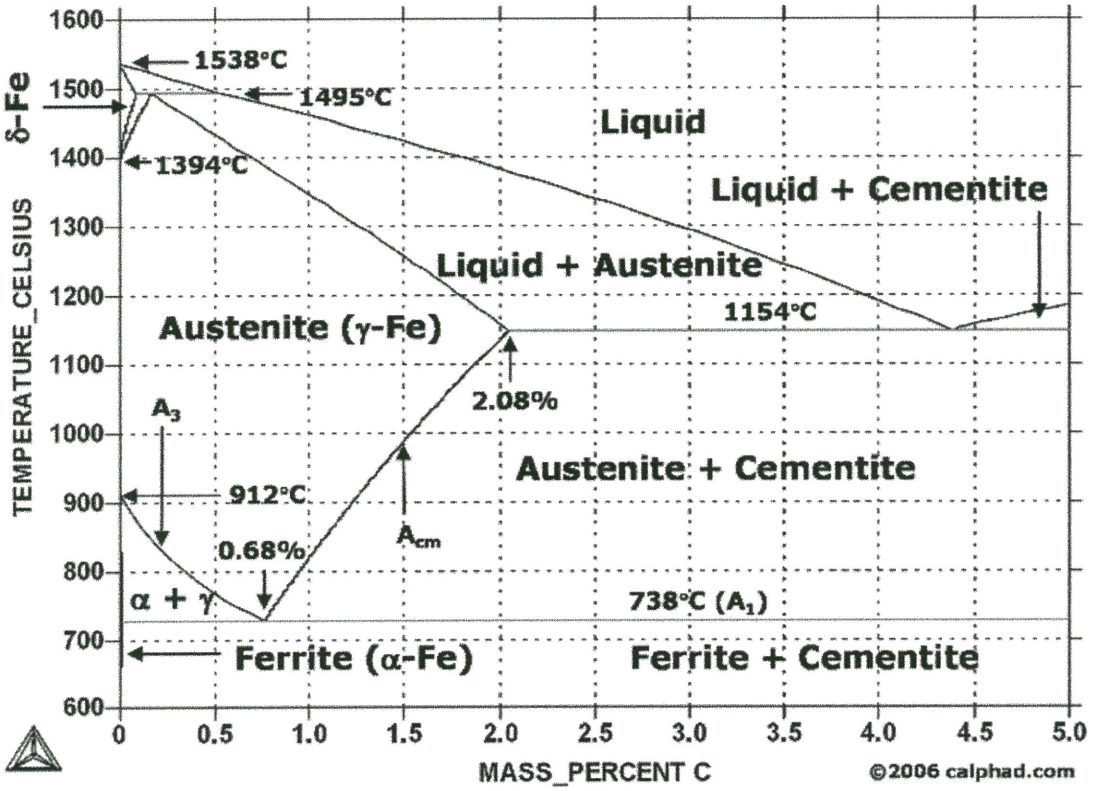

IRON-CARBON PHASE DIAGRAM

FIGURE Q4(a)

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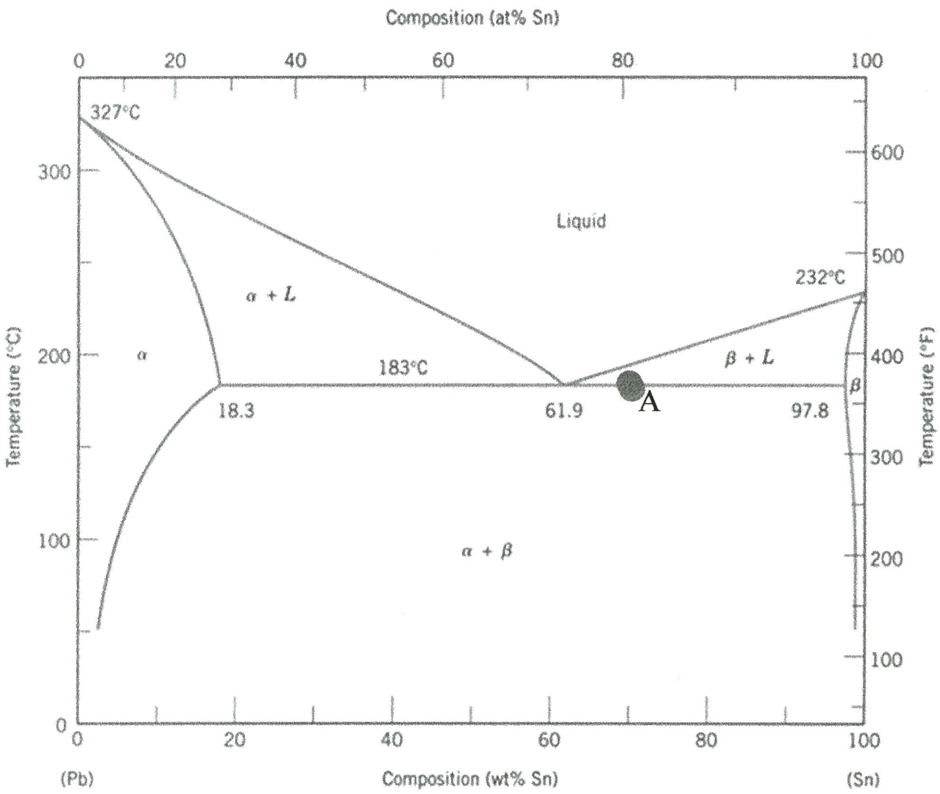

LEAD-TIN PHASE DIAGRAM

FIGURE Q4(b)