Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	MATERIALS SCIENCE
COURSE CODE	:	BDA 10803
PROGRAMME	:	1 BDD / 2 BDD
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS OUT OF SIX (6) QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 The results of tension 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

(a) Young Modulus
(b) Yield stress at 0.2% deformation
(c) Tensile strength
(d) Ductility
(e) Working stress, given the factor of safety is 2 and the yield stress in (b).

(20 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)

Q3 (a) An FCC iron-carbon alloy initially containing 0 wt% C is carburized at 950°C and in an atmosphere wherein 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 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.

(5 marks)

(c) Mr Shafaai has done the experiment for the diffusivity of iron atoms in the BCC metals. Iron lattice is 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)

Q4 (a) Refer to the Iron-Carbon phase diagram in Figure **Q4(a)**, identify where the Eutectic and Peritectic reactions in the system and state the definition of those reactions.

(4 marks)

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

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

(7 marks)

(c) What is a heat treatment?

(3 marks)

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

(6 marks)

Q5 (a) List **TWO (2)** types of polymerization.

(2 marks)

(b) By using ethylene as a sample, explain the process of addition polymerization.

(9 marks)

(c) Compare between thermoplastic and thermoset and give **ONE (1)** example of each type of the polymer.

(9 marks)

Q6 (a) You were asked by your supervisor to design a furnace which can be heated up to 1400°C.

(i) What type of ceramic is suitable for this purpose?

(2 marks)

(ii) Explain why you choose that ceramic?

(6 marks)

(b) Describe briefly the fabrication and processing of ceramic.

(8 marks)

(c) Give **TWO (2)** types of composites with an example.

(4 marks)

- END OF QUESTION –

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2013/2014
COURSE : MATERIALS SCIENCE

PROGRAMME : 1BDD/2BDD
COURSE CODE : BDA 10803

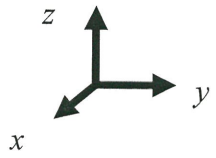
TABLE Q1

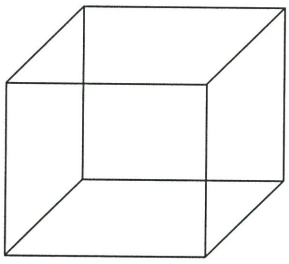
Load (N)	Length (mm)	Load (N)	Length (mm)
12700	50.825	119400	51.562
25400	50.851	128300	51.816
38100	50.876	149700	52.832
50800	50.902	159000	53.848
76200	50.952	160400	54.356
89100	51.003	159500	54.864
92700	51.054	151500	55.880
102500	51.181	124700	56.642 (failure)
107800	51.308		

FINAL EXAMINATION

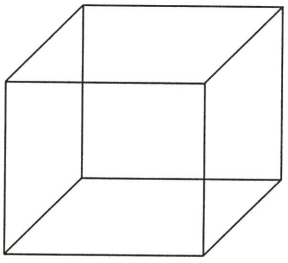
SEMESTER/SESSION : SEM II/2013/2014
COURSE : MATERIALS SCIENCE

PROGRAMME : 1BDD/2BDD
COURSE CODE : BDA 10803

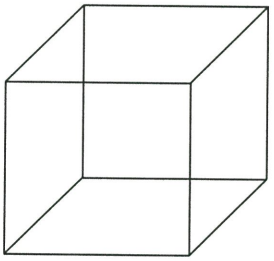




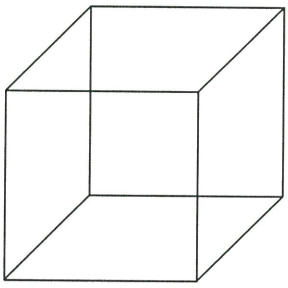
[1 2 1]



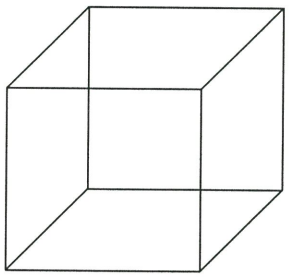
[$\bar{1}$ 3 0]



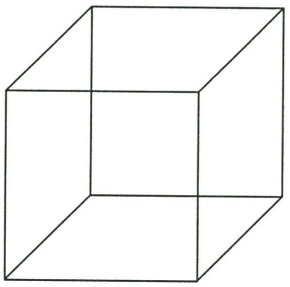
[6 2 $\bar{3}$]



(4 2 1)



(3 2 $\bar{1}$)



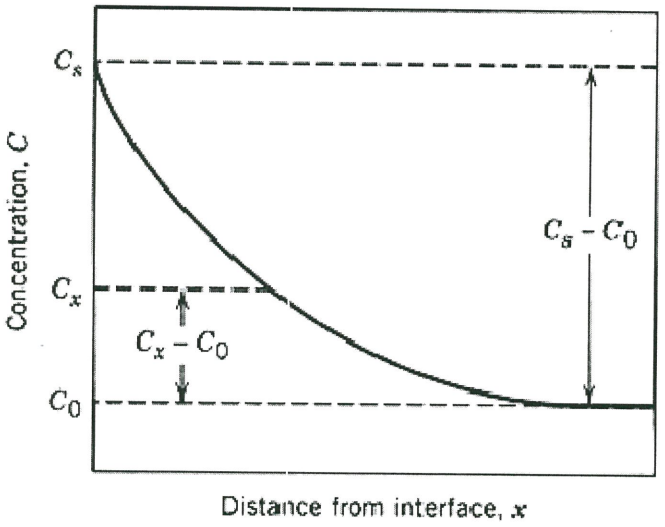
(2 0 2)

FIGURE Q2

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2013/2014
COURSE : MATERIALS SCIENCE

PROGRAMME : 1BDD/2BDD
COURSE CODE : BDA 10803



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

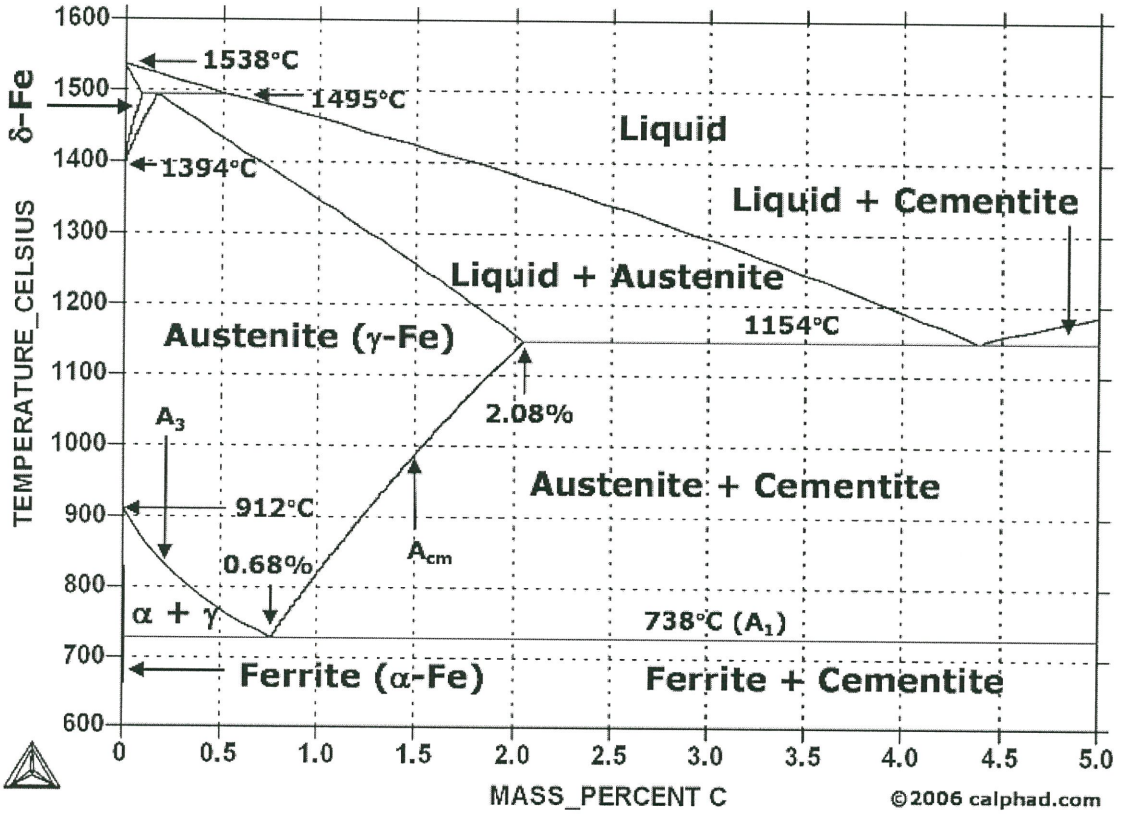
TABULATION OF ERROR FUNCTION

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

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2013/2014
COURSE : MATERIALS SCIENCE

PROGRAMME : 1BDD/2BDD
COURSE CODE : BDA 10803



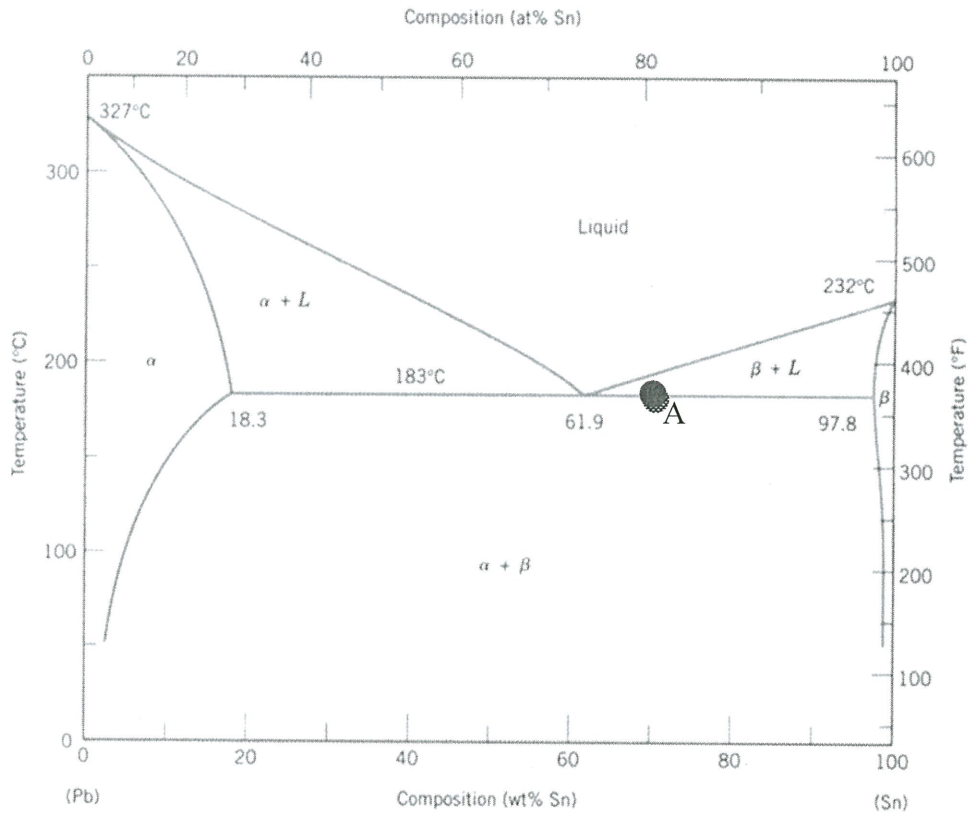
IRON-CARBON PHASE DIAGRAM

FIGURE Q4(a)

FINAL EXAMINATION

SEMESTER/SESSION : SEM II/2013/2014
COURSE : MATERIALS SCIENCE

PROGRAMME : 1BDD/2BDD
COURSE CODE : BDA 10803



LEAD-TIN PHASE DIAGRAM

FIGURE Q4(b)