UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	MATERIAL SCIENCE
COURSE CODE	:	BNR 10102
PROGRAMME	:	1 BNR
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	2 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS
		2. ATTACH FIGURE **Q4(b)** AND FIGURE **Q4(c)** WITH YOUR ANSWER BOOKLET

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Define materials science and list FIVE (5) types of materials.

(3 marks)

(b) Show that the atomic packing factor for FCC structure is 0.74

(3 marks)

(c) Sketch with complete label for the following planes and directions in unit cubes:

(i) $[1\ \bar{1}\ 0]$

(2 mark)

(ii) $[2\ 0\ \bar{1}]$

(2 mark)

(iii) $[1\ 2\ \bar{2}]$

(2 mark)

(v) $(2\ 2\ 1)$

(2 mark)

(vi) $(\bar{2}\ 0\ 1)$

(2 mark)

(d) Sodium at 20°C is BCC and has a lattice constant of 0.42906 nm. Calculate a value for the atomic radius of a sodium atom in nanometers.

(4 marks)

Q2 (a) Point defect and linear defect are two types of imperfection which generally found in crystals structure. Illustrate these two types of imperfection with brief explanation respectively

(10 marks)

(b) Considering the gas carburizing of a gear of 1020 steel at 927°C (1700°F). Calculate the time in minutes necessary to increase the carbon content to 0.8% at 0.70 mm below the surface. Assume that the carbon content at the surface is 0.60% and that the steel has a nominal carbon content of 0.30%. The diffusion coefficient for carbon in iron at this temperature is 1.28×10^{-11} m^2/s; assume that the steel piece is semi-finite. Use Table **Q2 (b)** to solve this question.

(10 marks)

Q3 (a) Distinguish between elastic and plastic deformation.

(4 marks)

(b) Figure **Q3(b)** shows a sample of pure aluminum 0.5 cm width, 0.040 cm thick and 8 cm length which has gage markings 2 cm apart in the middle of the sample is strained so that the gage markings are 2.65 cm apart. Calculate engineering strain elongation which the sample undergoes.

(3 marks)

(c) Sketch a typical creep curve of strain versus time at constant stress and constant elevated temperature.

(2 mark)

Show the following regions in the sketched curve:

(i) Instantaneous elongation

(2 mark)

(ii) Primary creep

(2 mark)

(iii) Secondary creep

(2 mark)

(iv) Tertiary creep

(2 mark)

(c) Define impact test and give TWO (2) types of fracture found in this test.

(3 marks)

Q4 (a) Describe and explain with appropriate figure for the following term in binary phase diagram:

(i) Eutectic

(2 mark)

(ii) Eutectoid

(2 mark)

(iii) Peritectic

(2 mark)

(b) A 40 wt.% Pb-60 wt.% Mg alloy is heated to a temperature within the α + liquid phase region. If the mass fraction of each phase is 0.5, then estimate using Figure **Q4(b)** (Return Figure **Q4(b)** with answer sheet):

(i) The temperature of the alloy

(3 mark)

(ii) The composition of the two phases

(3 mark)

(c) Using the isothermal transformation diagram in Figure **Q4(c)** for an iron–carbon alloy of eutectoid composition, specify the nature of the final microstructure (in terms of microconstituents present and approximate percentages) of a small specimen that has been subjected to the following time–temperature treatments. In each case assume that the specimen begins at 760°C (1400°F) and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenitic structure. (Return Figure **Q4(c)** with answer sheet).

(i) Rapidly cool to 350 °C , hold for 10^4 s, and quench to room temperature

(3 marks)

(ii) Rapidly cool to 250 °C, hold for 100s, and quench to room temperature

(2 marks)

(iii) Rapidly cool to 650 °C, hold for 20s, rapidly cool to 400 °C, hold for 10^3s and quench to room temperature

(3 marks)

Q5 (a) Explain chain reaction polymerization process and give THREE (3) differences between thermoplastic and thermoset

(8 marks)

(b) Explain the difference and the advantageous between each process for fabrication:

(i) Hand Lay-Up Method

(2 marks)

(ii) Filament winding

(2 marks)

(iii) Pultrusion

(2 marks)

(c) In terms of electron energy band structure, discuss the difference in electrical conductivity between semiconductor and insulator.

(6 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER/SESSION : SEM I/2014/2015 PROGRAMME : 1 BNR
COURSE NAME : MATERIAL SCIENCE COURSE CODE: BNR 10102

TABLE Q2(b)

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

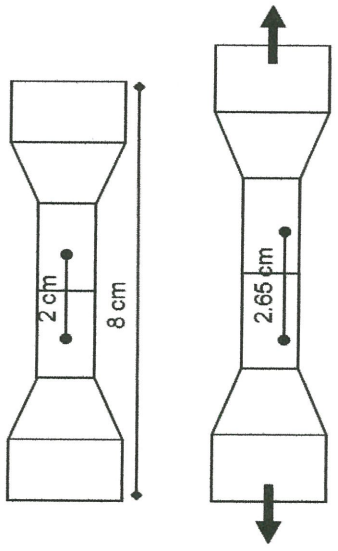

FIGURE Q3(c)

FINAL EXAMINATION

SEMESTER/SESSION : SEM I/2014/2015 PROGRAMME : 1 BNR
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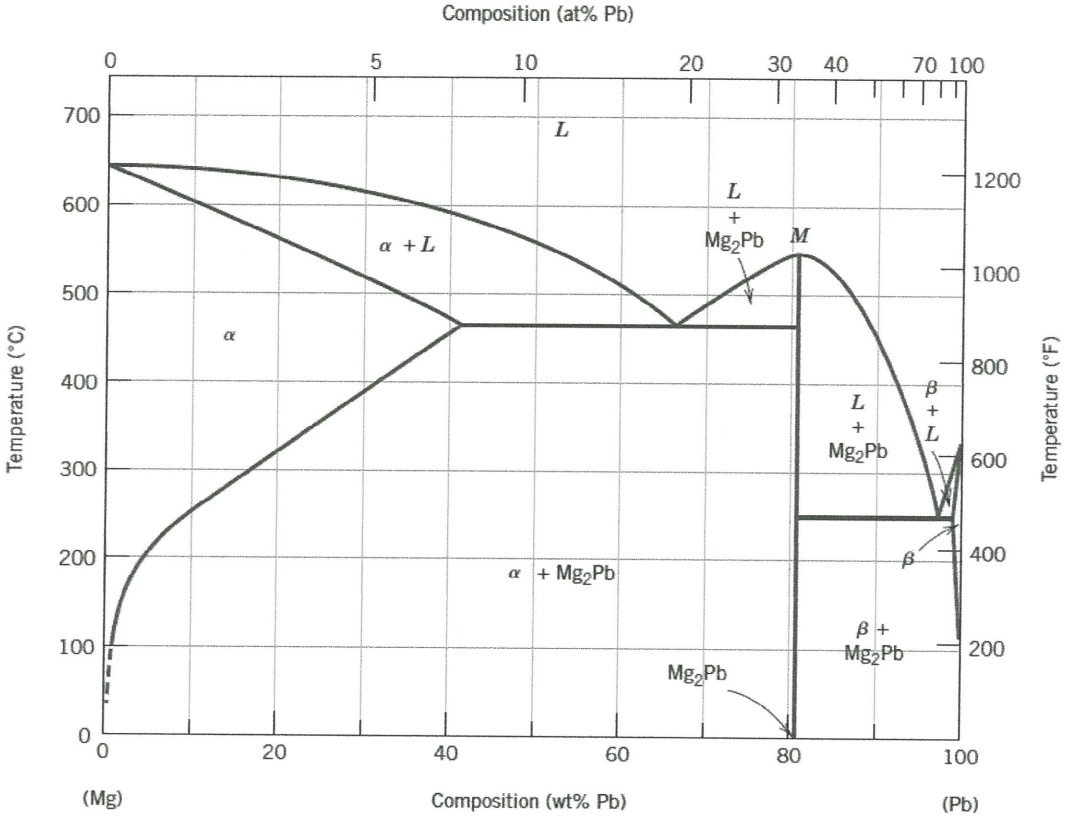

FIGURE Q4(b)

FINAL EXAMINATION

SEMESTER/SESSION : SEM I/2014/2015 PROGRAMME : 1 BNR
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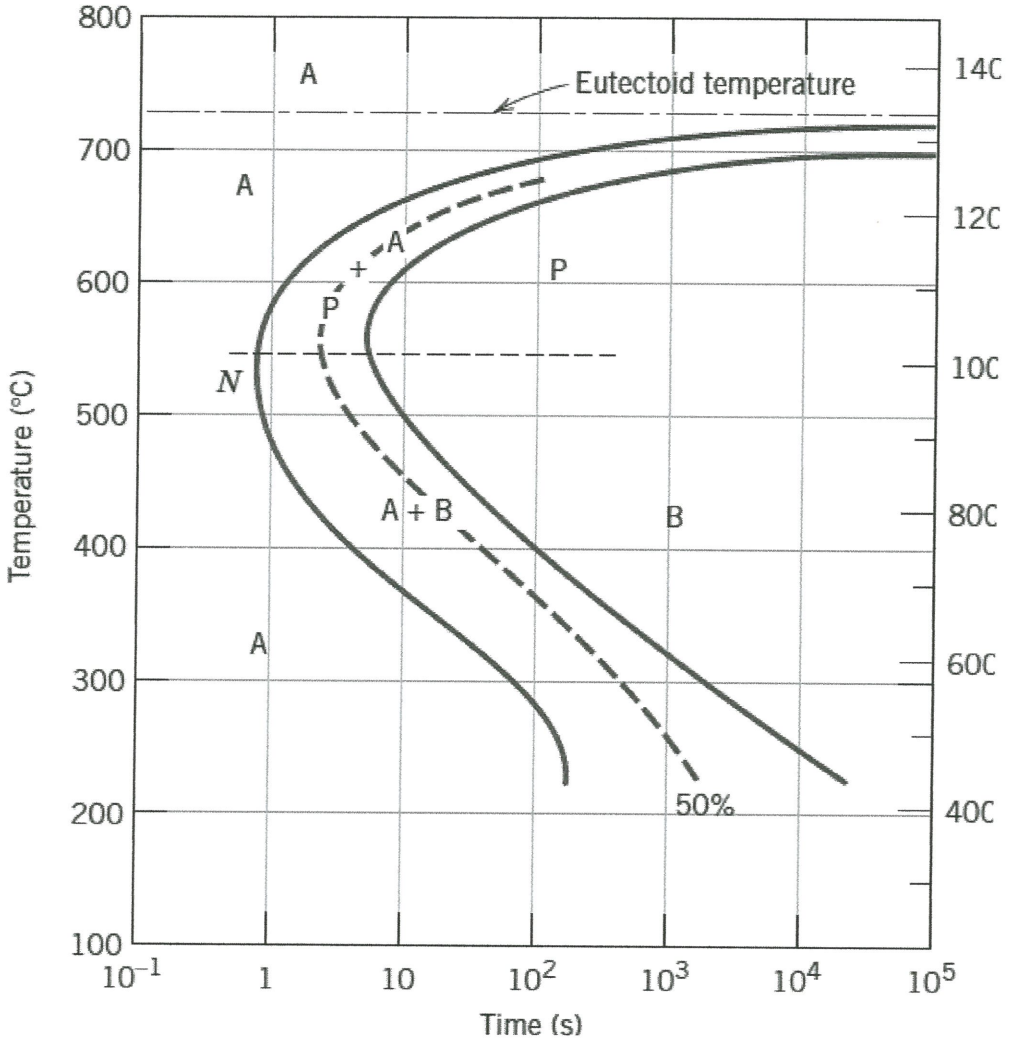

FIGURE Q4(c)