UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/2010

SUBJECT NAME	:	MATERIALS SCIENCE
SUBJECT CODE	:	DDA 2053
COURSE	:	2 DDM
EXAMINATION DATE	:	APRIL/MAY 2010
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER FIVE (5) FROM SIX (6) QUESTIONS.

THIS PAPER CONTAINS SEVEN (7) PAGES

Q1 (a) Define TWO (2) types of solid materials. Give an example for each type and sketch an appropriate structure.

(7 marks)

(b) Strontium is FCC and has an atomic radius of 0.215 nm. Calculate a value for its lattice constant in nanometers.

(3 marks)

(c) Determine the Miller indices of the planes in Figure Q1 (c).

(4 marks)

(d) Sketch with complete label for the following directions and crystal planes in cubic unit cell:

(i) $[1\ \bar{1}\ \bar{2}]$, $[1\ 2\ \bar{2}]$, $[\bar{2}\ \bar{2}\ 3]$
(ii) $(1\ 0\ \bar{2})$, $(3\ \bar{1}\ 2)$, $(1\ \bar{2}\ \bar{1})$

(6 marks)

Q2 (a) A plate of iron is exposed to a carburizing (carbon-rich) atmosphere on one side and a decarburizing (carbon-deficient) atmosphere on the other side at 700°C. If a condition of steady state is achieved, calculate the diffusion flux of carbon through the plate if the concentrations of carbon at positions of 5 and 10 mm (5×10^{-3} and 10^{-2} m) beneath the carburizing surface are 1.2 and 0.8 kg/m^3 respectively. Assume the diffusion coefficient of 3×10^{-11} m^2/s at this temperature.

(5 marks)

(b) Describe and illustrate the following imperfections that can exist in crystal lattice:

(i) Frenkel imperfection
(ii) Schottky imperfection

(5 marks)

(c) The surface of a steel gear made of 1018 steel (0.18 wt % C) is to be gas-carburized at 927°C. Calculate the time necessary to increase the carbon content to 0.35 wt % at 1.00 mm below the surface. Assume the carbon content of the surface of the gear is 1.20 wt %. D (C in γ iron) at 927°C = 1.28×10^{-11} m^2/s.
(Use table Q2 (c) if necessary)

(10 marks)

Q3 (a) Define hardness. State FOUR (4) common types of hardness test.

(4 marks)

(b) Twenty-cm- long rod with a diameter of 0.250 cm is loaded with a 5000 N weight. If the diameter decreases to 0.210 cm, at this load determine:

(i) The engineering stress and strain
(ii) The true stress and strain

(8 marks)

(c) List FIVE (5) factors that influence diffusivity.

(5 marks)

(d) Calculate the diffusivity in m^2/s for the diffusion of zinc in copper at 350°C. Use $D_0 = 3.4 \times 10^{-5}$ m^2/s; Q = 191 kJ/mol; R = 8.314 J/(mol.K).

(3 marks)

Q4 (a) Explain briefly the following processes:

(i) Annealing
(ii) Normalizing
(iii) Tempering

(6 marks)

(b) Refer to Figure Q4 (b), consider the binary eutectic copper-silver phase diagram. Make phase analysis of an 30 wt % Ag-70 wt % Cu alloy at the temperature 900°C. In the phase analysis, include:

(i) The phase present
(ii) The chemical compositions of the phases
(iii) The amounts of each phase
(iv) Sketch the microstructure by using circular microscopic fields.

(10 marks)

(c) Compare these invariant reactions between eutectoid and eutectic. State the equation respectively.

(4 marks)

Q5 (a) Define ferrous alloy and non-ferrous alloy.

(2 marks)

(b) Explain briefly only TWO (2) following types of cast iron in terms of compositions, mechanical properties and applications.

(i) White
(ii) Malleable
(iii) Gray
(iv) Ductile

(6 marks)

(c) State THREE (3) comparison between thermoplastic and thermosets polymer respectively.

(6 marks)

(d) List FOUR (4) general properties of ceramic materials and give TWO (2) applications of ceramic material.

(6 marks)

Q6 (a) Define a composite material. Give FOUR (4) fabrication methods for composite materials.

(6 marks)

(b) State the types of polymer processing and give TWO (2) examples.

(4 marks)

(c) What is the definition of corrosion and give TWO (2) factors that affect the corrosion of metals.

(4 marks)

(d) Explain briefly THREE (3) types of corrosion.

(6 marks)

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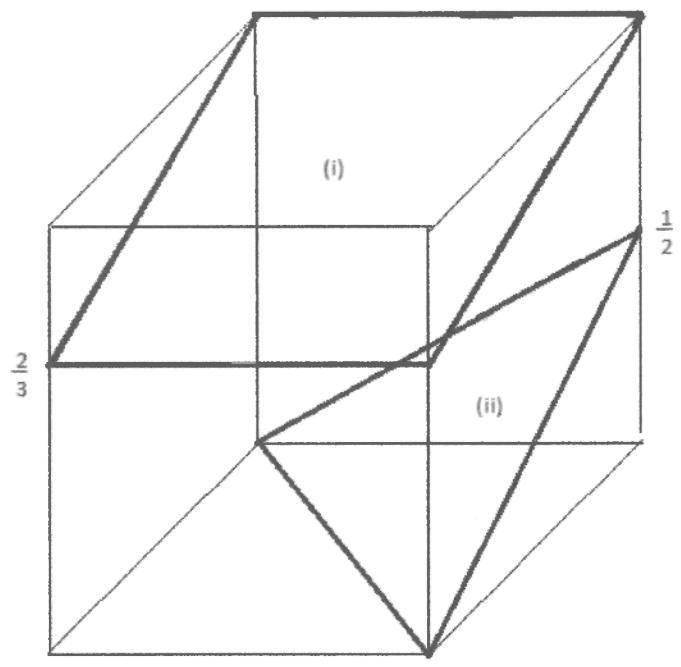

Figure Q1 (c)

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Table Q2 (c)

Table of error function

z	erf z	z	erf z	z	erf z	z	erf z
0	0	0.40	0.4284	0.85	0.7707	1.6	0.9763
0.025	0.0282	0.45	0.4755	0.90	0.7970	1.7	0.9838
0.05	0.0564	0.50	0.5205	0.95	0.8209	1.8	0.9891
0.10	0.1125	0.55	0.5633	1.0	0.8427	1.9	0.9928
0.15	0.1680	0.60	0.6039	1.1	0.8802	2.0	0.9953
0.20	0.2227	0.65	0.6420	1.2	0.9103	2.2	0.9981
0.25	0.2763	0.70	0.6778	1.3	0.9340	2.4	0.9993
0.30	0.3286	0.75	0.7112	1.4	0.9523	2.6	0.9998
0.35	0.3794	0.80	0.7421	1.5	0.9661	2.8	0.9999

EQUATION

$$\text{Concentration gradient} = \frac{dC}{dx} = \frac{C_A - C_B}{x_A - x_B}$$

$$\frac{C_x - C_o}{C_s - C_o} = 1 - \text{erf}\left(\frac{x}{2\sqrt{Dt}}\right)$$

$$\frac{C_s - C_x}{C_s - C_o} = \text{erf}\left(\frac{x}{2\sqrt{Dt}}\right)$$

$$\frac{x}{2\sqrt{Dt}} = z = \text{constant}$$

$$J = -D\frac{dC}{dx}$$

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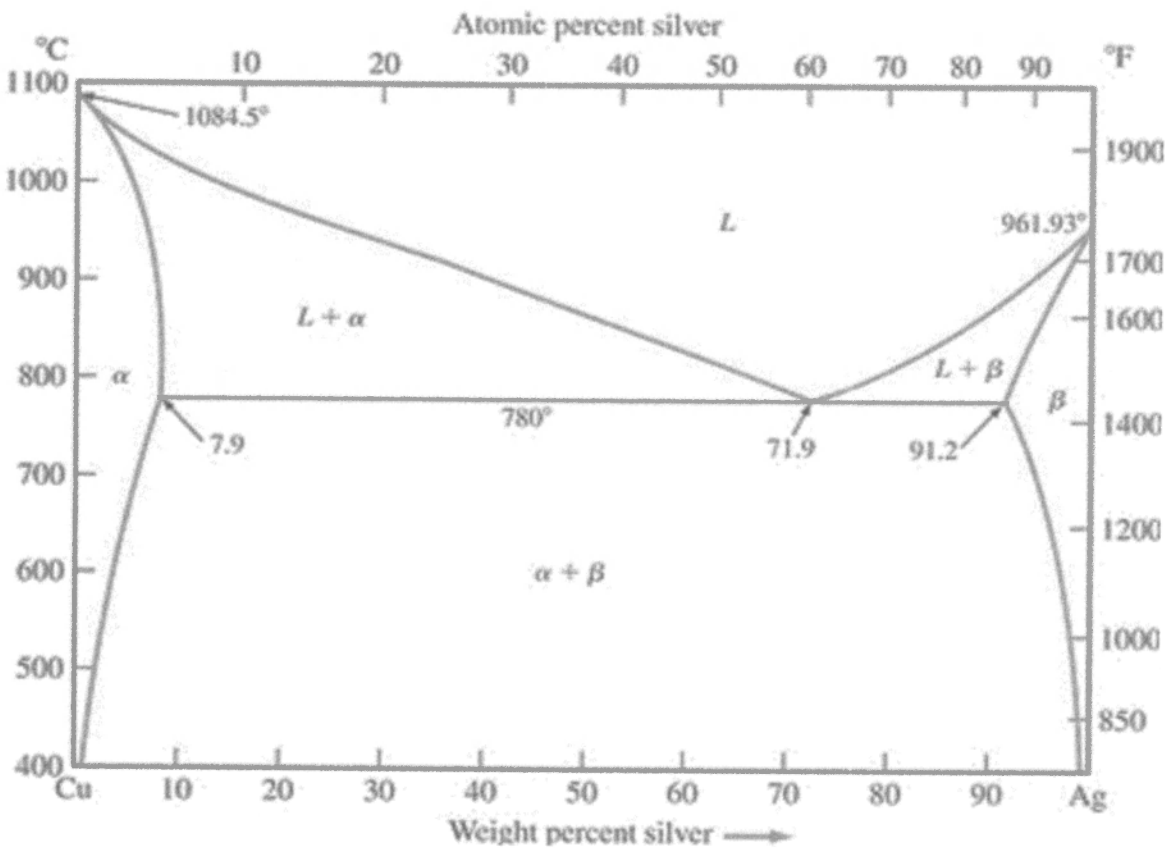

Figure O4 (b)