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SET A

UNIVERSITI KALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2010 SESSION

SUBJECT CODE	:	FTB 12102
SUBJECT TITLE	:	FUNDAMENTAL METALLURGY
LEVEL	:	BACHELOR
TIME / DURATION	:	4.00pm – 6.00pm (2 HOURS)
DATE	:	08 MAY 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of FIVE (5) questions. Answer FOUR (4) questions only.
6. Answer all questions in English.
7. Graph paper is appended.

THERE ARE 6 PAGES OF QUESTIONS AND 2 PAGES OF APPENDIX, EXCLUDING THIS PAGE.

INSTRUCTION: Answer FOUR (4) questions only.

Question 1

(a) List **THREE (3)** raw materials that melted in a blast furnace to produce pig iron.

(3 marks)

(b) Steelmaking from scrap metal involves melting scrap metal, removing impurities and casting into a desired shape. This process does not require the three step refinement as needed to produce steel from ore. Sketch and describe the process involved in the presence of oxygen in the electric arc furnace.

(10 marks)

(c) An important part of steel making is the formation of slag. Define the role of slag in steel making furnace.

(5 marks)

(d) Describe the processing of iron ore.

(7 marks)

Question 2

(a) Name the SAE number for the steel with the following components:

(ii) 1.75% manganese, 0.4% carbon

(iii) 5.0% Nickel, 0.6% Carbon

(4 marks)

(b) Rhodium has an atomic radius of 0.1345 nm and a density of 12.41 gcm^{-3}. Verify whether it has a face centered cubic (FCC) or body centered cubic (BCC) crystal structure. Atomic weight of Rhodium is 102.9 $gmol^{-1}$ and Avogadro's number is 6.023×10^{23} $atomsmol^{-1}$.

(8 marks)

(c) Describe the effect of oxygen in steel.

(2 marks)

(d) Describe the advantages and disadvantages of cast iron in industrial application.

(4 marks)

(e) Despite of grey cast iron graphite in malleable cast iron separates out much more slowly and has time to form spheroidal particles rather than flakes. Sketch its microstructure and describe the advantages and disadvantages in industrial application.

(7 marks)

Question 3

(a) Describe hypereutectoid alloy.

(4 marks)

(b) Sketch the microstructure at A, B and C points shown in Figure 1 of an iron-carbon alloy of hypereutectoid composition C_1 (containing between 0.76 and 2.14 wt% C), as it is cooled from within the austenite phase region to below the eutectoid temperature.

(6 marks)

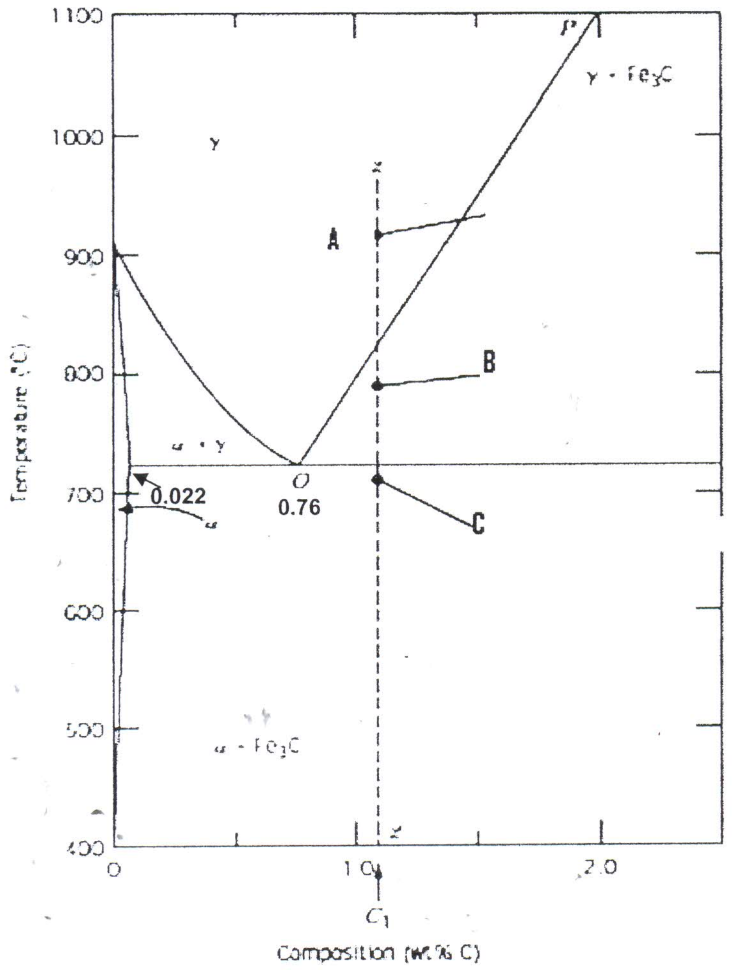

Figure 1: Iron Carbon Diagram

(c) For a 99.65 wt% Fe–0.35 wt% C alloy at a temperature just below the eutectoid, determine the following. Refer figure 1.

a. The fractions of total ferrite and cementite phases.

b. The fractions of the proeutectoid ferrite and pearlite.

c. The fraction of eutectoid ferrite.

(15 marks)

Question 4

(a) Draw a specimen for Charpy impact test. Label its dimensions clearly.

(3 marks)

(b) State the effect of carbon percentage increment in steel composition.

(4 marks)

(a) A cylindrical specimen of a titanium alloy having an elastic modulus of 107 GPa and an original diameter of 3.8 mm will experience only elastic deformation when a tensile load of 12000 N is applied. Compute the maximum length of the specimen before deformation if the maximum allowable elongation is 0.42 mm.

(8 marks)

(b) A 10 mm diameter bar of 1040 carbon steel is subjected to a tensile load of 50,000 N, taking it beyond its yield point. Calculate the elastic recovery that would occur upon removal of the tensile load.

(5 marks)

(c) A Brinell hardness measurement is made on a ductile iron (100-70-03, air-quenched) using a 10 mm diameter sphere of tungsten carbide. A load of 3,000 kg produces a 3.91 mm diameter impression in the iron surface. Calculate the BHN of this alloy.

(5 marks)

Question 5

(a) The following data (Table 1) were collected from a tensile test on a cylindrical specimen of aluminum that having a diameter of 12.5 mm and original gauge length is 50.5mm.

I. Plot Stress Strain curve.
II. Determine the yield strength by 0.2% offset
III. Determine the tensile strength for the aluminum sample.

(10 marks)

Strain (mm/mm)	Stress (MPa)
0.0000	0
0.0010	67
0.0020	127.3
0.0030	189.5
0.0040	246.2
0.0050	277.3
0.0100	308.4
0.0200	330.9
0.0400	358.1
0.0600	369
0.0800	377.5
0.1000	379
0.1200	368.2
0.1350	358.1
0.1500	341
0.1650	292.8
	Fracture

Table 1

(b) A part of metal has been heated to a high temperature and then has been cooled. Suggest and explain the most suitable cooling process to produce the softest part of metal.

(7 marks)

(d) Describe the type of corrosion failure shown in Figure 2 below.

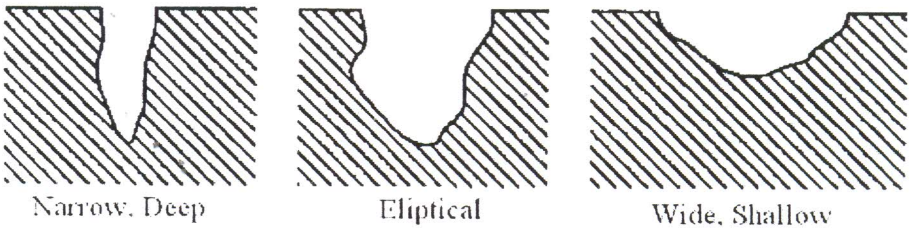

Figure 2: Failure

(3 marks)

(e) Suggest the prevention method to this corrosion.

(5 marks)

END OF QUESTION

Key: 29 ← Atomic number; Cu ← Symbol; 63.54 ← Atomic weight

☐ Metal

☐ Nonmetal

☐ Intermediate

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	0
1 H 1.0080																	2 He 4.0026
3 Li 6.939	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.183
11 Na 22.990	12 Mg 24.312											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.91	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	Rare earth series	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	Acti-nide series															

Rare earth series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	89 Ac (227)	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lw (257)

$$APF = (n)(\frac{4\pi r^3}{3})(\frac{1}{a^3})$$

$$\rho = \frac{nA}{V_c N_A}$$

$$N = \frac{N_A \rho}{A}$$

$$N_v = N \exp(\frac{-Q}{kT})$$

$$a_{fcc} = \frac{4r}{\sqrt{2}}$$

$$a_{bcc} = \frac{4r}{\sqrt{3}}$$

$$a_{sc} = 2r$$

$$D = D_o \exp(\frac{-Q_d}{RT})$$

$$m_\alpha\, phase = \frac{m_\beta - m_x}{m_\beta - m_\alpha} x Total\ Mass$$

$$m_\beta\, phase = \frac{m_x - m_\alpha}{m_\beta - m_\alpha} x Total\ Mass$$

$$m_L phase\% = \frac{m_s\% - m_x\%}{m_s\% - m_{L\%}} x100$$

$$m_s phase\% = \frac{m_x\% - m_L\%}{m_s\% - m_{L\%}} x100$$

$$\rho_\alpha = \frac{100}{\frac{C_{A(\alpha)}}{\rho_A} + \frac{C_{B(\alpha)}}{\rho_B}}$$

$$\rho_\beta = \frac{100}{\frac{C_{A(\beta)}}{\rho_A} + \frac{C_{B(\beta)}}{\rho_B}}$$

$$V_\alpha = \frac{\frac{m_\alpha}{\rho_\alpha}}{\frac{m_\alpha}{\rho_\alpha} + \frac{m_\beta}{\rho_\beta}}$$

$$V_\beta = \frac{\frac{m_\beta}{\rho_\beta}}{\frac{m_\alpha}{\rho_\alpha} + \frac{m_\beta}{\rho_\beta}}$$

$$\sigma = \frac{F}{A_o}$$

$$\varepsilon = \frac{\Delta l}{l_o}$$

$$E = \frac{\sigma}{\varepsilon}$$

$$\%elongation = \frac{\Delta l}{l_o} x100\%$$

$$\%\ area\ reduction = \frac{\Delta A}{A_o} x100\%$$

$$BHN = \frac{F}{\frac{\pi D}{2}(D - \sqrt{D^2 - d^2})}$$

$$VHN = \frac{1.85F}{d^2}$$