Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	ENGINEERING TECHNOLOGY MATERIALS
COURSE CODE	:	BDU 10603
PROGRAMME CODE	:	1 BDC /1 BDM
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FIVE (5)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) List four (4) mechanical properties of metals.

(4 marks)

(b) In cubic unit cells, sketch the following direction vectors and crystal planes

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

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

(iii) $(\bar{1}2\bar{3})$

(iv) $(0\bar{1}\bar{3})$

(8 marks)

(c) Calculate the atomic radius of Vanadium, given that Vanadium has a BCC structure, a density of 5.96g/cm^3 and an atomic weight of 50.9 g/mol

(8 marks)

Q2 (a) Compare the mechanism of interstitial and vacancy atomic for diffusion.

(4 marks)

(b) Briefly explain two (2) reasons why interstitial diffusion is normally more rapid than vacancy diffusion.

(4 marks)

(c) An FCC iron-carbon alloy initially containing 0.35 wt% C is exposed to an oxygen-rich and virtually carbon-free atmosphere at 1400 K (1127°C). Under these circumstances the carbon diffuses from the alloy and reacts at the surface with the oxygen in the atmosphere; that is, the carbon concentration at the surface position is maintained essentially at 0 wt% C. This process of carbon depletion is termed decarburization. At what position will the carbon concentration be 0.15 wt% after a 10-h treatment? The value of D at 1400 K is 6.9×10^{-11} m^2/s. (The Error Function value is given in Table Q2 (b).

(8 marks)

(d) The activation energy for the diffusion of carbon in chromium is 111,000 J/mol. Calculate the diffusion coefficient at 1100 K (827°C), given that D at 1400 K (1127°C) is 6.25 × 10-11 m^2/s.

(4 marks)

Q3 (a) A specimen of ductile cast iron having a rectangular cross section of dimensions 4.8 mm × 15.9 mm is deformed in tension and the results of the tensile test are given in Table Q3(a). Plot the engineering stress-strain curve for these data. (Note that 1 MPa = 1 N/mm²)

(8 marks)

(b) From the engineering stress strain curve plotted in Q3(a), determine :

(i) The 0.2% offset yield strength
(ii) The modulus of elasticity
(iii) The ultimate tensile strength
(iv) The percent of elongation

(8 marks)

(c) Gives four (4) methods to improve fatigue resistance of structural components.

(4 marks)

Q4 (a) Consider the Copper-Lead (Cu-Pb) phase diagram system in Figure Q4(a). Make the phase analyses which includes of the phases present, the chemical compositions of the phases and the amounts of each phase of Cu-10 wt % Pb at the temperatures of :

(i) 1000°C

(ii) 955°C + ΔT,

(iii) 955°C-ΔT,

(iv) 200°C.

(16 marks)

(b) Briefly explain the differences between pearlite, bainite, and spheroidite relative to microstructure and mechanical properties.

(4 marks)

Q5 (a) Describe the properties and gives two (2) examples for each of these metals:

(i) Ferrous metals

(ii) Non-ferrous metals

(8 marks)

(b) Suggest three (3) advantages and disadvantages of using advanced ceramics in automobile engines application.

(6 marks)

(c) Describe and illustrate four (4) types of Polymer microstructure.In the illustration, arrange the micsrostructure based on their covalent strength.

(6 marks)

Q6 (a) Continuous glass-fiber-reinforced-epoxy composite is made by 60% volume of E-glass fibers having a modulus of elasticity of 7.24×10^4 MPa and a tensile strength of 2.4 GPa; and a hardened epoxy resin with a modulus of 3.1×10^3 MPa and a tensile strength of 0.06 GPa. Assume the stress on the material causes uniform strain on all the composite layers. Calculate:

(i) The modulus of elasticity of this composite

(ii) The tensile strength

(6 marks)

(b) Briefly explains the benefits of using Polymer Matrix Composite (PMC), Metal Matrix Composites (MMC) and Ceramic Matrix Composites (CMC) with regards to the toughness, modulus of Elasticity and creep resistance of the materials, by providing relevance graph.

(6 marks)

(c) Hand layup and spray up techniques, Filament winding, Pultrusion, Autoclave moulding and Resin Transfer Moulding (RTM) are types of forming processes for Thermosets matrix composites. Choose two (2) of this forming process, explain the process and evaluate the advantages or disadvantages of the chosen process.

(8 marks)

-END OF QUESTIONS –

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Table Q2(b) : Tabulation of Error Function Values

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	0.9523
0.05	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

Table Q3(a): The tensile test of a Cast Iron

Load		Length	
N	lbf	mm	in
0	0	75	2.953
4,740	1,065	75.025	2.954
9,140	2,055	75.05	2.955
12,920	2,900	75.075	2.956
16,540	3,720	75.113	2.957
18,300	4,110	75.15	2.959
20,170	4,530	75.225	2.962
22,900	5,145	75.375	2.968
25,070	5,635	75.525	2.973
26,800	6,025	75.75	2.982
28,640	6,440	76.5	3.012
30,240	6,800	78	3.071
31,100	7,000	79.5	3.13
31,280	7,030	81	3.189
30,820	6,930	82.5	3.248
29,180	6,560	84	3.307
27,190	6,110	85.5	3.366
24,140	5,430	87	3.425
18,970	4,265	88.725	3.493
Fracture			

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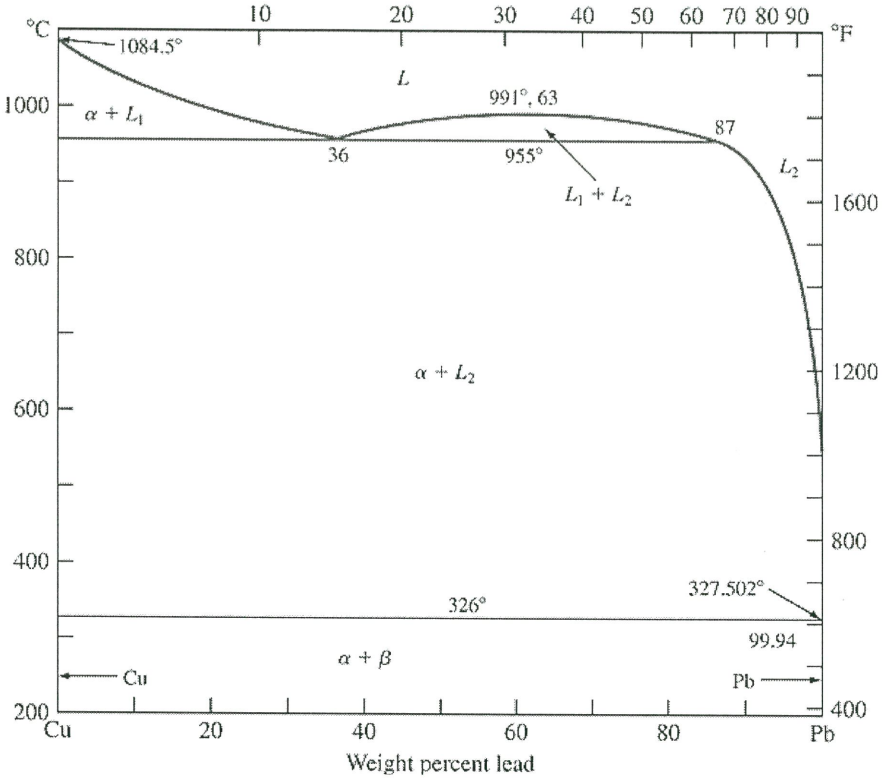

Figure Q4 (a): The Copper-Lead phase diagram.