UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAM
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	ENGINEERING TECHNOLOGY MATERIALS
COURSE CODE	:	BDU 10603
PROGRAMME	:	1 BDC/1 BDM
EXAMINATION DATE	:	JUNE 2015/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER FIVE (5) OF SIX (6) QUESTIONS

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

Q1 (a) Define the following terms:

(i) Fatigue

(ii) Creep

(iii) Composite material

(iv) Metals material

(4 marks)

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

(i) $[\bar{2}\bar{2}3]$

(ii) $[02\bar{1}]$

(iii) $(20\bar{1})$

(iv) $(10\bar{3})$

(8 marks)

(c) Consider Platinum below 102°C, where its structure is Face Centered Cubic (FCC). Given the density of FCC platinum as 21.45 g/cm^3 and its atomic mass as 195.09 g/mol, calculate its lattice constant *a,* of the unit cell and the radius of the Pt atom. Note that Avogadro number is $6.022 \times 10^{23}\ mol^{-1}$.

(8 marks)

Q2 (a) List out **FOUR (4)** types of volume or bulk defects occurs for 3D defects.

(4 marks)

(b) Boron is diffused into a thick slice of silicon with no previous Boron in it at a temperature of 1100°C for 5 hours. Given that Diffusion, D = $4 \times 10^{-13}\ cm^2/s$ for Boron diffusing in silicon at 1100°C. Determine the depth below the surface at which the concentration is 10^{17} atoms/cm^3 if the surface concentration is 10^{18} atoms/cm^3. (Error Function is given in Table **Q2(b)**).

(6 marks)

(c) Explain **FOUR (4)** factors that influence diffusivity of an atom.

(4 marks)

(d) The diffusivity of manganese atoms in the FCC iron lattice is 1.5×10^{-14} m^2/s at 1300°C and 1.5×10^{-15} m^2/s at 400°C. By applying the concept of temperature influenced diffusivity $= D_0 \exp\left(-\frac{Q_d}{RT}\right)$, show the activation energy in kJ/mol for this case in this temperature range. Given that R = 8.314 J/ (mol·K).

(6 marks)

Q3 (a) The results of a tensile test on a 0.2% C plain-carbon steel bar are given in **Table Q3(a).** The initial gauge length and the initial diameter of the bar are 25.00mm and 5.05mm respectively. The diameter at the fracture is 4.4mm. Plot the engineering stress-strain curve for these data.

(4 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 reduction of area

(6 marks)

(c) Describe the terms "plastic deformation" and illustrate the steps of plastic deformation.

(4 marks)

(d) A 20 cm long rod with a diameter of 0.250 cm is loaded with a 5000 N weight. If the diameter of the bar is 0.490 cm at this load, acquire

(i) The engineering stress and strain

(ii) The true stress and strain.

(6 marks)

Q4 Consider the binary peritectic Iridium-Osmium phase diagram of **FIGURE Q4(a).** Create phase analyses of a 70 wt % Ir-30 wt % Os at the temperatures of:

(a) 2600°C

(i) The phases present

(ii) The chemical compositions of the phases

(iii) The amounts of each phase

(iv) Sketch the microstructure by using 2 cm diameter circular fields

(4 marks)

(b) 2665°C + ΔT

(i) The phases present

(ii) The chemical compositions of the phases

(iii) The amounts of each phase

(iv) Sketch the microstructure by using 2 cm diameter circular fields

(4 marks)

(c) 2665°C – ΔT

(i) The phases present

(ii) The chemical compositions of the phases

(iii) The amounts of each phase

(iv) Sketch the microstructure by using 2 cm diameter circular fields

(4 marks)

(d) 2800°C

(i) The phases present

(ii) The chemical compositions of the phases

(iii) The amounts of each phase

(iv) Sketch the microstructure by using 2 cm diameter circular fields

(4 marks)

(e) Create an isothermal transformation diagram for a plain-carbon eutectoid steel and indicate the various decomposition products on it. Propose what is the microstructure produced after austempering a eutectoid plain-carbon steel. Justify whether an austempered steel need to be tempered.

(4 marks)

Q5 (a) Distinguish between traditional and engineering ceramic materials and give examples of each type.

(4 marks)

(b) Draw and propose aircraft parts which are made from composite materials.

(6 marks)

(c) Composite materials are becoming more important and widely use in aerospace industries. A350 and B787 compose of more than 50% of composite from total structure. Describe **FOUR (4)** influences of composite usage in aeronautical field.

(8 marks)

(d) Provide the two metals that are used to produce Brass.

(2 marks)

Q6 (a) One of the useful applications of ceramics is in sensors manufacturing. Provide the principle and operations of ceramic application in sensors by using appropriate example.

(5 marks)

(b) Ceramic fabrication techniques involve glass forming, particulate forming and cementation process. Choose **ONE (1)** of these techniques and explain in details the process.

(5 marks)

(c) Describe and illustrate the following types of point imperfections that can be present in metal lattices:

(i) vacancy,

(ii) divacancy,

(iii) interstitialcy.

(6 marks)

(d) Hand layup, spray-up, filament winding, pultrusion, autoclave moulding and resin transfer moulding are SIX (6) forming processes for Thermoset matrix composites. Choose **ONE (1)** of this forming process and discuss briefly on its process by evaluating the advantages and disadvantages of the chosen process.

(4 marks)

- END OF QUESTION –

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COURSE : MATERIAL SCIENCE SUBJECT CODE: BDU 10603

TABLE Q2(b): Error Function

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

TABLE Q3(a): Tensile test results

Data	Engineering Stress (MPa)	Engineering Strain (mm/mm)
1	0	0
2	103.4	0.0005
3	206.7	0.0010
4	275.6	0.0015
5	344.5	0.0020
6	413.4	0.0035
7	454.7	0.0040
8	482.3	0.0060
9	496.1	0.0080

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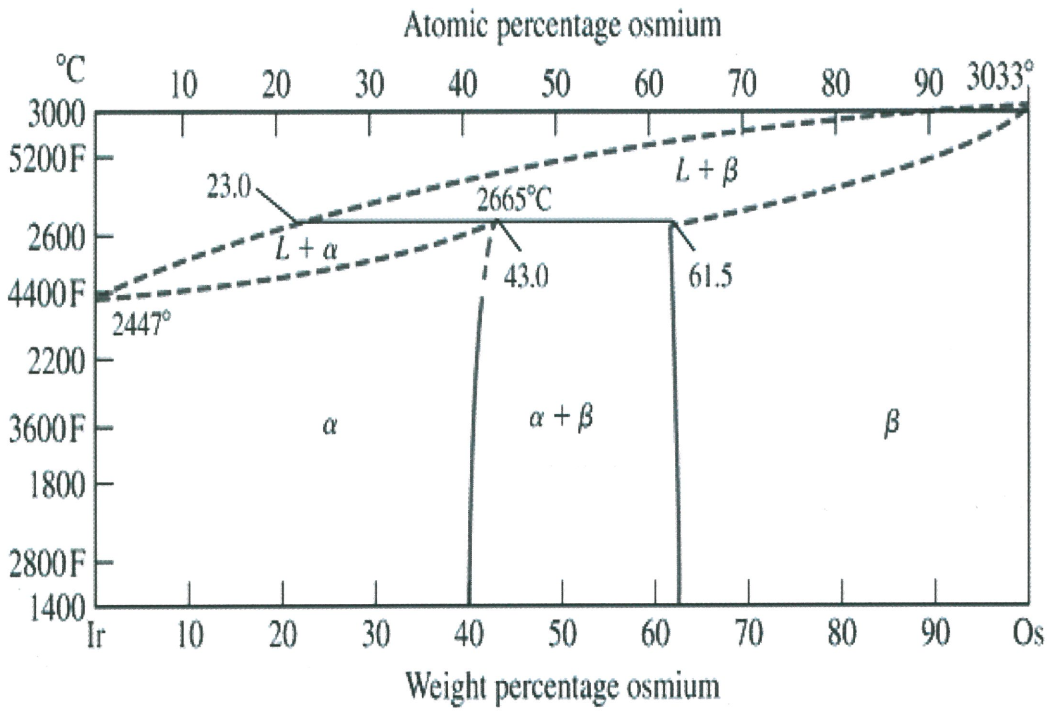

FIGURE Q4(a) : Binary pertitectic irdium-somium phase diagram