Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ENGINEERING TECHNOLOGY MATERIALS
COURSE CODE	:	BDU 10603
PROGRAMME CODE	:	BDM
EXAMINATION DATE	:	DECEMBER 2019 /JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ONLY FIVE (5)** QUESTIONS FROM **SIX (6)** QUESTIONS PROVIDED

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

Q1 (a) Differentiate between metal, polymer and ceramic in terms of the elemental content or elemental combinations that made up the materials.

(3 marks)

(b) Solid materials can be divided to crystalline materials and non-crystalline materials. Distinguish these materials in terms of energy and packing. Use appropriate figure to support your answer.

(5 marks)

(c) Most metals crystallize into three crystal packed structures namely body centered cube, face centered cube and hexagonal close-packed structure. Based on the volume of a cell unit and spheres, show the atomic packing factor for the structure with the lowest packing factor.

(6 marks)

(d) Use your knowledge about crystallographic plane to determine the atomic density at (110) of α-Fe with a body centered cube lattice in atom per millimeter. The lattice constant for α-Fe is 0.287 nm.

(6 marks)

Q2 (a) Explain the defects that occur in pure metals.

(2 marks)

(b) Describe the differences between point defects and linear defects.

(4 marks)

(c) The Second Fick's Law used in a non-steady state diffusion with a condition in which the diffusion constant is independent of the concentration is given as the following:

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2}$$

Sketch a concentration profile for a non-steady state diffusion by showing all the concentration parameters involved.

(4 marks)

(d) If boron is diffused into a thick slice of silicon with no previous boron in it at a temperature of 1100°C for 5 h, calculate 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.

D = 4 x 10^{-13} cm^2/s for boron diffusing in silicon at 1100°C.

(10 marks)

Q3 (a) Distinguish the following behaviors of a material. Support your statement with a stress-strain diagram.

(i) Material that behaves elastically.
(ii) Material that behaves plastically.

(10 marks)

(b) Illustrate FOUR (4) specimen geometries of a deformed specimen which underwent the tensile test.

(4 marks)

(c) You are required to conduct types of impact tests on a specimen. Explain both of this impact tests by the assistance of appropriate illustration of the samples.

(4 marks)

(d) Explain the difference between a fatigue test and a creep test.

(2 marks)

Q4 (a) By referring to Pb-Sn system in **Figure Q4**,

(i) State the type of invariant reaction occurs and gives the related equation.

(2 marks)

(ii) Apply a phase analysis for Pb-Sn alloy with composition of 30-wt% Sn at 183 + ΔT °C.

(6 marks)

(b) Distinguish the characteristics of phase diagram and TTT diagram.

(8 marks)

(c) Explain about quenching and tempering in heat treatment of steel.

(4 marks)

Q5 (a) Describe the following material fabrication techniques.
(i) Glass forming
(ii) Slip casting

(4 marks)

(b) Select one type of metallic alloy that suitable for wing of aircraft and justify your answer.

(4 marks)

(c) Distinguish between thermoplastic polymer and thermoset polymer.

(6 marks)

(d) Distinguish the properties of the materials and choose one potential candidate material for each of the following purpose with justifications:

(i) Water tap
(ii) Glass container

(6 marks)

Q6 (a) Define the following terms:

(i) Ultrahigh molecular weight polyethylene (UHMWPE)

(ii) Network polymer

(2 marks)

(b) Choose one type of composites materials that can be used to build the aircraft and write your justification.

(3 marks)

(c) Compare the properties of polymer matrix composites and ceramic composites and select one suitable application for each type of composite with justification.

(12 marks)

(d) Explain about the function of matrix, interface and reinforcement in composite material.

(3 marks)

- END OF QUESTIONS –

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Table 1 : 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

Figure Q2(d)

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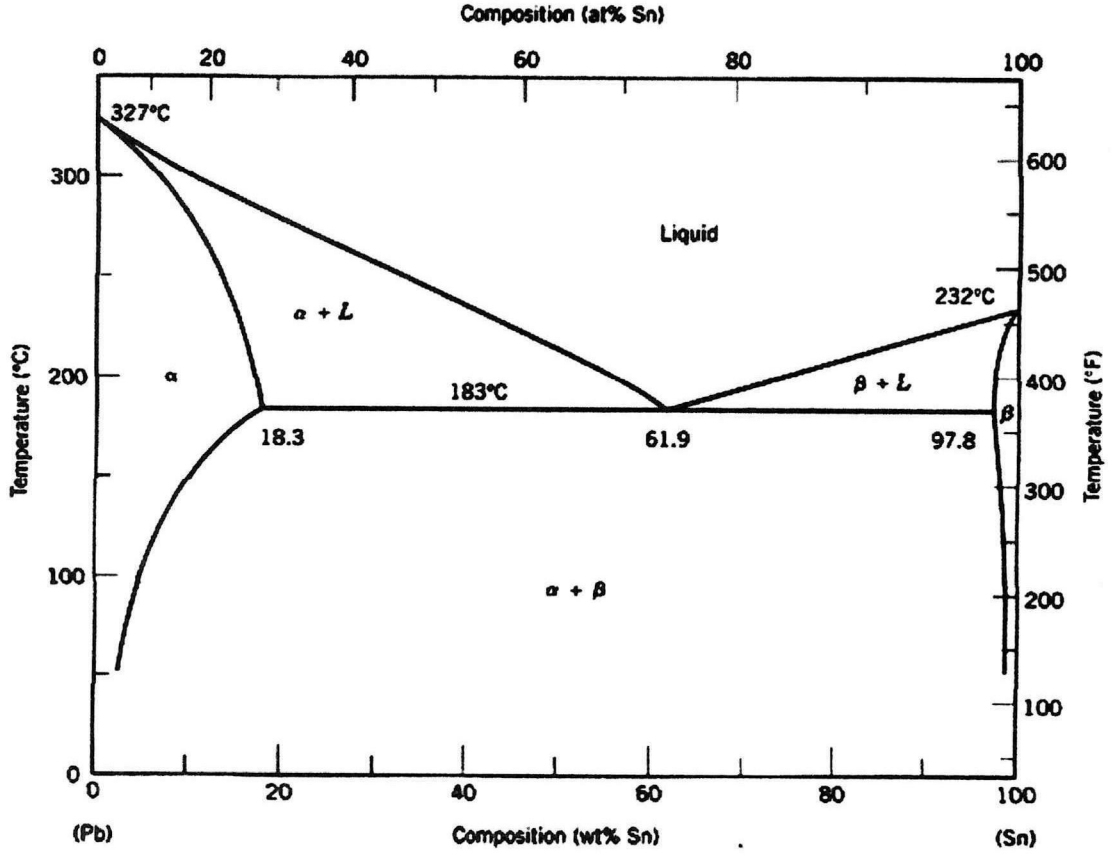

Figure Q4