



INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session : April 2019

Programme : Diploma in Electrical & Electronic Engineering (DEEI)

Course : EGM1182: Structures and Properties of Materials

Date of Examination : 31 July 2019 (Wednesday)

Time : 2:00pm – 4:00pm Reading Time : Nil

Duration : 2 Hours

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :
Non-Programmable Calculator

Materials provided :
Nil

Examiner(s) : Richard Lai Tian Fat

Moderator : Prof. Ir. Dr. Cheong Kuan Yew

This paper consists of 6 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
 EGM 1182: STRUCTURES AND PROPERTIES OF MATERIAL
 FINAL EXAMINATIONS: APRIL 2019 SESSION

Instructions: This paper consists of **SIX (6)** questions. Attempt any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

(a) The cladding (outside layers) of the United State quarter coin consists of an alloy of 75 wt% copper and 25 wt% nickel. What are the atomic percent Cu and atomic percent Ni contents of this material? Assume the gram-mole for Cu is 63.54 g/mol and Ni is 58.69 g/mol.

(2 marks)

(b) Briefly describe the following types of secondary bonding:

- (i) Fluctuating dipole,
- (ii) Permanent dipole and
- (iii) Interionic forces for an ion pair

(9 marks)

(c) Calculate the coulombic attractive force between a pair of Na^+ and Cl^- ions that just touch each other. Assume the ionic radius of the Na^+ ion to be 0.095 nm and that of the Cl^- ion to be 0.181 nm. Briefly explain the repulse force and determine its magnitude in this case.

(9 marks)

(d) Sketch and explain the atomic arrangement for solid and liquid.

(5 marks)

Question 2

(a) What are the two (2) main items of information that could be obtained from the Periodic Table of Elements?

(2 marks)

(b) Determine the Miller indices for the planes in the cubic unit cell shown in Figure 1 intersects the coordinates $(1 \frac{1}{4} 0)$, $(1 \frac{1}{2} 1)$, $(\frac{3}{4} 1 \frac{1}{4})$.

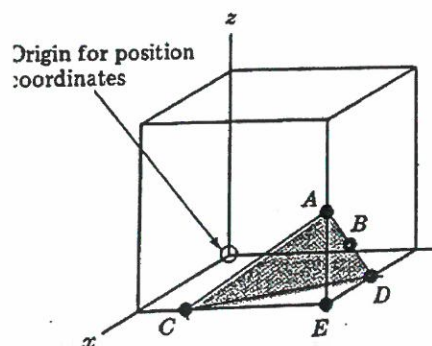


Figure 1.

(8 marks)

(c) Copper has an FCC crystal structure and an atomic radius of 0.1278 nm. Assuming the atoms to be hard spheres which touch each other along the face diagonals of the FCC unit cell. Calculate a theoretical value for the density of copper in megagrams per cubic meter. The atomic mass of copper is 63.54 g/mol.

(9 marks)

(d) Describe and illustrate the solidification process of a pure metal crystal.

(6 marks)

Question 3

(a) Explain point defects formation during solidification.

(6 marks)

(b) Calculate the radius of the largest interstitial void in the FCC γ iron lattice. The atomic radius of the iron atom in this lattice is 0.129 nm, and the largest interstitial voids occur at the position of $(\frac{1}{2} \ 0 \ 0)$; $(0 \ \frac{1}{2} \ 0)$; $(0 \ 0 \ \frac{1}{2})$, etc.

(7 marks)

(c) Define the following terms related to the mechanical behavior of materials

- (i) Endurance limits,
- (ii) Fatigue strength,
- (iii) Engineering stress and its SI unit,
- (iv) Engineering strain and its SI unit.

(8 marks)

(d) Calculate the engineering stress in SI units on a 15-cm long bar with a cross section of 4.25 mm \times 12.0 mm and subjected to a load of 5000 kg.

(4 marks)

Question 4

(a) What are the characteristics of a fracture surface in a ductile metal?

(3 marks)

(b) What are the characteristics of a fracture surface in a brittle metal?

(3 marks)

(c) What is metal creep?

(3 marks)

(d) Make phase analysis of the equilibrium solidification of lead-tin alloys at the following points in the lead-tin phase diagram as shown in Figure 2.

- (i) At the eutectic composition just below 183°C (eutectic temperature).
- (ii) The point c at 40% Sn and 230°C.
- (iii) The point d at 40% Sn and 180 °C + ΔT .
- (iv) The e at 40% Sn and 183 °C - ΔT .

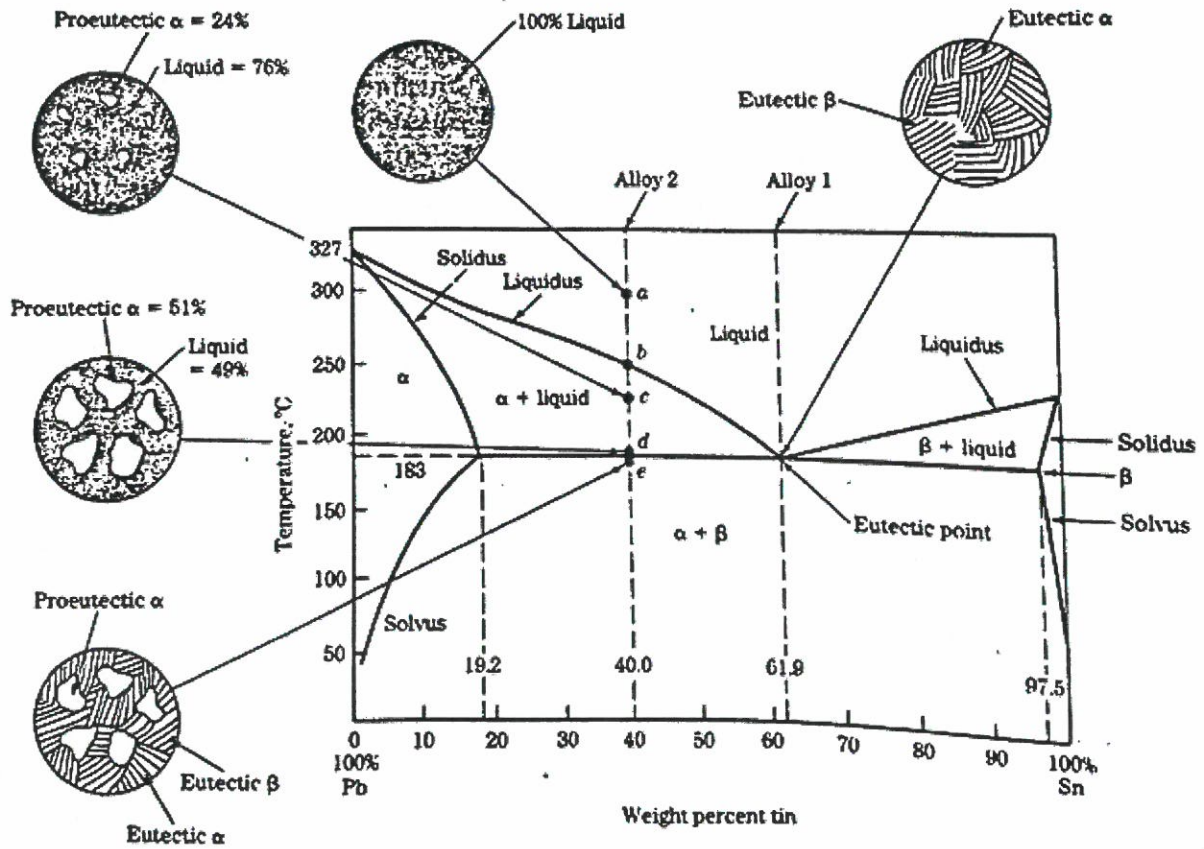


Figure 2

(16 marks)

Question 5

- (a) Distinguish between natural aging and artificial aging for a precipitation metal hardening (4 marks)
- (b) If a particular type of polyethylene has a molecule mass of 150000 g/mol, what is its degree of polymerization (DP)? (5 marks)
- (c) Distinguish between a homopolymer and a copolymer. (2 marks)
- (d) Illustrate the following types of copolymers by using filled and open circles for their polymers: (8 marks)
- random,
 - alternating,
 - block, and
 - graft.
- (e) List 6 mechanical properties of ceramic materials? (6 marks)

(6 marks)

Question 6

(a) A wire whose diameter is 0.2 cm must carry a 20 A current. The maximum power dissipation along the wire is 4W/m. Calculate the minimum allowable conductivity of the wire in $\Omega\text{-m}^{-1}$ for this application.

(5 marks)

(b) Write equations for the

(i) Macroscopic and

(ii) Microscopic forms of Ohm's law.

Define the symbols in each of the equations and indicate their SI units.

(6 marks)

(c) A Phosphorus-doped silicon wafer has an electrical resistivity of $8.33 \times 10^{-5} \Omega\cdot\text{m}$ at 27°C . Assume mobilities of charge carriers to be the constants $0.135 \text{ m}^2/(\text{V}\cdot\text{s})$ for electrons and $0.048 \text{ m}^2/(\text{V}\cdot\text{s})$ for holes. What is the majority carrier concentration if complete ionization is assumed?

(5 marks)

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

(i) The engineering strain at this load and

(ii) The modulus of elasticity.

(9 marks)

--THE END--

EGM 1182(F)apr19/richard

APPENDIX 1

PERIODIC TABLE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71																												
H 1-008 Hydrogen	He 4-003 Helium	Li 6-941 Lithium	Be 9-012 Beryllium	B 10-81 Boron	C 12-01 Carbon	N 14-01 Nitrogen	O 16-00 Oxygen	F 19-00 Fluorine	Ne 20-18 Neon	Na 22-99 Sodium	Mg 24-31 Magnesium	Al 26-98 Aluminium	Si 28-09 Silicon	P 30-97 Phosphorus	S 32-07 Sulfur	Cl 35-45 Chlorine	Ar 39-95 Argon	K 39-10 Potassium	Ca 40-08 Calcium	Sc 44-96 Scandium	Ti 47-88 Titanium	V 50-94 Vanadium	Cr 52-00 Chromium	Mn 54-94 Manganese	Fe 55-85 Iron	Co 58-93 Cobalt	Ni 58-69 Nickel	Cu 63-55 Copper	Zn 65-39 Zinc	Ga 69-72 Gallium	Ge 72-59 Germanium	As 74-92 Arsenic	Se 78-96 Selenium	Br 79-90 Bromine	Kr 83-80 Krypton	Sr 87-62 Strontium	Y 88-91 Yttrium	Zr 91-22 Zirconium	Nb 92-91 Niobium	Mo 95-94 Molybdenum	Ru 101-1 Ruthenium	Rh 102-9 Rhodium	Pd 106-4 Palladium	Ag 107-9 Silver	Cd 112-4 Cadmium	In 114-8 Indium	Sn 118-7 Tin	Sb 121-8 Antimony	Te 127-6 Tellurium	I 126-9 Iodine	Xe 131-3 Xenon	Ba 137-3 Barium	La 138-9 Lanthanum	Hf 178-5 Hafnium	Ta 180-9 Tantalum	W 183-9 Tungsten	Re 186-2 Rhenium	Os 190-2 Osmium	Pt 195-1 Platinum	Au 197-0 Gold	Hg 200-6 Mercury	Tl 204-4 Thallium	Pb 207-2 Lead	Bi 209-0 Bismuth	Po — Polonium	At — Astatine	Rn — Radon	Fr — Francium	Ra 226-0 Radium	Ac — Actinium	Ce 140-1 Cerium	Pr 140-9 Praseodymium	Nd 144-2 Neodymium	Pm — Promethium	Sm 150-4 Samarium	Eu 152-0 Europium	Gd 157-3 Gadolinium	Tb 158-9 Terbium	Dy 162-5 Dysprosium	Ho 164-9 Holmium	Er 167-3 Erbium	Tm 168-9 Thulium	Yb 173-0 Ytterbium	Lu 175-0 Lutetium	Th 232-0 Thorium	Pa 231-0 Protactinium	U 238-0 Uranium	Np 237-0 Neptunium	Pu 239-0 Plutonium	Am — Americium	Cm — Curium	Bk — Berkelium	Cf — Californium	Es — Einsteinium	Fm — Fermium	Md — Mendelevium	No — Nobelium	Lr — Lawrencium

1 H
1-008
Hydrogen

KEY
Atomic Number
Symbol of element
Name of element

79 Au
197-0
Gold

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