

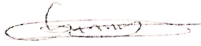


ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATION
2019/2020 ACADEMIC SESSION

COURSE: GNE 231 – Materials Science
CLASS: 200 Level - General Engineering



HOD'S SIGNATURE

INSTRUCTIONS:

- (i) Answer Questions 1 & 2 and ANY Other Three Questions
- (ii) Time Allowed: 3 Hours

The following constants/parameters may be useful:

Boltzmann's constant, k	=	$1.38 \times 10^{-23} \text{ J/K}$
Electron charge, q	=	$1.602 \times 10^{-19} \text{ C}$
Electron rest mass, m_e	=	$9.11 \times 10^{-31} \text{ kg}$
Neutron rest mass, m_N	=	$1.68 \times 10^{-27} \text{ kg}$
Planck's constant, h	=	$6.62 \times 10^{-34} \text{ J/s}$
Permittivity of vacuum, ϵ_0	=	$8.85 \times 10^{-12} \text{ farad/meter}$
Permeability of vacuum, μ_0	=	$4\pi \times 10^{-7} \text{ H/m}$
Velocity of light, c	=	$3 \times 10^8 \text{ m/s}$
Avogadro's Number, N	=	$6.023 \times 10^{26} \text{ (kg mol)}^{-1}$
Universal Gas Constant, R	=	$8.314 \times 10^3 \text{ J/(kg mol} \cdot \text{K)}$

- 1(a) Describe briefly, with the aid of schematic diagrams, the advantages, limitations, applications, etc., where appropriate, the following X-ray Diffraction Techniques:
 - (i) The Transmission Laue Method
 - (ii) The Rotating Crystal Method
 - (iii) The Debye-Scherrer (Powder) Method
- (b). Derive the Bragg's Law: $n\lambda = 2d\sin\theta$
- (c). A powder photomicrograph of a certain metal taken with radiation of wavelength of $1.540 \times 10^{-10} \text{ m}$, exhibits diffraction lines corresponding to the following Bragg angles: $20^\circ 14'$, $29^\circ 23'$, $36^\circ 50'$, $43^\circ 58'$, $50^\circ 45'$, $58^\circ 44'$, $66^\circ 35'$, and $78^\circ 34'$. Determine if (i) the metal is of a cubic crystal lattice structure, and if so, (ii) if the lattice is simple cubic (SC), body centered cubic (BCC) or face-centered cubic (FCC), and (iii) calculate the unit cell parameter, "a". [Hint: The interplanar spacing; "d" for a cubic crystal is given by $d = a/\{\sqrt{h^2 + k^2 + l^2}\}$].
- 2(a). (i) What are LASERS and MASERS? (ii) State the fundamental principles underlying each of their operations and (iii) mention two of their major applications.
- (b). With the aid of simple diagrams and examples, where necessary, explain the terms Crystal Imperfections and Lattice Imperfections.
- (c) (i) Write an expression for the concentration of Frenkel defects in a crystal lattice.
- (ii) The enthalpy of formation of a Frenkel defect, ΔH_f in AgCl is 1.4 eV. Calculate the ratio of the number of Frenkel defects at 20°C to that obtained by rapid cooling after holding at 300°C .

- 3(a). Comment briefly, with the aid of schematic sketches and at least two examples, on the different types of bonding in materials.
- (b) What is the basic difference between (i) crystalline and amorphous Solids; (ii) a unit cell and a primitive cell.
- (c). Sketch the (110) planes in (i) Simple-Cubic (SC); (ii) Body-Centered-Cubic (BCC) and (iii) Face-Centered-Cubic (FCC) structures. (iv) Write out the Families of Directions; $\langle 100 \rangle$, $\langle 110 \rangle$, and $\langle 111 \rangle$; in a cubic crystal.

- 4(a). (i) What are the two broad classification of Wood? (ii) Discuss the engineering importance of wood reinforcement.
- (b). (i) What are refractories? Name six refractory raw materials.
- (c). Mention Four (i) Ceramic Fabrication Methods; (ii) Polymeric Fabrication Methods.

- 5(a). (i) What is a composite material? (ii) Define cermets and give three examples of cermets.
- (b). Glass is generally weak in tension. How can its strength be increased/improved?
- (c). What is transformation temperature in glass? Give six applications of engineering glass.

- 6(a). Define briefly, the following terms:

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|--------------------|---------------|----------------|
| (i) Heat-treatment | (ii) Pearlite | (iii) Steel |
| (iv) Bainite | (v) Ferrite | (vi) Cementite |
| (vii) Martensite | | |

- (b) In strong but brief terms, distinguish between the three basic classes of engineering materials.

- (c) Compare and contrast between Thermoplastic and Thermosetting Polymers.
- 7(a). Mention the major factors of consideration in the selection of engineering materials for any engineering application.
- (b). As an Electrical Engineer, why would you select Aluminum for high tension cables and copper for domestic wiring cables instead of the best electrical conductor known to man – silver?
- (c). What are the two principal properties of a superconductor? Name four applications of superconductivity.