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	=	1.38×10^{-23} J/K
Electron charge, q	=	1.602×10^{-19} C
Electron rest mass, m_e	=	9.11×10^{-31}kg
Neutron rest mass, m_N	=	1.68×10^{-27} kg
Planck's constant, h	=	6.62×10^{-34} J/s
Permittivity of vacuum, ε_o	=	8.85×10^{-12} farad/meter
Permeability of vacuum, μ_0	=	$4\pi \times 10^{-7}$ H/m
Velocity of light, c	=	3×10^8 m/s
Avogadro's Number, N	=	6.023×10^{26} (kg mol)$^{-1}$
Universal Gas Constant, R	=	8.314×10^3 J/(kg mol . 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 1.540×10^{-10} m, exhibits diffraction lines corresponding to the following Bragg angles: 20°14', 29°23', 36°50', 43°58', 50°45', 58°44', 66°35', and 78°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 ^{0}C to that obtained by rapid cooling after holding at 300 ^{0}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; <100>, <110>, and <111>; 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:

(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.