ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATION
2020/2021 ACADEMIC SESSION

COURSE: GNE 259 – Materials Science (3-Unit)
CLASS: 200 Level - General Engineering

HOD'S SIGNATURE

INSTRUCTIONS:

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

March, 2021

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)

Question 1

(a) Comment briefly with schematic examples, the different types of bonds in solids.

(b) (i) Write out the name of an element and a compound that crystalizes as a simple cubic. (ii) List at least four elements with bcc, fcc and hcp structures.

(c) Show that the lattice constant; are respectively $4R/(\sqrt{3})$ and $4R/(\sqrt{2})$ for a Body-Centered and Face-Centered-Cubic Crystal:

(d) Hence or otherwise, show that the Atomic Packing Factor (APF) for Body-Centered-Cubic and Face-Centered-Cubic Crystals are equal to 68 and 74 %, respectively.

Question 2

(a). Comment briefly with notable examples, on the terms Polymorphism and Allotropy.

(b). Sketch the (110) planes in cubic structures, for (i) Simple cubic, SC. (ii) BCC and (iii) FCC.

(c). (i) Explain what you understand by crystal imperfections.
(ii) With the aid of well-labelled schematic diagrams, describe the various POINT DEFECTS in (a) pure Crystalline and (b) Ionic Solids.
(iii) How are Atomic Point defects produced?

(d). The enthalpy of formation of a Frenkel defect, ΔH_f in AgCl if 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.

Question 3

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

(b). What are the two broad classifications of Wood? Discus the engineering importance of wood reinforcement.

(c). In a tabular format, write briefly on the differences between a metal (e.g. iron) and glass (e.g. Silicate glass).

Question 4

(a) (i) What is a composite material?
(ii) Define cermets and give three examples of cermets.

(b) Compare and contrast between Thermoplastic and Thermosetting Polymers.

(c). Comment on the Factors that affect the strength of polymers.

Question 5

(a). What are refractories? Name six refractory raw materials.

(b). Mention Four (i) Ceramic Fabrication Methods; (ii) Polymeric Fabrication Methods.

(c). (i) What are diamagnetic, paramagnetic and ferromagnetic materials?
(ii) Distinguish between a soft and a hard magnet.

Question 6

(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.

Question 7

(a). What are LASERS and MASERS? (ii) State the fundamental principles underlying each of their operations and (iii) mention two of their major applications.

(b). Write briefly, with notable examples, on n-type and p-type semi-conductors.

(c). What is corrosion? Explain briefly why a food engineer would prefer an aluminum foil to foils of copper, mild steel or magnesium for packing certain food items.