UNIVERSITY OF GHANA

SECOND SEMESTER EXAMINATIONS: 2011/ 2012

LEVEL 200: BACHELOR OF SCIENCE IN ENGINEERING

BMEN 204: Introduction to Structure and Properties of Materials (2 Credits)

TIME ALLOWED: **TWO (2) HOURS**

Attempt all questions.

1. (a) Briefly cite the main differences between ionic, covalent and metallic bonding. How will you predict whether a particular bonding is predominantly metallic or predominantly covalent? **[5 marks]**

(b) Using this equation for potential energy

$$U(r) = -\frac{a}{r^m} + \frac{b}{r^n}$$

show that the potential energy of a pair of atoms or molecules can also be given as

$$U(r) = -\frac{a}{r^m}\left[1 - \frac{m}{n}\frac{(r_o)^{n-m}}{(r)^{n-m}}\right]$$

[10 marks]

EXAMINER: Bernard Owusu Asimeng

(c) (i) What is meant by cohesive energy of a crystal?

(ii) Draw a schematic figure showing the structure of sodium chloride. Obtain an expression for the total cohesive energy of an ionic crystal in terms of Madelung constant and other parameters.

(iii) How does sodium chloride structure differ from that of diamond?

[10 marks]

2. (a) What is a unit cell? Produce clear sketches to show the arrangements of atoms in the following types of crystals (i) body- centred cubic (bcc); (ii) face-centred cubic (fcc); (iii) hexagonal close-packed (hcp)

(α) Name one metal which crystallises in each of the above crystal forms.

(β) State the number of atoms per unit cell of each of the above structures showing your reasoning.

(γ) Of the three crystal forms listed above, which one possesses the closest atomic packing? **[10 marks]**

(b) Metallic iron changes from bcc to fcc structure at 910 °C. At this temperature, the atomic radii of the iron atom in the two structures are 1.258 Å and 1.292 Å respectively.

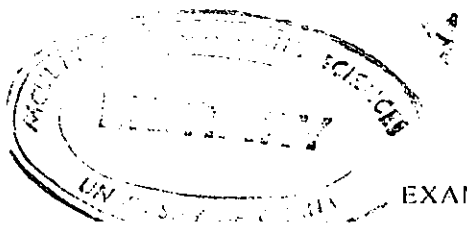
(i) Calculate the percentage in volume during this structural change

(ii) Calculate the percentage change in density.

(iii) Suggest any two possible properties the above transformation might bring.

[10 marks]

(c) In a tetragonal lattice a = b = 2.5 Å, c = 1.8 Å. Deduce the lattice spacing between (111) planes. **[5 marks]**



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3. (a) What are point and line defects? Explain the difference between Schokky and Frankel defects. **[10 marks]**

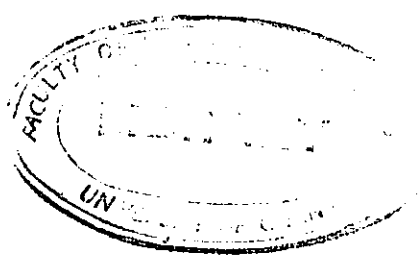
(b) Show that the maximum radius of an interstitial atom that can just fit into the void at the body centre of the fcc structure coordinated by the facial atoms is 0.414 r, where r is the radius of the atom. **[5 marks]**

(c) Explain why X - rays are diffracted by crystals? Describe the powder method for the analysis of crystal structure. **[10 marks]**

4. (a) What is superconductivity? Outline the important factors affecting the electrical resistance of engineering materials. **[5 marks]**

(b) Suggest five ways you would employ to improve on the properties of polymers. **[10 marks]**

(c) Explain the various processes in forming glass. What effect does annealing and tempering introduce during glass formation? **[10 marks]**



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