Index number: | | | | | | | | |

University of Ghana

Second semester examinations: 2014/2015

Level **200**: Bachelor of Science in Biomedical Engineering

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

Time: 2 hrs Total Marks: 100

*There are **15 questions** on **9 pages** and you are required to answer **all** questions on the space provided on the question paper. A separate sheet will be provided for any rough work you may want to do. Spaces have been provided for you to fill in your index numbers at the top page of each sheet. You are to ensure to provide your index numbers on all the pages.*

1) Why do we have to study the bonds in crystals?

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.....(2 marks)

2) What is the main distinction between covalent and metallic bonding?

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.....(2 marks)

3) Pick the odd one out in terms of metallic bonding.

(a) Na

(b) Si

(c) Ag

(d) Cu (2 marks)

Examiner: Bernard O. Asimeng

Index number: | | | | | | | | |

4) (a) Draw the binding force and energy diagram for ionic molecules showing the dependence of (i) repulsive (ii) attractive and (iii) net forces on interatomic separation, r for two isolated atoms. What is the significance of the equilibrium separation, r_o?

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..... (6 marks)

(b) Write down the net force and the net energy equation from your diagram in 4(a) and define all symbols.

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Index number: | | | | | | | | |

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.....(6 marks)

5. What is meant by the structure of a material? Why do we have to study the structure of a material?

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6. (a) What different types of structures are found in cubic systems of crystals? Produce sketches to show the arrangements of atoms in their unit cells.

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.....(8 marks)

Index number: | | | | | | | | |

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

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.....(6 marks)

(c) Determine the number of atoms per unit cell of each of the three cubic forms and show your calculations.

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..... (6 marks)

(d) Which of the three crystal forms above will possess the closest atomic packing?

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..... (2 marks)

7. Stainless steel has a BCC structure which transforms during processing to FCC structure. The atomic radius before and after the transformation is $r = 1.278$ Å and $r = 1.363$ Å,

respectively. Calculate the percentage change in volume. Comment on any property this structure evolvement might bring.

Index number: | | | | | | | | |

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..... (12 marks)

8. What is the significance of knowing planes in crystals?

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9. Sketch the crystal planes for (101), (110), (221) and calculate the number of atoms per mm^2 surface area for (110) plane for aluminium having FCC structure and lattice parameter, a= 4.049 Å.

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Index number: | | | | | | | | |

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10. Explain with illustrations how vacancies and substitutions increase the internal energy of a crystal.

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Index number: | | | | | | | | |

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.....(8 marks)

11. Why are X-rays used for crystal studies?

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.....(2 marks)

12. Give **three distinctions** between Laue and Debye-Scherer X-ray methods of studying crystals.

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13. Outline **two ways** by which you can enhance the mechanical properties of polymeric materials.

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14. Under what constraints will you go for die casting or sand casting to process a material?

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Index number: | | | | | | | | |

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15. Distinguish between the processing of **thermoplastic** and **thermosetting** materials.

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