TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED &HEALTH SCIENCES

MATHEMATICS & PHYSICS DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS AND BACHELOR OF TECHNOLOGY IN ENVIRONMENTAL PHYSICS & RENEWABLE ENERGY

APS 4206: STRUCTURE &PROPERTIES OF MATTER

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: 2 HOURS

DATE: MAY 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FOUR questions.

Do not write on the question paper. Answer question ONE (compulsory) and any other two questions.

Question ONE

(a) (i) What are the quantum numbers required to specify the state of an electron in an atom? (3 marks)

(ii) What are their interrelations? (3 marks)

(b) The $P.E$ of a pair of ions is of the form $\frac{A}{r^9}-\frac{B}{r^2}$ when their separation distance is r. The equilibrium separation is $0.28nm$ and dissociation energy is $8x10^{-19}J$.

(i) Interpret the two terms (2 marks)

(ii) Calculate the values of A and B. (3 marks)

(c) Draw the variation of $2s$, $2p$, $3s$ and $3p$ energy bands with atomic spacing on the same axes for a three-atom system. (4 marks)

(d) (i) State two factors on which the properties of solids depend. (2 marks)

(ii) Distinguish between crystalline solid structures and amorphous materials.

(2 marks)

(e) Explain the following terms in connection with alloys
  (i) Liquidus and solidus curves (2 marks)
  (ii) Eutectics composition and eutectic temperature (2 marks)

(f) Explain the following optical properties of materials.
  (i) Absorptivity of materials (1 mark)
  (ii) Reflectivity of materials (1 mark)
  (iii) Absorption coefficient (1 mark)

(g) With an aid of diagrams describe two methods of measuring strains in a material.
(4 marks

Question TWO

(i) What are the Miller indices? (1 mark)
  (ii) Calculate the Miller indices of a plane which intercepts at $x^1 = 1.5r$, $y^1 = 0.5r$, and $z = 0.25r$ in a simple cubic unit cell of sides r (5 marks)

(b) An f.c.c crystal has an atomic radius of $1.246A^0$. What are the d_{111} and d_{220} spacing.
(4 marks)

(c) Calculate the packing efficiency of f.c.c and bcc structures. (5 marks)

(d) The density of sodium chloride is $2.16gcm^{-3}$. Calculate the number of atoms per cubic metre and hence determine the spacing between atoms. (5 marks)

Question THREE

(a) Draw a well labeled load – extension curve for mild steel. Describe all the main sections of this curve, stating clearly what happens at each part of the curve (8 marks)

(b) Explain the atomic mechanism of elastic deformation in a piece of metal (5 marks)

(c) (i) Derive an expression for the modules of rupture at a rectangular beam of breadth b and depth d. (5 marks)
  (ii) Hence find the modulus of rupture of a beam of breadth 0.1m and depth 0.05m given that the failure load under a c.p.l of span 0.5m is 1000N. (2 marks)

Question FOUR

(a) Explain what you understand by the following terms
  (i) Notch sensitivity (2 marks)
  (ii) Toughness (2 marks)
  (iii) Creep (2 marks)
  (iv) Fatique strength (2 marks)

(b) Describe how the izod test is used to determine toughness of a metal. (4 marks)

(c) (i) State Griffith's criterion for crack formation and explain why it is not directly

useful to the theory of ductile failure. (2 marks)

(ii) Hence derive the necessary expressions to enable you calculate the tensile. Stress needed to fracture a glass plate which contains a sharp crack of length $1x10^{-6}\,m$ in its surface. (6 marks)