



# 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  $8 \times 10^{-19} J$ .
- (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.

- (e) Explain the following terms in connection with alloys (2 marks)
- (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 modulus 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) Fatigue 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  $1 \times 10^{-6} m$  in its surface.  
(6 marks)