THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
2ND YEAR/2ND SEMESTER EXAMINATIONS

BACHELOR OF ENGINEERING IN ELECTRICAL & ELECTRONIC ENGINEERING
INSTITUTIONAL-BASED PROGRAMME

EEE 2203 MATERIAL SCIENCE II

SERIES: JULY 2011

TIME: 2 HOURS

Instructions to Candidates:
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
This paper consists of **THREE** printed pages

Question 1 (Compulsory)

a) (i) Highlight **THREE** properties of superconductors that make so attractive as a research Endeavour today?

(ii) Describe some of the limitations of conventional conductors such as copper with regard to signal transmission (10 marks)

b) (i) Describe the conditions under which a dielectric either absorbs or scatters energy from the electric field acting on it.

(ii) Contrast the behavior between an insulator or dielectric and a conductor under the influence of an electric field (6 marks)

c) With the aid of sketches describe the concept of magnetic dipoles and how they relate to external magnetic fields (4 marks)

d) (i) Define the term magnetic susceptibility

$$x = \left(\mu_r - 1 \right)$$

(ii) Show that magnetic susceptibility is given by (4 marks)

e) (i) Explain the purpose of adhesives and the mechanism by which bonding is achieved
(ii) Outline FOUR desirable properties of adhesives (6 marks)

SECTION B (Answer any TWO questions) – 40 MARKS

Question 2

a) Describe:
(i)   **THREE** technological applications of superconductivity
(ii)   **FIVE** challenges of fabricating superconductors (8 marks)

b) How does cold working and annealing affect conductivity in metals (4 marks)

c) (i) Distinguish between intrinsic and extrinsic semi-conductors
(ii) Describe common semi-conductor materials and why they are used? (8 marks)

Question 3

$$\varepsilon_r$$

a) Define the term relative permittivity
(i)   Mathematically
(ii)   Using your own words (2 marks)

b) Explain the effect of the following dielectrics on the property of a capacitor
$$\left(\varepsilon_r = 1 \right)$$
(i)   Air
$$\left(\varepsilon_r = 4.7 \right)$$
(ii)   Teflon (4 marks)

c) Given a dielectric with a value ε_r, show that the polarization $\overline{P}$ of the dielectric can be given by the expression
$$\overline{P} = \varepsilon_0 \overline{E}(\varepsilon_r - 1)$$
(4 marks)

d) Describe the conditions under which the dielectric constant of a material may be:
   i)   A real quantity
   ii) A complex quantity   (4 marks)

e) Discuss briefly the properties of ferroelectric materials and their applications in the electrical industry   (6 marks)

Question 4

a) Explain the physical significance of the following physical constants (quoting their values):
   i) ε_0
   ii) μ_0 (4 marks)

b) Briefly discuss using appropriate sketches the properties of the following classification of magnetic materials
   (i)   Diamagnetic
   (ii)   Paramagnetic
   (iii) Ferromagnetic
   (iv)   Antiferromagnetic   (8 marks)

c) Explain the magnetocaloric effect (MCE) or the adiabatic temperature change and its possible application in the electrical industry   (4 marks)

d) With the aid of appropriate sketches describe any **FOUR** properties of ferromagnetic domains
(4 marks)

Question 5

a) Explain the purpose and process of encapsulating electronic components   (4 marks)

b) Briefly discuss the problems encountered with traditional two porting methods and how these have been overcome with alternative modern methods   (8 marks)

c) Mention **FOUR** applications of electrically conductive adhesives   (4 marks)

d) Briefly discuss the challenges encountered in the use of electrically conductive adhesives
(4 marks)