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KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021 / 2022 ACADEMIC YEAR**

**FIRST YEAR SECOND SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF MASTER OF SCIENCE IN PHYSICS

COURSE CODE: SPH 842E

COURSE TITLE: ELECTRICAL, MAGNETIC AND OPTICAL
PROPERTIES OF SOLIDS

DURATION: 3 HOURS

DATE: 11/05/2022

TIME: 2:00PM-4:00PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **3** printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

QUESTION ONE (30 MARKS)

- a) Give a precise account of the following properties of materials; Optical, Magnetic and Electrical properties of materials. (5 marks)
- b) Briefly give an account of dielectric strength of a given material (4 marks)
- c) What do you understand by the term Laser (1 mark)
- d) Using band gap theory, differentiate between conductors, semiconductors and insulators (5 marks)
- e) Explain any two factors that affect resistivity of a material (4 marks)
- f) Calculate the resistance of an aluminium wire 100 m long and having cross-sectional area of 3 sq. mm at 20°C. Given, the resistivity of Al at 20°C equals to $2.66 \times 10^{-8} \Omega\text{m}$. (5 marks)
- g) Briefly give an account of the following applications of the optical phenomena (i) luminescence (ii) Photoconductivity (iii) coherence (iv) Optical fibres in communication (6 marks).

QUESTION TWO (20 MARKS)

- a) State the two hypothesis of Weiss molecular field theory of ferromagnetism. (2 marks)
- b) Discuss various mechanisms of strengthening in metals (8 marks)
- c) Discuss the applications of optical phenomena in (i) Lasers (ii) optical fibres in communication (6 marks)
- d) State and explain any four resistive properties of real dielectrics (4 marks)

QUESTION THREE (20 MARKS)

- a) Using a well labeled diagram, discuss the concept of domains and hysteresis in magnetic materials (10 marks)
- b) Briefly discuss the concepts of Piezoelectricity and Pressure electricity as used in the study of electrical properties of materials (7 marks)
- c) Show that the relative dielectric constant of a barium titanate crystal, which, when inserted in a parallel plate condenser of area 10 mm x 10 mm and distance of separation of 2 mm, gives a capacitance of 10^{-9} F is 2259. (3 marks)

QUESTION FOUR (20 MARKS)

- a) Briefly discuss the atomic and electronic interactions in solid materials (8 marks)
- b) Discuss the following concepts (i) electrical conduction (ii) electrical conductivity (iii) electronic and ionic conduction (3, 3, 2 marks)
- c) The resistivity of pure copper is 1.56 micro-ohm-cm. An alloy of copper containing 2 atomic percent nickel has a resistivity of 4.06 micro-ohm-cm. An alloy of copper, containing 1 atomic percent silver, has a resistivity of 1.7 micro-ohm-cm. Find the resistivity of a copper alloy containing 1 atomic percent nickel and 3 atomic percent silver. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Give a detailed account of phase difference and dielectric loss (16 marks)
- b) In a 440 V, 50 Hz transformer, the total iron loss is 2300 W. When the applied voltage is 220 V at 25 Hz, the total iron loss is 750 W. Show that the eddy current loss at the normal voltage and frequency is 1600 W. (4 marks)