ANDHRA UNIVERSITY
TRANS-DISCIPLINARY RESEARCH HUB

PHYSICS

MATERIALS SCIENCE

UNIT 1: Dielectrics

Dielectric polarization and atomic forces-electronic polarization, mechanism of polarization, macroscopic description of the static dielectric constant of materials, the electronic and ionic polarizabilities of molecules. Orientational Polarization, Measurement of dielectric constant of a solid, dielectric breakdown-electric energy stored in dielectrics, the internal field of Lorentz, Clausius-Mosotti relation, dielectric losses and relaxation times, elementary ideas on dipole relaxation.

UNIT 2: Ferroelectrics

Ferroelectrics: General characteristics – piezoelectric, pyroelectric and ferroelectric materials. Classification of ferroelectric crystals and representative materials– $BaTiO_3$ and its ferroelectric behavior, structure of KDP and explanation for its ferroelectric behavior, spontaneous polarization and theory of spontaneous polarization in BaTiO3, Dielectric theory of ferroelectricity, ferroelectric hysteresis.

UNIT 3: Magnetic properties

Quantum theory of diamagnetism, Origin of permanent magnetic moment, Theories of paramagnetism, paramagnetic cooling, spontaneous magnetization, Weiss theory of spontaneous magnetization, Nature and origin of the Weiss molecular field, Heisenberg exchange interaction, Hysteresis. The Block wall, Neel's theory of Antiferromagnetism. Ferromagnetism, Ferrite's and their applications (basic concepts only).

UNIT 4: Superconductivity

Superconductors, Occurrence of superconductivity, properties of super conductors, Experimental observations, persistent currents, Effect of magnetic fields, Meissner effect, Type I and Type II super conductors, Elements of BCS theory, Cooper pairs, AC and DC Josephson effects, Superconducting Quantum Interference Devices (SQUID), High temperature superconductors, applications of superconductors.

UNIT 5: Optical Properties

Feynman's vision, nanotechnology and nano science, history of nano materials, concept of nanoparticle, size dependent properties, length scales, classification of nano materials, zero, one, two and three dimensional nanostructures, quantum dots, nano wires, ultra-thin films.

LED materials, liquid crystals, properties and structure, liquid crystal displays, comparison between LED and LC displays.

REFERENCES:

1. Applied Physics by Dr.M.Chandra Sekhar & Dr.P.Appala Naidu
2. Material science by M.Arumugam
3. Material Science and Engineering: An Introduction by W.D.Callister, John Wiley & Sons,2007
4. Materials Science & Engineering – V.Raghavan
5. Science of Engineering materials – C.M.Srivastava and C.Srinivasan
6. Introduction to superconductivity – AC Rose – Innes and EH Rhoderick
7. Physics of High T_c superconductors – JC Phillips (Academic Press, 1989)
8. Goddard III W.A., et. al.,(Ed.), Handbook of Nanoscience, Engineering, and Technology, Taylor & Francis Group, 2007.
9. Cao, G., Nanostructures and Nanomaterials Synthesis, Properties, and Applications, Imperial College Press, 2004

Modifications Done:

1) First unit has been divided into two units by adding some topics to each unit.
2) Fourth unit Fiber optics and laser has been deleted.
3) New topics regarding Liquid crystals and nanomaterials have been added as fifth unit.

Topics Added	Topics deleted
Unit 1: Dielectric polarization and atomic forces-electronic polarization, mechanism of polarization, dielectric breakdown-electric energy stored in dielectrics.	NIL
Unit 2: Ferroelectrics: General characteristics – piezoelectric, pyroelectric and ferroelectric materials, theory of spontaneous polarization in BaTiO3.	NIL
Unit 3: NIL	NIL
Unit 4: Superconductors, properties of super conductors, AC and DC Josephson effects, Superconducting Quantum Interference Devices (SQUID), High temperature superconductors, applications of superconductors.	Intermediate states, Entropy and heat capacity, energy gap, Isotope effect, Thermal conductivity, Theoretical explanations, London's equation, Penetration depth, Coherence length, Giaver tunneling Josephson effects (basic ideas)
Unit 5: Feynman's vision, nanotechnology and nano science, history of nano materials, concept of nanoparticle, size dependent properties, length scales, classification of nano materials, zero, one, two and three dimensional nanostructures, quantum dots, nano wires, ultra-thin films. LED materials, liquid crystals, properties and structure, liquid crystal displays, comparison between LED and LC displays.	NIL

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MODEL QUESTION PAPER

MATERIALS SCIENCE

Time: 3hrs **Max Marks: 100**

Answer ALL the questions. All carry equal marks (5x20=100)

1. a) what is Dielectric Polarization? Explain the mechanism of polarization and various types of polarization in detail.

OR

b) What is Dielectric Breakdown? Explain how dielectric constant of a solid is measured and obtain Clausius – Mossotti equation.

2. a) what are Ferroelectrics? Explain the structure of $BaTiO_3$ and KDP and their ferroelectric behavior in detail

OR

b) What is Spontaneous polarization? Explain the theory of spontaneous polarization in $BaTiO_3$ and write a note on Ferroelectric hysteresis.

3. a) What is Spontaneous magnetization? Explain Weiss theory of spontaneous magnetization and curie-Weiss law in detail.

OR

b) What is Hysteresis loop for ferromagnetic materials? Explain Neel's theory of Antiferromagnetism.

4. a) what is Superconductivity? Define Meissner effect and explain types of superconductors with examples.

OR

b) What is Cooper pair? Explain the BCS theory of superconductivity. Give an account on SQUID and its applications.

5. a) What are nano materials? Explain Classification of nano materials and give examples.

OR

b) What are liquid crystals? Explain the structure and properties of Liquid crystals. Give a note on comparison between LED and LC displays.