



Department of Physics

w.e. f. Session 2015-16

Pre Ph.D. Course (Physics)

Composites, Bulk and Nanoceramics (PY 601)

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Unit I Geometry of Crystals and Bonding

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The Electronic Structure of Atoms, Atomic Bonding, Crystallography, Bravais Crystal System, Laws of Crystallography, Miller Indices, Geometrical Structure Factor, Determination of Crystal Structure, Crystal Structure Analysis, and Imperfections in Crystals.

Unit II Electrical, Thermal and Semiconducting Properties of Materials

8

Free Electron Theory Of Metals, Band Theory, Effective Mass, Fermi-Dirac Statistics, and Electron Distribution in Solids, Density of States and Fermi Energy, The Fermi Distribution Function, Electrical Conductivity From Quantum Mechanical Considerations, Factors Affecting Resistivity of Metals, Conductivity at High Frequency, Superconductivity, Semiconductors, classification of semiconductors, Fermi level, electrical charge neutrality, mobility, Energy Band Diagrams of Common Semiconductors, Hall Effect, Drift and Diffusion Current, Einstein's Relation, Continuity Equation, Diffusion Length.

Unit III Dielectric and Magnetic Properties of Materials

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Polarization Mechanism, Types of Polarization, Behavior of Dielectric in Static Field, Behaviour of Dielectric in Alternating Field, Dielectric Loss and Strength, Ferroelectric Material, Piezoelectric, Smart Materials, Piezoelectricity, Langevin's Theory of Polarization in Polar Dielectrics. Classification of Magnetic Materials, Magnetic Anisotropy, Magnetostriction, Langevin's Theory of Diamagnetism and Paramagnetism, Weiss Theory of Ferromagnetism.

Unit IV Composites, Ceramics, nanoceramics and Their Applications

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Fibrous Composites, Matrix, Resin, Laminated Composite, Fiber-Reinforcement Composites, Metal Matrix Composite, Particulate Composite, Filled Composite, Sandwich Structures, Facing Material, Core Materials, Honeycomb Structure, Cladded Metal Structure, Structure of Ceramics, Silicate Structures, Powder Processing, Thermal Treatments, Thermal Properties of Ceramics, Mechanical Properties of Ceramics, Electrical Properties of Ceramics, Ferroelectric Ceramics, Classification of Ferroelectric Crystals (KDP, TGS, Perovskites Type), Barium Titanates and Modified Barium Titanates, Piezoelectric Ceramics, PZT (Lead Zirconate Titanate and PLZT System), Applications, Glasses, Glass Transition Temperature, Structure of Glass, Properties of Glass, Glass Forming.

Unit V Synthesis and Characterizations of nanomaterials

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Ball Milling, Molecular beam epitaxy, Chemical vapor deposition, Ion sputtering, Electron deposition, Sol-gel technique, hydrothermal processing, Solid state reaction method. X-ray diffraction, Particle size determination, Scanning electron microscope (SEM), Transmission electron microscope (TEM), UV-VIS-IR spectrophotometers, Atomic force microscopy (AFM).

References:

1. Ceramic and Glass Materials, Structure, Properties and Processing: James F. Shackelford, Robert H. Doremus, Springer.
2. Ceramic Materials: Processes, Properties and Applications: Philippe Boch, Jean-Claude Niepce, HERMES Science Europe Ltd, 2001.
3. Ceramic Matrix Composites: Fiber Reinforced Ceramics and their Applications: Walter Krenkel, WILEY-VCH Verlag GmbH & Co.
4. Handbook of dielectric, piezoelectric and ferroelectric materials: Synthesis, properties and Applications, Zuo-Guang Ye, WOODHEAD PUBLISHING LIMITED, Cambridge England.
5. Solid State Physics: C. Kittel
6. Material Science and Engineering, William D. Callister.
7. Introduction to Engineering Material, George Murray, Charles V. White, Wolfgang Weise.