

Syllabus for the entrance exam for MTech (Material Science) at Central University of Tamil Nadu, Thiruvarur

Crystal structure, Different types of bonding: ionic, covalent, metallic and van der Waals. Lattice energy - Madelung constants – Born Haber cycle – cohesive energy . Quantum states- binding energy-interatomic spacing - variation in bonding characteristics - Single crystals – polycrystalline - Non crystalline solids - Imperfection in solids – Vacancies – Interstitials. Equilibrium thermodynamics, Phase equilibria, Phase transformations,

Crystalline and amorphous solids, primitive and unit cells, Bravais lattices, crystal structure, lattice and basis. packing factors – cubic, hexagonal, diamond structures Lattice translation operation. Elementary idea of point symmetry operations (inversion centre, rotation and reflection symmetry). Primitive translation vectors, lattice planes – Miller indices for designating crystal planes. Inter-planar distances – directions. Reciprocal lattice. Volume of a primitive cell in the reciprocal space. Geometrical interpretation of the Bragg equation in the reciprocal space. Structural characterization Basic principles of X-ray diffraction spectroscopy.

Law of thermodynamics and related applications, Concepts of free energy and entropy,

Mechanical properties - Stress, Strain, Elastic properties Optical properties - refraction, reflection, Absorption, Transmission, Insulators, luminescence - Magnetic properties - paramagnetism - ferromagnetism - domain theory - magnetic hysteresis, – antiferromagnetism.

Free electron gas in one and three dimensions. Thermionic emission , work function , electrical conductivity of the free electron gas: Drude Lorentz Model, Sommerfield's quantum theory.the heat-capacity of the conduction electrons (Electron Specific heat) Wiedemann-Franz law and its validity. Metallic conduction, Energy bands, Brillouin zones, Temperature dependence of metallic conductivity - carrier concentrations in intrinsic, extrinsic semiconductors – Impurity contributions, Doping effects, Law of mass action. Fermi level - variation of conductivity, mobility with temperature

Electrons in periodic potential, Origin of energy bands in solids, classification of solids as metals , insulators and semiconductors on the basis of the band picture, Origin of the energy gap (qualitative discussions). Bloch's theorem in one dimension, nearly free electron approximation - formation of energy bands and gaps - Brillouin zones and boundaries - the Kronig-Penney model. E-K diagram , Reduced zone representation , Brillouin zone ,concept of effective mass and holes, Fermi- Dirac distribution function, Density of states for electrons in band. temperature dependence of Fermi energy.

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classification of nanostructures, nanoscale architecture – Effects of the nanometre length scale - surface to volume ratio – Effect of nanoscale dimensions on various properties – Structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Structure of nanomaterials - comparison with conventional materials.

Top down and bottom up synthesis approach, physical and chemical techniques for nanomaterial synthesis.