NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	MTech Semiconductor Technology
Course Code:	6EC372CC24
Course Title:	Material Physics
Course Type:	Departmental Elective
Year of Introduction:	2024-25

L	**T**	**Practical component**				**C**
		LPW	**PW**	**W**	**S**	
3	**-**	**-**	**-**	**-**	**-**	**3**

Course Learning Outcomes (CLOs)

At the end of the course, students will be able to

1. comprehend the fundamental concepts of materials science (BL3)
2. apply the properties of material for different applications (BL4)
3. explore the experimental techniques used in materials science (BL4)
4. analyse the applications of materials Physics in modern technology. (BL5)

	Contents	**Teaching hours (Total 45)**
Unit I	**Elements of Crystallography** Elements of crystallography: classification of crystals, crystal structure, unit cell, Bravais lattice, Miller indices, symmetries in crystals, cubic crystals (calculations of various parameters, body centered cubic (BCC) cell, face cantered cubic (FCC) cell, hexagonal close packed (hcp) structure, positions of atoms in cubic unit cells), graphite structure, indices of crystallographic direction, lattice planes and Miller indices, interplanar spacings in cubic lattice, atomic packing, voids, Ionic solids, crystal structure analysis, crystal defects (point defects, vacancies, energy of vacancy formation in metallic crystal, Schottky defect, Frankel defect)	**10**
Unit II	**Nanomaterials and structures** Nanomaterials, nanofabrication techniques, top-down approach (high energy ball milling, laser ablation, sputtering technique, molecular beam epitaxy (MBE) method), bottom-Up approach, (chemical vapor deposition (CVD), physical vapor deposition (PVD)), properties of various nanomaterials, nanostructures (quantum confinement of charge carriers, quantum dot, quantum wire, quantum well), applications and limitations of nanomaterials	**08**

Unit III	**Smart and Advanced Materials** Shape memory alloys (SMA) (working principle) austenite and martensite phases, thermoelastic transformation of SMA, superelasticity, fabrication techniques, properties of various SMA, applications and limitations of SMA, biomaterials and their applications, GaAs, SiC, GaN, Group III-V compound materials, graphene.	**08**
Unit IV	**Properties of Materials** Electrical properties (Drude- Lorentz model), electron scattering rate, relaxation time, electron mobility, conductivity, band gap), magnetic properties (Bohr Magnetron, Curie temperature, hysteresis loop- Coercivity, retentivity), optical properties (refractive index, optical band gap, dielectric constant, fluorescence, phosphorescence) mechanical properties (tensile strength, modulus of elasticity, modulus of rigidity, bulk modulus.	**10**
Unit V	**Materials at Low Temperature** Superconductivity, discovery and basic properties of superconductors, Meissner effect and its applications, London equations, type I and type II superconductors, BCS theory- formation of Cooper pair, Josephson effects and tunnelling, general properties of superconductor, high-temperature (HTc) superconductors, applications of superconductivity	**09**

Self Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggested Readings/References:

1. C. Kittle, Solid State Physics, Wiley
2. S. O. Pillai, Solid State Physics, New Age International Publishing House
3. N. Ashcroft, N. D. Mermin, Introduction to Solid State Physics, Cengage Publishing