IIT Mandi

Course Name	: **Solid State Physics for Quantum Technologies**
Course Number	: QT 510
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: Students of this course learn (i) Basics of solid states physics, (ii) Various approximations for electronic states in matter, (iii) The theory of phonons in solids, (iv) The theory of magnetism, (v) The theory of superconductivity

Course Content and syllabus:

- Structure of solids –
  - Symmetry, Bravais lattices
  - Laue equations and Bragg's law,
  - Brillouin Zones
  - Atomic scattering and structure factors.
- Characterisation of crystal structures – XRD etc.
- Bonding in solids –
  - van der Waals and Repulsive interactions,
  - Lennard Jones potential,
  - Madelung constant
- The Drude theory of metals –
  - DC & AC electrical conductivity of a metal;
  - Hall effect & magnetoresistance,
  - Density of states, Fermi-Dirac distribution, Specific heat of degenerate electron gases
  - Free electron model
- Beyond the Free electron model
  - Kronig-Penney Model
  - Periodic potential – Bloch Theorem
  - Band theory
  - Tight binding model
- Phonons in Solids
  - One dimensional monoatomic and diatomic chains
  - Normal modes and Phonons
  - Phonon spectrum
  - Long wavelength acoustic phonons and elastic constants
  - Vibrational Properties- normal modes, acoustic and optical phonons.
- Magnetism
  - Dia-, Para-, and Ferromagnetism

    - Langevin's theory of paramagnetism
    - Weiss Molecular theory
- Superconductivity:
    - Phenomenological description – Zero resistance, Meissner effect
    - London Theory
    - BCS theory
    - Ginzburg-Landau Theory
    - Type-I and type-II superconductors
    - Flux quantization
    - Josephson effect.
    - High Tc superconductivity

Course References:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition (2019)
2. Condensed Matter Physics, M P Marder, 2nd Edition, John Wiley and Sons (2010)
3. Introduction to Superconductivity, Michael Tinkham, standard edition, Medtech (2017)