OPEN ELECTIVE – Quantum Materials

Course Code: 26ENXXXX

Semester: 6

Programs Offered: B. Tech All Branches

Course Type: Core

L – T – P – J: 3 – 0 – 2 – 0

Course Modules

Module - 1: Fundamentals of Quantum Materials (8 hours)

Introduction to quantum mechanics in condensed matter systems, Energy bands and electronic structure of solids, Fermions, bosons, and quasiparticles, Electron correlation and quantum confinement, Classical materials vs quantum materials, Introduction to crystal structure and symmetry. [8 hours]

Module - 2: Superconductors and Quantum Magnetism (8 Hours)

Basics of superconductivity, Meissner effect and critical temperature, Type-I and Type-II superconductors, High-temperature superconductors, Quantum magnetism and spin interactions, Spintronics and magnetic materials. [8 hours]

Module - 3: Two-Dimensional and Topological Materials (10 Hours)

Introduction to 2D materials, Graphene and transition metal dichalcogenides, Quantum Hall effect, Topological insulators and semimetals, Surface states and protected conduction, Applications in nanoelectronics [10 hours]

Module - 4: Characterization Techniques for Quantum Materials (10 Hours)

X-ray diffraction (XRD), Electron microscopy (SEM/TEM), Raman spectroscopy, Magnetic characterization techniques, Electrical transport measurements, Introduction to synchrotron-based techniques

Module - 5: Future Quantum Technologies (9 Hours)

Quantum computing materials, Quantum communication materials, Quantum sensors, Materials for renewable energy applications, Artificial intelligence in materials discovery, Future scope of quantum technologies. [6 hours]