INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Physics

Subject Code: PHO-102 **Course Title:** Space Exploration

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: History of Space Explorations by different Nations, need for Space-based Technology, Need for Knowledge of Space Sciences, Plasma in Near-Earth Space, Waves in the Atmosphere, Atmosphere/Ionosphere of other Planets, Measurement in Space: Active and Passive Remote Sensing and In-situ Measurements, Orbits: Kepler's Law of Planetary Motion, Types of Orbits, Hohmann Transfer Orbit, Satellite Communication and Navigations, Applications of Space Technology.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Physics

Subject Code: PHO-103 **Course Title:** Physics of Quantum Materials

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Quantum mechanical formulation of Bloch functions in periodic crystals. Classification of materials based on electronic structure. Berry phase in electronic solids. Quantum Hall effect. Topology of graphene. Topological insulators. Topological classification of matter. Topological superconductivity. Applications of quantum materials.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Physics

Subject Code: PHO-104 **Course Title:** Topological Phases of Matter

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Integer quantum Hall effect. Symmetry protected topological phases. Classification of non-interacting fermionic topological phases. Topological band structures, Berry phases and Chern numbers. Graphene and Topological Insulators. Haldane model. Kane-Mele model. Su–Schrieffer–Heeger model. Topological Superconductors. Topological quantum computing.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Physics

Subject Code: PHO-105 **Course Title:** Introductory Quantum Information Theory

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Basics of quantum information pertaining to its measures and entanglement quantifiers. With a review of relevant quantum and statistical mechanics, the calculation of Shannon entropy, von Neumann Entropy, Quantum Relative Entropy and Renyi Entropy will be covered. Additional topics: Bipartite Systems, Dense Coding and Teleportation, Entanglement Measures, Shannon's Mutual Information, Markov Chains, Entropy of Partied Systems, Strong Subadditivity, Holevo Quantity, Entropy Exchange.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Physics

Subject Code: PHO-101 **Course Title:** Introduction to Spintronics Technology

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Fundamentals of magnetism, Spin-orbit interaction, Dipolar interaction, Exchange interaction, Magnetic anisotropy, Spin-dependent transport: Anomalous Hall effect, Anisotropic magnetoresistance (AMR), Giant magnetoresistance (GMR), Tunnelling magnetoresistance (TMR), Spin-valves (SVs), Magnetic tunnel junctions (MTJs), Spin-transfer torque (STT), Spin Hall effect (SHE), Spin currents, Spin-orbit torque (SOT), Orbital Hall effect (OHE), Magnetization switching, Magnetic skyrmions, Magneto resistive random-access memory (MRAM) technology–STT-MRAM, SOT-MRAM, Spin-torque and spin Hall nano-oscillators (STNOs and SHNOs), Spin caloritronic devices, Racetrack memory, Spin-based quantum computing: Spin-logic, Oscillator-based neuromorphic computing, Spin-wave computing.