# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE/SCHOOL:** Centre for Nanotechnology

**Subject Code:** NTC-501                    **Course Title:** Nanoscale Materials

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

**Course Outlines:** Classification and nomenclature of nanomaterials, synthesis by physical and chemical methods, novel properties of nanomaterials, size effect in nanomaterials, and characterization of nanomaterials.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE/SCHOOL:** Centre for Nanotechnology

**Subject Code:** NTC-503      **Course Title:** Advanced Characterizations and Analytical Techniques

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

**Course Outlines:** Structural, microscopic, compositional, optical, thermal, mechanical, electrical, and magnetic characterization of nanomaterials.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE/SCHOOL:** Centre for Nanotechnology

**Subject Code:** NTC-505          **Course Title:** Emerging Applications of Nanomaterials

**L-T-P:** 3-1-0          **Credits:** 4          **Subject Area:** PCC

**Course Outlines:** Emerging applications of nanomaterials in the fields of energy generation and storage, photovoltaics, sensors and detectors, nanoelectronics devices, environmental pollutant detection, biomedical and nanobiotechnological applications with relevant case studies.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE/SCHOOL:** Centre for Nanotechnology

**Subject Code:** NTC-507        **Course Title:** Nanoscale Modeling and Simulation

**L-T-P:** 3-0-2        **Credits:** 4        **Subject Area:** PCC

**Course Outlines:** Modeling and simulation techniques for understanding nano, micro, meso, and continuum scales; Molecular dynamics and Monte Carlo (MC) methods; AI and ML in nanotechnology; Case studies using modeling, simulation, and visualization softwares.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE/SCHOOL:** Centre for Nanotechnology

**Subject Code:** NTC-509          **Course Title:** Laboratory

**L-T-P:** 0-0-4        **Credits:** 2        **Subject Area:** PCC

**Course Outlines:** Synthesis and characterization of 0D, 1D, and 2D materials, applications of nanomaterials in energy, environment, and healthcare, nanomaterials interaction with biomolecules, and analysis of nanomaterials toxicity.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE/SCHOOL:** Centre for Nanotechnology

**Subject Code:** NTS-501          **Course Title:** Safety and Ethics in Nanotechnology Research

**L-T-P:** 2-0-0          **Credits:** 2          **Subject Area:** SSC

**Course Outlines:** Introduction to safety and ethics of nanotechnology, good laboratory practices (GLP), health and safety issues, societal and philosophical issues, environmental issues, and various in vitro and in vivo models for understanding the toxicity of nanomaterials.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-501          **Course Title:** Structural Analysis of Nanomaterials

**L-T-P:** 3-1-0          **Credits:** 4          **Subject Area:** PEC

**Course Outlines:** Size, shape, and crystallinity of nanomaterials, structure-property relationships at the nanoscale, XRD for nanomaterials, Williamson-Hall analysis for size and strain broadening, Rietveld structure refinement, SAXS, neutron diffraction, SANS, AFM techniques and modes, liquid state AFM, SPM for structural analysis, Raman spectroscopy for crystallinity and layer numbers, SPR, SERS.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-502        **Course Title:** Supramolecular Chemistry of Nanomaterials

**L-T-P:** 3-1-0        **Credits:** 4        **Subject Area:** PEC

**Course Outlines:** Introduction to supramolecular chemistry, non-covalent interactions and their importance in natural systems, host-guest chemistry, molecular hosts for cations, anions, simultaneous cation and anion binding and neutral molecules, types of self-assembly, synthesis of supramolecular nanomaterials, solid state supramolecular materials, molecular machines and applications of self-assembled nanomaterials in diverse arena.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-503        **Course Title:** Physics of Nanomaterials

**L-T-P:** 3-1-0        **Credits:** 4        **Subject Area:** PEC

**Course Outlines:** Introduction to quantum mechanics, time-dependent and time-independent Schrödinger equation, particle in a box, crystal structure-band structure correlation, electronic band structure of solids, density of state in low-dimensional materials, direct and indirect bandgap, elementary and alloy semiconductors, heterojunction, quantum confinement, superlattice, nanoclusters and nanoparticles, carbon nanostructure and its applications.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-504          **Course Title:** Biomedical Nanotechnology

**L-T-P:** 3-1-0          **Credits:** 4          **Subject Area:** PEC

**Course Outlines:** Synthesis of nanobiomaterials, nano-biomimicry, biological nanostructures and their applications, nanomaterials for therapeutic and diagnostic applications, nanotoxicology.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-505      **Course Title:** Electronic Properties and Measurement Techniques of Nanomaterials

**L-T-P:** 3-1-0      **Credits:** 4      **Subject Area:** PEC

**Course Outlines:** Electrical and thermal conduction in nanomaterials; modern theory of solids; semiconductors; dielectric and magnetic properties of nanomaterials; charge transport in disordered and low dimensional materials; various measurement techniques to determine electrical, dielectric, magnetic properties of nanomaterials.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-506          **Course Title:** Nanoscale Fabrication Techniques

**L-T-P:** 3-1-0          **Credits:** 4          **Subject Area:** PEC

**Course Outlines:** Introduction to nanostructure fabrication, thin film technology, thermal deposition, sputtering, molecular beam epitaxy, pulsed laser deposition, chemical vapor deposition, photolithography, soft lithography, electron beam lithography, nanopatterning and nanoindentation, micro-electromechanical systems (MEMS) and nano-electromechanical systems (NEMS) and their application in various fields.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-507        **Course Title:** Environmental Nanotechnology

**L-T-P:** 3-1-0        **Credits:** 4        **Subject Area:** PEC

**Course Outlines:** Transport, aggregation, deposition of nanomaterials, their environmental impacts and life cycle risk. Analytical methods for studying the impact of nanomaterials on the environment. Nanotechnology based remediation of environmental contaminants using adsorption, membrane technology, ion exchange, advanced oxidation processes.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTL-508          **Course Title:** Surface Engineering of Nanoscale Materials

**L-T-P:** 3-1-0          **Credits:** 4          **Subject Area:** PEC

**Course Outlines:** Introduction and rationale of surface engineering. The principles and applications of surface engineering and coating technologies for nanoscale materials. Tribology, surface modification methods, deposition techniques, nano-coatings, and their characterization. Current trends and challenges in surface modification of nanomaterials for various applications.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTT-501                **Course Title:** Technology of Nanoscale Devices

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

**Course Outlines:** Introduction to nanotechnology and nanoscale devices; basics of nanoscale electronic and optoelectronic devices; nanotechnology for solar cells, light emitting diodes, photodetectors, field effect transistors, etc; single electron transistors; low dimensional carbon-based devices; nanomaterials-based sensors: physical, chemical and biological; nanodevices for healthcare; nanotechnology inspired IoT and artificial intelligence.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTT-502          **Course Title:** Quantum Materials

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

**Course Outlines:** Introduction to quantum materials; quantum confinement and low dimensional materials; 1D, 2D, and 0D materials; topological insulators and van der Waals heterojunctions; materials for spintronics; quantum hall effect; quantum effect in low-dimensional magnetic systems; superconducting materials.

# INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/ CENTRE:** Centre for Nanotechnology

**Subject Code:** NTT-503          **Course Title:** AI and ML for Nanotechnology

**L-T-P:** 2-0-2        **Credits:** 3        **Subject Area:** STAR

**Course Outlines:** Data analysis, Python programming and visualization, regression and dimensional reduction of properties at nanoscale, machine learning for nanosensors, supervised learning for selection of nanomaterials, optimization for nanodevices, explainable AI in nanobiotechnology, and capstone project.