Sr.	Course Code	Course Title	Course Contents
1.	CT-646	Research methodology	Research design and planning, Research methods and tools, Data analysis and interpretation. Research proposal. Literature review and report writing, Important steps in writing a technical paper, Thesis writing, Plagiarism, Origin software, Endnote software
2.	MM-601	Advance materials characterization Techniques	Modern methods of materials characterization. X-ray techniques, X-ray diffraction (XRD), Spectroscopy, Optical Microscopy, Fourier Transform Infrared Spectroscopy (FTIR), Raman spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Particle Beam Analysis, Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS), Nano indenter technique, differential scanning calorimeter(DSC), Atomic force microscopy (AFM), Dilatometer technique
3.	MM-602	Advance materials and processes	Biomaterials, Nanomaterial, Materials for solar energy, Materials for solar environment, Hydrogen production by means of water splitting, Dense medium separation process, Gravity medium separation process, Beneficiation process, Hydrometallurgy process, Pyro metallurgy process, Electrometallurgy process, Advanced sintering process, Synthesis and production of materials with engineered microstructures for desired properties, Casting and solidification; diffusion, microstructural evolution, and phase transformations; Modification and processing of surfaces and interfaces; Deposition of thin films; solid state shape forming; powder consolidation; Joining of materials.
4.	MM-603	Nano Engineering and Smart materials	Synthesis and characterization of nanoparticles, nanocomposites and other materials with nanoscale features. Nanofabrication techniques. Design and properties of devices based on nanotechnology. Importance of nanostructured materials. Structure-property-processing relationship in nanomaterials and

			5.uses in electronics, photonics, magnetic applications. Classification, Application Areas, Piezoelectric Materials, Piezoeffect, Piezoelectric Materials, Ferroelectricity, Fabrication, Applications, Magnetostrictive Materials, Magnetostriction, Cryogenic Materials, Rare Earth - Fe phases, Thin Film Materials, Applications, Shape Memory Alloys, Nano catalysis; homogenous and heterogeneous catalysis
5.	MM-604	Thin Film Technology	Methods of preparation of thin films: electrolytic deposition; cathodic and anodic films, physical vapour deposition. The physics and chemistry of thermal evaporation. Film thicknesses; uniformity and purity, Evaporation hardware and techniques, sputtering, sputtering processes; laser ablation hybrid and modified PVD processes; chemical vapour deposition: reaction types, thermodynamics of CVD, gas transport, growth kinetics, CVD processes and system. Growth and structure of films; atomistic nucleation processes; post-nucleation growth; film structures; structural aspects of epitaxial films; lattice misfit and imperfection in epitaxial films; Epitaxial Film growth and characterization; amorphous thin films.
6.	MM-605	Environment Engineering and Solar Energy Systems	Introduction to environment and ecology, pollution concept, types of pollution. Environmental policy and standards; Environmental Monitoring (Air, Water & Soil): Air pollution control technologies, water pollution control technologies, water treatment technologies, soil pollution control technologies, noise pollution control technologies. Biotechnology for environment, industrial pollution control; Occupational safety devices. Solar energy: solar insulation vs. world energy demand, current energy consumption from different sources, environmental and health effects. Sustainable Energy: production and storage, resources and utilization. Fundamentals of solar cells: types of solar cells, semiconducting materials, band gap theory, absorption of photons, excitons and photoemission of electrons, band engineering; Solar cell properties and design. Single

			junction and triple-junction solar panels, metal-semiconductor hetero junctions, and semiconducting materials for solar cells. Organic and inorganic solar cells
7.	MM-606	Biomaterials	Introduction to Biomaterials, Biocompatibility, biocompatibility issues of biomaterials, how to overcome these issues, Bio functionality, In vitro and in vivo testing, Tissue -biomaterial interactions, biological response with bio-materials, Metallic biomaterials, Organic biomaterials, Biomaterials processing and synthesis, Hydroxyapatite (HA) coatings, Materials selection for implants and prostheses, Dental materials, Orthodontic wires Shape memory alloys, Use of β-Titanium and Ni-Ti alloys as biomaterials, Corrosion and biodegradation of biomaterials, Stress shielding effect, how to overcome stress shielding effects Applications of biomaterials
8.	MM-607	Dental implants	Classification of dental implants, implant structure, biocompatibility, process of dental implantation, Osseo integration , materials for dental implants, innovations in dental implant design, influence of bone implant interface properties, heat treatment of dental implants, microstructure and mechanical properties of dental implants, corrosion aspects of dental implants, strategy to prevent wear and corrosion, manufacturing process for dental implants, characterization of dental implants
9.	MM-608	Surface engineering of dental implants	Philosophy of surface engineering, General Applications and Requirements, Principles and design of coatings, Surface treatment of dental implants, Surface engineering as part of a manufacturing process, Integrating coating systems into the design process, Coating manufacturing processes, plasma spraying, sputter deposition , pulsed layer deposition, Electro deposition, Flame spraying, Plasma spray, Physical vapour deposition, Chemical vapour deposition, HIP surface treatments, Sol-gel coatings, Spin coating methods
10.	MM-609	Hydrometallurgical Processes and Techniques	This course will provide the student with a basic understanding of fundamental and practical aspects of hydrometallurgy

			processes used to extract and recover mineral and metal values. Unit processes where aqueous solutions play a major role will be examined in detail. The course will focus on the chemistry and engineering aspects of hydrometallurgical unit processes - leaching, separation, extraction and recovery. Extraction techniques will include the oxidative and non-oxidative leaching of minerals, purification and recovery of metals by precipitation, ion exchange and solvent extraction. Recovery of metals by reduction and electrowinning. Chemistry, design and operation of some common hydrometallurgical processes. It also considers practical industrial processes, and discusses overall processes for the recovery of gold, copper, nickel, uranium etc
11.	MM-610	Pyrometallurgical Processes and Techniques	This unit covers dewatering, drying and high temperature metallurgical processes such as roasting, smelting and refining. The relevant unit processes are examined through consideration of: thermodynamics and kinetics of interactions which occur among individual phases (i.e. gases, solids, metals, mattes and slag), fluid dynamics, heat-transfer and mass transfer characteristics, different reactors and techniques used to carry out these processes. References to industrial practice for production of materials such as copper, nickel, zinc, lead, gold, aluminum, tin, silicon, iron and steel will be made.
12.	MM-611	Computational Materials Science	Statistical methods in data processing and prediction of materials behave, Transport equations and the relevant problems in materials science and engineering, Imaging technologies in materials studies, First principle Monte-Carlo simulations in materials science and engineering, (Application of Monte-Carlo technique to RXN and grain growth), modeling and simulation of process metallurgy, MATLAB software, THERMOCAL software
13.	MM-612	Fracture Mechanics and Failure Analysis	Fundamental concepts of fracture mechanics and their applications, concepts of elastic-plastic fracture mechanics, dynamic and time-dependent fracture aspects, fracture mechanisms in metals, fracture toughness

			testing of metals, fatigue crack propagation, environmentally assisted cracking in metals and computational fracture mechanics. Engineering aspects of fracture and failure analysis, mechanical and metallurgical causes of failure, failure modes, characterization of fractured surface, macroscopic and microscopic features of fracture, fatigue, creep and corrosion assisted / induced failures, fractography, selected case histories and failure prevention methods.
14.	MM-613	Advanced Mineral Processing Techniques	Mineralogical analysis, liberation, sampling, metallurgical balances particle size analysis and distribution functions, screening, classification, crushing, grinding, gravity separation, dense medium separation, washability curves, magnetic separation, electrostatic separation, ore sorting. Solid-liquid separations - flocculation, thickening, centrifuges, filtration and thermal drying. This unit has on-site laboratory requirements Electro-kinetics, surface adsorption, mineral-bubble interactions, flotation - theory and practice, sulphides, non-sulphides, coal, agglomeration. Rheological properties of slurries. This unit has on-site laboratory requirements.