INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Metallurgical and Materials Engineering

Subject code: MTO-103 **Course Title:** Non Destructive Testing

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

Course Outlines: Non destructive testing and its comparison with destructive testing, role of NDT in quality control; principles, equipment, advantages, limitations, and applications of: Liquid penetrant inspection, Magnetic particle inspection, Ultrasonic inspection, Eddy current inspection, X-ray radiography; Statistical quality control, Control charts, Control chart attributes and variables, Acceptance sampling, Quality assurance and ISO 9000:2000.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: Hydrology

Subject Code: HYO-101 **Course Title:** Desalination and membrane technology

L-T-P: 2-1-0 **Credits:** 3 **Subject Area**: OEC

Course Outlines: Membrane separation technology and its applications, especially in desalination, filtration and wastewater treatment; Global water shortages and the need for membrane technology,microfiltration, ultrafiltration, nanofiltration, membrane distillation, forward osmosis, membrane bioreactors and reverse osmosis membrane processes; Operational issues of membrane-based systems, their limitations and system configuration and design.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Chemical Engineering

Subject code: CHO-103 **Course Title:** Polymer World

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

Course Outlines: Polymer Family: plastic, rubber, fiber (by use), Addition and condensation polymer (by kinetics); natural, semi-synthetic and synthetic (by origin); Thermoplastic and thermosetting (thermal behavior); Crystalline, amorphous and semi-crystalline; Atactic, syndiotectic and isotactic (by disposition of groups in space); domestic and engineering polymers. Polymer Products: Tyre, hose, cable, automotive, Packaging. Construction polymers, different moulded products.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Chemical Engineering

Subject code: CHO-105 **Course Title:** Environmental Engineering

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

Course Outlines: Classification of environment; Definition of air, water, solid, and hazardous pollutants and their effects on the environment; Characterization of industrial pollution and its limits based on various sectors and clusters; Various industrial wastewater treatment technologies and their design procedures; Estimation of industrial effluent discharges and their impact on river water; Estimation of carrying capacity of river; Modeling of river.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Mathematics

Subject Code: MAO-101 **Course Title**: Optimization Techniques

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

Course Outlines:

OR models, case studies. Convex sets, Linear Programming Problems: Graphical Method, Simplex Method, Revised Simplex Method. Duality Theory, Dual Simplex Method, Sensitivity Analysis. All-Integer and Mixed-Integer Programming Problems, 0-1 Integer Programming. Transportation Problems and Assignment Problems. Game Theory: Rectangular Games, Graphical solution of $2 \times n$ and $m \times 2$ games, reduction to Linear Programming Problems. Sequencing and Scheduling: Processing of Jobs through Machines, CPM and PERT

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Mathematics

Subject Code: MAO-102 **Course Title**: Advanced Engineering Mathematics

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

Course Outlines:

Functions of a complex variable: Analytic functions. Conformal Mappings: Bilinear transformations, Schwartz-Christoffel transformations. Complex Integration: Line integrals, Cauchy integral theorem, Taylor's and Laurent's expansions, zeros and singularities, Cauchy residue theorem, contour integration and its applications. Partial differential equations (PDEs): Solution of first order PDEs, classification of second order PDEs, solutions of one dimensional wave and diffusion equations, Laplace equation in 2 and 3 dimensions. Calculus of Variations: Functionals, Euler's equations for one and several variables, isoperimetric problems, sufficient conditions for weak and strong maxima and minima.

INDIA INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Centre of Excellence in Disaster Mitigation and Management

Subject Code: DMO-101 **Course Title:** Participatory Nature-based Risk Resilience

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

Course Outlines: Introduction to nature-based adaptation and mitigation, participatory resilience planning; Nature-assisted Risk Resilience; Risk and Development; Resilience Assessment Tool; Environmental Impact Assessment of Alternative Solutions: Environmental Impact Assessment for Nature-based projects; Environmental Management Plan: Projects types, Process, Components, Stakeholders in Project Management; Community Participation: Significance, concept, approaches and Tools; Resilience Integrated Development.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Chemical Engineering

Subject Code: CHO-101 **Course Title:** Computational Fluid Dynamics

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

Course Outline: Philosophy of computational fluid dynamics (CFD), review of equations governing fluid flow and heat transfer, flow models, flow classification, structured and unstructured grids, choice of suitable grid, grid transformation of equations, Finite Difference Method (FDM): discretization of ODE and PDE, approximation for first, second and mixed derivatives, implementation of boundary conditions, discretization errors, Finite Volume Method (FVM): discretization methods, approximations of surface integrals and volume integrals, interpolation and differential practices, implementation of boundary conditions, Case studies using FDM and FVM.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE: Department of Earthquake Engineering

Subject Code: EQO-101 **Course Title**: Seismic Safety

L-T-P: 2-1-0 **Credits**: 03 **Subject Area**: OEC

Course Outlines: Plate tectonics- continental drift, types and characteristics of various plate margins, Earthquake catalogue and seismicity of the earth, Major earthquakes in the world, Important Indian earthquakes, Theory of Seismic pickups (Seismometers, accelerometers); Un-damped and damped, free and forced vibrations, Steady-state and transient response, Response, Concept of Response spectrum, Design spectrum, Modes, mode shapes and modal analysis, seismic response analysis; Concept of strength, over strength and ductility, Concept of equal displacement and equal energy principles, Capacity Design, Seismic design consideration in buildings with irregularities; Acceleration and drift sensitive components, Floor acceleration, Anchorage forces in equipment mounted at an elevation in buildings.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE: Department of Earthquake Engineering

Subject Code: EQO-102 **Course Title**: Deformation and Flow in Environment

L-T-P: 2-1-0 **Credits**: 03 **Subject Area**: OEC

Course Outlines: Continuum description of solids and fluids, stress, strains, vorticity, conservation principles and closure conditions; Cauchy's equation of motion, Newtonian viscous fluid and Navier-Stokes equations, applications in glaciers, landslides, volcanic systems, atmosphere; Bending and flexure of plates, deformation of strata overlying an igneous intrusion, application in earth, flexure of lithosphere, flexure of sedimentary basin, flexure of ice shelf; crustal rheology; diffusion creep, dislocation creep, shear flows, mantle rheology; cooling of the oceanic lithosphere, plate cooling model of the lithosphere, Stefan problem, solidification of dikes and sills; Dimensional analysis, scaling, dimensionless numbers, vorticity diffusion, low-Re flows applied to lava, debris, and glacier flows; flow of crustal rocks and diapirism; folding of crustal rocks, postglacial rebound; channel flows, asthenospheric counterflow, flow through volcanic pipes; Stoke's flow and ascent of mantle plume; ocean gravity waves, shallow waves on deep water, tsunami waves, internal gravity waves; modelling of mantle convection and tectonic forces.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE: Department of Earthquake Engineering

Subject Code: EQO-103 **Course Title**: Engineering Seismology

L-T-P: 2-1-0 **Credits**: 03 **Subject Area**: OEC

Course Outlines: Introduction, Important terms, Causes of earthquake, Plate tectonics, Seismic waves-Body waves & Surface waves, Law of reflection & refraction, Seismic phases, Earthquake magnitude and intensity, Seismic, earthquake instrumentation- seismological & strong motion networks and their engineering importance, Processing and Analysis of earthquake data for hypocentral and earthquake source parameters, seismic hazard assessment-Definition and important terms, probabilistic and deterministic seismic hazard approach, earthquake occurrence models, estimation of maximum credible earthquake, design basis earthquake, frequency magnitude relation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRO-101 **Course Title:** Small Hydro Power Development

L-T-P: 3-0-0 **Credits:** 03 **Subject Area:** OEC

Course Outlines:

Necessity and importance of harnessing small hydro power; Small hydro power scenario and type of schemes; Site selection and investigations, Environmental aspects, Flow duration, water power studies; Diversion structures & power channels, Desilting arrangements, forebay tank and balancing reservoir, Penstock and power-house building; Types of turbines and their selection, Gates and valves, Governing system (mechanical & electrical); Types of generators– synchronous and induction, Protection & controls, Power evacuation system; Cost estimation, financial, and policy aspects.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRO-102 **Course Title:** Energy Conservation and Management

L-T-P: 3-0-0 **Credits:** 03 **Subject Area:** OEC

Course Outlines:

Definition of energy conservation, energy management, Energy conservation opportunities, general principles, Types, procedures, and instruments for energy auditing in an industry, Assessments of technical merits of energy conservation methods and techniques in specific applications, energy saving methods, energy strategy, and industrial energy applications, Energy conservation in steam boilers, engines; principles, types, and applications of different heat recovery systems, Energy conservation in electrical motors, transformers, and conductors, Energy conservation in illumination in building shells, Material conservation and recycling, waste to energy.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-101	**Course Title:** Power and Politics in Contemporary India: Issues and Approaches

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Approaches to understand contemporary India, Caste and class politics, Backward Class Movements, Dalit Politics, Ethnicisation of Caste, India's Middle Classes, Populism, Development induced dispossession and tribals, Jal-Jangal-Jameen Politics, Agrarian crisis, Commercialisation of agriculture, Neoliberalism and the WTO, Farmers suicides, Formal-informal dualism, Labour and migration, Right to the city, Precarity, Crisis in labour movements.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-102 **Course Title:** Society, Culture, and Development

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: The sociology of development, Theoretical approaches to development, Dependency theories, World system theory, Modernization theories, Actor-oriented theories, Culture and development, Concept of culture, Cultural institutions and development, Society, community and development, Globalization and development, Concept and theories of globalization, Inequality and globalization, Globalization and economic transformation in developing countries, Regional development in India, Development and underdevelopment in India; Development and exclusion in India, Concept of social exclusion and inclusive development, Caste, tribe, gender and social exclusion, Environment and development, Sustainable development, Dimensions and principles of sustainable development, Alternative development.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-103 **Course Title:** Science, Technology and Society

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Social significance of science and technology, Contextual nature of science, Scientist as analogical, indexical and practical reasoned, Perspectives on scientific knowledge, Robert Merton's ethos of science, Matthew effect in science, symbolism of intellectual property, Thomas Kuhn's structures of scientific revolutions, Karl Popper's theory of falsification and Manuel Castell's network society, Positioning HSS in technology institutes, science and technology in ancient and colonial India, peer review in Indian science, Recent trends in Sociology of Science, Science and technology in developing and developed countries, information technology and globalisation, internet and social inequality.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-104 **Course Title:** Industrial Sociology

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: The Sociological Imagination, Context for development of Sociology and industrial Sociology, The Industrial, French and Bolshevic Revolutions and their socioeconomic and industrial implications, Types of productive systems, industrialisation and post-industrial society, Max Weber, F. W. Taylor, Human Relations approach, Fordism, Types and structure of trade unions, Theories of labour movement, Labour movements in India, Recent trends in work and industry, IT industry in India, McDonaldisation of society, Future of work, Social exclusion in Indian MNCs.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-105 **Course Title:** Cognitive Ergonomics

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Introduction to Cognitive Ergonomics, Approaches to Cognitive Ergonomics, Perception, Attention, Memory and Learning, Thinking and Language, Human Information Processing, User-centered design, Scenario-based design, Personas, Monitoring and Supervisory Control, Definitions of usability by International Organization of Standardization (ISO) and Nielsen, Usability Testing, User Experience, Error, Types of Human Error, Concept of risk and Risk Management, Cognitive Safety and Basic Concepts, Safety Performance Measurement, Health and Well-being at Work, Safety-critical Scenarios.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-106 **Course Title:** Dimension of Human Behavior

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Biological Basis of Behavior: Neuron- Basic Structure and Functions, Brain- Major Structures and Functions, Localisation and Lateralisation of Brain Functions; States of Consciousness and Bodily Rhythms: Consciousness and Brain activity, Sleep- Varieties, Theories, Circadian Rhythm, Dreaming- Theories, Activation-synthesis Model; Psychopathology: Clinical Assessment and Diagnosis, Anxiety Disorders- Phobias, OCD, Personality Disorder- Clusters A, B & C, Substance-Related Disorders, Mood Disorders, Schizophrenia; Parapsychology: Historical roots, Methodology, Recurring Issues; Group Behavior: Social Cognition- Heuristics, Schemas, Attribution- Theories, Impression Formation, Social Influence- Conformity, Compliance, Obedience, Attitudes- Persuasion, Cognitive Dissonance.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-107 **Course Title:** Positive Psychology

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Positive Psychology- Background and the various Perspectives, Positive Emotional States- Well-being, emotional, social and psychological, Emotional Intelligence (EI) and its different perspectives, Positive Cognitive States- Wisdom, courage, humanity, justice, temperance, transcendence, hope, optimism, mindfulness and spirituality, Prosocial Behaviours-Altruism, empathy and forgiveness, Psychological Resilience, Positive Self, Positive Psychological Therapies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-108 **Course Title:** Gender and Culture Studies

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Development of Gender Theories, Correlation between Gender and Culture Theories, History and Concept of Feminism, Understanding Post-modernism and its Intersection with Feminist Theories, Theories of the Construction of Gender, Gender and Language, Gender and Society, Gendered Identities, Culture through Gender, Post-modernist Cultural Theories, Contemporary Issues-Technology and Gender, Media and Gender, Sports and Gender.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-109 **Course Title:** Disability and Literature

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Graphic Medicine, Ethics of Care, Medical and Social Disability, Debility, Public Health and Global South, Epidemics and Identity, Modernity and Medicine, Subjectivity and Illness, Writing and Healing, Medical and Emotional care.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-110 **Course Title:** Women's Writing

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Introduction to Feminist Theory, Writing and Gender, Women's Writing in India, Global Women's Writing, Adaptations, Genres of Feminist Narrative, Friendship and Kinship, Dystopia and Feminist Science Fiction.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-111 **Course Title:** Film & Literature

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Literature and Film, Evolution of Cinema, Adaptation Theories, Aspects of Cinematography, Montage, Flashback Technique, Film Narratives, Story, Plot, Script, Narration (Restricted and omniscient) Duration, Motivation, Motif- Parallelism, Character Traits, Cause and Effects, Visual Effects, Exposition, Climax, Point of View, Film Editing, Difference Between the Adapted Movie and the Novel.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-112 **Course Title:** Medical Humanities

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Medical Humanities-An Interdisciplinary Approach, Ethical Aspect of Medical Humanities: Principle of Medical Humanities-Respect for Autonomy, Principle of No maleficence, Principle of Beneficence, Principle of Justice, Literature and Medicine-Connoisseurship of patient, Emotional existence, Feminist Approach, Patriarchal Approach, Biomedical Discourse, Attention Disorders, Sexual Behavior, Death and Dying, The Mind and its Discontents, Narrative Medicine-Patient Narrative & the Real World, Narrative of Double Marginalized, (Dis)Ability and Literature, Medical Humanities-Exploring Social Issues.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-113 **Course Title:** Creative Writing in English

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Creativity & Resistance, Poetry- Types of Poems, Poetic Diction, Simile, Metaphor, Imagery, Symbol, Rhymes and Rhythm, Impersonal Theory of Poetry; Novel and Short Story- Writing a Novel: Situation and Event; Plot and Character; Style of Fiction; Drama- Elements and Types of Drama, Writing a Drama: Exposition, Rising Action, Climax, Anti-Climax and Resolution;Objective Correlative; Aesthetic Distance; Creative Writing-Media and Creative Writing; Writing Literary Reviews; Report and Feature Writing for Dailies and Magazines; Conducting Interview of Celebrities.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-114 **Course Title:** Partition Literature

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Introducing the History of the Partition of India, History and Alternative Memory Writings, Woman and Community, Home and Nostalgia in the Immigrant Discourse, Studying Displaced People and Abandoned Homes through Fictions, Trauma, Silence and Agency/Lack thereof in the Immigrant Woman's Writing, Looking Back at Partition – Literature in the 21st Century.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-115 **Course Title:** Canadian Literature – Perspectives on Postcolonialism

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Introducing Canadian Literature: History of Canada and Canadian Literature, Missionaries and the Canadian First Nations Reserves, Alternative Story/History-telling by the Canadian Indigenous Communities, Documentaries on the Canadian Indigenous People, Multiculturalism – The Mosaic as an Impasse, Immigration and the South Asian Diaspora, The Canadian South Asian Stage.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-116 **Course Title:** Fiction of Indian Diaspora

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Fiction : Types, origin and development ; 'Diaspora', a brief historical account ; Multiculturalism, Enculturation, Deculturation, Acculturation, Assimilation and Transculturation, Expatriation and Immigration, Boarder and Cultural Space; Indian Diaspora: The different periods; demography and the characteristic features; the Writers of Indian Diaspora: Major Concerns, Themes, Narrative Technique(s) and Current Debates; Detailed Critical Discussion on the Prescribed texts, themes, literary influences and techniques; Diaspora Writings: significance, implications and impact on our life and the formation of culture.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Humanities and Social Sciences

Subject Code: HSO-117 **Course Title:** Psychological Basis of Behavior

L-T-P: 2-1-0 **Credits:** 03 **Subject Area**: OEC

Course Outlines: Introduction to Psychology, Application and Methods, Principles of Learning, Theories of Learning, Memory and types, Theories of Forgetting, Thinking, Concept Formation, Problem Solving, Motivation, Drives, Needs, Theories of Motivation, Perception, Principles of Perception, Factors influencing Perception, Personality, Nature versus Nurture, Theories of Personality Development, Intelligence, Accessing Intelligence, Individual Differences, Theories of Intelligence.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF CENTRE: Centre for Indian Knowledge Systems

Subject Code: IKO-101 **Course Title:** Sanskrit for Communication

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

Course Outlines: Introduction to Sanskrit Language, Devanagari script, vowels and consonants, pronunciation of vowels and consonants, classification of consonants, conjunct consonants, Introduction to Case (vibhakti) and Conjugations (lakara): Noun and verb declensions; Nominative to Dative cases, Ablative to Locative cases, Present, past and future tenses, Imperative mood, usage of indeclinables, upasargas, pronouns and parasmaipada verb forms. Introduction to various suffixes and relations, Usage of Active, passive and middle voices in Sanskrit (Kartari, karmaṇi and bhāve prayogas in Sanskrit with exercises), Usages of some suffixes and various exceptions in noun declensions and Introduction to Kāraka and upapada vibhaktis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF CENTRE: Centre for Indian Knowledge Systems

Subject Code: IKO-102 **Course Title:** Consciousness Studies in Samkhya and Yoga Sutras

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

Course Outlines: Brief understanding of consciousness, three bodies and five koshas of Vedantic systems. Gunas as fundamental qualities in Existence. Purusha as consciousness principle in Samkhya. Purusha Prakriti interactions as per Samkhya. The 25 principle elements of Samkhya. Levels of Samaadhi as per Yoga Sutras, Yoga System of Patanjali, The Eight Limbs of Ashtanga Yoga, Samyama or the perfect discipline of consciousness, Self-Realization, Kaivalya or Ultimate Freedom.

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: Centre of Excellence in Disaster Mitigation & Management

1. **Subject Code:** DMO-102 **Course Title:** Introduction to Climate Change
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration(Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage: CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** OEC
8. **Pre-requisite:** Nil
9. **Objective:** To understand the climate system and basics of climate change.

10. Details of the Course:

S.No.	Particulars	Contact Hours
1.	**Climate System and its Components**: Atmosphere, Hydrosphere, Cryosphere, Lithosphere and Biosphere	6
2.	**Energy Balance, Hydrological and Carbon Cycles**: The Earth's Energy Budget, Greenhouse Effect, Radiative Balance, Global and Local Water Balance and Water Transport, Terrestrial and Oceanic Carbon Cycle	8
3.	**Climate System Modelling:** Types of Climate models, Components of a Climate model, Numerical Methods Adopted for Solving Governing Equations, Methods to Validate Climate Model	6
4.	**Causes and Mechanism of Climate Change:** Climate Variability and Time scales, Climate Extremes, Reconstruction of Past Climate, Natural and Anthropogenic Climate Change	7
5.	**Climate Forcings and Feedbacks:** Radiative Forcings, Physical Feedback, Geochemical, Biogeochemical and Biogeophysical Feedbacks	6
6.	**Future Climate Change:** Climate Change Scenarios Development, Carbon Emission Pathways, Future Climate Simulation, Tipping Points and Irreversible Changes, Observed and Projected Changes in Extreme Weather Events in India	6
7.	**Mitigation and Adaptation:** Climate Change Risks and Vulnerabilities, Mitigation Efforts, Adaptation Strategies	3
Total		**42**

11. Suggested Books:

S.No.	Name of Authors/ Books/Publisher	Year of Publication/Reprint
1.	L. M. Krauss, "The Physics of Climate Change", Post Hill Press	2021
2.	H. Goosse, "Climate System Dynamics and Modelling", Cambridge University Press	2015
3.	J. H. Seinfeld and S. N. Pandis, "Atmospheric Chemistry and Physics: From Air Pollution to Climate Change", Wiley	2015
4.	J. D. Neelin, "Climate Change and Climate Modeling", Cambridge University Press	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Earth Sciences

Subject Code: ESO-101 **Course Title:** Fractals and Applications

L-T-P: 2-1-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Mathematical background**,** deterministic and random fractals, natural fractals; Dynamical systems, interval self-mappings, complex iteration, perturbation; Applications in fragmentation, tectonics, geomorphology, seismology; Applications in other fields, image compression, finance, soil mechanics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Earth Sciences

Subject Code: ESO-103 **Course Title:** Planetary Geosciences

L-T-P: 2-1-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Composition and architecture of the Solar System**;** Planetary surfaces and atmospheres**;** Planetary interiors, meteorite mineralogy; Past, present and future planetary exploration missions; Physical processes, bio-signatures and habitable conditions of exoplanets; Origin and evolution of planets.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Earth Sciences

Subject Code: ESO-104 **Course Title:** Carbon Sequestration

L-T-P: 2-1-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Carbon cycle, global carbon budget, atmospheric CO_2 through geological time; Global carbon flux, sources and sinks of atmospheric carbon, natural CO_2 source; Geological storage, rocks for CO_2 storage, storage in reservoirs, seals, traps, aquifers and depleted oil fields; Carbon sequestration, hazards associated with carbon sequestration; Carbon capture and sequestration potential in India and beyond.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Metallurgical and Materials Engineering

Subject Code: MTO-101 **Course Title**: Introduction to Nanomaterials

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

Course Outlines: Definition and applications of nanomaterials; surfaces and structures of nanomaterials; synthesis mechanisms of 0D, 1D, 2D nanomaterials; bulk nanostructured materials, properties of nanomaterials as a function of size.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Chemistry

Subject Code: CYO-103 **Course Title:** Introduction to Instrumental Methods of Analysis

L-T-P: 2-1-0 **Credits:** 3 **Subject Area:** OEC

Course Outlines: Error analysis and sampling. Atomic absorption and emission spectrometry techniques. Structural analysis using UV-visible, infrared, and NMR spectroscopic techniques and mass spectrometry. Chromatographic analysis: GC, LC, HPLC, and hyphenated techniques. Electroanalytical techniques: potentiometry and voltammetry. Thermal analysis: TGA, DTG and DSC. X-ray diffraction studies and microscopic techniques.