

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**NAME OF DEPARTMENT:** Department of Hydro and Renewable Energy**Subject Code:** HRC-501 **Course Title:** Hydro Power Planning and Management**L-T-P:** 3-1-0**Credits:** 4**Subject Area:** PCC

Course Outlines: Development of water resources, electricity Act and policy, constitutional provisions, development process, water policy, hydropower and Pumped storage policy, electricity regulation. Types of hydro projects, Civil works components and E&M works and other related equipment, layouts, hydropower planning, Environmental impact assessment, cumulative impact assessment, environmental flows, cost estimation, financial and economic analysis, tariff determination, project financing, stream gauging, rainfall, runoff estimation, peak flood estimation, Hydrological analysis, power potential assessment, Site selection, surveys and investigations, Types of project reports and their relevance, Methods of project implementation, Schedules, Operation, maintenance and Management of hydropower plants.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-503 **Course Title:** Renewable Energy Resources Development Technology

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Fossil and non-fossil energy sources, Global and Indian energy scenario and power mix, Renewable energy and its environment implications, Concepts of global warming and climate change. Solar energy: Availability, solar constant, types of solar radiation, solar geometry, solar thermal and solar photovoltaic-based power generation, types of collectors, components of PV panel, standalone solar PV system design, Wind energy and its availability, types of wind mills/turbines and their characteristics, elementary design principles, Betz limit, Biomass: Sources and characterization, Thermo-chemical and Biochemical processes, Biorefinery concept, Waste to energy, Hydrogen energy, fuel cells and electrolyzers, Hydropower systems, turbines selection.

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-505 **Course Title:** Grid Integration of Renewable Energy

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Introduction, state of variable renewable energy (VRE) generation globally and in India, Various aspects of VRE integration, sensing and measurement, forecasting, power electronics in grid integration, energy storage, Grid Integration at Transmission level, Overview of VRE forecasting and modelling for resource assessment, production cost simulation studies, and grid reliability assessment in transmission systems; Grid Integration at Distribution Level Impact of increasing levels of electric vehicles; visibility and control concerns of distributed VRE generation; use of distributed VRE generation for providing grid services at multiple temporal and spatial scales; Advances in grid integration of VREs.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-507

Course Title: Renewable and Hydro Energy Lab

L-T-P: 0-0-6

Credits: 3

Subject Area: PCC

Course Outlines: Performance of hydropower plant, Solar Photovoltaic and Solar Thermal systems, Biomass based thermochemical conversion processes, biochemical conversion processes, biomass characterization, Gas analysis, wind energy conversion system performance analysis and characterisation, Production cost simulation, transmission and distribution power flow analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-509 **Course Title:** Finance Policy and Regulations for Renewable Energy

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Energy statistics, economics and balances, impact of energy and energy use, Energy demand, supply and forecasting, Energy regulation and acts, Power markets, Organization of wholesale power markets, long term, day ahead, real-time market, power market trading, Role of stakeholders. Financing of energy projects, Challenges in integration of renewable resources, Role of flexibility and storage, energy regulation and governance, Electricity act, energy policy, electricity tariff models, open access, policy and regulatory framework for renewable energy development, Renewable energy forecasting, scheduling, dispatch and deviation settlement regulations, Case studies, Models of renewable energy power and energy storage purchase agreements.

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-513

Course Title: Project Formulation and Implementation

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Project objectives and formulation, pre-feasibility and detailed project reports; Project implementation methods and management, public hearing process; Project planning, scheduling, PERT and CPM, monitoring and control, management concepts; Tendering procedures, procurement; Cost estimates, economic and financial analysis, Financial management, resource mobilization and sustainability, use of project management software, deficiencies in project formulation and challenges in implementation.

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-515

Course Title: Waste Water Collection, Treatment and Disposal

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Wastewater fundamentals, sources and classification of wastewater, impacts of untreated wastewater on inland water bodies, wastewater collection – sewage systems, sewage pumping and natural drainage systems, wastewater treatment methods and technologies- basic design considerations, reactors and reactions kinetics, unit operations and process, wastewater treatment, nature-based solutions including constructed wetlands and bioremediation, for wastewater treatment, sewage sludge management – present scenarios, environmental concerns, best practices and resource recovery, disinfection of wastewater, treatment wastewater reuse, recycling, revenue generation and safe disposal, concepts in self-sustainable wastewater treatment plants, case studies for comparative assessment of STPs based on different treatment technologies

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRC-519

Course Title: Aquatic Ecology

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PCC

Course Outlines: Historical developments in ecological principles and theories in aquatic ecology, Freshwater resource status in national and international perspectives, structure and functions of ponds, lakes, rivers, wetlands, and reservoirs, Wetland management and global ecology, Human Impacts on Aquatic Ecosystems, Impacts monitoring and assessment of aquatic ecosystems, preventive measures for sustainable aquatic ecosystems , Aquatic Microbiology – different forms of microbes in water bodies, their roles and functions in sustainability of aquatic ecosystems,

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRS-502

Course Title: Energy Economics

L-T-P: 2-0-0

Credits: 2

Subject Area: SSC

Course Outlines:

Overview of World energy scenario, primary energy demand, and supply. Energy and development linkage, energy prices. Fundamentals of economics, decision-making process, investment appraisal methods. Economic and financial analysis of renewable energy projects, government incentives and disincentives, project financing for energy projects, case studies. Environmental externalities, business and the environment, environmental protection as an opportunity for sustainability.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Hydro and Renewable Energy

Subject Code: HRC-511

Course Title: Integrated Management of Water Bodies

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PCC

Course Outlines: Land use, human impacts on water bodies, quality assessment indices and criteria, bio-monitoring in rivers and lakes; sampling protocol, water quality management, case histories of ongoing projects, EIA, water and sustainable development, stakeholders, water governance, public participation; legal and institutional arrangement and policies in water sector, eco-mapping.

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Hydro and Renewable Energy

Subject Code: HRC-517

Course Title: Environmental Management Lab

L-T-P: 0-0-3

Credits: 2

Subject Area: PCC

Course Outlines: Performance evaluation of sewage and effluent treatment plants, safe disposal of treated solid waste and treated water, possibilities of resource generation on account of biogas and manure production, Flow measurement techniques, sediment analysis, chemical and elemental analyses of water and sediment samples, Demonstration of advanced instruments facilities at Institute Instrumentation Centre.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-511

Course Title: Hydro Electric Equipment

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: Types, characteristics and testing of ac generators, Sizing and specification of single and three phase generators, Power factor and its correction methodologies, excitation systems, Electro-mechanical and digital governor, electronic load controller, Types of relays, contactors and control schemes for hydropower stations, SCADA, integrated computer control system for hydropower stations, Switchyard equipment, Protection schemes for generator, transformer and bus-bar, auxiliary and grounding systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-512 **Course Title:** Design of Hydropower Structures

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Hydropower layouts, design of diversion and intake structures, innovative designs, Dams and intake works, Channel, under drainage works, tunnels, Sediment properties and transport, desilting devices, silt disposal, Cross drainage works, Balancing reservoir, spillway and forebay, Penstock, anchor block and saddle, surge shaft, Gates, valves and trash racks, Power House Layout, Power house building and machine foundation, standards and codes of practice for designs of civil works.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-513

Course Title: Hydro mechanical Equipment

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: Types of hydro turbines, Design concepts, geometric similarity, characteristic curves, hill curves, Governing of hydro turbines, mechanical and electro-mechanical governors, mechanical drives, gear box, pulleys, Selection of hydro turbines based on specific speed and their optimal selection, gates and valves, Model testing of hydro turbines, performance testing of turbines at site, cavitation and silt erosion, commissioning, operation and maintenance of turbines.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-514

Course Title: Modelling, Simulation and Computer Applications

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: Simulation language and package, Principles of modeling, physical, mathematical, static and dynamic models, Nature of simulation, techniques of simulation, discrete and continuous system simulation, parallel and distributed simulation, Numerical computation techniques for continuous and discrete models. Modeling of intake, channel, desilting tank, forebay tank, penstock, Modeling of electro-mechanical equipment.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-515

Course Title: Wind Energy Application Technology

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Properties of wind, wind velocity and rose diagram, power estimation; Types of wind turbines, characteristics, construction of wind mills; Aerodynamic considerations of wind mill design, wind stream profile, rotor blade profile; Drive system-gears, wind electric generators, regulating and control systems for wind mills; Performance evaluation and recent technologies of wind energy conversion system; Wind energy potential estimation and site selection; wind farms.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-516

Course Title: Instrumentation for Hydro Power Plants

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: Need of instrumentation for hydro power projects; Static and dynamic characteristics of instruments and measurement systems; Noise and interference in instrumentation; Frequency response; Transducers and systems for measurement of level, pressure, flow, temperature and vibration; Measurement of voltage, current, power, phase and frequency; PC-based instrumentation system; Data acquisition using GPIB, serial interfaces, etc; Networked data acquisition SCADA Case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-517

Course Title: Rural Electrical Energy System Planning
and Design

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Electrical load survey and forecasting, rural load management; Route survey and profiling of T&D lines; Mechanical and electrical design of low-tension distribution lines; Planning, selection and design of substations; Load flow methods for transmission and distribution system; Fault analysis; Co-ordination between power and tele-communication lines; Maintenance of T&D lines; Case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-518 **Course Title:** Remote Sensing and GIS for Renewable Energy Planning

L-T-P: 3-0-2

Credits: 4

Subject Area: PEC

Course Outlines: Satellite platforms and sensors, characteristics of electromagnetic radiation, Indian satellite system. Digital Image processing, enhancement techniques and classification. GIS, Data sources and data collection, Coordinate system, Projection system, Attribute data management, Spatial data analysis and modelling, Multi criteria evaluation technique, GPS. Digital Elevation Model, Application of Drone in Renewable Energy planning, Case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-519 **Course Title:** Construction Planning and Management

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Project objectives and activities, Planning for construction of projects, Construction planning for river diversion, cost estimates, tendering process, Construction schedules, network techniques, Construction methods, construction plants and machinery, resource mobilisation, safety measures, Quality control and management, coordination between different organizations and monitoring, foundation construction and treatment.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-520 **Course Title:** Biomass, Bioenergy and Biofuels

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Biomass, biofuels and its sources and potential, Pre-treatment of biomass for energy application, Biochemical conversion processes, Thermochemical conversion processes, Biorefinery, Algal Biomass, Bioenergy and Waste to Energy Power Plants, Bioethanol, Biodiesel, Policies and Case Studies, Biomass supply chain logistics, Biogas plants, Design of reactors for biomass conversion.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-521

Course Title: Solar Photo-Voltaic Design and Application

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Introduction to photovoltaic technology and its status in India and the World; Solar radiation – basic concepts, assessment and variability; Structure, characteristics, electrical models and working of solar cells; Various solar cell technologies; Grid-connected systems/ stand-alone systems/ hybrid systems; Characteristics and operation of solar modules and solar PV systems; Design of grid-connected and stand-alone PV plants; Operation and maintenance of Solar PV systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-522 **Course Title:** Energy Conservation and Management

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Organization of an energy conservation program, definition of energy conservation, energy management, energy conservation opportunities, general principles, types, procedures, and instruments for energy auditing. Merits of energy conservation methods and techniques in specific applications, energy saving methods, and industrial energy applications. Supply and demand side management of energy in residential, commercial, transport, and industrial sectors, electricity utilities.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-523

Course Title: Climate Change and Water Resources

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Natural eco-systems including water bodies, anthropogenic climate change, role of different gases, integrated assessment model, impacts and adaptation, Biological and physico-chemical methods for carbon sequestration, water resources and greenhouse gas emissions, mitigation measures and adaptation to climate change, Kyoto protocol, Paris agreement, UNFCCC, IPCC, geopolitics of GHG control, emission trading mechanisms, non-CO₂ GHGs, relevance for India, Case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-524

Course Title: Electric Vehicular Technology

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Need for transportation electrification, global scenario, modern electrified transportation systems, Vehicle architectures, powertrain components, electric traction motor sizing and performance, Batteries, cell balancing circuits, and battery pack management, Battery charging infrastructure, charging requirements, Types of battery chargers, on-board chargers, off-board chargers, wireless charging electric vehicle charging and renewable based electric charging, Standards, polices and regulations.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-525

Course Title: Energy Storage Systems

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Energy storage systems and technologies (thermal, mechanical, chemical, electrochemical, electrical); applications of ESS, national and international experience, demand management for storage, Pumped hydro storage, national and international status, technology: fixed and variable, and innovative options for PSP development, Pumped hydro Potential assessment, investigations, and clearances, Financial, regulations and policy for pumped storage and battery storage.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-526

Course Title: Hydrogen Technology and Economy

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: The current market for hydrogen, the use of hydrogen in oil refineries, chemical industry, iron and steel industry, Methods of hydrogen production, Cost of Production of Hydrogen by Electrolysis, Hydrogen Storage and Transport, Case Studies for the Hydrogen Economy, Fundamentals of electrochemical cells, Reversible cell potential, Nernst Potential, efficiency, fuel utilization, Activation potential, Ohmic overpotential, mass transfer overpotential, scaleup issues.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-527

Course Title: Advanced Modelling for Renewable Energy
Power Systems

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: Numerical techniques for power systems analysis under high VRE systems; Modelling of generation, transmission and distribution systems for various power systems analyses; optimization approaches for planning high VRE power (transmission and distribution) systems; approaches for evaluating reliability of high VRE power systems, version control systems for power systems software development, co-simulation platforms for power systems modelling.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-528

Course Title: Hydrology and Modeling of water bodies

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Importance and practical applications of hydrology; global water availability, hydrologic cycles, precipitation, evaporation, infiltration, measurements, indices, runoffs, catchments, water budget, Hydrographs, Sediment yield, reservoir sediment control, river basins, water resources projects, ecological flow in rivers, Types of pollutants and modelling approach, molecular diffusion, steady and unsteady point sources, statistical analysis of water quality, transverse mixing, mechanism of longitudinal dispersion.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-529

Course Title: Environmental Laws, Public Participation and Institutional Development

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Environmental acts and laws, water act, central/state boards, pollution abatement policy, municipal and solid waste management, waste water reuse rules, National environmental policy, water policy, biodiversity act, latest laws and amendments, health, safety and environment management system, NGT act, Civil society, Awareness generation, institutional framework for environmental management, Laws related to institutions. Sustainability of the institutions, case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-531 **Course Title:** Planning and Management of Environmental Facility

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Concepts and history of Environmental Planning, Global Concerns, Development of habitat patterns, settlement structure and form in response to environmental challenges, essential components and principles of planning and management and sustainable environmental facility development, materials quality and quantity assessment, financial aspects, Measures for sustainability, operation and maintenance of the assets and facilities, case studies on environmental facilities.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-532

Course Title: Application of RS & GIS in Environment
Management

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Satellite platforms and sensors, characteristics of electromagnetic radiation, Indian satellite system. Digital Image processing, enhancement techniques and classification. GIS, Data sources and data collection, Coordinate system, Projection system, Attribute data management, Spatial data analysis and modelling, Multi criteria evaluation technique, GPS. Digital Elevation Model, Application of Drone in solid waste management sites, Case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-533

Course Title: Environmental Modelling, Simulation and
Computer Applications

L-T-P: 3-1-2/2

Credits: 4

Subject Area: PEC

Course Outlines: Introduction of simulation language and package, Principles of modeling, physical, mathematical, static and dynamic models, discrete and continuous system simulation, Numerical computation techniques, Water-Quality Models, Reaction Kinetics, Mass Balance, Steady-State Solution, and Response Time, Feedforward Systems and Feedback systems, BOD and Oxygen Saturation, Streeter-Phelps: Point Sources, Queuing Theory.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Hydro and Renewable Energy

Subject Code: HRL-534

Course Title: Biodiversity Conservation

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outlines: Biodiversity fundamentals; Levels of biodiversity - microbial, genetic, species, ecosystem, landscape; Biodiversity-ecosystem functioning and services; Assessment and Monitoring of biodiversity – Indicators, methodologies, fieldwork; Factors causing biodiversity degradation; In-situ and ex-situ conservation strategies; Conservation Practices in India and World; Policies and institutional framework; Biodiversity restoration; Case studies in India.