

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-501

Course Title: Design of Water Resources Structures

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Introduction to Storage Structures and Diversions Structures; Gravity dams- general features; forces acting on gravity dam; galleries and their functions; stability analysis; Earth dams- homogeneous and zoned sections; filter design and stability analysis; Spillways-layout and design of various types of spillways; Design of hydraulic structures on permeable foundation including weir and barrage.; Tunnels-classification; rock cover; hydraulic design and supporting systems; concrete lining; portals and plugs;.Hydro power-function; classification and main components.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-503

Course Title: Water Resources Planning and Management

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: Needs and opportunities; spatial and temporal characteristics; constraints; demand and conflict among multiple users; characteristics and functions of reservoirs: storage, sedimentation, operation, simulation, resiliency and vulnerability assessment; groundwater evaluation; conjunctive use; cost-benefit analysis; basin planning: inter-basin water transfer; environmental impacts assessment: guidelines and case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-505

Course Title: Applied Hydrology

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Hydrologic design requirements, hydrologic cycle, classification of processes and models; Data collection and Processing; Probability distributions, statistical analysis; Types of Rainfall runoff models, Unit hydrograph; Decisions with inadequate hydrologic data; Hydrologic Design, dependable yield, design storm, design flood estimation, reservoir and channel routing; Flood Forecasting; Elements of Groundwater Hydrology.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-506

Course Title: Rural and Urban Water Supply

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Importance to water supply for public health, water supply issues related to rural, hilly and urban areas, local, regional, and national perspective of water supply, water pricing. Estimation of water demands, Water supply sources – types and yield estimation, Intake structures, Water Quality – parameters and standards, Water treatment processes, Water Distribution Networks, Hydraulics of flow through pipelines.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-507

Course Title: System Design Techniques

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: System concepts and types, Mathematical formulation and solution of simultaneous equations, Linear Programming (LP) - model formulation, Graphical and Simplex methods of solution, Special cases of Linear Programming programs like Transportation, Integer, and Assignment, Dynamic Programming (DP); Decision Making (DM) under certainty, risk and uncertainty, Multi-criteria decision making (MCDM).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-511

Course Title: Hydro Generating Equipment

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Characteristics and specification of fixed and variable speed hydro-generators, starting and braking, excitation requirement- sources; drives; automatic excitation control, electro-hydraulic governor, abnormal operations of hydro generators and their protection schemes, fire protection, electrical and mechanical tests, operating limits of hydro generators, different types of turbines including reversible pump turbines.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-513

Course Title: Hydropower system Planning

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: Sources of energy and status of hydropower, principles of hydropower development, components of a hydropower scheme, types of hydropower plants, Rainfall–runoff relationships, flow measurement in rivers and streams, flow and power duration curves, Diversion structures, site selection, intakes, spillways, energy dissipaters, Water conveyance, diameter of penstock, conduit valves, water hammer, Economics and financial analysis of hydropower projects, Benefit cost analysis, energy pricing and tariff principles

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-515 **Course Title:** Project Planning and Management

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Definition of project and project management, Project scope and time management, Work break down structure, Characteristics of water resources projects, Project feasibility, appraisal, and financing, Contract Management, Risk and uncertainties in project planning, Construction and operational phases, Linear programming - transportation & assignment problems, Network development for project planning, Project monitoring systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-517

Course Title: Hybrid Renewable Energy System

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Handling intermittency of Renewable Energy sources, Basic characteristics of Solar, Wind and Hydro sources, Energy storage technologies-Grid scale batteries, pumped storage plants, and compressed air systems, Hybrid station planning for meeting minimum output requirements.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-521 **Course Title:** Design of Hydro Mechanical Equipment

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

Course Outlines: Different types of hydro turbines with their constructional details, Pumps for pumping water-characteristics, Gates for different types of spillways, Various types of hoists for gates- design of rope drum hoist, Hydraulic and structural design of penstock, Fabrication, handling, alignment, erection and support arrangement of penstocks.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-533

Course Title: Design of Irrigation Structures and Drainage Works

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Necessity of irrigation system, types of irrigation; crop water requirement, irrigation efficiencies, consumptive use, canal capacity, rotational delivery, conveyance and seepage losses; Design of lined and unlined channels, economics of canal lining, discharge measuring devices; Design of distributary regulators, seepage theory, protection works; design of canal falls/drops; design principles; canal escape and their function; waterlogging, types of drainage system; layout and design of surface drains; flood management, structural and non-structural measures.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-535

Course Title: On Farm Development

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Introduction to techno-economic and environmental issues of canal commands, Command area development programme, On Farm Development Planning, Identification and reclamation of waterlogged and salt-affected lands, Water distribution practices in India and other neighbouring countries in canal, tube well, small storage and diversion structures; On farm system design, Agricultural extension, Participatory irrigation management, Irrigation management transfer, Runoff recycling, mixed use of fresh and effluent water in agriculture, Conjunctive use planning, Sub surface drainage.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-537

Course Title: Principles and Practices of Irrigation

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Water resources and its status, problems of irrigation development; Soil water plant atmosphere relationship, Rainfall-runoff analysis, water availability assessment, infiltration, and water balance study; Approaches of estimating reference crop evapotranspiration, net irrigation requirement, crop growth stages; soil moisture depletion; Basin, border, furrow, sprinkler and drip irrigation and their design procedures; evaluation of irrigation performance; Automation in irrigation; Water quality testing, classification, treatment and management; Groundwater quality contamination, effluent and wastewater use in agriculture.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-543

Course Title: Drinking Water and Sanitation Sustainability

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Introduction to the society and water resources, concepts of Environmental Management and Environmental Health, Water Sanitization and Hygiene, Information, Education and Communication (IEC), Behavioural Change Communication (BCC), Water Sources Sustainability, Environmental, economic, and social sustainability of drinking water sources, Land and River Management, Environmental impact assessment and mitigation, Need Assessment and Governance, Project Management for Development.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRC-545 **Course Title:** Water Sanitation, Hygiene, and Infrastructural Management

L-T-P: 3-0-2

Credits: 4

Subject Area: PCC

Course Outlines: Pathogen Exposure and Disease Classification, Excreta-Related Diseases, Introduction to Drinking Water Quality, Water Quality Standards and Public Health Risks, Water-Sanitation-Disease Relationship, Risk Behaviours, Hygiene Evaluation, WASH Behavior Change, Menstrual Hygiene, Urban Sanitation, Faecal Sludge Management, Low-cost Sewerage, Container-based Sanitation, Urban Water Infrastructure, Water System Management, Water Treatment Principles, Technology Selection, Water Safety Plans, Pour-flush Latrines, Pit Latrines, VIP Latrines, Composting Latrines, Septic Tanks, Soakage Systems, Ecological Sanitation, Design of Water Supply Network and its Monitoring, Solid and Liquid Waste Management, Sanitary Landfill, Sanitation Value Chain, Project Cycle, Theory of Change, Case Studies on WASH Projects.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRS-501

Course Title: Water and Society

L-T-P: 2-0-0

Credits: 2

Subject Area: SSC

Course Outlines: Water and sustainable development, water development and management practices in the past communities, socio-economic and cultural dimensions of water, water demand for drinking, food, industry, energy, and recreation, water supply challenges in rural and urban areas, water resources in changing climate, extreme weather events and disaster management, water conservation practices and efficient water use, water quality and health, water and urbanization, transboundary/inter-state water sharing challenges, community water management.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Water Resources Development and Management

Subject Code: WRT-501 **Course Title:** Artificial Intelligence (AI) & Machine Learning (ML) for Water Resources

L-T-P: 2-0-2

Credits: 3

Subject Area: STAR

Course Outlines: Introduction to AI & ML, Systems and Modeling, Statistics and Data Analysis, Probability theory and Distribution, Search Algorithm, Gradient Decent, Genetic Algorithm, Model Development, Types of Regression Models, Classification, Parameters Estimation, Building Linear Neural Models, Feed Forward, Multilayer Perceptron, Sensitivity and Uncertainty Analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-505

Course Title: Irrigation Structures

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Site selection and investigations for diversion works; Hydraulics of flow over weirs/under sluices, seepage theory, Design flood estimation; Types and design of energy dissipaters, Head regulator; Cross regulator, Types of cross drainage works, design aspects of sediment excluder and sediment ejector, Structural design of raft foundation, piers, abutments, and retaining walls.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-507

Course Title: River Engineering

L-T-P: 3-0-2

Credits: 4

Subject Area: PEC

Course Outlines: Sediment Transport Processes, Incipient motion of sediment particles, Resistance to flow and velocity distribution in alluvial streams, River Morphology, Meandering and braided stream characteristics, River equilibrium, River Training Techniques, Principles of stabilization of rivers, Inland Navigation and Channel Development, Navigation, Locks and terminals, River Models, Scale modeling-types, Principles of Similitude and Dimensional Analysis, Flood Risk Management, Applications of Remote Sensing and GIS for flood management, Flood control planning- structural and non-structural measures.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-523

Course Title: Planning and Design of Small Hydro Power Scheme

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Small hydro country status, Basic components of a small hydro scheme Hydrology, Regional flow duration models, Considerations for environmental flow Planning and design of diversion, Types of turbines for small hydro, Synchronous and induction generators, Power evacuation system, Planning and design of auxiliary systems, Protection of synchronous and induction generators, Economic and financial analysis, Case Studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-525 **Course Title:** Modelling and Simulation of Hydro-Electric Energy Systems

L-T-P: 1-1-4

Credits: 4

Subject Area: PEC

Course Outlines: Electromagnetic energy conversion modelling and analysis – modelling of converters – modelling of synchronous machine, excitation system – modelling of squirrel cage induction generator, excitation system - modelling of doubly fed induction generator – steady state modelling -dynamic modelling -simulation of developed model to study real and reactive power generation in hydropower plants.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-535

Course Title: Renewable Energy System Technology

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Types of renewable energy sources -Solar thermal energy conversion technologies - Solar photo voltaic systems - Electric generators for wind turbine application- Hydropower generation using synchronous and induction generators– Biomass conversion technologies for electricity generation- Wave energy and ocean thermal energy conversion technologies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-536

Course Title: Water Quality Monitoring and Modeling

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Water Quality Parameters, Physical, chemical and biological parameters, Water Quality Standards, Eutrophication, Surface and groundwater pollution, Sources of pollution, Water Quality Indices, Physical, chemical and biological monitoring, Water Quality Testing, Testing Procedures, heavy minerals, Organic contaminants, Waterborne pathogens, Dissolved oxygen, Natural purification, point source protection, Water legislation, Treatment processes, water and wastewater systems, Biological treatment, Tertiary treatments, Surface and groundwater interaction, point and non-point source pollution, diffusion and dispersion problems, Water quality models.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-537

Course Title: Groundwater Development and Management

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Groundwater utilization, impact and future need. Use of groundwater for irrigation water management. Hydrologic properties of water bearing formation, occurrence, storage and distribution of groundwater, use of groundwater zone maps. Ground resources estimation, Groundwater budget, Well hydraulics Steady State, Infiltration, Unsteady flow of ground water, Aquifer parameter termination, Recovery, Well Design, Ground water conservation and artificial recharge, sustained yield, Conjunctive use, Technical, socio-economic and organizational aspects of groundwater management. Rainwater Harvesting.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-539 **Course Title:** Remote Sensing and GIS Applications in Water Systems

L-T-P: 3-0-2

Credits: 4

Subject Area: PEC

Course Outlines: Remote sensing, sensors, platforms, and their characteristics; principles of remote sensing and data analysis, image interpretation virtual and digital, use of image processing software, Geographical information system (GIS), definition, essential components of GIS, GIS packages and salient features, use of remote sensing and GIS techniques in agriculture and water resources.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-544 **Course Title:** Operation Maintenance and Management of Irrigation Systems

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Irrigation organizations, Organizational management, Organizational change mechanism, Maintenance types, Canal irrigation maintenance problems physical and social phenomenon, Canal irrigation maintenance practices, Pressurized irrigation maintenance problems and practices, Catchment protection to check soil erosion, Diagnostic analysis of canal system, Reservoir and canal operation, Concepts of automatic regulation of canal operation, Water charges, revenue recovery and performance budgeting.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-553

Course Title: Wastewater and Fecal Sludge Management

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Types and sources of wastewater, Characteristics of faecal sludge, Treatment methods (biological, chemical, and physical), Design and operation of wastewater treatment facilities, Regulations and guidelines governing wastewater management, Health risks and impacts associated with improper management, Sustainability practices in wastewater treatment, Low-cost faecal sludge management, Faecal sludge collection and disposal systems, Resource recovery techniques, Socio-economic measures for Faecal sludge management.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-556

Course Title: Water and Wastewater Engineering

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Water and wastewater characteristics, Design principles for water treatment systems, Water treatment system unit operations, Sedimentation, Coagulation and flocculation, Softening, Filtration, Disinfection, Wastewater treatment system unit operations, Activated sludge process, Wastewater disposal and reuse, Advanced waste water treatment, Adsorption, Ion exchange, Advanced oxidation process, Water quality assessment and standards, Membrane technologies, Biological treatment methods, Residual management.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-558

Course Title: Flow Hydraulics and Urban Drainage

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Properties of fluids, Pressure and its measurement, Hydrostatic forces on surfaces, Kinematics of flow, Ideal flow, Dynamics of fluid flow, Flow through orifices and mouthpieces, Turbulent flow, Forces on submerged bodies, Storm water runoff generation; Frequency analysis, IDF relations, Sources of surface and ground water pollution, Heavy minerals, Eutrophication of water resources, Water Legislations and Standards, Need of Integrated water resources management, Water conservation and cycling.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Water Resources Development and Management

Subject Code: WRL-561

Course Title: Sustainable Water Resources

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Sustainable development and water, climate change and challenges, water footprints, water use & balancing needs, demand and supply, water reuse, identification of water potential and water management using RS and GIS, water quality issues, agricultural water use, food- water-energy nexus, water accounting, sustainability index: concepts and assessment, water scarcity challenges, Millenium/Sustainable Development Goals, and global & local water- related problems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Water Resources Development and Management

Subject Code: WRL-562

Course Title: Open Channel Hydraulics

L-T-P: 3-0-2

Credits: 4

Subject Area: PEC

Course Outlines: Open channel flow, Velocity distribution, Conservation of mass, momentum and energy in open channel flows, Transitions in open channel, Hydraulically efficient channel section, Compound channel, Flow in curved channels, Theoretical aspects of hydraulic jumps, characteristics, and features, Analysis of flow profiles in nonuniform channel, Surface waves, Dimensional Analysis, Model similitude, Model scales, Physical modelling, Computational hydraulics, Theory and applications.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Water Resources Development and Management

Subject Code: WRL-563

Course Title: Sediment Transport in Rivers

L-T-P: 3-0-2

Credits: 4

Subject Area: PEC

Course Outlines: Open channel control structures, Sediment properties, Hydrodynamics of fluid particle systems, settling velocity of particles, Plan form variations and river channel pattern; Meandering and braided stream characteristics; Sediment Threshold concept, Bed load, Suspended load, Design of stable channels-regime, Bedforms, Bed features in gravel bed streams, Scours and their counter measures in open channel, Sedimentation in reservoirs, Coastal sediment problems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Water Resources Development and Management

Subject Code: WRL-564 **Course Title:** Preparation of Water Resource Project Report

L-T-P: 0-0-4

Credits: 2

Subject Area: PEC

Course Outlines: Design of diversion channel, spillway, under sluice, head regulator, tunnel intake structure, desilting basins, reservoir, head race tunnel, adits, surge shafts, pressure shaft, powerhouse, tail race channel, turbines main inlet valve, generator, transformation system.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Water Resources Development and Management

Subject Code: WRL-565

Course Title: Mini Project on Drinking Water and Sanitation

L-T-P: 0-0-4

Credits: 2

Subject Area: PEC

Course Outlines: Water quality and sanitation; Water quality parameters; Water and wastewater; pH, Color, Turbidity, Hardness, and Alkalinity; Chlorides, nitrates; Dissolved Oxygen, Biological Oxygen Demand; Chemical Oxygen Demand; Microbial water quality; MPN; Membrane filtration; heavy metals and micro pollutants; Total Organic Carbon; MLSS; MVLSS; Water Sample collection; Testing; Analysis; Case studies.