Annexure-VI

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
DEPARTMENT OF HYDRO AND RENEWABLE ENERGY

Program Code: **13** **M.TECH. (ENVIRONMENTAL MANAGEMENT OF RIVERS AND LAKES)**
Department: **HRE** **DEPARTMENT OF HYDRO AND RENEWABLE ENERGY**
Year: **I**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credits**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Semester- I (Autumn)														
1.	HRE-523	Integrated Management of water bodies	PCC	4	3	1	2/2	3	-	20	20	20	40	-
2.	HRE-525	Aquatic Ecology	PCC	4	3	1	2/2	3	-	20	20	20	40	-
3.	HRE-544	Project Formulation and Implementation	PCC	4	3	1	-	3	-	25	-	25	50	-
4.		Programme Elective Course-I*	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective Course-II*	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		20	9	3	2							
Semester-II (Spring)														
1.	HRE-527	Laboratory Course	PCC	2	-	-	3	-	3	-	50	-	-	50
2.	HRE-554	Waste Water Collection, Treatment and Disposal	PCC	4	3	1	-	3	-	25	-	25	50	-
3.	HRE-700	Seminar	SEM	2	-	-	-	-	-	-	-	100	-	-
4.		Programme Elective Course-III*	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective Course-IV*	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		16	3	1	3							

Program Code: **13** **M.TECH. (ENVIRONMENTAL MANAGEMENT OF RIVERS AND LAKES)**
Department: **HRE** **DEPARTMENT OF HYDRO AND RENEWABLE ENERGY**
Year: **II**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credits**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Semester- I (Autumn)														
1.	HRE-701A	Thesis Stage–I (to be continued in next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	HRE-701B	Thesis Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester	1	2	3	4
Semester-wise Total Credits	**20**	**16**	**12**	**18**
Total Credits	**66**			

PROGRAM ELECTIVE COURSES (EMRL)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	HRE-517 B	Modeling, Simulation and Computer Application	PEC	4	3	1	2/2	3	-	20	20	20	40	-
2.	HRE-518	Environmental Planning and Management	PEC	4	3	1	-	3	-	25	-	25	50	-
3.	HRE-540	Solar Photo-Voltaic Design and Application	PEC	4	3	1	-	3	-	25	-	25	50	-
4.	HRE-542	Energy Conservation and Management	PEC	4	3	1	-	3	-	25	-	25	50	-
5.	HRE-550	Application of RS & GIS in Environment Management	PEC	4	3	1	-	3	-	25	-	25	50	-
6.	HRE-552	Hydrology and Modeling of water bodies	PEC	4	3	1	-	3	-	25	-	25	50	-
7.	HRE-556	Environmental Laws, Public Participation and Institutional Development	PEC	4	3	1	-	3	-	25	-	25	50	-
8.	HRE-558	Coastal Pollution Monitoring and Impact Assessment	PEC	4	3	1	-	3	-	25	-	25	50	-
9.	HRE-576	Planning and Management of Environmental Facility	PEC	4	3	1	-	3	-	25	-	25	50	-
10.	HRE-580	Climate Change and water bodies	PEC	4	3	1	-	3	-	25	-	25	50	-
13.	CE-603	Industrial and Hazardous Waste Management	PEC	4	3	1	-	3	-	25	-	25	50	-
12.	CE-604	Environment Impact & Risk Assessment	PEC	4	3	1	-	3	-	25	-	25	50	-
11.	CE-605	Solid Waste Management	PEC	4	3	1	-	3	-	25	-	25	50	-
14.	HY-527	Ground Water Hydrology	PEC	4	3	1	-	3	-	25	-	25	50	-
15.	HY-531	Water Shed Behavior & Conservation Practices	PEC	4	3	1	-	3	-	25	-	25	50	-
16.	HY-542	Urban Hydrology	PEC	4	3	1	-	3	-	25	-	25	50	-

HRE-523: INTEGRATED MANAGEMENT OF WATER BODIES
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 2/2

Hydrology, types, hydrological processes and water balance of water bodies, estimation of present and projected demands, human impacts, inventory of human activities in a basin, land use and impact of anthropogenic activities on water quality, domestic water demand, wastewater generation, collection and treatment and disposal, urban storm water, industrial waste generaion, open defication, municipal solid wastes collection, transport and disposal, impacts of dumping in drains or sewer lines; Point and non point sources, types of water pollution, water quality criteria and standards, designated best uses of water; equilibrium, acid base, oxidation – reduction, precipitation and complex reactions; Physical methods (turbidimetry, nephlometry, optical methods of measurement, potentiometry, chromatography, spectroscopy); measurement of sulphates, Na, DO, BOD, TOC, all forms of N, fluorides exposure to analytical techniques of IIC like ICP, AAS, GC, biological components (periphyton, phytoplankton, zoobenthos, nekton, biodiversity indices, trophic status, P/R ratio microbiological MPN, coliform and streptococcus, bioindicators, biomonitoring of water bodies), sampling, schedule and water quality monitoring program of national rivers and lakes; sampling protocol of NRCD, standards, water quality indices, strategy for water quality management, case histories of ongoing projects; Principles of environmental management, EIA, water and sustainable development, involvement of stakeholders, water governance, environmental education, public participation; Legal, constitutional provisions, national policies, legal and institutional arrangement for the management of water quality and quantity; Application of remote sensing and GIS for water management, modeling (forecasting and growth modeling), eco–mapping, inter river basin transfer, cost–benefit analysis, environmental taxes, economics of natural resources.

HRE-525: AQUATIC ECOLOGY
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 2/2

Definition, relevance, principles and scope of ecology, sub-divisions, Structure and functions, biotic and abiotic components and productivity of ecosystem and energy flow, materials cycling, energetics, limiting factors, development and evolution; Trophic levels, food chain and food webs, ecological pyramids, competition, population ecology; Lakes, wetlands and rivers, reservoirs and springs, structure and functions, usefulness, natural and manmade ecosystems; concept, importance and conservation of aquatic biodiversity role of invasive species and its importance; System analysis, ecosystem models, Stressed ecosystems, homeostasis, ecological succession, ecosystem resilience; Pollution of lakes and rivers, causes, impacts and control of eutrophication; principles and application of restoration methods, ecotechnologies; National/international perspectives, policies, Ramsar convention, NLCP, NRCD, case studies of Dal lake, Nainital lake, Chilka, Loktak and Asan wetlands, Tehri dam reservoir, river Ganges and Yamuna; Elementary biochemistry, salient features of biomolecules, enzymes and other tools of biotechnology, discovery and diversity, prokaryotic cell, microbial energetics, biosynthesis and nutrition, autotrophic way of life, growth, macromolecular synthesis; Microorganism in environment, microbiology of water, bacteria and viruses, bacteriophages, animal and plant viruses, structure, replication and quantification, structure and diversity of algae, protozoa and rotifers.

HRE-544: PROJECT FORMULATION AND IMPLEMENTATION
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Project objectives and formulation, preparation of pre-feasibility and detailed project reports; Project implementation methods and management, project management agencies, public hearing process; Project planning, background of network charts, network elements, drawing the network, PERT and CPM comparison and application, monitoring and control, management concepts; Tendering procedures, tender documents of central and different state governments, standard tender documents from international bodies like world bank, ADB and other funding agencies, on-line tendering procedure, procurement; Cost estimates, economic and financial analysis, internal rate of return, cost benefit analysis Financial management, resource mobilization and sustainability of the project, use of application softwares in project management, equipment development of lab, identification of appropriate equipment; Specific regulations/statuary acts of other countries not practiced in India, problems of project implementation.

HRE-527: LABORATORY COURSE
Credit: 2
Contact Hours: Lecture: 0, Tutorial: 0, Practical: 3

Solid waste characterization, soil characteristics: permeability, porosity, LL, PL, grain size distribution, soil classification and resistivity; Performance evaluation: sewage and effluent treatment plants, disposal of treated solid waste and treated water, possibilities of resource generation on account of biogas and manure production; Performance evaluation of toilets, crematoria and river fronts; Flow measurement techniques: 'V' notch and area-velocity method; Sediment analysis; Trace element analysis; Performance evaluation of various waste water treatment systems: lagoons, oxidation pond, ASP, UASB and other treatment plants; Students to work at least for two weeks time at any STP set-up under GAP/NRCD to carry out the comprehensive evaluation of STPs or ETPs; Demonstration of latest equipment of Institute Instrumentation Centre.

HRE-554: WASTE WATER COLLECTION, TREATMENT AND DISPOSAL
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Overview, sources-domestic and industrial, waste water, its quality, effluent standards, waste water load and its evaluation, flow rates, water supply data, actual measurement and analysis of flow data; Waste water collection, sewerage systems and sewage pumping, natural drainage system and waste water disposal; Typical sewage quality, its composition and health hazards of handling and disposal; Software for sewer design and estimation of waste water, objectives, methods and implementation strategy of treatment processes, physical operations like screening, grit removal, flow equalisation, sedimentation; aerobic, anaerobic, attached and suspended growth processes; pond system, combination and/or alternatives, design of treatment units, life cycle cost; Operation and maintenance of waste water treatment plants, polishing of treated waste water, disinfection, nutrient removal, natural treatment systems; Treatment of sludge, disposal of treated effluent and sludge; Resource generation by way of biogas generation, sale of treated water and sludge, tertiary treatment, reuse of treated water in agriculture/horticulture/construction work, CDM of conservation facilities like STPs, toilets, crematoria to generate additional revenues.

HRE-517 B: MODELING, SIMULATION AND COMPUTER APPLICATIONS
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 2/2

Review of C++; Principles of modeling, physical, mathematical, static and dynamic models, transport phenomena based model; Modeling of empirical data, estimation of model parameter, goodness of fit, confidence level Experimental and mathematical simulation; numerical methods used for simulation and exposure to available computer softwares; parameter estimation for models and sensitivity analysis/ANN based model development; Design of experiment and optimization; Uniform and non-uniform continuous distribution random numbers, computer generation of random numbers, Monte-Carlo simulation, spread sheet simulation, numerical computation techniques for continuous and discrete systems; Water quality modelling, assimilation capacity, dispersion of pollutants in water bodies; Case studies; modelling of waste treatment and other pollution mitigation system; Monte-Carlo simulation for risk analysis of conservation of rivers and lakes, lake water balance and simulation, modelling for dependable yields from a lake.

HRE-518: ENVIRONMENTAL PLANNING AND MANAGEMENT
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Basic ecological principles, concept and components of ecosystem, energy flow, nutrient cycling, cybernetics, ecological regulating, ecological diversity; Interaction of various components of environment, ecological disorders; Environmental impact assessment (EIA) of water resources projects with emphasis on renewable energy projects e.g. shp, biomass, solar energy; Conservation of resources, environmental policies, laws and acts; Significance of EIA of renewable energy projects, case studies of large and small hydro projects; Environmental compatible growth.

HRE-540: SOLAR PHOTO-VOLTAIC DESIGN AND APPLICATION
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Solar energy data, estimation of solar energy on different planes; Principle, characteristics and types of solar photo-voltaic (PV) cell; Manufacturing and performance testing of solar PV modules; PV modules, array, batteries, battery chargers, block diodes, inverters, load distribution unit, monitoring equipment, circuit breakers; Load estimation, sizing of array and battery; Types of PV system, isolated and grid connected PV power plants; Installation and maintenance, grid interfacing, field monitoring; economic analysis, cost effective hybrid designs.

HRE-542: ENERGY CONSERVATION AND MANAGEMENT
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Definition, organization of an energy conservation programme, definition of energy conservation, energy management, energy conservation opportunities, general principles, types, procedures and instruments for energy auditing; Assessments of technical merits of energy conservation methods and techniques in specific applications, energy saving methods, energy strategy, industrial energy applications; Methods of cost estimation for potential savings of fuel and electricity; Supply and demand side management of energy in residential, commercial, transport and industrial sectors, electricity utilities; 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, buildings heat losses, effect of fabrics, solar gains, ventilation, cooling, thermal storage and heat pumps; Topping and bottoming cogeneration cycles, total energy systems.

HRE-550: APPLICATION OF RS AND GIS IN ENVIRONMENT MANAGEMENT
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Definition of remote sensing, ideal remote sensing system, sensors and their characteristics; Image processing software, image registration, image enhancement, image classification; Definition and components of GIS, sources of data, coordinates and projection system, global Positioning System; Spatial and non spatial data, raster and vector data, data errors and editing creation of data base, special data operations and analysis; Applications of RS and GIS in optimal routing of solid wastes collection system of an urban area, environmental siting of industries, zoning atlas development and impact of land use and land cover change on environment; Re-modelling of water distribution and sewer network systems using GIS; GIS for sustainable land use urban development planning, rivers, lakes and coastal areas; Groundwater vulnerability modelling using GIS, environmental degradation and soil erosion of catchment, reservoir capacity and sedimentation.

HRE-552:HYDROLOGY AND MODELLING OF WATER BODIES
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Definition, importance, practical applications of hydrology; global water availability, India's water availability, hydrologic cycles; definition, forms and types of precipitation, measurement of rain fall using rain gauges, selection of rain gauge stations, consistency of rainfall data, computation of mean rainfall, estimation of missing rainfall data, presentation of precipitation data; Losses from evaporation, definition, process, factors and measurement, estimation using empirical formulae; infiltration, factors affecting infiltration capacity, measurement, Harton's infiltration equation, infiltration indices, runoffs, concept of catchments, water budget, components, factors affecting runoff, rainfall-runoff relationship using simple regression analysis, agricultural practices to minimize impacts of runoffs carrying chemicals and pesticides on river ecology; Hydrographs, definition, components and its derivation from simple storm hydrographs, base flow separation, S-curve and its uses, stream flow and its stages, discharge measurement by area-velocity and slope area methods, simple stage discharge relation; Sediment yield and its determination in reservoir/lake, reservoir sediment control, water wealth, river basins and their potential, importance of water resources projects in India, need of minimum ecological flow in rivers, its regulations in India and other countries, small scale and small tank harvesting, urban rainwater harvesting, methods of ground water recharge; Types of pollutants, modeling approach, molecular diffusion in a stagnant fluid, molecular diffusion equation and its classical solutions advection-diffusion equation, its classical solutions and its depth and cross-section averaging, shear flow dispersion, Taylor’s analysis of turbulent shear flow; Mechanisms of vertical mixing from steady transverse line, steady and unsteady point sources, statistical analysis of water quality, mechanisms of transverse mixing, constant-coefficient and two-dimensional numerical mixing models, cumulative discharge method for transverse dispersion, transverse mixing from a diffuser of finite length; Mechanism of longitudinal dispersion, Fickian and alternative models, estimation of mixing length, analytical and numerical solutions of longitudinal dispersion equation, estimation of longitudinal dispersion coefficients, non-Fickian behavior of dispersion process, field measurements of mixing in river and lakes.

HRE-556: ENVIRONMENTAL LAWS, PUBLIC PARTICIPATION AND INSTITUTIONAL DEVELOPMENT
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Genesis of environmental acts and main national laws, water (prevention and control of pollution) act/rules, constitution of central and state boards; Environment (protection) act rules, prevention, control and abatement of environmental pollution, hazardous wastes management and handling rules, pollution abatement policy, municipal and solid waste (management and handling rules), biomedical waste rules and chemical accidents rules; National environmental policy, water policy, EIA guidelines of MoEF and successive amendments, biodiversity act, latest laws and amendments, industrial and MSW rules, health, safety and environment management system, water resources management through community participation; Notification of MoEF for construction projects, National environmental tribunal act and appellate authority; Environment audit, international protocol, treaties and conventions, Latest International global environmental concepts like global warming and its impact on water resources, Stock-holm and Basal convention, Copenhagen conference, Rio-Earth summit, maintenance of biodiversity, awareness; Modes of awareness generation, information, education, communication, costing of awareness generation, Sustainability and impact assessment, role of civil society in awareness generation, stages and forms of public participation, forms of public participation, role of institutions, evaluation of existing institutions, design of institutions, Case studies, Laws related to institutions.

HRE-558: COASTAL POLLUTION MONITORING AND IMPACT ASSESSMENT
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Brief history, importance, fields of application and fundamental concepts of coastal pollution, collection, processing, analysis and quality control of data; Fundamentals of acoustic wave propagation in ocean waters, sound velocity computation, attenuation, refraction and reflection, frequency band width, multibeam echosounders, sea floor classification; Water levels and flow measurements, principles of tides and water levels, astronomical tide producing forces, tidal characteristics, non-tidal water level variations, tide and water level datum, harmonic analysis and tide prediction, principles of tidal currents, measurements and prediction; Biological/chemical indicators of coastal pollution, methods for the assessment of coastal and marine pollution, biological productivity and pollution monitoring, physical/chemical/biological water quality, sampling techniques and problems, nutrients, anoxia, impacts of heavy metals, pathways of radioactivity, data storage and processing, water quality standards; Coastal pollution, types, causes and impact, concept and guidelines of sewage or sludge disposal into the sea; Notification of coastal regulation zone (CRZ) and environment clearance with practical case studies, desalination units for drinking water; Case studies of EIA of developmental projects on coastal areas.

HRE-576: PLANNING AND MANAGEMENT OF ENVIRONMENTAL FACILITY
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Estimation of earthwork volume by cross-section, spot levels and contour, construction of mass diagram, calculation of haul, over haul and economic haul lead and lift; Procedure for working out quantities and rates for lime and cement mortars, lime and cement concrete, brick and stone masonry, flooring, plastering, RCC works, centering and works for different RCC items, doors, windows and ventilators; Drawing up specifications for construction materials such as coarse aggregate lime, cement, mortars, plain and reinforce concrete, brick masonry, stone masonry, flooring, roofing, plastering, wood work, earthwork and surfing,

water supply distribution lines, surface and sub-surface drainage line (including stone-ware pipes); Methods for estimating the quantities, preparation of detailed and abstract estimates for the environmental engineering works like septic tank, manhole, pump house, store room, calculation for procuring steel for reinforcement for the basic components such as small slabs, chejja and lintels; Financial aspects, cost price and its different forms, gross and net income, outgoings and its types, obsolescence, annuity, year's purchase; Capital cost, operating cost, capitalized value, time value of money, sinking fund, depreciation and methods of its calculation, cost fixation on the produced commodity; Fiscal incentives for environmental protection: exemption from it, investment and depreciation allowance, exemption from tax to capital gains, rebate in cess levied on consumption of water; Measures for sustainability, operation and maintenance of the assets and facilities.

HRE-580: CLIMATE CHANGE AND WATER RESOURCES
Credit: 4
Contact Hours: Lecture: 3, Tutorial: 1, Practical: 0

Natural eco-systems, autotrophs, heterotrophs, energy flows, pre-industrial humanity; efficiency of photosynthesis and ecosystems like forests, crops, respiration, combustion and other oxidation processes, biomethanation; History of climate change, greenhouse gas effect, anthropogenic climate change, role of different gases, global climatic problems, integrated assessment model, impacts and adaptation, uncertainties precautionary principle; Biological and physico-chemical methods for carbon sequestration, CO_2 capture from large point sources, pre-, post- and oxy-combustion technology, transport, storage and monitoring, feasibility, economics and public perceptions; Water resources and green house gas emissions, mitigation measures and adaptation to climate change; Kyoto protocol, UNFCCC, IPCC, geopolitics of GHG control, CDM and other emission trading mechanisms, non-CO_2 GHGs, relevance for India, procedure for registration for CDM projects and its benefit; Case studies.