BE CIVIL ENGINEERING

1701MGX001		PROFESSIONAL ETHICS	L	T	P	C
			3	0	0	3

Course Objectives:	
	1.The primary goal is to stimulate critical and responsible reflection on moral issues surrounding engineering practice and to provide the conceptual tools necessary for pursuing those issues. 2.Also to make the students aware of the different ethical issues, codes of conduct for engineers in the society and moralities in an organization.
Unit I	**INTRODUCTION & HUMAN VALUES** **9 Hours**
Morals, Values and Ethics- Work Ethic - Team work – Types of Ethics - Respect for Others- Living Peacefully- Honesty- Courage - Valuing Time - Co-operation - Commitment- Self-Confidence - Customs and religion-Caring and Sharing.	
Unit II	**ENGINEERING ETHICS** **9 Hours**
Engineering ethics – Variety of moral issues – Types of Inquiry – Professional accountability – Self Interest – Moral dilemmas – Kohlberg's Theory – Gilligan's Theory – Theories about Right Action – Ethical codes of IEEE and Institution of Engineers.	
Unit III	**SAFETY & RESPONSIBILITY OF ENGINEERS** **10 Hours**
Engineering as experimentation – Safety and Risks – Risk – benefit analysis – Computer Technology Privacy – Social Policy – Engineering standards – Communicating Risk and Public Policy – Occupational Crime – Professional Rights and Employee Rights – Whistle Blowing – Collective Bargaining – Conflicts of Interest.	
Unit IV	**ENGINEER'S ROLE** **9 Hours**
Engineers as Managers, Advisors, Consultants, Experts and Witness – Engineers role in industry and society – Theories about right action – Moral leadership - Collegiality and loyalty – IPR – Discrimination - Bhopal gas tragedy case study.	
Unit V	**GLOBAL ISSUES** **8 Hours**
Multinational corporations-Environmental Ethics- Weapons Development- Code of Conduct – Eco – friendly production system – Sustainable technology & development – ozone depletion – Eco system – Pollution control.	
	Total: **45 Hours**

Further Proceeding:	
	1. Analysis about Safety and Risk Management in an Organisation
	2. Analysis about Code of Conduct for Ethical & Moral values

Course Outcomes:	
	After completion of the course, Student will be able to
	3. Obtain awareness on Human Values & Social Values of the every individual.
	4. Knowledge about ethical theories and relevant code of conduct for engineers.
	5. Enumerate the safety and responsibility of engineers in the society.
	6. Realize their responsibilities, professional rights and moralities for the enhancement of an organization.
	7. Explain about the environmental impacts at present day scenario.

1702CE305		BUILDING MATERIALS AND RESOURCE PLANNING	L	T	P	C
			3	0	0	3

Course Objectives:	
	1. To give students an understanding of typical and potential application of Building materials.
	2.To ensure that students know about the manufacturing process of Building materials and mix designing procedure of concrete
	3.Give students an appreciation of the effective use of common and modern materials in construction

Unit I	Stones – bricks – concrete blocks	9 Hours

Stone as building material – Criteria for selection – Tests on stones – Deterioration and Preservation of stone work – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks – Compressive Strength – Water Absorption – Efflorescence – Bricks for special use – Refractory bricks – Cement, Concrete blocks – Lightweight concrete blocks.

Unit II	Lime – cement – aggregates – mortar	9 Hours

Lime – Preparation of lime mortar – Cement – Ingredients – Manufacturing process – Types and Grades – Properties of cement and Cement mortar – Hydration – Compressive strength – Tensile strength – Fineness– Soundness and consistency – Setting time – Industrial byproducts – Fly ash – Aggregates – Natural stone aggregates – Crushing strength – Impact strength – Flakiness Index – Elongation Index – Abrasion Resistance – Grading – Sand Bulking.

Unit III	Concrete	9 Hours

Concrete – Ingredients – Manufacturing Process – Batching plants – RMC – Properties of fresh concrete – Slump – Flow and compaction Factor – Properties of hardened concrete – Compressive, Tensile and shear strength – Modulus of rupture – Tests – Mix specification – Mix proportioning – BIS method – High Strength Concrete and HPC – Self compacting Concrete – Other types of Concrete – Durability of Concrete.

Unit IV	Timber and modern material	9 Hours

Timber – Market forms – Industrial timber– Plywood – Veneer – Therma Cole – Panels of laminates – Steel Aluminum composite panel – Uses – Paints – Varnishes – Distempers – Bitumens.Glass – Ceramics – Sealants for joints – Fiber glass reinforced plastic – Clay products – Refractories – Composite materials — Fiber textiles – Geomembranes and Geotextiles for earth reinforcement.

Unit V	Materials management	9 Hours

Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management

	Total:	45 Hours

Further Reading:	
	1. On completion of this course the students will be able to Compare the properties of most common and advanced building materials and understand the typical and potential applications of these materials

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Summarize the most common and advanced materials used for construction.
	2.Explain the manufacturing process of various building materials
	3. Explain the properties of fresh and hardened concrete and performance of other types of concrete.

	4. Illustrate the usage of timber, plywood and aluminum, composite material, paints, distemper and modern materials.
	5.summarize the procedure in material management

1702CE604		WATER SUPPLY ENGINEERING	L	T	P	C
			3	0	0	3

Course Objectives:

1. To examine the water supply system and conveyance system.
2. To create an ability to evaluate the water treatment and advanced water treatment system.
3. To train the students to analyze water distribution system and supply to buildings.

Unit I	**PLANNING FOR WATER SUPPLY SYSTEM**	**08 Hours**

Public water supply system -Planning -Design period - Population forecasting -Water demand -Sources of water and their characteristics -Surface and Groundwater- Impounding Reservoir Well hydraulics - Development and selection of source - Water quality - Characterization and standards.

Unit II	**CONVEYANCE SYSTEM**	**07 Hours**

Water supply -intake structures -Functions and drawings -Pipes and conduits for water- Pipe materials - Hydraulics of flow in pipes -Transmission main design – Materials of pipes- Laying, jointing and testing of pipes - Drawings appurtenances - Types and capacity of pumps -Selection of pumps and pipe materials.

Unit III	**WATER TREATMENT**	**12 Hours**

Objectives - Unit operations and processes - Principles, functions design and drawing of Screens, Flash mixers, flocculators, sedimentation tanks and sand filters - Disinfection- Residue Management.

Unit IV	**ADVANCED WATER TREATMENT**	**09 Hours**

Aerator - Iron and manganese removal, Defluoridation and demineralization -Water softening - Desalination - Membrane Systems-Construction and Operation & Maintenance aspects of Water Treatment Plants- Recent advances-Membrane processes.

Unit V	**WATER DISTRIBUTION AND SUPPLY TO BUILDINGS**	**09 Hours**

Requirements of water distribution -Components -Service reservoirs -Functions and drawings -Network design - Analysis of distribution networks –Pipe Appurtenances -operation and maintenance -Leak detection, Methods. Principles of design of water supply in buildings -House service connection -Fixtures and fittings - Systems of plumbing and drawings of types of plumbing.

Total:	**45 Hours**

Further Reading:

1. Apply an appropriate unit system for the water treatment.
2. Estimate the quantity of wastewater and storm run-off generated from the town/ city and design a suitable collection system for the generated wastewater.

Course Outcomes:

After completion of the course, Student will be able to

1. Discuss about the principles and development of water supply system.
2. Design the pipelines for water supply system governed with head loss.
3. Design drawing of various unit operations in water supply system.
4. Identify the methods for removing contaminants in water treatment system using advanced techniques.
5. Interpret the network for water supply to buildings and House service connection.

References:

1. Garg, S.K., "Environmental Engineering", Vol.1 Khanna Publishers, New Delhi, 2005.
2. Modi, P.N. "Water Supply Engineering", Vol. I Standard Book House, New Delhi, 2005.
3. Punmia, B.C., Ashok K Jain and Arun K Jain, "Water Supply Engineering", Laxmi Publications Pvt. Ltd., New Delhi, 2005

1702CE652		ENVIRONMENTAL AND IRRIGATION DESIGN AND DRAWING	L	T	P	C
			3	0	0	3

Course Objectives:

1.to know about the design of environmental structures

2.to know the pictorial representation of irrigation structures

Unit I	**WATER SUPPLY AND TREATMENT**	**08 Hours**

Design & Drawing of flash mixer, flocculator, clarifier – Slow sand filter – Rapid sand filter – Infiltration gallery – Intake towers – Service reservoirs – Pumping station – House service connection for water supply and drainage.

Unit II	**SEWAGE TREATMENT & DISPOSAL**	**07 Hours**

Design and Drawing of screen chamber - Grit channel - Primary clarifier - Activated sludge process – Aeration tank & oxidation ditch – Trickling filters – Secondary clarifiers – Sludge digester – Sludge drying beds – Waste stabilisation ponds - Septic tanks and disposal arrangements – Manholes.

Unit III	**IMPOUNDING STRUCTURES**	**12 Hours**

Gravity dam, Tank Surplus Weir, Tank Sluice with tower road – Drawing showing plan, elevation, half section including foundation details.

Unit IV	**CANAL TRANSMISSION STRUCTURES**	**09 Hours**

Aqueducts – Syphon Aqueducts – Super passage – Canal siphon – Canal Drops- Drawing showing plan, elevation and foundation details.

Unit V	**CANAL REGULATION STRUCTURES**	**09 Hours**

Canal head works- Canal Regular – Canal escape- Proportional Distributors – Drawing showing detailed plan, elevation and foundation.

Total:	**45 Hours**

Further Reading:

1.to analyse and draw advanced irrigation and environmental structures

Course Outcomes:

After completion of the course, Student will be able to

1.design environmental treatment system

2. design the irrigationimpounding structures

3. design the canal transmission structures

4. design the canal regulation structures

References:

1.Garg, S.K., "Environmental Engineering", Vol.1 Khanna Publishers, New Delhi, 2005.

2.Sathyanarayana Murthy “Irrigation Design and Drawing” Published by MrsL.Banumathi, Tuni east Godavari District. A.P. 1998

3.Sharma R.K. Irrigation Engineering and Hydraulic Structures Oxford and IBH Publishing co., New Delhi 2002.

4.Modi, P.N. "Water Supply Engineering", Vol. I Standard Book House, New Delhi, 2005.

5.Punmia, B.C., Ashok K Jain and Arun K Jain, "Water Supply Engineering", Laxmi Publications Pvt. Ltd., New Delhi, 2005

1702CE702		WASTE WATER ENGINEERING	L	T	P	C
			3	0	0	3

Course Objectives:

1. To understand the importance of planning and design of sewerage system.
2. To create an ability to evaluate the waste water treatment system.
3. To impart the signification of disposal of Sewage.

Unit I	**PLANNING FOR SEWERAGE SYSTEMS**	**09 Hours**

Sources of wastewater generation – Effects – Estimation of sanitary sewage flow – Estimation of storm runoff – Factors affecting Characteristics and composition of sewage and their significance – Effluent standards – Legislation requirements.

Unit II	**DESIGN OF SEWER**	**09 Hours**

Sewerage – Hydraulics of flow in sewers – Design period - Design of sanitary and storm sewers – Small bore systems – Materials of sewers– Laying, joining & testing of sewers – Forces acting on sewers– Cleaning and maintenances of sewers- Sewer appurtenances – Pumps – selection of pumps and pipe Drainage -. Plumbing System for Buildings – One pipe and two pipe system.

Unit III	**PRIMARY TREATMENT OF SEWAGE**	**09 Hours**

Objective – Unit Operation and Processes – Selection of treatment processes – Principles, functions design and drawing of screen, grit chambers and primary sedimentation tanks – Operation and Maintenance aspects – Onsite sanitation - Septic tank, Grey water harvesting.

Unit IV	**SECONDARY TREATMENT OF SEWAGE**	**09 Hours**

Objective – Selection of Treatment Methods – Principles, Functions, Design and Drawing of Units - Activated Sludge Process and Trickling filter, other treatment methods – Oxidation ditches, UASB – Waste Stabilization Ponds – Reclamation and Reuse of sewage - Recent Advances in Sewage Treatment – Construction and Operation & Maintenance of Sewage Treatment Plants.

Unit V	**DISPOSAL OF SEWAGE AND SLUDGE**	**09 Hours**

Standards for Disposal - Methods – dilution – Self-purification of surface water bodies – Oxygen sag curve – Land disposal – Sewage farming – Deep well injection – Soil dispersion system -Sludge characterization – Thickening – Sludge digestion – Biogas recovery – Sludge Conditioning and Dewatering – disposal – Advances in Sludge Treatment and disposal.

Total:	**45 Hours**

Further Reading:

1. Design the necessary treatment units for energy conservation.
2. Design the suitable disposal unit for the sludge without endangering the environment.

Course Outcomes:

After completion of the course, Student will be able to

1. Examine the waste water quality characteristics and standards.

	2. Design sewerage systems and discuss about the treatment process step by step done in primary level.
	3. Design the various unit operations for waste water treatment.
	4. Design the sludge treatment and disposal methods.
	5. Perform quality analysis of sewage the characteristics and composition of sewage, self - Purification of streams.

1703CE006		**SOLID WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To study the Sources and types of municipal solid wastes					
	To impart the knowledge of On-site Processing, collection and transfer of solid waste.					
	To acquire the knowledge of Off –site Processing and waste disposal management.					
Unit I	**SOURCES AND TYPES OF MUNICIPAL SOLID WASTES**					**8 Hours**
Sources and types of solid wastes - Quantity – factors affecting generation of solid wastes- characteristics – methods of sampling and characterization- Effects of improper disposal of solid wastes – public health effects- Principle of solid waste management – social & economic aspects - Public awareness- Role of NGOs- Legislation.						
Unit II	**ON-SITE STORAGE & PROCESSING**					**8 Hours**
On-site storage methods – materials used for containers – on-site segregation of solid wastes – public health & economic aspects of storage – options under Indian conditions – Critical Evaluation of Options.						
Unit III	**COLLECTION AND TRANSFER**					**8 Hours**
Methods of Collection – types of vehicles – Manpower requirement – collection routes; transfer stations – selection of location, operation & maintenance; options under Indian conditions.						
Unit IV	**OFF-SITE PROCESSING**					**12 Hours**
Processing techniques and Equipment; Resource recovery from solid wastes – composting, incineration, Pyrolysis - options under Indian conditions.						
Unit V	**DISPOSAL**					**9 Hours**
Dumping of solid waste; sanitary landfills – site selection, design and operation of sanitary landfills – Leachate collection & treatment						
		Total:				**45 Hours**
Further Reading:						
	They can categorize the types of wastes					
	They can choose the disposal units					
Course Outcomes:						
	After completion of the course, Student will be able to					
	Explain the Sources and types of municipal solid wastes					
	Interpret the suitable method of Segregation of solid waste under Indian condition.					
	Identify the methods of collection and transfer of solid wastes					
	Demonstrate the suitable Off –site Processing techniques					
	Choose the various options for disposal of wastes and their selection criteria					
References:						

Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000
R.E.Landreth and P.A.Rebers, Municipal Solid Wastes – problems and Solutions, Lewis Publishers, 1997.

1703CE009		**GROUND WATER ENGINEERING**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	1.To introduce the student to the principles of Groundwater governing Equations and Characteristics of different aquifers					
	2.Characteristicsofdifferentaquifers					
	3.To understand the techniques of development and management of groundwater					
	4.To be introduced to the different theories of traffic flow					
	5.To be aware of the importance of traffic safety					
Unit I	**HYDROGEOLOGICAL PARAMETERS**					**9 Hours**
Introduction – Water bearing Properties of Rock – Type of aquifers - Aquifer properties – permeability, specific yield, transmissivity and storage coefficient – Methods of Estimation–Ground water table fluctuation and its interpretations – Groundwater development and Potential in India – GEC norms.						
Unit II	**WELLHYDRAULICS**					**9Hours**
ObjectivesofGroundwaterhydraulics–Darcy'sLaw-Groundwaterequation–steadystate flow. Dupuit Forchheimer assumption-Unsteady state flow-Theis method-Jacob Method-Slug tests – Image well theory –Partial penetrations of wells						
Unit III	**GROUNDWATER MANAGEMENT**					**9Hours**
Need for Management Model – Database for groundwater management –groundwater balance study – Introduction to Mathematical model – Conjunctive use – Collector well and Infiltration gallery						
Unit IV	**GROUNDWATER QUALITY**					**9 Hours**
Ground water chemistry - Origin, movement and quality - Water quality standards – Health and aesthetic aspects of water quality - Saline intrusion – Environmental concern and Regulatory requirements						
Unit V	**GROUNDWATER CONSERVATION**					**9 Hours**
Artificial recharge techniques – Remediation of Saline intrusion– Ground water management studies – Protection zone delineation, Contamination source inventory, remediation schemes - Ground water Pollution and legislation.						
				Total:		**45 Hours**
Further Reading:						
	1. Ground water to improving quality parameter					
	2. Water resource and hydrology for features need.					
Course Outcomes:						

	1. Students will be able to understand aquifer properties and its dynamics after the completion of the course. It gives an exposure towards well design and practical problems of ground water aquifers
	2. Studentswillbeabletounderstandtheimportanceofartificialrechargeandgroundwater quality concepts
	3. Model regional ground water flow and design water wells
	4.Estimatewaterqualityparameters
	5.To safety ground water improvements of quality parameter

ME ENVIRONMENTAL ENGINEERING

17EV102		**ENVIRONMENTAL CHEMISTRY**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	1. To educate the students about water chemistry					
	2. To impart knowledge in the area of air and soil chemistry					
	3. To impart knowledge on the transformation of chemicals in the environment					
Unit I	**Introduction**					**9 Hours**
Stoichiometry and mass balance-Chemical equilibrium, acid base, solubility product (Ksp), heavy metal precipitation, amphoteric hydroxides, CO2 solubility in water and species distribution – Chemical kinetics, First order- 12 Principles of green chemistry.						
Unit II	**Aquatic Chemistry**					**11 Hours**
Water quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation – Degradation of synthetic chemicals-Metals, complex formation, oxidation and reduction, pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation.						
Unit III	**Atmospheric Chemistry**					**7 Hours**
Atmospheric structure –-chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO_2 capture and sequestration – Acid rain- origin and composition of particulates. Air quality parameters-effects and determination.						
Unit IV	**Soil Chemistry**					**9 Hours**
Nature and composition of soil-Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – Agricultural chemicals in soil-Reclamation of contaminated land; salt by leaching-Heavy metals by electrokinetic remediation.						
Unit V	**Environmental Chemicals**					**9 Hours**

Heavy metals-Chemical speciation –Speciation of Hg &As- Organic chemicals- Pesticides, Dioxins, PCBs, PAHs and endocrine disruptors and their Toxicity- Nano materials, CNT, titania, composites, environmental applications.						
		Total:				**45 Hours**
Further Reading						
	To analyze and create a solution for environmental issues.					
Course Outcomes:						
	After completion of the course, Student will be able to					
	1. Distinguish the chemistry involved					
	2. Understand the chemistry involved in water					
	3. Identify and solve the air pollution related issues					
	4. Understand the soil related chemistry and issues					
	5. Identify contaminating chemicals and can work out chemicals need calculations for treatment purpose					

17EV103		**ENVIRONMENTAL MICROBIOLOGY**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	1. The course provides a basic understanding on microbiology relevant to environmental engineering for candidates with little prior knowledge of the subject.					
	2. The morphology, behavior and biochemistry of bacteria, fungi, protozoa, viruses, and algae are outlined.					
	3. The microbiology of wastewater, sewage sludge and solid waste treatment processes is also provided. Aspects on nutrient removal and the transmission of disease-causing organisms are also covered.					
	4. An exposure to toxicology due to industrial products and byproducts are also covered.					
	5. The course provides a basic understanding on microbiology relevant to environmental engineering for candidates with little prior knowledge of the subject.					
Unit I	**Classification And Characteristics**					**5 Hours**
Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology.						
Unit II	**Microbes And Nutrient Cycles**					**10 Hours**
Distribution of microorganisms – Distribution / diversity of Microorganisms – fresh and marine, terrestrial – microbes in surface soil, Air – outdoor and Indoor, aerosols, biosafety in Laboratory – Extreme Environment – archaebacteria – Significance in water supplies – problems and control. Transmissible diseases. Biogeochemical cycles-----Hydrological - Nitrogen, Carbon, Phosphorus, Sulphur, Cycle – Role of Micro Organism in nutrient cycle.						
Unit III	**Metabolism of Microorganisms**					**10 Hours**
Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb‟s cycle, hexose monophosphate						

pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.		
Unit IV	**Pathogens in Wastewater**	**10 Hours**
Introduction to Water Borne pathogens and Parasites and their effects on Human, Animal and Plant health, Transmission of pathogens – Bacterial, Viral, Protozoan, and Helminths, Indicator organisms of water – Coliforms - total coliforms, E-coli, Streptococcus, Clostridium, Concentration and detection of virus. Control of microorganisms; Microbiology of biological treatment processes – aerobic and anaerobic, □-oxidation, β-oxidation, nitrification and de-nitrification, eutrophication. Nutrients Removal – BOD, Nitrogen, Phosphate. Microbiology of Sewage Sludge.		
Unit V	**Toxicology**	**10 Hours**
Ecotoxicology – toxicants and toxicity, Factors influencing toxicity. Effects – acute, chronic, Test organisms – toxicity testing, Bio concentration – Bioaccumulation, bio magnification, bioassay, bio monitoring, bioleaching.		
	Total:	**45 Hours**

Further Reading	
	Identification and culturing of microorganisms from different sources
Course Outcomes:	
	After completion of the course, Student will be able to
	1. The candidate at the end of the course will have a basic understanding on the basics of microbiology and their diversity and on the genetic material in the living cell.
	2. The candidate would be able to understand and describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem.
	3. The candidate would have understood the role microbial metabolism in a wastewater treatment plant.
	4. The candidate would know the role of microorganisms in contaminated water and the diseases caused.
	5. The candidate has the ability to conduct and test the toxicity due to various natural and synthetic products in the environment.

References:

1. S.C.Bhatia, Hand Book of Environmental Microbiology, Part 1 and 2, Atlantic Publisher
2. Gabriel Bitton, Wastewater Microbiology, 2nd Edition ,
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, Environmental Microbiology, Academic Press.
4. SVS. Rana, Essentials of Ecology and Environmental Science, 3rd Edition, Prentice Hall of India Private Limited
5. Stanley E. Manahan, Environmental Science and Technology, Lewis Publishers.
6. Hurst, C.J. (2002) Manual of Environmental Microbiology. 2nd Ed. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199 - X.
7. Frank C. Lu and Sam Kacew, LU‟s Basic Toxicology, Taylor & Francis, London (4th Ed), 2002

17EV104		TRANSPORT OF WATER AND WASTEWATER	L	T	P	C
			3	0	0	3
Course Objectives:						
	1. To educate the students in detailed design concepts related to water transmission mains, water distribution system, sewer networks and storm water drain					
	2. To educate the students in computer application on design.					
Unit I	**General Hydraulics and Flow Measurement**					**8 Hours**
Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying Capacity–Flow measurement.						
Unit II	**Water Transmission and Distribution**					**10 Hours**
Need for Transport of water and wastewater-Planning of Water System –Selection of pipe materials, Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics-economics; Specials, Jointing, laying and maintenance, water hammer analysis; water distribution pipe networks Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection Storage reservoirs.						
Unit III	**Wastewater Collection and Conveyance**					**10 Hours**
Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; Wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.						
Unit IV	**Storm Water Drainage**					**7 Hours**

Necessity- - combined and separate system; Estimation of storm water run-off Formulation of rainfall intensity duration and frequency relationships- Rational methods.		
Unit V	**Case Studies and Software Applications**	**10 Hours**
Use of computer software in water transmission, water distribution and sewer design – EPANET 2.0, LOOP version 4.0, SEWER, BRANCH, Canal ++ and GIS based softwares.		
	Total:	**45 Hours**
Further Reading		
	Designing of pipelines and sewers for various project areas	
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Understand the fluid flow properties	
	2. Design water supply main, distribution network and sewer for various field conditions	
	3. Design the drainage network for wastewater	
	4. Design the storm water drainage systems	
	5. Troubleshooting in water and sewage transmission be able to use various computer software for the design of water and sewage network	

17EV105		**PRINCIPLES AND DESIGN OF PHYSICO-CHEMICAL TREATMENT SYSTEMS**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	1. To educate the students on the principles and process designs of various treatment systems for water and wastewater					
	2. To educate the students on design of treatment systems and the components comprising such systems, leading to the selection of specific process.					
Unit I	**Introduction**					**5 Hours**
Pollutants in water and wastewater – characteristics, Standards for performance - Significance of physio-chemical treatment – Selection criteria-types of reactors- reactor selection-batch- continuous type-kinetics.						
Unit II	**Treatment Principles**					**10 Hours**
Physical treatment - Screening – Mixing, Equalization – Sedimentation – Filtration – Evaporation – Incineration – gas transfer – mass transfer coefficient Adsorption – Isotherms – Membrane separation, Reverse Osmosis, nano filtration, ultra-filtration and hyper filtration electro dialysis, distillation – stripping and crystallization – Recent Advances. Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation solidification and stabilization – Disinfection, Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Trends						
Unit III	**Design of Municipal Water Treatment Plants**					**10 Hours**
Selection of Treatment – Design of municipal water treatment plant units – Aerators – chemical feeding – Flocculation – clarifier – tube settling – filters – Rapid sand filters, slow sand filter, pressure filter, dual media Disinfection - Displacement and gaseous type - Flow charts – Layouts – Hydraulic Profile, PID - construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends.						
Unit IV	**Design of Industrial Water Treatment Plants**					**10Hours**
Design of Industrial Water Treatment Units- Selection of process – Design of softeners – Demineralisers – Reverse osmosis plants –Flow charts – Layouts –Hydraulic Profile, PID - construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends.						

Unit V	Design of Wastewater Treatment Plants	10 Hours
Design of municipal wastewater treatment units-screens-detritors-grit chamber-settling tanks- sludge thickening-sludge dewatering systems-sludge drying beds - Design of Industrial Wastewater Treatment Units-Equalization- Neutralization-Chemical Feeding Devices-mixers- floatation units-oil skimmer Flow charts – Layouts –Hydraulic Profile, PID, construction and O&M aspects – case studies, Retrofitting - Residue management – Upgradation of existing plants – Recent Trends.		
	Total:	**45 Hours**

Further Reading	
	Implementation of advanced treatment technologies for various wastewater treatment
Course Outcomes:	
	After completion of the course, Student will be able to
	1. Identify the pollutants type in the wastewater
	2. Understand the various treatment principles
	3. Design the sewage treatment plants
	4. Design suitable treatment units for various industries
	5. Develop conceptual schematics required for the treatment of wastewater

17EV106		ENVIRONMENTAL CHEMISTRY LABORATORY	L	T	P	C
			0	0	2	1
Course Objectives:						
	1. To train in the analysis of physical parameters of water and waste water					
	2. To train in the analysis of chemical parameters of water and waste water					
List of Experiments:						
1. Good Laboratory Practices, Quality control, calibration of Glassware						03
2. Sampling and Analysis of water (pH, alkalinity, hardness chloride, Sulphate, turbidity EC, TDS, nitrate, fluoride)						12
3. Wastewater analysis (BOD, COD, Phosphate, TKN, Oil & Grease, Surfactant and heavy metals). 12						
4. Sampling and analysis of air pollutants Ambient & Stack (RSPM, SO2 and NOx)						09
5. Sampling and characterization of soil (CEC & SAR, pH and K).						09
		Total :	**45 Hours**			

Course Outcomes:	
	After completion of the course, Student will be able to
	1. assess quality of environment
	2. conduct analysis on characteristics of water and waste water

References:

1. APHA, Standard Methods for the Examination of Water and Wastewater, 21st Ed.
2. Washington, 2005.
3. Laboratory Manual for the Examination of water, wastewater soil Rump, H.H. and Krist, H.
4. Second Edition, VCH, Germany, 1992.
5. Methods of air sampling & analysis, James P.Lodge Jr(Editor) 3rd Edition, Lewis publishers,Inc,USA,1989.

17EV107		ENVIRONMENTAL MICROBIOLOGY LABORATORY	L	T	P	C
			0	0	2	1

Course Objectives:

1. To train in the analysis of physical parameters of water and waste water
2. To train in the analysis of chemical parameters of water and waste water

List of Experiments:

1. Preparation of culture media
2. Isolation, culturing and Identification of Microorganisms
3. Microorganisms from polluted habitats (soil, water and air)
4. Measurement of growth of microorganisms, Assay of enzymes involved in biotransformation
5. Biodegradation of organic matter in waste water Analysis of air borne microorganisms
6. Staining of bacteria
7. Effect of pH, temperature on microbial growth
8. Pollutant removal using microbes from industrial effluent.
9. Effect of pesticides on soil microorganisms
10. Bacteriological analysis of wastewater (Coliforms, E.coli, Streptococcus) – MPN
11. Bacteriological analysis of wastewater (Coliforms, Streptococcus) - MF techniques
12. Effect of Heavy metals on microbial growth
13. Detection of Anaerobic bacteria (Clostridium sp.)
14. Bioreactors

	Total :	**45 Hours**

Course Outcomes:

After completion of the course, Student will be able to

1. Field oriented testing of water, wastewater and solid waste for microbial contamination.
2. Perform toxicity test.

References:

1. Standard methods for the examination of water and wastewater, American Public Health Association (21st edition) 2005.
2. Charles Gerba, Environmental Microbiology: A laboratory manual, Elsevier Publications, 2012.
3. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, and Linda D. Stetzenbach, Manual of Environmental Microbiology, 3rd Edition, ASM Press, 2007.

17EV201		PRINCIPLES AND DESIGN OF BIOLOGICAL TREATMENT SYSTEMS	L	T	P	C
			3	0	0	3
Course Objectives:						
	To educate the students on the principles and process designs of various treatment systems for water and wastewater and students should gain competency in the process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process.					
Unit I	**Introduction**					**10 Hours**
Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal – Biodegradability assessment -selection of process- reactors-batch-continuous type.						
Unit II	**Aerobic Treatment of Wastewater**					**10 Hours**
Design of sewage treatment plant units –Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters-Bio Tower-RBC-Moving Bed Reactors-fluidized bed reactors, aerated lagoons, waste stabilization ponds – nutrient removal systems – natural treatment systems, constructed wet land – Disinfection – disposal options – reclamation and reuse – Flow charts, layout, PID, hydraulic profile, recent trends.						
Unit III	**Anaerobic Treatment of Wastewater**					**10 Hours**
Attached and suspended growth, Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal – Nutrient removal systems – Flow chart, Layout and Hydraulic profile – Recent trends.						
Unit IV	**Sludge Treatment and Disposal**					**5 Hours**
Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering (mechanical and gravity) Layout, PID, hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.						
Unit V	**Construction Operations and Maintenance Aspects**					**10 Hours**

Construction and Operational Maintenance problems – Trouble shooting – Planning, Organizing and controlling of plant operations – capacity building - Retrofitting Case studies – sewage treatment plants – sludge management facilities.		
	Total:	**45 Hours**
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Develop conceptual schematics required for biological treatment of wastewater	
	2. Translate pertinent criteria into system requirements.	
References:		
1. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2000.		
2. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.		
3. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata Mc Graw-Hill Publishing Company Limited, New Delhi, 2003.		
4. F.R. Spellman, Hand Book of Water and Wastewater Treatment Plant operations, CRC Press, New York (2009).		

17EV202		**AIR POLLUTION MONITORING AND CONTROL**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To impart knowledge on the principles and design of control of indoor/particulate/gaseous air pollutant and its emerging trends					
Unit I	**Introduction**					**7 Hours**
Structure and composition of Atmosphere – Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation & animals, Materials & Structures – Effects of air Pollutants on the atmosphere, Soil & Water bodies – Long- term effects on the planet – Global Climate Change, Ozone Holes – Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories – Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants.						
Unit II	**Air Pollution Modelling**					**5 Hours**
Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants – Modeling Techniques - Air Pollution Climatology.						
Unit III	**Control Of Particulate Contaminants**					**11 Hours**
Factors affecting Selection of Control Equipment – Gas Particle Interaction, – Working principle, Design and performance equations of Gravity Separators (cyclone) , Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations - Process Control and Monitoring – Costing of APC equipment – Case studies for stationary and mobile sources.						
Unit IV	**Control of Gaseous Contaminants**					**11 Hours**
Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and						

Monitoring - Operational Considerations - Costing of APC Equipment – Case studies for stationary and mobile sources.		
Unit V	**Indoor Air Quality Management**	**11 Hours**
Sources types and control of indoor air pollutants, sick building syndrome types – Radon Pollution and its control – Membrane process - UV photolysis – Internal Combustion Engines - Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.		
	Total:	**45 Hours**
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Apply sampling techniques	
	2. Apply modelling techniques	
	3. Suggest suitable air pollution prevention equipment's and techniques for various gaseous and particulate pollutants to Industries. Discuss the emission standards	

17EV203		**INDUSTRIAL WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To impart knowledge on the concept and application of Industrial pollution prevention, cleaner technologies, industrial wastewater treatment and residue management.					
Unit I	**Introduction**					**8 Hours**
Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.						
Unit II	**Industrial Pollution Prevention & Waste Minimisation**					**8 Hours**
Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimisation Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing & Promoting Pollution Prevention Programs in Industries.						
Unit III	**Industrial Wastewater Treatment**					**10 Hours**
Flow and Load Equalization – Solids Separation – Removal of Fats, Oil & Grease- Neutralization – Removal of Inorganic Constituents – Precipitation, Heavy metal removal , Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Eletrodialysis & Evaporation – Removal of Organic Constituents – Biological treatment Processes, Chemical Oxidation Processes, Advanced Oxidation processes – Treatability Studies.						
Unit IV	**Wastewater Reuse and Residual Management**					**9 Hours**

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.		
Unit V	**Case Studies**	**10 Hours**
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries		
	Total:	**45 Hours**
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Define the Principles of pollution prevention and mechanism of oxidation processes.	
	2. Suggest the suitable technologies for the treatment of wastewater.	
	3. Discuss about the wastewater characteristics	
	4. Design the treatment systems	

17EV204		**SOLID AND HAZARDOUS WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for solid wastes including the related engineering principles, design criteria, methods and equipment.					
Unit I	**Sources, Classification and Regulatory Framework**					**9 Hours**
Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management –- Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, nuclear wastes - lead acid batteries, electronic wastes , plastics and fly ash – Elements of integrated waste management and roles of stakeholders - Financing and Public Private Participation for waste management.						
Unit II	**Waste Characterization and Source Reduction**					**8 Hours**
Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes –Waste exchange - Extended producer responsibility - Recycling and reuse.						
Unit III	**Storage, Collection and Transport Of Wastes**					**9 Hours**
Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport.						
Unit IV	**Waste Processing Technologies**					**10 Hours**

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes - Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment.		
Unit V	**Waste Disposal**	**9 Hours**
Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation.		
	Total:	**45 Hours**

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Understand the characteristics of different types of solid and hazardous wastes and the factors affecting variation
	2. Define and explain important concepts in the field of solid waste management and suggest suitable technical solutions for treatment of municipal and industrial waste
	3. Understand the role legislation and policy drivers play in stakeholders' response to the waste and apply the basic scientific principles for solving practical waste management challenges

17EV205		**ENVIRONMENTAL IMPACT ASSESSMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	
	1. To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.
	2. To provide knowledge related to the broad field of environmental risk assessment, important processes that control contaminant transport and tools that can be used in predicting and managing human health risks.

Unit I	**Introduction**	**8 Hours**
Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA –.EIA process- screening – scoping - setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA.		
Unit II	**Impact Identification and Prediction**	**10 Hours**
Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological — Cumulative Impact Assessment.		
Unit III	**Social Impact Assessment and EIA Documentation**	**8 Hours**
Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation		

of EIA findings – planning – organization of information and visual display materials – Report preparation.		
Unit IV	**Environmental Management Plan**	**7 Hours**
Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies.		
Unit V	**Environmental Risk Assessment and Management**	**12 Hours**
Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipathway exposure modeling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.		
	Total:	**45 Hours**

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Understand the necessity to study the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.
	2. Know about the legal requirements of Environmental and Risk Assessment for projects.

17EV206		**UNIT OPERATIONS AND PROCESSES LABORATORY**	**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**

Course Objectives:	
	1. To develop the skill for conducting Treatability studies of water and wastewater treatment by various Unit Operations and Processes using laboratory scale models.
	2. To develop the skill for conducting Treatability studies of water and wastewater treatment by various Unit Operations and Processes using laboratory scale models.

List of Experiments:	
1. Coagulation and Flocculation	7
2. Batch studies on settling	10
3. Studies on Filtration- Characteristics of Filter media	7
4. Water softening	7
5. Adsorption studies/Kinetics	7
6. Reverse Osmosis- Silt Density Index	7
7. Kinetics of suspended growth process (activated sludge process)- Sludge volume Index	14
8. Anaerobic Reactor systems / kinetics (Demonstration)	10

9. Advanced Oxidation Processes – (Ozonation, Photocatalysis)		14
10. Disinfection for Drinking water		7
	Total :	**45 Hours**

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Conduct treatability studies for water and waste water treatment.
	2. Design laboratory models for various unit operations and processes.

References:

1. Metcalf and Eddy. Inc. „Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
2. Lee, C.C. and Shun dar Lin. Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
3. Casey T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wileys Sons, London, 1993.
4. David W.Hendricks, „Water Treatment Unit Processes: Physical and Chemical", CRC Press, Boca Raton, 2006.

17EV001		**AIR POLLUTION METEOROLOGY AND MODELING**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:		
	To introduce the emerging concepts of climate modeling and projecting future climate change, understand data analysis and application.	
Unit I	**Atmospheric Pollution**	**9 Hours**

Atmospheric Pollution, type of pollutants, gaseous and particulate pollutants, size of atmospheric particles, emission inventory, various sources of emissions, bio-mass burning, pollution formation in combustion, Visibility and Acid Deposition Industrial pollution.

Unit II	**Meteorology**	**9 Hours**

Air pollution meteorology: sources of air pollution, methods for air pollution measurement and control, meteorological factors that contribute to air quality degradation, basic chemistry of the atmosphere and how it contributes to secondary pollutant formation. Effect of air pollution on Human health, material and vegetation, Deposition of particulate pollutants in the respiratory system.

Unit III	**Transport Models**	**9 Hours**

Atmospheric chemical transport models, box models, three-dimensional atmospheric chemical transport models, components of air quality forecasting and modelling, evaluation and validation, air quality standards and index, long range transport of pollutants. Back trajectory construction and applications		
Unit IV	**Dispersion Models**	**9 Hours**
Transport and dispersion of air pollutants - wind velocity, wind speed and turbulence; estimating concentrations from point sources - the Gaussian Equation - atmospheric stability - Air pollution modelling and prediction - Plume rise, modelling techniques.		
Unit V	**Software Modelling**	**9 Hours**
Exposure to computer models for air quality.		
	Total:	**45 Hours**

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Know the causes of climate change
	2. Know the effects of climate change on various environments and various models.
References:	
1. Rao.M.N. &RaoH.V.N., "Air Pollution", Tata McGraw Hill,2006.	
2. Richard W. Boubel, Donald L. Fox, D. Bruce Turner & Arthur C. Stern, "Fundamentals of Air Pollution, Hardcover", 2007.	
3. Kenneth Wark, Cecil F. Warn,"Air pollution its origin and control", 2007.	
4. StevenC.Chapra, "Surface Water quality modeling", The McGraw-Hill- Companies Inc., New York, 1997.	

17EV002		**CLIMATE CHANGE AND MODELING**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To introduce the emerging concepts of climate modeling and projecting future climate change, understand data analysis and application.					
Unit I	**Climate Change and Climate Variability**					**9 Hours**
Introduction – Atmosphere - weather and Climate - climate parameters (Temperature ,Rainfall, Humidity, Wind etc) – Equations governing the atmosphere - Numerical Weather Prediction Models - Introduction to GCMs - Application in Climate Change Projections.						
Unit II	**IPCC SRES Scenarios**					**9 Hours**
Intergovernmental Panel on Climate Change (IPCC) - An Overview - Key Assumptions - Scenario Family - Storyline (A1, B1, A2, B2).						
Unit III	**Global Climate MODEL (GCM) and Regional Climate Model (RCM)**					**9 Hours**

Some typical GCMs (HadCM3Q-UK Met Office) - Issues with GCMs - Introduction to RCMs and LAMs - some typical RCMs like PRECIS, Sim CLIM, MAGICC/SCENGENE - Advantages and Disadvantages of GCMs and RCMs.		
Unit IV	**Downscaling Global Climate Model - An Overview**	**9 Hours**
Need for downscaling - Selection of GCMs for regional climate change studies - Ensemble theory – Selection of - Ensembles, Model Domain (Spatial domain and temporal domain), Resolution and climate variables - Lateral boundary conditions - Methods of downscaling (Statistical and Dynamical) - examples from each and their limitations.		
Unit V	**Analysis /Post Processing**	**9 Hours**
a. Model validation - post processing – Introduction to Analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS b. Climate change Impact - Vulnerability assessment – adaptation strategies.		
	Total:	**45 Hours**
Course Outcomes:		
	After completion of the course, Student will be able to	
	1.Know the causes of climate change	
	2.Know the effects of climate change on various environments and various models.	
References:		
1. IPCC Fourth Assessment Report, Cambridge University Press, Cambridge, UK.		
2. McGuffie, K. and Henderson-Sellers, A. "A Climate Modelling Primer, Third Edition, John Wiley & Sons, Ltd, Chichester, UK. ,2005		
3. Neelin David J, "Climate Change and Climate Modelling", Cambridge University Press		
4. Thomas Stocker, "Introduction to Climate Modelling", Advances in Geophysical and Environmental Mechanics and Mathematics. Springer Publication.		

17EV005		**ENVIRONMENTAL POLICIES AND LEGISLATION**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India.					
Unit I	**Introduction**					**9 Hours**
Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration– Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework(SPCB/CPCB/MoEF)						
Unit II	**Water (P&CP) Act, 1974**					**8 Hours**
Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet –						

Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.		
Unit III	**Air (P&CP) Act, 1981**	**8 Hours**
Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation		
Unit IV	**Environment (Protection) Act 1986**	**13 Hours**
Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards		
Unit V	**Other Topics**	**7 Hours**
Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.		
	Total:	**45 Hours**
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Know the National environmental legislations and the policies	
	2. plan programmes to comply with the legal requirements related to organizations	

17EV008		**MEMBRANE TECHNOLOGIES FOR WATER AND WASTE WATER TREATMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Course Objectives:						
	To introduce the concept and principles of membrane separation and its applications in water and wastewater treatment.					
Unit I	**Membrane Filtration Processes**					**10 Hours**
Solid Liquid separation systems- Theory of Membrane separation – mass Transport Characteristics- Cross Flow filtration - Membrane Filtration- Flux and Pressure drop -Types and choice of membranes, porous, non-porous, symmetric and asymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes						
Unit II	**Membrane Systems**					**10 Hours**
Microfiltration principles and applications – Ultra filtration principles and applications - Nano Filtration principles and applications – Reverse Osmosis: Theory and design of modules, assembly, plant						

process control and applications – Electro dialysis : Ion exchange membranes, process design- Pervaporation – Liquid membrane – Liquid Pertraction – Supported Liquid Membrane and Emulsion Liquid membrane - Membrane manufactures – Membrane Module/Element designs – Membrane System components – Design of Membrane systems - pump types and Pump selection– Plant operations – Economics of Membrane systems

Unit III	**Membrane Bioreactors**	**9 Hours**

Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies.

Unit IV	**Pretreatment Systems**	**8 Hours**

Membrane Fouling – Control of Fouling and Concentration Polarisation-Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning , Biofoulant control.

Unit V	**Case Studies**	**8 Hours**

Case studies on the design of membrane-based water and wastewater treatment systems – zero Liquid effluent discharge Plants – Desalination of brackish water.

	Total:	**45 Hours**

Course Outcomes:

After completion of the course, Student will be

1. familiar with main membrane processes, principles, separation mechanisms, and applications
2. understand the selection criteria for different membrane processes
3. know the principle of the most common membrane applications
4. Carry out design of project for a particular membrane technology application.

17EV009		**REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL MANAGEMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

1. To educate the students on aspects of Remote Sensing
2. Develop the different remote sensing technique
3. To educate the students on aspects of GIS and data management
4. Develop the GIS Applications for monitoring and management of environment

Unit I	**Remote Sensing Elements**	**8 Hours**

Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Electromagnetic spectrum, Energy interaction, Spectral response pattern of earth surface features, Energy recording technology.

Unit II	**Remote Sensing Technology**	**9 Hours**

Classification of Remote Sensing Systems, Aerial photographs, Photographic systems – Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing – Active and passive sensors, RADAR, LIDAR		
Unit III	**Social Impact Assessment and EIA Documentation**	**9 Hours**
Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.		
Unit IV	**Environmental Management Plan**	**10 Hours**
Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies.		
Unit V	**Environmental Risk Assessment and Management**	**9 Hours**
Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modeling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.		
	Total:	**45 Hours**
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Understand the necessity to study the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.	
	2. Know about the legal requirements of Environmental and Risk Assessment for projects.	