BE CIVIL ENGINEERING

1902CE401	BUILDING MATERIALS AND MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT I	BUILDING MATERIALS	9 Hours

Lime, Brick, Timber and its Products, Floor and Wall Tiles, Pozzolanas, Ferrous metals, Thermal Insulation Material. Finishing Materials: Glass, Timber, Aluminum, Plastics, Paints, Varnishes, Distemper, Waterproofing and Damp Proofing Materials, Ferrocement and its application, Fabre textiles – Geo membranes and Geotextiles for earth reinforcement.

UNIT II	BUILDING COMPONENTS	9 Hours

Partition wall and Cavity wall, Composite Masonry, Doors, Windows, Ventilators, Stairs, Lift, Ramps, Escalators, Anti Termite Treatment, Brick masonry- Bond- Jointing-Stone masonry
Temporary building structures - Site Clearance - Marking –Earthwork, Slip and moving forms, scaffolding, Plumbing and Sanitation, Fire Protection, Introduction to Building Maintenance, Acoustics and Sound Insulation.

UNIT III	SUB STRUCTURE AND SUPERSTRUCTURE TECHNIQUES	9 Hours

Techniques of box jacking- pipe jacking- under water construction of diaphragm walls and basement Tunneling techniques, caisson -sinking cofferdam, Dewatering and stand by plant equipment for underground open excavation, Launching girders, bridge decks, off shore platforms, braced domes and space decks.

UNIT IV	CONSTRUCTION EQUIPMENTS	9 Hours

Selection of equipment for earth work - types of earthwork equipment, Equipment for material handling and erection of structures, Equipment for dredging, trenching, tunneling, Equipment for compaction, batching and mixing and concreting, Equipment for foundation and pile driving.

UNIT V	MANAGEMENT	9 Hours

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

	Total:	45 Hours

COURSE OUTCOMES:

1. Summarize the most common and advanced materials used for construction.
2. Illustrate the construction process of various building components.
3. Explain the various construction methods and techniques involved in sub structure and super structure.
4. Choose the appropriate modern construction tools and equipment in various construction activities.
5. Choose the appropriate method of management for materials.

REFERENCES:

1. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2012.
2. Rajput. R.K., "Engineering Materials", S. Chand and Company Ltd., 2008.
3.Gambhir.M.L., "Concrete Technology", 3rd Edition, Tata McGraw Hill Education, 2004
4. Duggal.S.K., "Building Materials", 4th Edition, New Age International, 2008.
5.Jagadish.K.S, "Alternative Building Materials Technology", New Age International, 2007.
6.Gambhir. M.L., &NehaJamwal., "Building Materials, products, properties and systems", Tata McGraw Hill Educations Pvt. Ltd, New Delhi, 2012.

1902CE505		ENVIRONMENTAL ENGINEEERING	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.
4. To understand the importance of planning and design of sewerage system.
5. To create an ability to design the waste water treatment system.
6. To impart the signification of disposal of Sewage.

Unit I	**WATER SUPPLY SYSTEMS – SOURCE AND CONVEYANCE**	**9 Hours**

Objectives – Population forecasting – Design period – Water demand –Sources of water – Source selection – Water quality parameters and significance –Standards – Intake structures – Conveyance – Hydraulics – Laying, jointing and testing of pipes – Pump selection –Appurtenances.

Unit II	**DESIGN PRINCIPLES OF WATER TREATMENT**	**9 Hours**

Objectives – Selection of unit operations and processes – Principles of flocculation, sedimentation, filtration, disinfection – Design principles of flash mixer, flocculator, clarifiers, filters – Disinfection devices – Softening – Demineralization – Aeration – Iron removal – Defluoridation – Operation and maintenance aspects – Residue management.

Unit III	**DISTRIBUTION**	**9 Hours**

Requirements of water distribution -Components -Service reservoirs -Functions and drawings -Network design - Analysis of distribution networks – Hardy cross method – Equivalent pipe method - Pipe Appurtenances -operation and maintenance -Leak detection, Methods. House service connection - Systems of plumbing.

Unit IV	**SEWERAGE SYSTEM, COLLECTION AND TRANSMISSION**	**9 Hours**

Sources of wastewater – Quantity of sanitary sewage – Storm runoff estimation – Wastewater characteristics and significance – Effluent disposal stand over – Design of sewers – Computer applications – Laying, jointing and testing of sewers – Sewer appurtenances – Pump selection.

Unit V	**SEWAGE TREATMENT AND DISPOSAL**	**9 Hours**

Objectives – Selection of unit operation and process – Design principles of primary and secondary treatment, screen chamber, grit chamber, primary sedimentation tanks, activated sludge process – Aeration tank and oxidation ditch – Trickling filter –Stabilization ponds – Septic tanks with soak pits – Sludge: treatment and disposal –Biogas recovery – Sewage farming.

Disposal on land – Disposal into water bodies – Oxygen sag curve – Streeter Phelp's model – Wastewater reclamation techniques.

	Total:	**45 Hours**

Course Outcomes:

After completion of the course, Student will be able to

1. Design the components of the transmission main for the water conveyance
2. Design the water treatment units based on its principles and functions
3. Extend the water distribution to the individual buildings
4. Build a sewerage system by flow estimation and designing suitable size of sewers
5. Design the treatment units for the treatment of waste water based on the quality and quantity.

References:

Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers, New Delhi, 2003.

Punmia, B.C., Jain, A.K., and Jain.A., Environmental Engineering, Vol.II, Lakshmi Publications, Newsletter, 2005

Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1997.

Government of India, "Manual on Water Supply and Treatment", CPHEEO, Ministry of Urban Development, New Delhi, 2003

1902CE552		ENVIRONMENTAL ENGINEERING LAB	L	T	P	C
			0	0	2	1

Course Objectives:	
	1. To know the basics, importance of water and wastewater treatment and methods measurement.
	2. Tostudy the various effects of water and waste water pollution.
	3.Effect of BOD and COD
	4.To find Calcium, Potassium and Sodium
	5.Heavy metal effects and finding methods

List of experiments

1. Measurement of pH, Electrical conductivity and turbidity
2. Determination of Calcium, Potassium and Sodium
3. Determination of Phosphate and Sulphate
4. Determination of Optimum Coagulant Dosage by Jar test apparatus
5. Determination of available Chlorine in Bleaching powder and residual chlorine in water
6. Determination of Ammonia Nitrogen
7. Estimation of suspended, volatile and fixed solids
8. Determination of Dissolved Oxygen
9. Estimation of B.O.D
10. Estimation of C.O. D

	Total:	45 Hours

Course Outcomes:	
	After completion of the course, Student will be able to
	1.characterize given water and waste water sample

References:

1.Standard methods for the examination of water and wastewater, APHA, 20th Edition, Washington, 1998

2. Garg, S.K., "Environmental Engineering Vol. I & II", Khanna Publishers, New Delhi

3. Modi, P.N., "Environmental Engineering Vol. I & II", Standard Book House, Delhi-6

1902CE603		HYDROLOGY AND WATER RESOURCES ENGINEERING	L	T	P	C
			3	0	0	3

Course Objectives:

To introduce the student to the concept of hydrological aspects of water availability and requirements and should be able to quantify, control and regulate the water resources.

Unit I	**PRECIPITATION AND ABSTRACTIONS**	**9 Hours**

Hydrological cycle-Meteorological measurements–Requirements, types and forms of precipitation -Rain Gauges-Spatial analysis of rainfall data using Thiessen and Isohyetal methods-Interception-Evaporation. Horton's equation, pan evaporation measurements and evaporation suppression-Infiltration-Horton's equation-double ring infiltrometer, infiltration indices

Unit II	**RUNOFF**	**9 Hours**

Watershed, catchment and basin-Catchment characteristics-factors affecting runoff-Run off estimation using empirical-Strange‟s table and SCS methods–Stage discharge relationships flow measurements-Hydrograph–Unit Hydrograph–IUH

Unit III	**FLOOD AND DROUGHT**	**9 Hours**

Natural Disasters-Flood Estimation-Frequency Analysis-Flood Control-Definitions of droughts Meteorological, hydrological and agricultural droughts-IMD method-NDVI analysis-Drought Prone Area Programme (DPAP)

Unit IV	**RESERVOIRS**	**9 Hours**

Classification of reservoirs, General principles of design, site selection, spillways, elevation–area-capacity-storage estimation, sedimentation-life of reservoirs–rule curve

Unit V	**GROUNDWATER AND MANAGEMENT**	**9Hours**

Origin-Classification and types-properties of aquifers-governing equations–steady and unsteady flow-artificial recharge-RWH in rural and urban areas

	Total:	**45 Hours**

Further Reading:

1. How to prepare data for GIS and RS
2. Civil engineering application for various fields

Course Outcomes:

After completion of the course, Student will be able to

1. Explain the key drivers on water resources, hydrological processes and their integrated behavior in catchments
2. Make use of hydrological models to surface water problems including basin characteristics, runoff and Hydrograph
3. Outline the concept of hydrological extremes such as Flood and Drought and management strategies
4. Describe the importance of spatial analysis of rainfall and design water storage reservoirs
5. Illustrate the concepts of groundwater for water resources management

References:

Subramanya .K. "Engineering Hydrology"-Tata McGraw Hill, 2010

David Keith Todd. "Groundwater Hydrology", John Wiley & Sons, Inc. 2007

1901MGX01		**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:	To facilitate the understanding of Quality Management principles and process.

Unit I	INTRODUCTION	**9 Hours**

Introduction – Need for quality – Evolution of quality – Definitions of quality – Dimensions of product and service quality – Basic concepts of TQM – TQM Framework – Contributions of Deming, Juran and Crosby – Barriers to TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Costs of quality.

Unit II	TQM PRINCIPLES	**9 Hours**

Leadership – Strategic quality planning, Quality Councils – Employee involvement – Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal – Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating

Unit III	TQM TOOLS AND TECHNIQUES I	**9 Hours**

The seven traditional tools of quality – New management tools – Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

Unit IV	TQM TOOLS AND TECHNIQUES II	**9 Hours**

Control Charts – Process Capability – Concepts of Six Sigma – Quality Function Development (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures.

Unit V	QUALITY SYSTEMS	**9Hours**

Need for ISO 9000 – ISO 9001-2008 Quality System – Elements, Documentation, Quality Auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – TQM Implementation in manufacturing and service sectors.

	Total:	**45 Hours**

Further Reading:	
	1. Engineering economics and cost analysis
	2. Construction and planning management

Course Outcomes:	
	After completion of the course, Student will be able to
	1. Understand the concepts, dimension quality and philosophies of TQM.
	2. Understand the principles of TQM and its strategies.
	3. Apply seven statistical quality and management tools.
	4. Understand TQM tools for continuous improvement.
	5. Understand the QMS and EMS.

1902CE604		GLOBAL WARMING AND CLIMATE CHANGE	L	T	P	C
			3	0	0	3

Course Objectives:

1. To understand the Earth's Climate System and the concept of Global Warming.
2. To analyze the global warming and their effects due to climate change.
3. To comprehend the impact of climate change on society and its mitigation measures.

Unit I	**INTRODUCTION OF GLOBAL WARMING**	**9 Hours**

Introduction - the gas law - ideal gas equation- the mole concept- sample calculations- ppm - sulphur pollutants-oxides of nitrogen - particulate - Green House Gases.

Unit II	**MITIGATION MEASURE, EMISSION TARGETS AND CARBON TREADING**	**9 Hours**

Introduction-reduction of carbon dioxide emissions from power generation- carbon credits- carbon dioxide from vehicle - miscellaneous source of carbon dioxide- uptake of carbon dioxide by vegetation

Unit III	**OVERVIEW OF CLIMATE VARIABILITY AND CLIMATE SCIENCE**	**9 Hours**

Climate dynamics, climate change and climate prediction - the chemical and physical climate system and aspects - El Nino and global warming - global change in recent history.

Unit IV	**BASICS OF GLOBAL CLIMATE**	**9 Hours**

Components and phenomena in the climate system - basics of radioactive forcing - atmospheric circulation-ocean circulation-land surface processes - the carbon cycle.

Unit V	**PHYSICAL PROCESSES IN THE CLIMATE SYSTEM**	**9 Hours**

Conservation of momentum-equation of state- temperature equation - continuity equation - conservation of mass applied to moisture – saturation - wave processes in the atmosphere and ocean.

	Total:	**45 Hours**

Course Outcomes:

After completion of the course, Student will be able to

1. Outline the principle involved in the greenhouse gas emission.
2. Explain the carbon emission and its mitigation methods.
3. Illustrate about the climate variability parameters.
4. Describe the climate components and the circulation system.
5. Discuss about the physical processes involved in the climate system.

1903CE033		WATER POLLUTION AND MANAGEMENT	L	T	P	C
			3	0	0	3

Course Objectives:

1. To impart knowledge on the importance and necessity of water
2. To educate about the water pollution and its impact
3. To impart knowledge on water quality analyzing techniques
4. To make awareness in monitoring and management of water

Unit I	**WATER RESOURCES**	**9 Hours**

Necessity & properties of water –Water resources of the world and India –National Water Policy– Water cycle– Surface & subsurface sources –Water Quality Parameters – Standards.

Unit II	**WATER POLLUTION**	**9 Hours**

Sources – Classification, nature and Toxicology of water pollutants –Ground water pollution–Ocean Pollution by toxic wastes– River pollution-A case study

Unit III	**EFFECTS OF WATER POLLUTION**	**9 Hours**

Effects of water pollutants on Human health– Ecological and Economic impacts of water pollution–Marine oil pollution and its impacts.

Unit IV	**ANALYSIS & INSTRUMENTATION**	**9 Hours**

Analysis of Pollutants: Titrimetry – Gravimetry – Spectrophotometry – Chromatography and Flame techniques. Instrumentation: Principles and Applications of UV– VIS Spectrophotometer – Flame Photometer – Atomic Absorption Spectrophotometer –Gas Chromatography – GLC – HPLC

Unit V	**MONITORING & MANAGEMENT**	**9 Hours**

Water quality monitoring–Water (Prevention and Pollution Control) act 1974 – Pollution control devices – Polluters pay principle.

	Total:	**45 Hours**

Further Reading:

1. Water supply engineering
2. Waste water engineering

Course Outcomes:

After completion of the course, Student will be able to

1. Illustrate about the sources of water and the quality standards
2. Classify the nature of pollutants and its source
3. Outline the effects of water pollution on biodiversity
4. Select the suitable analysis technique for the water quality parameter estimation
5. Select the accurate monitoring and management methods

References:

1. Laurent Hodges – Environmental Pollution
2. Willard, Merritt and Dean – Instrumental Analysis
3. APHA – Analysis of Water and Waste Water

1901HS002	INTELLECTUAL PROPERTY RIGHTS FOR ENGINEERS	L	T	P	C
		3	0	0	3

PREREQUISITE:

The course assumes no prior skill or background in design, art or engineering. This course covers the fundamental aspects of intellectual property (IP): copyright and related rights, trademarks, patents, geographical indications, and industrial designs. It also covers contemporary issues impacting the IP field such as: new plant varieties, unfair competition, enforcement of IP rights and emerging issues in IP.

COURSE OBJECTIVES:

1. A foundation in the basic concepts of IP
2. Better understanding of the relationship between IP and other policy areas such as health, climate change, traditional knowledge and emerging technologies

Module I	Introduction	9 Hours

Overview of IP, Copyright, Trademarks, Geographical Indicators, Industrial Designs, Patents, Unfair competition, Enforcement of IP Rights, Emerging Issues in IP & IP Management

Module II	Copyrights &Trademarks	6 Hours

The concept, Case Study, Historical background, Principles, Notion of Work, Rights and Limitations, Formats & Filing Procedures

Module III	Geographical Indicators & Industrial Designs	6 Hours

The concept, Case Study, Historical background, Principles, Notion of Work, Rights and Limitations, Formats & Filing Procedures

Module IV	Patents	15 Hours

The Macro-Economic Impact of the Patent System, The Patent Application Process, The Different Layers of the International Patent System and Regional Patent Protection Mechanisms, Kinds of Intellectual Property Protection Based on Types of Inventions, Legal Issues of the Patenting Process, Enforcement, New Issues, Important Cases and Discussions, IP and Development - Flexibilities and Public Domain under Patents, Patent Search

Module V	Patent Cooperation Treaty	9 Hours

What is PCT? Use of PCT, Preparing a PCT Application, PCT Services, Patent Agent and Common Representatives, International Search, International Examination

TOTAL: 45 HOURS

Course Outcomes:

1. Explain various types of IPRs specific to Engineering
2. Explain concepts such as Copyrights, Trademarks, GIs and Industrial designs
3. Explain basic concepts of Engineering Patents
4. Explain concept of Patent Search and various methods to do it
5. Develop a sample PCT Application and explain examination procedures

FURTHER READING:

1. Intellectual Property Rights by PandeyNeeraj&DharniKhushdeep, 2014
2. Fundamentals of IPR: for students, Industrialist and patent lawyers, Ramakrishna B & Anil Kumar HS, 2017Drucker

REFERENCES:

1. Law relating to IPR by Dr MK Bandarai, Central Law Publication, 2014
2. Introduction to Intellectual Property Rights, H.S. Chawla, Oxfors& IBH Publishing, 2020
3. Introduction to IPR by JP Mishra, Central Law Publications
4. https://patents.google.comIntroduction to IPR books

1901HS006	DESIGN THINKING FOR INNOVATION	L	T	P	C
		3	0	0	3

PREREQUISITE:

The course assumes no prior skill or background in design, art, engineering, or prototyping. It is open to all undergraduates and graduate students with an interest in learning design thinking, and is especially recommended for those students planning social-venture and other kinds of design interventions

COURSE OBJECTIVES:

1. Understand how teaching and learning occurs in the design process
2. Recognize the ethical and social dilemmas and obligations of the practice of design
3. Diagnose common adoption barriers in individuals, groups and organizations.
4. Develop a design theory from independent and qualitative research and observations
5. Participate in and lead innovation in creative and collaborative settings
6. Undertake complex and unstructured problem-solving challenges in unfamiliar domains

Module I	**Introduction to Design Thinking**	**8 Hours**

Human Centered Design, Why Design Thinking, 5-Step Design Thinking Process, Applications, Creative Confidence, The culture of Innovation

Module II	**Design Thinking Approach**	**12 Hours**

IDEO's method of Design Thinking, Divergent Thinking & Innovation Funnel, Customer Journey Maps to uncover Innovation Opportunities, Case Study : Turing Creative Ideas into Viable Companies

Module III	**Exploring Design Thinking ToolKit**	**5 Hours**

Discovery, Interpretation, Ideation, Experimentation, Evolution

Module IV	**Design Challenge Project: Phase-1**	**5 Hours**

Define a Challenge, Project Plan, How Might We statement, Project Timeline, Project Checklist

Module V	**Design Challenge Project: Phase-2**	**15 Hours**

Discovery – Understand the Challenge, Prepare Research, Gather Inspiration, Interpretation – Tell Stories, Search for meaning, Frame Opportunities, Ideation – Generate Ideas, Refine Ideas, Experimentation – Make Prototypes, Get Feedback, Evolution – Track Learnings, Engage Others

TOTAL: 45 HOURS

Course Outcomes:

1. Describe Key Concepts and basics of Design Thinking Principles
2. Elaborate the Design Thinking Approach through IDEO's method & Customer Journey Maps
3. Conduct user interviews and synthesize learnings to uncover insights and identify opportunities for innovation
4. Develop Design Driven Innovative Solutions to Real World Problems

FURTHER READING:

1.Design for Social Impact: How to by IDEO.org
2.Design Thinking Tool Kit by IDEO.org
3.The Field guide to Human Centered Design by IDEO.org

REFERENCES:

1.Creative Confidence: Unleashing the Creative Potential Within Us All Book by David M. Kelley and Tom Kelley, 2013

2.Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation Book by Tim Brown, 2009

1901MGX07		UNIVERSAL HUMAN VALUES & ETHICS	L	T	P	C
			3	0	0	3
Course Objectives:						
	1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education. 2. To help students initiate a process of dialog within themselves to know what they 'really want to be' in their life and profession 3. To help students understand the meaning of happiness and prosperity for a human being. 4. To facilitate the students to understand harmony at all the levels of human living, and live accordingly. 5. To facilitate the students in applying the understanding of harmony in existence in their profession and lead an ethical life				
Unit I	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**					**9 Hours**
Understanding the need, basic guidelines, content and process for Value Education-Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration - Continuous Happiness and Prosperity- A look at basic Human Aspirations - Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being withtheir correct priority - Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario - Method to fulfill the above human aspirations: understanding and living in harmony at various levels						
Unit II	**Understanding Harmony in the Human Being - Harmony in Myself**					**9 Hours**
Understanding human being as a co-existence of the sentient 'I' and the material 'Body' - Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha - Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) - Understanding the characteristics and activities of 'I' and harmony in 'I' - Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail - Programs to ensure Sanyam and Swasthya						
Unit III	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**					**10 Hours**
Understanding harmony in the Family- the basic unit of human interaction - Understanding values in human-human relationship; meaning of *Nyaya* and program for its fulfillment to ensure *Ubhay-tripti*; Trust (*Vishwas*) and Respect (*Samman*) as the foundational values of relationship - Understanding the meaning of *Vishwas*; Difference between intention and competence - Understanding the meaning of *Samman*, Difference between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): *Samadhan*, *Samridhi*, *Abhay*, *Sah-astitva* as comprehensive Human Goals - Visualizing a universal harmonious order in society- Undivided Society (*AkhandSamaj*), Universal Order (*SarvabhaumVyawastha*)- from family to world family!						
Unit IV	**Understanding Harmony in the Nature and Existence - Whole existence as Co-existence**					**9 Hours**

Understanding the harmony in the Nature - Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature - Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting units in all-pervasive space - Holistic perception of harmony at all levels of existence		
Unit V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics**	**8 Hours**
Natural acceptance of human values - Definitiveness of Ethical Human Conduct - Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order - Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, - b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models - Case studies of typical holistic technologies, management models and production systems - Strategy for transition from the present state to Universal Human Order:a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers - b) At the level of society: as mutually enriching institutions and organizations		
	Total:	**45 Hours**
Further Proceeding:		
	1. Analysis about Code of Conduct for Ethical & Moral values	
Course Outcomes:		
	After completion of the course, Student will be able to	
	1. Understand the significance of value inputs in a classroom and start applying them in their life and profession	
	2. Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.	
	3. Understand the value of harmonious relationship based on trust and respect in their life and profession	
	4. Understand the role of a human being in ensuring harmony in society and nature.	
	5. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	
References:		
1. A Nagraj, 1998, JeevanVidyaEkParichay, Divya Path Sansthan, Amarkantak.		
2. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.		
3. A N Tripathy, 2003, Human Values, New Age International Publishers.		
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA		

1902CE019	COASTAL ZONE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:	At the end of the semester, 1.The student shall be able to understand the coastal processes
	2.The student shall be able to understand the coastal dynamics
	3.The student shall be able to understand impacts of structures like docks, harbors and quays leading to simple management perspectives along the coastal zone

Unit I	**COASTAL ZONE**	**9 Hours**

Coastal zone – Coastal zone regulations – Beach profile – Surf zone – Off shore – Coastal waters – Estuaries – Wet lands and Lagoons – Living resources – Nonliving resources.

Unit II	**WAVE DYNAMICS**	**9 Hours**

Wave classification – Airy's Linear Wave theory – Deep water waves – Shallow water waves – Wave pressure – Wave energy – Wave Decay – Reflection, Refraction and Diffraction of waves – Breaking of waves – Wave force on structures – Vertical – Sloping and stepped barriers – Force on piles.

Unit III	**WAVE FORECASTING AND TIDES**	**9 Hours**

Need for forecasting – SMB and PNJ methods of wave forecasting – Classification of tides – Darwin's equilibrium theory of tides – Effects on structures – seiches, Surges and Tsunamis.

Unit IV	**COASTAL PROCESSES**	**9 Hours**

Erosion and depositional shore features – Methods of protection – Littoral currents – Coastal aquifers – Sea water intrusion – Impact of sewage disposal in seas.

Unit V	**HARBOURS**	**9 Hours**

Structures near coast – Selection of site – Types and selection of break waters – Need and mode of dredging – Selection of dredgers – Effect of Mangalore Forest.

	Total:	**45 Hours**

Further Reading:

1.Richard Sylvester, "Coastal Engineering, Volume I and II", Elseiner Scientific Publishing Co., 1999

2.Quinn, A.D., "Design & Construction of Ports and Marine Structures", McGraw Hill Book Co., 1999

Course Outcomes:

After completion of the course, Student will be able to

1. Describe the Coastal zone regulations,
2. Describe the coastal processes
3. Explain the wave dynamics and forecast waves
4. Understand the erosion and depositional shore protection
5. Plan the coastal structures including harbours and tides

References:

1.Ed. A.T. Ippen, "Coastline Hydrodynamics", McGraw-Hill Inc., New York, 1993

2.Dwivedi, S.N., Natarajan, R and Ramachandran, S.,"Coastal Zone Management in Tamilnadu", Madras, 199

3.Richard Sylvester, "Coastal Engineering, Volume I and II", Elseiner Scientific Publishing Co., 1999

4.Quinn, A.D., "Design & Construction of Ports and Marine Structures", McGraw Hill Book Co., 1999

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
2. Batch studies on settling
3. Studies on Filtration- Characteristics of Filter media
4. Water softening
5. Adsorption studies/Kinetics
6. Reverse Osmosis- Silt Density Index
7. Kinetics of suspended growth process (activated sludge process)- Sludge volume Index
8. Anaerobic Reactor systems / kinetics (Demonstration)
9. Advanced Oxidation Processes – (Ozonation, Photocatalysis)
10. Disinfection for Drinking water

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.