PUDUCHERRY TECHNOLOGICAL UNIVERSITY
PUDUCHERRY–605014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi

for

M.Tech. (Environmental Engineering)

(With effect from Academic year 2020-21)

(Approved in Sixth Academic Council Meeting held on 20th March 2021)

CURRICULUM

The curriculum of M.Tech. (Environmental Engineering) is designed to fulfill the Programme Educational Objectives (PEO) and Programme Outcomes (PO) listed below:

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1	Strengthening the fundamental concepts	To equip the students with capabilities required for identifying, formulating and management of environmental issues/problems
PEO2	Core competence	To impart training to the students to prepare them for conducting high value research on environmental engineering and other related issues and also to pursue lifelong learning.
PEO3	Research and Consultancy Approach	To introduce the students to the environmental problems at international, national and regional level so that they get exposure to the burning issues.
PEO4	Professionalism & Management Skills	To impart training to the students to gain capabilities for conducting joint collaborating works.

PROGRAMME OUTCOMES (PO)

PO1	To acquire in depth knowledge of Environmental Engineering with an ability to carry out research and development and give solution for Environmental Engineering problems.
PO2	To create appropriate technologies and design for solving environmental complex issues and challenges in the field.
PO3	To possess knowledge and carryout interdisciplinary scientific research applied to Chemical Engineering and Energy Management.
PO4	To create innovative methods, conduct investigations and write the technical report on environmental challenging field problems.
PO5	To conceive and visualize theory and apply the same to one's own work to practice as consultant
PO6	To coordinate, liaison and monitor potential activities of regulatory boards for sustainability of environmental quality.

Distribution of Credits among the subjects grouped under various categories:

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

Sl. No.	Category	Credits	Course Category Code (CCC)
1	Programme Core Course	24	PCC
2	Programme Specific Elective Courses	15	PSE
3	Open Elective Courses	03	OEC
4	Professional Activity Courses (Project Work, Seminar)	28	PAC
5	Mandatory Audit Courses	Non Credit	MAC
	Total	**70**	

Semester wise Courses and credits

Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE263	Environmental Systems Analysis	PCC	3	0	0	3
CY251	Environmental Chemistry and Microbiology	PCC	3	0	0	3
CE264	Principles of Physico- Chemical and Biological Treatment Systems	PCC	3	0	0	3
CEZNN	Programme Specific Elective -1	PSE	3	0	0	3
CEZNN	Programme Specific Elective -2	PSE	3	0	0	3
CE265	Environmental Chemistry and Microbiology Laboratory.	PCC	0	0	4	2
CE255	Research Methodology and IPR	PCC	2	0	0	2
AD2NN	Audit Course – I	MAC	2	0	0	0
Total			**23**			**19**

Semester II

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE266	Transport of Water and Wastewater	PCC	3	0	0	3
CE267	Design and Operation of Water and Wastewater Treatment Systems	PCC	3	0	0	3
CE268	Environmental Impact Assessment	PCC	3	0	0	3
CEZNN	Programme Specific Elective – 3	PSE	3	0	0	3
CEZNN	Programme Specific Elective – 4	PSE	3	0	0	3
CE269	Environmental Processes Monitoring Laboratory	PCC	0	0	4	2
CE270	Mini Project and Seminar	PAC	0	0	4	2
AD2NN	Audit Course - II	MAC	2	0	0	0
Total			**25**			**19**

Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE271	Dissertation – Phase I	PAC	0	0	20	10
CEZNN	Programme Specific Elective – 5	PSE	3	0	0	3
OE2NN	Open Elective	OEC	3	0	0	3
Total			**26**			**16**

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE272	Dissertation – Phase II	PAC	0	0	32	16
Total			**32**			**16**

Total Credits: 70

Audit Courses (MAC)

AD201	English for Academic Writing (HS)
AD202	Disaster Management (CE)
AD203	Value Education (HS)
AD204	Constitution of India (HS)
AD205	Pedagogy Studies (HS)
AD206	Stress Management by Yoga (HS)

Open Elective Courses (OEC)

OE201	Business Analytics (IT)
OE202	Industrial Safety and Maintenance (ME)
OE203	Operations Research(ME)
OE204	Cost Management of Engineering Projects (CE)
OE205	Composite Materials (PH)
OE206	Waste to Energy (CE)

Programme Specific Electives (PSE)

PSE – 1	**CEZ21**	Industrial Wastewater Management and Reuse
	CEZ22	Cleaner Production and Environmental management
	CEZ23	Environmental Reaction Engineering
	CEZ24	Fundamentals of Sustainable Development
PSE – 2	**CEZ25**	Air Pollution Control Engineering
	CEZ26	Solid and Hazardous Waste Management
	CEZ27	Atmospheric Processes and Climate Change
	CEZ28	Ecological Engineering
PSE – 3	**CYZ01**	Environmental Pollution Monitoring Techniques
	CEZ29	Environmental Biotechnology
	CEZ30	Environmental Policies and Legislations
	CEZ31	Remote Sensing and GIS Applications in Environmental Engineering
PSE – 4	**CEZ32**	Environmental Geo-technology
	CEZ33	Environmental Risk Assessment and Management
	CEZ34	Air and Water Quality Modeling
	CEZ35	Environment, Health and Safety in Industries
PSE – 5	**CEZ36**	Project Formulation and Appraisal
	CEZ37	Energy and Environmental Management
	CEZ38	Groundwater Flow and Contaminant Transport
	CEZ39	Aerosol Science and Technology

XX – Department Code; **NN** – Running double digit number; **N** – Running single digit number

Department : **Civil Engineering**		Programme: **M.Tech (Environmental Engineering)**						
Semester: **I**		Course Category Code: **PCC**			Semester Exam Type :**TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE263	**ENVIRONMENTAL SYSTEMS ANALYSIS**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to
	CO1 To analyse the system performance using simulation models
	CO2 To optimize environmental engineering systems using optimization models
	CO3 To employ model-based environmental analysis
	CO4 To choose a suitable environmental system analysis method and tool for a given decision situation
	CO5 To analyse the models for environmental problems

UNIT – I	**System Engineering**	**Periods : 9**
Analysis -Design-Synthesis –applications to environmental engineering Systems		**CO1**
UNIT – II	**Role of optimization models**	**Periods : 9**
Deterministic models/ linear programming, Dynamics programming, Separable and Nonlinear program models. Formulation of objective functions and constraints for environmental engineering planning and design.		**CO2**
UNIT – III	**Probabilistic models**	**Periods : 9**
Fuzzy models –Simulation models.		**CO3**
UNIT – IV	**Modern tools**	**Periods : 9**
Experts -Neural Networks –Genetic Algorithm		**CO4**
UNIT – V	**Applications**	**Periods : 9**
Case studies and Applications		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Rich L.G., Environmental Systems Engineering, McGraw Hill, 1973.2.
2. Thoman R.V., Systems Analysis & water Quality control, McGraw Hill, 1978.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	-	-	-	-
CO2	2	1	1	-	-	-
CO3	3	1	-	1	-	-
CO4	3	1	2	1	-	-
CO5	3	1	2	1	-	1

Score: **3** – High; **2** – Medium; **1** – Low

Department : Chemistry		**Programme:** M.Tech.(Environmental Engineering)						
Semester : I		**Category: PCC**						
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
CY251	**ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY**	3	0	0	3	40	60	100
Prerequisite								
Course Outcome	At the end of the course, students will be able to:							
	CO1	Analytical chemistry for the analysis of micro pollutants						
	CO2	Assess the role of size dependent properties of different materials in environmental applications						
	CO3	Determine the water quality parameters like alkalinity, Total hardness and Oxygen demand in sewage and industrial effluents						
	CO4	Understand the role of microorganisms in pollution control and apply the knowledge in biological treatment processes						
	CO5	Acquire knowledge on soil, aquatic and air microbiology.						

UNIT – I	**BASIC CONCEPTS OF GENERAL CHEMISTRY**	**Periods: 9**
Valency Oxidation State and Bonding, Oxidation and Reduction Equations, Gas Laws, Equilibrium and Le Chatelier's Principle, Shifting of Equilibrium		**CO1**
UNIT – II	**BASIC CONCEPTS OF PHYSICAL CHEMISTRY**	**Periods: 9**
Osmosis, Dialysis, Colloids, dispersion of colloids, general and electrokinetic properties of colloids, colloidal solution and mixtures		**CO2**
UNIT – III	**ENVIRONMENTAL CHEMISTRY**	**Periods: 9**
CNP cycles under aerobic and anaerobic reactions, concept of Hardness, BOD, COD, TOC, Chemistry involved in water treatment process - coagulation, softening, fluorination, defluorination, iron and manganese removal, demineralization, analysis of pesticide and heavy metals. Reactivity of organic functional groups in the interest of Environmental Engineers, Enzymes, and Classification enzymes catalyzed reaction, Mechanism and factors influencing enzymatic reaction, Breakdown and synthesis of carbohydrates, fats, proteins under aerobic and anaerobic reactions.		**CO3**
UNIT – IV	**BASIC CONCEPTS OF ENVIRONMENTAL MICROBIOLOGY**	**Periods: 9**
Introduction of microbiology, haeckel's classification and characterization of microorganisms viruses. Morphology and structure of bacteria, nutrient requirement, growth of bacteria - prokaryotic, eukaryotic, structure, characteristics, nucleic acids-DNA, RNA, replication. Culturing of microorganisms-Environmental factors influencing microbial growth Distribution of microorganisms - Toxic and Nontoxic microorganisms -Water, Air and Soil, Indicator organisms, coliforms—fecal coliforms, E. coli, Streptococcus, Clostridium, Significance in water. Algae in water supplies—problems and control. MPN and MFT, Virus-concentration techniques.		**CO4**
UNIT – V	**MICROBIOLOGY AND ECOTOXICOLOGY**	**Periods: 9**
Concepts - Microbiological applications in solid waste management -Toxic and Nontoxic microorganisms in Air, Water and Soil, Aquatics - Toxicants and toxicity, factors influencing toxicity, effects—acute, chronic, concentration response relationships, test organisms, toxicity testing, bio concentration, bioaccumulation, bio magnification, bioassay, bio monitoring.		**CO5**

Total Contact Hours : 45	**Total Tutorials : 0**	**Total Practical Class : 0**	**Total Hours : 45**

Reference Books

1. C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineering and Science, 5th Ed,TataMc, Graw-Hill, 2003.
2. Tortora. G.J, B.R. Furke, and C.L. Case, "Microbiology-An Introduction" (4th Ed.), Benjamin/Cummings Publ.Co., Inc., California, 1992.
3. Arun Kumar De, Environmental Chemistry, 7th Ed, New Age International P Ltd, New Delhi, 2006.

4. ArunBhal, B.S. Bahl and G.D. Tuli “Essentials of Physical Chemsitry”, S. Chand & Company Ltd. New Delhi, Revised edition 2012.
5. Pelczar, M.J., Chan E.C.S. and Krieg, N. R. Microbiology, Tata Mcgraw Hill, New Delhi,2006.
6. Mitchell, R., and Gu, J.D., Environmental Microbiology, 2nd Ed., Wiley-Blackwell, 2010.

Department : **Civil Engineering**		Programme: **M.Tech (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE264	**PRINCIPLES OF PHYSICO-CHEMICAL AND BIOLOGICAL TREATMENT SYSTEMS**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Understand the significance of equalization and design of equalization tank and realize its impact on wastewater treatment system.
	CO2	Understand different types of settling involved in treatment and design appropriate sedimentation units to remove the suspended impurities.
	CO3	Understand the mechanisms involved and types of filtration for water/wastewater treatment and design the filtration units for the removal of finely divided colloidal and dissolved solids.
	CO4	Identify and design chemical treatment methods for the conversion of harmful components in water/ wastewater into harmless ones or change their state amenable for subsequent physical removal.
	CO5	Select appropriate mixing and aeration devices required for the treatment.

UNIT – I	**INTRODUCTION**	**Periods : 9**
Pollutants in water and wastewater – characteristics, Standards for performance Significance of physico-chemical treatment – Selection criteria-types of reactor- reactor selection-batch-continuous type-kinetics.		**CO1**
UNIT – II	**PHYSICAL TREATMENT PRINCIPLES**	**Periods : 9**
Principles of Screening – Mixing, Equalization – Sedimentation, flotation – Filtration – Modeling back washing – Evaporation – Incineration – gas transfer – mass transfer coefficient.		**CO2**
UNIT – III	**CHEMICAL TREATMENT PRINCIPLES**	**Periods : 9**
Principles of Chemical treatment – Coagulation and flocculation, Adsorption – Isotherms – Principles, kinetics, Precipitation,– Disinfection, Dechlorination, Ion exchange, Electrolytic methods.		**CO3**
UNIT – IV	**BIOLOGICAL TREATMENT PRINCIPLES**	**Periods : 9**
Objectives of biological treatment – significance – 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-kinetics, Introduction to advanced biological treatment methods.		**CO4**
UNIT – V	**ADVANCED TREATMENT PRINCIPLES**	**Periods : 9**
Water softening process, solidification and stabilization, Phosphorous and Nitrogen removal methods, regeneration membrane separation, Reverse Osmosis, Nano filtration, ultra filtration and hyper filtration electrodialysis, distillation – stripping and crystallization – Recent Advances. Solvent extraction – advanced oxidation /reduction – Recent Trends – Forced Evaporation methods ,MEE, ATFD, Spray dryers– Expert systems and software's.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.
2. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
3. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 2009.
4. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, New York, 2011.
5. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.
6. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Govt. of India, New Delhi, 2013.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	1	-
CO2	3	2	2	-	-	-
CO3	-	-	-	2	-	-
CO4	-	-	-	1	2	2
CO5	2	1	-	1	-	-

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme: **M.Tech(Environmental Engineering)**						
Semester: **I**		Course Category Code: **PCC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CE265	**ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY LABORATORY**	-	-	4	2	40	60	100

Course Outcomes	**CO1**	Identify the quality of water in order to fix its pollution status
	CO2	Conduct test on wastewater to identify their characteristics so as to suggest suitable treatment methods
	CO3	Determine the dosage of coagulants and disinfectants required for the treatment of water/ wastewater
	CO4	Measure the quality of ambient air with respect to various particulate matters.
	CO5	Conduct test for microorganism in water and waste water.

CHEMISTRY LABORATORY PRACTICE	**CO1 to CO5**
Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods – Sampling and analysis of ambient air for SPM, SO2, and Oxides of nitrogen – Good laboratory practice – Analytical quality control.	
MICROBIOLOGY LABORATORY PRACTICALS	
Media preparation and inoculation – staining – environmental factors – bacteriological analysis of water, sewage, test for plate count – coliforms – faecal coliforms – E.coli – S.fecalis – M.P.N. and M.F. techniques. Techniques for studying aquatic organisms – identification of phytoplankton and zooplankton – bioassay study and biodegradation.	
AIR POLLUTANTS AND LEACHATE ANALYSES	
Instrumental methods of analyses for particulates, HC, CO, NOx, SO2, bio-aerosols, TCLP and leachate tests for solid wastes.	

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 60**	**Total Periods: 60**

Reference Books

1. Sawyer, C.N. and McCarty, P.L. and Parkin, G.F. “Chemistry for Environmental Engineers”, 5th Edition, McGraw Hill, New Delhi, 2003.
2. De.A.K. “Environmental Chemistry”, New Age International Ltd., New Delhi, 2006.
3. Lee, CC &Shundar Lin, “Hand book of Environmental Engineering Calculations”, Mc Graw Hill, New York, 2009.
4. “Standard Methods for the Examination of Water and Wastewater”, 21th Edition, American Public Health Association, Washington. D.C. 2005.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	2	2	2
CO4	3	3	2	3	2	2
CO5	3	1	-	3	3	-

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M.Tech (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PCC**			Semester Exam type :**TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE255	**RESEARCH METHODOLOGY AND IPR**	2	0	0	2	40	60	100
Prerequisite								

Course Outcomes	**CO1**	Understand the research problem formulation
	CO2	Analyze and Follow ethics while formulating the research problem.
	CO3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
	CO4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
	CO5	UnderstandthatIPRprotectionprovidesanincentivetoinventorsforfurtherresearch. Work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT – I	**Periods : 6**	
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations		**CO1**
UNIT – II	**Periods : 6**	
Effective literature studies approaches, analysis plagiarism, and Research ethics.		**CO2**
UNIT – III	**Periods : 6**	
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee		**CO3**
UNIT – IV	**Periods : 6**	
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		**CO4**
UNIT – V	**Periods : 6**	
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs		**CO5**

Lecture Periods : 30	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 30**

Reference Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall , "Industrial Design", McGraw Hill,1992.
6. Niebel , "Product Design", McGraw Hill,1974.
7. Asimov , "Introduction to Design", Prentice Hall,1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New

Technological Age",2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2008

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M.Tech (Environmental Engineering)**						
Semester : **II**		Course Category Code: **PCC**			Semester Exam type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE266	**TRANSPORT OF WATER AND WASTEWATER**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	**CO1**	Understand and apply the principle of hydraulics in water transportation and distribution and wastewater collection and conveyance
	CO2	Design water supply mains taking into account all the design parameters.
	CO3	Analyze a water supply distribution network.
	CO4	Select an appropriate pipe material, necessary pipe appurtenances and able to locate the leaking mains for the water distribution system.
	CO5	Estimate the quantity of storm drainage and design a proper storm drainage for speedy draining of storm water from the city area.

UNIT – I	**GENERAL HYDRAULICS AND FLOW MEASUREMENT**	**Periods : 9**
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.		**CO1**
UNIT – II	**WATER TRANSMISSION AND DISTRIBUTION**	**Periods : 9**
Need for Transport of water and Wastewater-Planning of Water System –Selection of pipe materials, pipe thickness calculations. Design of intake works - Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics-economics; Specials, Jointing, laying and maintenance, water hammer analysis.		**CO2**
UNIT – III	**WATER DISTRIBUTION SYSTEMS**	**Periods : 9**
Water distribution pipe networks, Methods, Design, analysis and optimization – appurtenances – Corrosion prevention – minimization of water losses – leak detection Storage reservoirs. Use of computer software in water transmission and water distribution.		**CO3**
UNIT – IV	**WASTEWATER COLLECTION AND CONVEYANCE**	**Periods : 9**
Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design. Handling and transport of slurry. Wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters. Use of computer software in sewer design, handling and transport of slurries.		**CO4**
UNIT – V	**STORM WATER DRAINAGE**	**Periods : 9**
Necessity - combined and separate system; Estimation of storm water runoff Formulation of rainfall intensity duration and frequency relationships- Rational methods. Use of computer software in storm water design.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Simla, 2003. 2.Hammer M.J., "Water and Wastewater Technology", Regents/ Prentice Hall, New Jersey, 2007 3. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000. 4. Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2013.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	1	2	-
CO2	3	3	3	1	2	-
CO3	3	3	3	3	1	1
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M.Tech (Environmental Engineering)**						
Semester : **II**		Course Category Code: **PCC**			Semester Exam type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE267	**DESIGN AND OPERATION OF WATER AND WASTEWATER TREATMENT SYSTEMS**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	**CO1**	Use the basic principles of process kinetics and microbial growth (bacteria) - reaction kinetics for reactor design
	CO2	Design a suspended growth treatment processes to treat municipal wastewater.
	CO3	Design an attached growth treatment processes to treat municipal wastewater.
	CO4	Use the basic principles of sludge process, kinetic relationship and to design a sludge treatment system.
	CO5	Application of theory through mini project.

UNIT – I	**DESIGN OF MUNICIPAL WATER TREATMENT PLANTS**	**Periods : 9**
Selection of Treatment – Design of municipal water treatment plant units – Aerators – Chemical feeding – Flocculation – clarifies – tube settling – filters – Rapid sand filters slow sand filter, pressure filter, Dual media inlets Displacement and gaseous type –flow charts – Layouts –Hydraulic Profile PID O&M aspects – case studies, Residue and reject management – Recent Trends - Software application, Upgradation of existing plants–, Construction and Operational Maintenance problems – Trouble shooting – Planning, Organizing and Controlling of plant operations – capacity building, CDM and carbon credit assessments.		**CO1**

UNIT – II	**DESIGN OF WASTEWATER TREATMENT PLANTS**	**Periods : 9**
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 – Disinfectant – disposal options – reclamation and reuse – Flow charts, layout, hydraulic profile, recent trends Software application. O&M aspects – case studies, Residue and rejects management – Recent Trends– Software application, Upgradation of existing plants, Construction and Operational Maintenance problems – Trouble shooting – Planning, Organizing and Controlling of plant operations – capacity building, CDM and carbon credit assessments.		**CO2**

UNIT – III	**DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS**	**Periods : 9**
Design of Industrial Water Treatment Units- Selection of process – Design of softeners – Demineralizer –Reverse osmosis plants, Desalination Plants –Flow charts – Layouts –Hydraulic Profile, PID - construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Recent Trends – Software application capacity building, CDM and carbon credit assessments.		**CO3**

UNIT – IV	**SLUDGE AND RESIDUAL MANAGEMENT**	**Periods : 9**
Design of sludge/ Residue management facilities – Water and Wastewater treatment systems, sludge thickening, sludge digestion, Mathematical Sludge Quantification – Recycle and reuse methods, biogas generation, sludge dewatering (mechanical and gravity) Layout PID hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.		**CO4**

UNIT – V	MINI PROJECT – CASE STUDIES		Periods : 9
Design, Drawing and detailing of Water/ Wastewater systems, Retrofitting Case studies, CDM and carbon credit assessments.			CO5
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Arceivala, S.J., Wastewater Treatment for Pollution Control, TMH, New Delhi, Second Edition, 2008.
2. Metcalf & Eddy, INC, 'Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata Mc Graw-HillPublishing Company Limited, New Delhi, 2003.
3. Qasim, S.R. Wastewater Treatment Plant, Planning, Design & Operation, Techonomic Publications, NewYork, 2004.
4. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi,2000.
5. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	-
CO2	3	3	3	2	-	-
CO3	3	3	2	2	-	-
CO4	3	3	2	1	1	-
CO5	2	2	2	3	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering**)						
Semester :**II**		Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE268	**ENVIRONMENTAL IMPACT ASSESSMENT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to prepare draft and detailed reports under EIA.
	CO2	Ability to compare and validate the impacts on real systems under air, water and soil.
	CO3	Understand the necessity to study the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.
	CO4	Prepare terms of reference for environmental impact and socio-economic impact for any developmental project.
	CO5	Describe the legal requirements of environmental and risk assessment for projects.

UNIT – I	**Introduction**	**Periods : 9**
Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Public Participation in EIA. EIA process- screening – scoping - setting – analysis – mitigation		**CO1**
UNIT – II	**Components and Methods for EIA**	**Periods : 9**
Matrices – Networks – Checklists – Connections and combinations of processes - 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 – Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation. EIA methods in other countries.		**CO2**
UNIT – III	**Socio-Economic Impact Assessment**	**Periods : 9**
Definition of social impact assessment. Social impact assessment model and the planning process. Rationale and measurement for SIA variables. Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition - neighborhood and community impacts. Selecting, testing and understanding significant social impacts. Mitigation and enhancement in social assessment. Environmental costing of projects.		**CO3**
UNIT – IV	**Environmental Management Plan**	**Periods : 9**
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.		**CO4**
UNIT – V	**Sectoral EIA**	**Periods : 9**
EIA related to the following sectors - Infrastructure –construction and housing- Highways - Mining – Industrial - Thermal Power - River valley and Hydroelectric – coastal projects- Nuclear Power.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996 2. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley Interscience, New Jersey, 2003. 3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 2009. 4. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996. 5. World Bank –Source book on EIA 6. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999. 7. John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	-	-
CO2	3	-	1	-	-	-
CO3	3	3	2	1	2	2
CO4	3	3	2	2	-	2
CO5	3	2	2	3	1	-

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester: **II**		Course Category Code: **PCC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CE269	**ENVIRONMENTAL PROCESSES MONITORING LABORATORY**	-	-	4	2	40	60	100
Prerequisite								

Course Outcomes		
	CO1	Identify the quality of water in order to fix its pollution status
	CO2	To design and analyse various treatability options for water and waste water
	CO3	To Monitor the status of quality of ambient air and noise
	CO4	Measure the quality of ambient air with respect to various particulate matters.
	CO5	To identify the remedial measures for controlling the air and noise pollution

List of Experiments:	
1. Coagulation and Flocculation 2. Batch studies and settling 3. Studies on Filtration – Characteristics of Filter media 4. Water Softening 5. Adsorption Studies / Kinetics 6. Langelier Saturation Index and Silt Density Index – For Membrane Filtration 7. Kinetics of suspended growth process (activated sludge process) – and Sludge Volume Index 8. Sludge Filterability Test 9. Anaerobic Reactor Systems / Kinetics (Demonstration) 10. Advanced Oxidation Process – (Photo Catalysis) 11. Disinfection in drinking water (Chlorination) 12. Ambient air sampling – Determination of PM10,PM2.5,SO2 and NO2 13. Noise monitoring – Determination of Equivalent Noise Level	**CO1 to CO5**

Lecture Periods: -	**Tutorial Periods:**	**Practical Periods: 60**	**Total Periods: 60**

Reference Books

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 Shundar Lin. " Handbook of Environmental Engineering Calculations", McGraw Hill, New York, 1999.
3. AEESP Environmental Processes Laboratory Manual, Association of Environmental Engineering and Science Professors Foundation, Washington, 2002
4. Aery N C, " Manual of Environmental Analysis",Ane Books Pvt.Ltd. New Delhi2014
5. CPCB, Guidelines for the measurement of Ambient Air Pollutants, Volume I, Central Pollution Control Board, Ministry of Environment and Forests, Government of India,2001.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	-
CO2	3	3	2	2	3	2
CO3	3	3	3	2	3	2
CO4	2	1	1	3	3	2
CO5	2	-	1	3	2	-

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme**: M.Tech. (Environmental Engineering)**						
Semester: **II**		Course Category Code: **PAC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CE270	**MINI PROJECT & SEMINAR**	-	-	4	2	40	60	100
Prerequisite								

Course Outcomes		
	CO1	Identify Environmental Engineering problems reviewing available literature
	CO2	Study different techniques to solve the Environmental related issues
	CO3	Work on the solutions given and present solution by using his/her technique applying engineering principles.

Description :	
In the mini project, student will be encouraged to visualize field condition and perform a field oriented design in the core area of the subject including analysis, design and validate it with real system. By this exercise student will get field exposure and capability in solving potential problems and issues.	**CO1**
	CO2
	CO3

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 60**	**Total Periods: 60**

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester: **III**		Course Category Code: **PAC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE271	**DISSERTATION PHASE-I**	-	-	20	10	250	250	500
Prerequisite								

Course Outcomes		
	CO1	Identify Environmental Engineering problems reviewing available literature
	CO2	Identify appropriate techniques to analyse environmental related issues.
	CO3	Apply engineering and management principles through efficient handling of project

Description:

The project work will start in semester III and the duration would be six months. Project phase –I include introduction including objectives, limitations of study, Literature Survey, background to the research, Problem statement and methodology of work, Theoretical contents associated with topic of research, Field Applications, case studies, Data collection from field/organizations or details of experimental work/analytical work. The evaluation of the dissertation will be as per the regulations.	**CO1** **CO2** **CO3**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 300**	**Total Periods: 300**

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme: **M.Tech.(Environmental Engineering)**						
Semester: **IV**		Course Category Code: **PAC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		CA	SE	TM
CE272	**DISSERTATION PHASE-II**	-	-	32	16	250	250	500
Prerequisite								

Course Outcomes		
	CO1	Able to solve Environmental related problems by applying appropriate techniques and tools
	CO2	Exhibit good communication skill to the engineering community and society
	CO3	Demonstrate professional ethics and work culture

Description :

It is the continuation of the Project Phase-I. It includes a detailed experimental work/ analytical work, results and discussion, conclusions and future research work. The project is to be submitted at the end of fourth semester. The evaluation of the dissertation will be as per the regulations. The findings or outcome of the dissertation work shall be published in standard journals/symposia etc. Publication may be completed before the viva-voce examination.	**CO1** **CO2** **CO3**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 480**	**Total Periods: 480**

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

PROGRAMME SPECIFIC ELECTIVES (PSE)

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ21	**INDUSTRIAL WASTEWATER MANAGEMENT AND REUSE**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Characterize the wastewater generated from a specific industry and understand the possible impacts on the environment.
	CO2	Identify the means and methods to reduce the quantity of generation of wastewater from an industrial premises by performing source reduction techniques and waste audit.
	CO3	Design appropriate treatment systems for the wastewater generated from the industries.
	CO4	Probe the possible recycling and reuse opportunities for the generated wastewater and residuals by employing suitable treatment units.
	CO5	Understand the feasibility and benefits of individual, common and joint treatment of industrial wastewater.

UNIT – I	**Introduction**	**Periods : 9**
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.		**CO1**
UNIT – II	**Industrial Pollution Prevention**	**Periods : 9**
Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy – Source reduction techniques – Pollution Prevention of Assessment - Material balance - Evaluation of Pollution prevention options –Cost benefit analysis – payback period - Waste minimization Circles		**CO2**
UNIT – III	**Industrial Wastewater Treatment**	**Periods : 9**
Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – carbon adsorption - Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal. - Treatability studies.		**CO3**
UNIT – IV	**Wastewater Reuse and Residual Management**	**Periods : 9**
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.		**CO4**
UNIT – V	**Case Studies**	**Periods : 9**
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Diaries - Textiles – Tanneries – Pulp and paper – Sugar and Distilleries - metal finishing – Oil Refining – Pharmaceuticals. Policies and legislations including challenges posed by various sectors of industries and legislation framework and regulation in India		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Eckenfelder, W.W., 'Industrial Water Pollution Control', Mc-Graw Hill, 2001.
2. Frank Woodard, 'Industrial waste treatment Handbook', Butterworth Heinemann, New Delhi, 2001.
3. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw-Hillcompanies, 2007.
4. Nelson Leonard Nemerow, "Industrial waste treatment – contemporary practice and vision for the future", Elsevier, Singapore, 2007
5. "Industrial wastewater management, treatment & disposal, Water Environment" Federation Alexandria Virginia, Third Edition, 2008.
6. World Bank Group, 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production'.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	-	-
CO2	3	3	3	3	1	2
CO3	3	3	3	3	2	1
CO4	3	3	2	3	3	-
CO5	3	2	3	2	1	2

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type**: TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ22	**CLEANER PRODUCTION AND ENVIRONMENTAL MANAGEMENT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to apply the acquired knowledge under the cleaner practices in industrial, production systems.
	CO2	Ability to apply the acquired knowledge in environmental management system.
	CO3	Ability to prepare environmental assessment and preparation of reports under cleaner production and environmental management.
	CO4	Ability to perform Life cycle analysis and costing
	CO5	Exposure to ISO 14001 and Environmental internal auditing.

UNIT – I	**Introduction**	**Periods : 9**
Sustainable Development – Indicators of Sustainability – Sustainability Strategies Barriers to Sustainability – Industrial activity and Environment – Industrialization and sustainable development – Industrial Ecology – clean development mechanism, Cleaner Production (CP) in Achieving Sustainability – Prevention versus Control of Industrial Pollution – Environmental Polices and Legislations – Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches.		**CO1**
UNIT – II	**Principles Cleaner Production**	**Periods : 9**
Definition – Importance – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Government and Institutions – Environmental Management Hierarchy – Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Internet Information & Other CP Resources.		**CO2**
UNIT – III	**Cleaner Production Project Development and Implementation**	**Periods : 9**
Overview of CP Assessment Steps and Skills, preparing for the Site, Visit, Site, Visit, Information Gathering, and Process Flow Diagram, Material Balance, CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Establishing a Program – Organizing a Program – Preparing a Program Plan – Measuring Progress – Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement, carbon credit, carbon sequestration, carbon trading.		**CO3**
UNIT – IV	**Life Cycle Assessment and Environmental Management Systems**	**Periods : 9**
Elements of LCA – Life Cycle Costing – Eco Labeling – Circular Economy – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit, Green building & green energy concepts and management		**CO4**

UNIT – V	Case Studies		Periods : 9
Industrial applications of CP, LCA, EMS and Environmental Audits, green energy and green process management.			CO5
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Modak, P. (1996). Waste Minimization: A guide to cleaner production and Enhanced profitability. Ahmedabad: center for Environmental Education.
2. Modak, P., C. Visvanathan and Mandar Parasnis (2005), Cleaner production Audit, Environmental systemsReviews. Bangkok: Asian Institute of Technology.
3. Paul L Bishop (2000) 'Pollution Prevention: Fundamentals and Practice', McGraw Hill International.
4. World Bank Group (2005) 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production',World Bank and UNEP, Washington D.C.

CO – PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	3	2	-
CO2	3	-	1	2	1	-
CO3	2	1	-	3	2	2
CO4	1	1	2	3	3	2
CO5	1	-	2	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ23	**ENVIRONMENTAL REACTION ENGINEERING**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Apply the ability gained through multi-disciplinary approach on to the implementable solutions involving environmental reaction and process engineering.
	CO2	Apply the acquired knowledge for solving environmental pollution problems involving reaction engineering transformations.
	CO3	Designing of various types of reactors
	CO4	Understanding the mass transfer between two phases of interaction
	CO5	Understanding the kinetics of biological process

UNIT – I	**Introduction**	**Periods : 9**
Reaction engineering principles with applications to environmental systems, general reaction mechanisms: Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation solidification and stabilization– Disinfection, Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Trends. Rate relationships: Concepts and applications to homogenous systems and heterogeneous systems with respective chemical and biological reactions.		**CO1**
UNIT – II	**Pollutants and Reactions in Environment**	**Periods : 9**
Reaction leading to generation of pollutants, impact of pollutants and their reactions on environment, ozone depletion, smog formation, acid rain, chemical reactions in major treatment technologies- gas – solid catalytic reactions, catalytic oxidation of VOCs, incineration, selective catalytic reduction. Gas – liquid reaction FCC (fluid catalytic cracking) off gas cleaning, wet- gas scrubbing, H2S removal and spent caustic oxidation.		**CO2**
UNIT – III	**Reactors Modelling and Design**	**Periods : 9**
Ideal systems modeling and design, reactor concepts, ideal reactors, reaction rate measurements, hybrid system modeling and design, sequencing batch reactor, reactors in series and reactors in recycle. Non-ideal system modeling and design, non-ideal reactor behavior, RTD analysis, PFDR model		**CO3**
UNIT – IV	**Mass Transfer and its Applications in Environmental Engineering**	**Periods : 9**
Principles of diffusion and mass transfer between phases, Gas absorption, humidification operations, leaching and extraction, drying of solids, fixed-bed separation, membrane separation process, fluid solid surface reactions, Gas liquid bulk phase reaction, adsorption.		**CO4**

UNIT – V	Biological Reaction Engineering	Periods : 9	
Biological kinetics, enzyme kinetics, Michaelis – Menden equation, bioreactors, Batch and continuous operation in bioreactors, Aerobic processes: Activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotatingdrums, oxidation ponds. b) Anaerobic processes: Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactor. bio concentration, bioaccumulation, biomagnification, bioassay, bio monitoring. Biotechnology in reduction of CO2 emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications. Vermitechnology, Methane production, Root zone treatment, Membrane technologies.			**CO5**
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Dunn I.J, Elmar Heinzle, John Ingham, Prenosil J.E, „Biological reaction engineering‟, Wiley inter science, 2005.
2. Weber, W.J and Di Giano, F.A., "Process Dynamics in Environmental systems", John Wiley sons Inc, 1996.
3. . Metcalf and Eddy, "wastewater engineering, treatment, disposal and Reuse", Inc. Third edition McGraw –hill 1991.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	2	1
CO2	3	2	-	1	2	1
CO3	3	3	2	-	2	2
CO4	2	3	1	-	2	-
CO5	3	2	2	2	1	1

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ24	**FUNDAMENTALS OF SUSTAINABLE DEVELOPMENT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to apply the gained knowledge in the design of sustainable management system.
	CO2	Ability to visualize the practical issues and the solving complex problems through sustainable principle and design.
	CO3	Understanding of greenhouse gas and sustainable development
	CO4	Ability to have idea on development of action plan for sustainable development
	CO5	Understand various issues and international summits and conventions.

UNIT – I	**Principles of Sustainable Development**	**Periods : 9**
History and emergence of the concept of Sustainable Development – Definitions – Environmental issues and crisis – Resource degradation – greenhouse gases – desertification – social insecurity – Industrialization – Globalization and Environment.		**CO1**
UNIT – II	**Indian Judiciary System and Sustainable Development**	**Periods : 9**
Judicial System in India – Induction of sustainability concepts through legal systems – concepts – principles – doctrines – case laws.		**CO2**
UNIT – III	**Sustainable Development and International Contribution**	**Periods : 9**
Components of sustainability – Complexity of growth and equity – International Summits – Conventions – Agreements – Transboundary issues – Action plan for implementing sustainable development – Moral obligations and Operational guidelines		**CO3**
UNIT – IV	**Socio-Economic Sustainable Development Systems**	**Periods : 9**
Socio-economic policies for sustainable development – Strategies for implementing Eco development programmes – Sustainable development through trade – Economic growth – Carrying Capacity – Public participation.		**CO4**
UNIT – V	**Agenda for Future Global Sustainable Development**	**Periods : 9**
Role of developed countries in the sustainable development of developing countries – Demographic dynamics and sustainability – Integrated approach for resource protection and management.		**CO5**

Lecture Periods : 45	Tutorial Periods : 0	Practical Periods : 0	Total Periods : 45

Reference Books
1. Kirkby, J., O' Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London, 1996.
2. Mackenthun, K.M., Basic Concepts in Environmental Management,LewisPublication,London, 1998.
3. Bowers, J.,Sustainability and Environmental Economics-an alternative text,Longman, London, 1997.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	2	2	2
CO2	3	3	-	-	2	-
CO3	2	2	1	-	2	1
CO4	2	-	2	-	2	3
CO5	2	-	-	2	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam type**: TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ25	**AIR POLLUTION CONTROL ENGINEERING**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes		
	CO1	Understand the atmospheric process and pollutant transport mechanism
	CO2	Apply modelling techniques and to determine the fate of air pollutant with respect to time and space
	CO3	Understanding new technologies for pollution control
	CO4	Prevent and control air pollution by suitable air pollution control measures
	CO5	Knowledge on indoor air quality maintenance and noise pollution.

UNIT – I	**INTRODUCTION**	**Periods : 9**
Sources and classification of Air Pollutants: Natural contaminants-aerosol – gases and vapour. Air quality standards – Meteorology and Air Pollution: Atmospheric stability and inversions-mixing height-plume rise estimation – effluent dispersion theories - Isokinetic sampling – Modelling.		**CO1**
UNIT – II	**CONTROL OF PARTICULATES**	**Periods : 9**
Objectives – Filters, gravitational, centrifugal – multiple type cyclones, prediction of collection efficiency, pressure drop, wet collectors, Electrostatic Precipitation theory-particle charging-particle collection –ESP design procedure.		**CO2**
UNIT – III	**GASEOUS POLLUTANT CONTROL**	**Periods : 9**
Absorption: principles, description of equipment-packed and plate columns, design and performance equations. Adsorption: principal adsorbents, equipment descriptions – PSA – adsorption cycle-solvent recovery system continuous rotary bed-fluidized bed, Design and performance equations. Condensation: contact condensers-shell and tube condensers, design and performance equation. Incineration: hydrocarbon incineration kinetics, equipment description, design and performance equations.		**CO3**
UNIT – IV	**CONTROL MEASURES FOR INDUSTRIAL APPLICATIONS**	**Periods : 9**
Control methods – Processes based control mechanisms – mineral products – asphaltic concrete, cement plants and glass manufacturing plants; Thermal power plants, Petroleum refining and storage plants, Fertilizers, Pharmaceuticals and wood processing industry. Field Study.		**CO4**
UNIT – V	**INDOOR AIR QUALITY MANAGEMENT**	**Periods : 9**
Noise Standards; measurement, control and preventive measures, indoor air quality measures and management.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. M.N. Rao et al, “Air Pollution” Tata McGraw Hill, 2005.
2. Noel de Nevers, Air Pollution Control Engineering, McGraw Hill, New York, 2009
3. Richard W. Boubel et al “Fundamentals of Air pollution”, Academic Press, New York, 2004.
4. Danielson, J.A. (ed.): Air Pollution Engineering manual, U.S. Environmental Protection Agency Report PB 225-132/OAS, Government Printing Office, Washington, DC, p. 149, 1998.
5. Butcher, S.S., and R.J. Charlson: An Introduction to Air chemistry, Academic Press, New York, p.184, 1972

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	-
CO2	3	3	2	2	3	2
CO3	3	3	3	2	3	2
CO4	2	1	1	3	3	2
CO5	2	-	1	3	2	-

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ26	**SOLID AND HAZARDOUS WASTE MANAGEMENT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to
	CO1 Explain the functional elements of municipal solid waste management system
	CO2 Evaluate the various processing technologies for MSW
	CO3 Analyze the various options for disposal of MSW
	CO4 Choose the treatment, storage, and disposal options for hazardous waste
	CO5 Suggest feasible remediation measures for the contaminated sites.

UNIT – I	**Municipal Solid Waste Management**	**Periods : 9**
Legal and Organizational foundation: Definition of solid waste – waste generation technological society – major legislation, monitoring responsibilities, sources and types of solid waste – sampling and characterization – Determination of composition of MSW – storage and handling of solid waste – Future changes in waste composition.		**CO1**
UNIT – II	**Collection and Transport of Solid Waste**	**Periods : 9**
Collection of Solid Waste: Type of waste collection systems, analysis of collection system – alternative techniques for collection system. Separation and Processing and Transformation of Solid Waste: unit operations for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, anaerobic methods for materials recovery and treatment – Energy recovery – Incinerators Transfer and Transport: Need for transfer operation, transport means and methods, transfer station types and design requirements. Landfills: Site selection, design and operation, drainage and leachate collection systems – control of leachate in landfills, designated waste landfill remediation – Integrated waste management facilities.		**CO2**
UNIT – III	**Hazardous Waste Management**	**Periods : 9**
Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e-waste - sources, collection, treatment and reuse management.		**CO3**
UNIT – IV	**Hazardous Waste Treatment and Design**	**Periods : 9**
Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration – Resource Recovery -AFR. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.		**CO4**
UNIT – V	**Laboratory Practice**	**Periods : 9**
Sampling and characterization of Solid Wastes; TCLP tests and leachate studies.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. George Techobanoglous et al, “Integrated Solid Waste Management”, McGraw-Hill Publication, 1993. 2. Charles A. Wentz; “Hazardous Waste Management”, McGraw Hill Publication, 1995. 3. Flintoff, Frank (1976). “Management of Solid wastes in Developing Countries”, WHO South – EastAsia Series, no.1. 4. Manual on Municipal Solid Waste Management. New Delhi: Central Public Health and Environmental Engineering Organization and Ministry of Urban Development, GOI. 5. Management of Municipal Solid waste: Delhi: CPCB.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	2	1
CO2	3	3	3	2	2	1
CO3	3	2	-	-	2	1
CO4	3	3	3	3	2	1
CO5	3	3	3	2	1	-

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme:**M.Tech. (Environmental Engineering)**						
Semester :**I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ27	**ATMOSPHERIC PROCESSES AND CLIMATE CHANGE**	3	0	0	3	40	60	100
Prerequisite								
Course Outcomes	At the end of the course, students will be able to							
	CO1	Ability to visualize the fundamental of atmosphere						
	CO2	Ability to prepare models related to atmosphere and climate change						
	CO3	To understand the different levels of atmosphere						
	CO4	To create atmospheric models in macro and micro scale						
	CO5	To understand the policies and legislations implemented for climate change						
UNIT – I	**Introduction**				**Periods : 9**			
Structure of atmosphere, composition, global cycles and lifetimes								**CO1**
UNIT – II	**Atmosphere chemistry**				**Periods : 9**			
Atmosphericchemistry: troposphere and stratospheric								**CO2**
UNIT – III	**Atmospheric Aerosols**				**Periods : 9**			
Atmospheric aerosols :properties,chemistry and processes								**CO3**
UNIT – IV	**Atmospheric models**				**Periods : 9**			
Meso andmacroscaleatmospheric and meteorological processes – Global circulation models – Radiationbalance –directandindirecteffectsofpollutants								**CO4**
UNIT – V	**Case Studies**				**Periods : 9**			
Climate change Implications – Policies and legislations in India and International protocols related climate change – case studies								**CO5**
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**			**Total Periods : 45**			

Reference Books

1. Seinfeld, J. H., and Pandis, S N., Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley, New York, 1998.
2. Almeida, G.A., Koepke, P., and Shettle, E.P., Atmospheric Aerosols: Global Climatoloty and Radiative Characteristics, A. Deepak Publishing, Virginia, 1981.
3. Charlson, R.J., and Heintzenberg, O.J. (Eds.), Aerosol Forcing of Climate, John Wiley and Sons, N.Y., 1995.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	-	1	-
CO2	3	-	1	-	-	-
CO3	3	-	2	-	2	1
CO4	3	-	2	1	-	-
CO5	3	-	1	2	1	-

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ28	**ECOLOGICAL ENGINEERING**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	To apply the acquired knowledge and skill on the ecological control of air, water and soil systems
	CO2	Ability to solve environmental problems and issues under ecological engineering.
	CO3	Ability to visualize the application of control principles on the ecological control of natural and manmade systems.
	CO4	Ability to perform energy flow and material cycle in ecosystem
	CO5	Ability to assess human modifications and their impacts on ecology

UNIT – I	**Introduction to Ecology and Ecological Engineering**	**Periods : 9**
Aim – scope and applications of Ecology, Ecological Engineering and Eco-technology and their relevance to human civilization – Development and evolution of ecosystems – Principles and concepts were pertaining to communities in ecosystem – Energy flow and material cycling in ecosystems – Productivity in ecosystems.		**CO1**
UNIT – II	**Systems Approach in Ecological Engineering**	**Periods : 9**
Classification of eco-technology – Principles and components of Systems and Modeling – Structural and functional interactions in environmental systems – Human modifications of environmental systems.		**CO2**
UNIT – III	**Ecological Engineering Processes**	**Periods : 9**
Self-organizing processes – Multiple seeded microcosms – Interface coupling in ecological systems. Concepts of energy – Adapting ecological engineering systems to potentially catastrophic events – Agro ecosystems – Determination of sustainable loading of ecosystems.		**CO3**
UNIT – IV	**Eco-technology for Waste Treatment**	**Periods : 9**
Principles and operation of soil infiltration systems – wetlands and ponds – source separation systems- aqua cultural systems – detritus based treatment for solid wastes – Applications of Ecological Engineering marine systems.		**CO4**
UNIT – V	**Case Studies**	**Periods : 9**
Case studies of integrated Ecological Engineering systems.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Mitsch, J.W & Jorgensen, S.E., Ecological Engineering – An Introduction to Ecotechnology, John Wiley &Sons, New York, 2009.
2. Smith, R.L. and Thomas M. Smith (2003), Elements of Ecology (5th ed.). San Francisco: Benjamin Cummings.
3. White, I.D, Mottershed, D.N and Harrison, S.L., Environmental Systems – An Introductory Text, Chapman Hall, London, 2004.
4.. Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and Practice, Lewis Publishers, New York, 2003.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	-
CO2	3	3	3	3	2	1
CO3	3	3	2	2	-	1
CO4	3	2	1	1	2	1
CO5	3	-	3	3	1	-

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Chemistry**			Programme: **M.Tech.** (**Environmental Engineering**)						
Semester: **II**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	**Course Name**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
CYZ01	**ENVIRONMENTAL POLLUTION MONITORING TECHNIQUES**		3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome	The course will enable the students to:								
	CO1	Get knowledge about basic analytical and electro analytical techniques							
	CO2	Understand the principles of spectroscopic techniques							
	CO3	Study the concepts of various chromatographic techniques							
	CO4	Understand the principles of analysis of water pollution							
	CO5	Familiarize the spectroscopic analysis of air and water pollutants							
UNIT-I	**Physico-Chemical Techniques**					**Periods: 9**			
Basic principles of Volumetric Analysis, Gravimetric analysis, Basic principles and instrumentation of pH measurement, Conductometry – Theory and methodology of conductometric titrations, Potentiometry – Theory and methodology of potentiometric titrations.									**CO1**
UNIT-II	**Spectroscopic Techniques**					**Periods: 9**			
Basic principles and Instrumentation of IR spectroscopy, UV-Visible spectroscopy, Atomic Absorption Spectroscopy, Flame Emission Spectroscopy, Fluorescent Spectroscopy, Nephlometry, Turbidimetry, Mass Spectrometry.									**CO2**
UNIT-III	**Chromatographic Techniques**					**Periods: 9**			
Paper Chromatography, Thin Layer Chromatography, Gas Chromatography, High Pressure Liquid Chromatography, GC-Mass Spectrometry.									**CO3**
UNIT-IV	**Pollution Monitoring-I**					**Periods: 9**			
Applications – Determination of Hardness by EDTA method, analysis of Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Analysis of Chloride, Nitrogen, Fluoride, Cyanide, Sulphate, Phosphate in water samples.									**CO4**
UNIT-V	**Pollution Monitoring-II**					**Periods: 9**			
Analysis of CO(x), NO(x), SO(x), Hydrocarbon, particulates in air. Atomic Absorption Spectroscopic method of determination of Arsenic, Chromium, Copper, Mercury. Spectrophotometric method of determination of Iron, Manganese.									**CO5**
Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**				**Total Periods: 45**			

Reference Books

1. C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineering and Science, 5th Ed, Tata Mc, Graw-Hill, 2003.
2. Anil Kumar De, Environmental Chemistry, 7th Ed, New Age International P Ltd, New Delhi, 2006
3. H.H, Willard, L.L Merit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 7th Ed. CBP Publishers and Distributors, New Delhi, 2004.
4. D. A. Skoog, D. M. West and T. A. Nieman, Principles of Instrumental Analysis, 5th Ed. Thomson Asion (P) Ltd. Singapore, 2004.

Web sites: NIL

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester :**II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ29	**ENVIRONMENTAL BIOTECHNOLOGY**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to visualize the practical application of biotechnological principles on the environmental pollution control engineering.
	CO2	Apply the gained knowledge on the design and implementation of biotechnological control systems.
	CO3	Understand the role of micro-organisms in degrading contaminants.
	CO4	Mass balancing of reactors and activated sludge processes application of biological processes to degrade contaminants.
	CO5	Application of biological processes to degrade contaminants.

UNIT – I	**Principles and Concepts**	**Periods : 9**
Principles and concepts of environmental biotechnology – usefulness to mankind.		**CO1**
UNIT – II	**Microbial Systems for Detoxification of Environmental Pollutants**	**Periods : 9**
Degradation of high concentrated toxic pollutants – non-halogenated – halogenated-petroleum hydrocarbons – metals. Mechanisms of detoxification – oxidation reactions, dehalogenation – biotransformation of metals. Microbial cell/ enzyme technology – adapted microorganisms – biological removal of nutrients – microalgae - biotechnology and applications in agriculture – role of extracellular polymers.		**CO2**
UNIT – III	**Microbial Technology for Waste Management**	**Periods : 9**
Biotechnological remedies for environmental damages – decontamination of ground water systems – subsurface environment – reclamation concepts – bioremediation. Production of proteins – bio fertilizers. Biodegradation of solid wastes – physical, chemical and microbiological factors of composting – health risk – pathogens – odour management – technologies of commercial importance advances in biogas technology – case study.		**CO3**
UNIT – IV	**Recombinant DNA Technology**	**Periods : 9**
Concept of rDNA technology – plasmid – cloning of DNA – mutation – construction of microbial strains.		**CO4**
UNIT – V	**Regulatory and Ethical Issues**	**Periods : 9**
Environmental effects and ethics of microbial technology – safety of genetically engineered organisms.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, LutgardeRaskin, Insitu Bioremediation (2nd Edition) Nayes Publication, U.S.A, 1991.
2. Old R.W., and Primrose, S.B., Principles of Gene Manipulation (3rd Edition) Blackwell Science Publication, Cambridge, 1985.
3. BWainwright, M, An Introduction to Environmental Biotechnology, 2009.
4. Martin, A.M., Biological Degradation of Wastes, Elsevier Appl. Science, New York, 2001.
5. Sayler, Gray S. Robert Fox and James W. Blackburn Environmental Biotechnology for Waste Treatment, Plenum Press, New York, 1991.
6. Chaudhury, G.R. 'Biological degradation and Bioremediation of toxic chemicals', Dioscorides Press, Oregon, 2004.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	1	2	-
CO2	2	3	2	-	2	1
CO3	3	-	2	1	-	-
CO4	3	2	1	1	2	1
CO5	2	2	2	-	1	-

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M.Tech.(Environmental Engineering**)						
Semester : **II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ30	**ENVIRONMENTAL POLICIES AND LEGISLATIONS**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to apply the environmental policies and legislative measures on the effective management of environmental problems.
	CO2	Ability to develop strategies for new environmental reforms and policies for effective environmental management.
	CO3	Describe the Indian Legal System and the fundamentals of Indian Constitution.
	CO4	Apply the provision for legal control of industrial pollution by legislations.
	CO5	Give critic comment on environmental legal framework.

UNIT – I	**Introduction**	**Periods : 9**
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)		**CO1**
UNIT – II	**Water (P&CP) Act, 1974**	**Periods : 9**
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.		**CO2**
UNIT – III	**Air (P&CP) Act, 1981**	**Periods : 9**
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.		**CO3**
UNIT – IV	**Environment (Protection) Act 1986**	**Periods : 9**
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 – Solid Waste Management Rule – E-waste and Biomedical waste , Rules , Regulations and Management.		**CO4**

UNIT – V	Other Topics		Periods : 9
Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation – Write petitions - Supreme Court Judgments in Landmark cases.			CO5
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. U.AD. Kesari, Administrative Law University Book Trade Delhi, 1998.
   Greger I. Megregor, "Environmental law and enforcement", Lewis Publishers, London. 2004

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	1	3	3
CO2	-	-	-	1	3	2
CO3	-	-	1	-	2	2
CO4	1	-	-	-	2	3
CO5	-	-	-	1	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ31	**REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL ENGINEERING**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	To apply the gained knowledge in the application of remote sensing and GIS application in environmental pollution control assessment and monitoring.
	CO2	Understandings of available satellite and their band ranges
	CO3	Understanding the important of Vector and raster data
	CO4	Ability to understand spectral reflectance on different objects
	CO5	Understanding of various open and commercial software's for analysis.

UNIT – I	**Remote Sensing**	**Periods : 9**
Definition – Components of Remote Sensing - Energy, Sensor, Interacting Body - Active and Passive Remote Sensing – Platforms – Aerial and Space Platforms - Balloons, Helicopters, Aircraft and Satellites- Synoptivity and Repetivity - Electro Magnetic Radiation (EMR) – EMR Spectrum – Visible, Infra-Red (IR), Near IR, Middle IR,Thermal IR and Microwave – Black Body Radiation – Planck's Law - Stefan- Boltzman law.		**CO1**
UNIT – II	**EMR Interaction with Atmosphere and Earth Materials**	**Periods : 9**
Atmosphere characteristics - Scattering of EMR - Raleigh, Mie, Non –Selective and Raman Scattering – EMRInteraction with water vapor and ozone – Atmosphere Windows – Significance of Atmospheric Windows – EMRinteraction with earth surface Materials – Radiance,Irradiance,Incident,Reflected, Absorbed and Transmitted Energy – Reflectance – Specular and Diffuse Reflection Surfaces – Spectral Signature – Spectral Signature curves – EMR interaction with water, soil, and Earth surface		**CO2**
UNIT – III	**Optical and Microwave Remote Sensing**	**Periods : 9**
Satellites – Classification – Based on Orbits – Sun Synchronous and Geo Synchronous – Based on Purpose – EarthResources Satellites, Communication Satellites, Weather Satellites, Spy Satellites, Satellite Sensors, Resolution –Spectral , Spatial Radiometric and Temporal Resolution – Description of Multi Spectral Scanning – Along and Across Track scanners – Description of Sensors in Landsat, SPOT, IRS series – Current Satellites – Radar – Speckle – Back Scattering – Side Looking Airborne Radar - Synthetic Aperture Radar – Radiometer – Geometrical characteristics		**CO3**
UNIT – IV	**Geographic Information System**	**Periods : 9**
GIS - Components of GIS – Hardware, Software and Organization Context – Data – Spatial and Non Spatial – Maps – Types of Maps – Projection – Types of Projection – Data Input – Digitizer, Scanner - Editing - Raster and Vector data structures - Comparison of Raster and Vector Date structure – Analysis using raster and Vector Data - Retrieval,Reclassification, Overlaying, Buffering – Data Output – Printers and Plotters.		**CO4**

UNIT – V	Miscellaneous Topics	Periods : 9	
Visual Interpretation of Satellite Images - Elements of Interpretation - Interpretation Keys Characteristics of Digital Satellite Image - Image enhancement - Filtering - Classification – Integration of GIS and Remote Sensing – Application Remote Sensing and GIS in Environmental Engineering –management and monitoring of land,air,water pollution, conservation of resources and coastal zone management.			**CO5**
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Lilliesand, T.M and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, 2004.
2. Chang, K.T., Introduction to Geographic Information Systems, Tata McGraw – Hill ,2006
3. Burrough, P.A and McDonnel, R.A., Principles of Geographic Information Systems, Oxford university press, 2009.
4. Lintz,J. and Simonet , Remote sensing of Environment, Addison Wesley Pub. Com., 2004.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	1	-
CO2	3	2	-	-	1	2
CO3	2	3	2	-	2	1
CO4	3	2	2	1	1	-
CO5	2	-	2	-	2	2

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester : **II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ32	**ENVIRONMENTAL GEOTECHNOLOGY**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to apply the geo environmental principles on the environmental pollution control engineering.
	CO2	Ability to apply the control techniques on the remediation of soil pollutant laden system.
	CO3	Understanding the pollution transport controlling techniques in contaminated soil
	CO4	Understanding the pollutant interaction between the soil particles.
	CO5	Management of municipal and hazardous waste landfill.

UNIT – I	**Soil- Pollutant Interaction**	**Periods : 9**
Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction- Physico-chemical behavior and modeling -failures of foundations due to pollutants.		**CO1**
UNIT – II	**Characterization, Stabilization and Disposal**	**Periods : 9**
Safe disposal of waste – site selection for landfills – characterization of land fill sites – waste characterization – stability of landfills – current practice of waste disposal- passive contaminant system - Hazardous waste control and storage system – mechanism of stabilization -solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation- detoxification – organic and inorganic stabilization		**CO2**
UNIT – III	**Transport of Contaminants**	**Periods : 9**
Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.		**CO3**
UNIT – IV	**Detection and Testing Methods**	**Periods : 9**
Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes.		**CO4**
UNIT – V	**Remediation of Contaminated Soils**	**Periods : 9**
Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
2. Daniel, B.E., Geotechnical practice for waste disposal, Chapman and Hall, London, 1993.
3. Lagrega, M.d., Bukingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.
4. Mitchell, J. K and Soga, K Fundamentals of Soil Behaviour, John Wiley and Sons Inc., 2005.
5. Rowe, R. K, Geotechnical and Geo environmental Engineering Handbook, Kluwer Academic Publishers,2001.
6. Fang, H.Y. Introduction to environmental Geotechnology, CRC press New York, 1997.
7. Reddi, L. N. and Inyang, H. F, Geo environmental Engineering - Principles and Applications, Marcel Dekker Inc, 2000.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	-	1	-
CO2	3	3	3	3	2	1
CO3	2	3	2	2	-	1
CO4	3	2	1	1	1	1
CO5	2	-	2	3	2	2

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester :**II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ33	**ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	Ability to solve environmental risk assessment in process and chemical industries and allied environmental problems by applying environmental risk principles and meditative measures.
	CO2	Ability to have pathway for the risk assessment analysis
	CO3	Ability to characterization of risk their consequences.
	CO4	Ability to perform Ecological Assessment
	CO5	Exposure to case studies of major disasters and management of hazardous chemical storage.

UNIT – I	**Introduction**	**Periods : 9**
Sources of Environmental hazards – Environmental and ecological risks – Environmental risk assessment framework – Regulatory perspectives and requirements – Risk Analysis and Management and historical perspective; Social benefit Vs technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines.		**CO1**
UNIT – II	**Elements of Environmental Risk Assessment**	**Periods : 9**
Hazard identification and accounting – Fate and behavior of toxics and persistent substances in the environment – Properties, processes and parameters that control fate and transport of contaminants – Receptor exposure to Environmental Contaminants – Dose Response Evaluation – Exposure Assessment – Exposure Factors, Slope Factors, Dose Response calculations and Dose Conversion Factors – Risk Characterization and consequence determination – Vulnerability assessment – Uncertainty analysis.		**CO2**
UNIT – III	**Tools and Methods for Risk Assessment**	**Periods : 9**
HAZOP and FEMA methods – Cause failure analysis – Event tree and fault tree modeling and analysis – Multimedia and multipath way exposure modeling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products – Estimation of carcinogenic and non-carcinogenic risks to human health – Methods in Ecological risk assessment – Probabilistic risk assessments – radiation risk assessment – Data sources and evaluation		**CO3**
UNIT – IV	**Risk Management**	**Periods : 9**
Risk communication and Risk Perception – comparative risks – Risk based decision making – Risk based environmental standard setting – Risk Cost Benefit optimization and trade offs – Emergency Preparedness Plans – Emergency planning for chemical agent release – Design of risk management programs – risk based remediation; Risk communication, adaptive management, precaution and stake holder involvement.		**CO4**
UNIT – V	**Applications**	**Periods : 9**
Case studies on risk assessment and management for hazardous chemical storage – Chemical industries – Tanneries – Textile industries – Mineral processing and Petrochemical plants – Hazardous waste disposal facilities – nuclear power plants – contaminated site remediation – Case histories on Bhopal, Chernobyl, Seveso and Three Mile Island.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996 2. Wentz, Charles A (1989), Hazardous Waste Management, McGraw Hill, New York. 3. Weston, Joe (1997), Environmental planning and impact assessment in practice. Reading, Mass.: Addison Wesley Longman. 4. Government of India (1994), Handbook of Environmental procedures and guidelines. New Delhi: MoEF. 5. Cutter, S.L. Environmental Risks and Hazards, Prentice – Hall of India Pvt. Ltd., New Delhi, 1999.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	1	3	3
CO2	3	2	2	1	3	2
CO3	3	-	1	-	2	2
CO4	2	2	-	-	2	3
CO5	2	-	-	1	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester :**II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ34	**AIR AND WATER QUALITY MODELLING**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to
	CO1 Understand the meteorology and its relationship with transport of air pollutants.
	CO2 Develop or formulate governing equation for atmospheric pollutant transport processes.
	CO3 Apply air quality models such as ISC-3,CALINE for point source and line source air pollutants dispersion and simulate its concentration.
	CO4 Understand the meteorology and its relationship with transport of water pollutants.
	CO5 Understanding factor's governing pollutant transport process in river and groundwater.

UNIT – I	**Modelling/Concept**	**Periods : 9**
Water and air quality management – Role of mathematical models; systems approach – systems and models – kinds of mathematical models – model development and validation effluent and stream standards; ambient air quality standards.		**CO1**
UNIT – II	**Surface Water Quality Modelling**	**Periods : 9**
Historical development of water quality models; rivers and streams water quality modeling – river hydrology and flow – low flow analysis – dispersion and mixing – flow, depth and velocity –estuaries – estuarine transport, net estuarine flow, estuary dispersion coefficient; Lakes and impoundments – Water quality response to inputs; water quality modeling process – model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens; Streeter – Phelps models.		**CO2**
UNIT – III	**Air Quality Modelling**	**Periods : 9**
Transport and dispersion of air pollutants – wind velocity, wind speed and turbulence; estimating concentrations from point sources – the Gaussian Equation – determination of dispersion parameters, atmospheric stability; dispersion instrumentation – Atmospheric traces; concentration variation with averaging time; Air pollution modeling and prediction – Plume rise modeling techniques, modeling for non-reactive pollutants, single source – short term impact, multiple sources and area sources, model performance and utilization, computer models.		**CO3**
UNIT – IV	**Groundwater Quality Modelling**	**Periods : 9**
Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modeling		**CO4**
UNIT – V	**Computer Models**	**Periods : 9**
Exposure to computer models for surface water quality, groundwater quality and air quality.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. Steven C. Chapra, Surface Water Quality Modeling, The McGraw-Hill Companies, Inc., New York, 1997. 2. Arthur C.Stern Air Pollution (3rd Ed.) Volume I – Air Pollutants, their transformation and Transport, 2006. 3. R.W.Boubel, D.L. Fox, D.B. Turner & A.C. Stern, Fundamentals of Air Pollution Academic Press, New York, 1994. 4. Ralph A. Wurbs, Water Management Models – A Guide to Software, Prentice Hall. PTR, New Jersey,1995. 5. Richard W. Boubel, Donald L. Fox, D. Bruce Turner & Arthur C. Stern, "Fundamentals of Air Pollution, Hardcover", 2007. 6. Deaton and Wine brake, "Dynamic Modeling of Environmental Systems", Wiley & sons, 2002.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	-
CO2	3	3	3	3	2	1
CO3	3	3	2	2	-	1
CO4	3	2	1	1	2	1
CO5	3	-	3	3	1	-

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester :**II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ35	**ENVIRONMENTAL, HEALTH AND SAFETY IN INDUSTRIES**	3	0	0	3	40	60	100
Prerequisite								

Course Outcome	At the end of the course, students will be able to	
	CO1	Ability to apply and monitor the safety measures in industries under health andenvironmental protection perspectives.
	CO2	Ability to visualize and forecast the damages under safety measures under worst industrial pollution scenarios.
	CO3	Comply with work place safety acts and rules and establish safety systems for any industry.
	CO4	Identify potential hazards and prepare a risk assessment report for highly polluting industries.
	CO5	Understand safety practices and environmental issues in construction.

UNIT – I	**Introduction**	**Periods : 9**
Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place.		**CO1**
UNIT – II	**Occupational Health and Hygiene**	**Periods : 9**
Definition of the term occupational health and hygiene. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress.		**CO2**
UNIT – III	**Workplace Safety and Safety Systems**	**Periods : 9**
Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.		**CO3**
UNIT – IV	**Techniques of Environmental Safety**	**Periods : 9**
Elements of a health and safety policy and methods of its effective implementation and review. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents- Principles of quality management systems in health and safety management. Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organization for health and safety. Industry specific EHS issues.		**CO4**

UNIT – V	Education and Training	Periods : 9	
Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.			CO5
Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia,
2. William Andrew Inc. NY, 1995.
3. Diberardinis, L.J., "Handbook of Occupational Safety and Health", John Wiley, New York, 1998.
4. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
5. Peterson, R.D., and Cohen, J.M., "The Complete Guide to OSHA Compliance", Lewis Publishers, New York, 1997.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	-	2
CO2	3	2	1	-	2	2
CO3	3	1	-	3	2	2
CO4	2	1	2	3	2	1
CO5	3	-	-	3	3	-

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme:**M.Tech. (Environmental Engineering)**						
Semester :**III**		Course Category Code: **PSE**			Semester Exam type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ36	**PROJECT FORMULATION AND APPRAISAL**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	On completion of this course the students will be able to know the formulations of projects, projects costing, appraisal and financing.
	CO2	Ability to assign different management strategies for effective control
	CO3	Ability to perform cash flow analysis in an organization
	CO4	Ability to write and structuration of DPR
	CO5	Ability to understand the process and characterization of project appraisal

UNIT – I	**Project Formulation**	**Periods : 9**
Project – Concepts – Capital investments - Generation and Screening of Project Ideas - Project identification – Preliminary Analysis, Market, Technical, Financial, Economic and Ecological - Pre-Feasibility Report and its Clearance, Project Estimates and Techno-Economic Feasibility Report, Detailed Project Report – Different Project Clearances required.		**CO1**
UNIT – II	**Project Costing**	**Periods : 9**
Project Cash Flows – Time Value of Money – Cost of Capital.		**CO2**
UNIT – III	**Project Appraisal**	**Periods : 9**
NPV – BCR – IRR – ARR – Urgency – Pay Back Period – Assessment of Various Methods – Indian Practice of Investment Appraisal – International Practice of Appraisal – Analysis of Risk – Different Methods – Selection of a Project and Risk Analysis in Practice – Applications to environmental engineering project management.		**CO3**
UNIT – IV	**Project Financing**	**Periods : 9**
Project Financing – Means of Finance – Financial Institutions – Special Schemes – Key Financial Indicators – Ratios.		**CO4**
UNIT – V	**Private Sector Participation**	**Periods : 9**
Private sector participation in Infrastructure Development Projects – Environmental pollution control systems BOT, BOLT, BOOT - Technology Transfer and Foreign Collaboration - Scope of Technology Transfer – Emerging environmental management techniques and strategies.		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. Barcus, S.W. and Wilkinson.J.W., Hand Book of Management Consulting Services, McGraw Hill, New York, 1986. 2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation Review, McGraw Hill Publishing Company Ltd., New Delhi. 2006. 3. Baum, W.C., The Project Cycle, pamphlet issued by the World Bank, Washington, D.C., 20433, 1982. 4. Manual on project formulation and appraisal in water supply and sanitation, Prepared by Centre for Environmental Studies, College of Engineering, Guindy, Madras, 1984.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	2	3
CO2	1	2	-	3	3	2
CO3	2	2	-	3	2	3
CO4	2	-	1	3	3	2
CO5	1	-	-	2	3	2

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme:**M.Tech. (Environmental Engineering)**						
Semester :**III**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ37	**ENERGY AND ENVIRONMENTAL MANAGEMENT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	An ability to identify and quantify the impacts due to various projects on environment and plan, mitigation measures; to safeguard the environment.
	CO2	An ability to quantify the energy utilization under various applied environmental management system.
	CO3	Understandability of Industrial policies and statement
	CO4	Understand various types of Energy storage technologies
	CO5	Knowledge on legal aspects in environmental management

UNIT – I	**Energy Systems**	**Periods : 9**
Energy sources; coal oil, natural gas; nuclear energy; hydroelectricity, other fossil fuels; geothermal; supply and demand; depletion of resources; need for conservation; uncertainties; national and international issues.		**CO1**
UNIT – II	**Energy Requirements and Utilization**	**Periods : 9**
Forecasting techniques; energy demand; magnitude and pattern; input and output analysis; energy modeling and optimal mix of energy sources. Energy; various forms; energy storage; structural properties of environment; Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution; growth and change; patterns of consumption in developing and advances countries; commercial generation of power requirements and benefit.		**CO2**
UNIT – III	**Power and Production System**	**Periods : 9**
Bio-geo-chemical cycles; society and environment population and technology. Energy and evolution; growth and change; patterns of consumption in developing and advances countries; commercial generation of power requirements and benefit		**CO3**
UNIT – IV	**Environmental Management**	**Periods : 9**
Environmental Management – Global and national Environmental issues – Environmental strategies for developing environmental awareness and protection – Sustainable Development – Stakeholders Concept – Environmental resources and Environmental Conflict.		**CO4**
UNIT – V	**Legal aspects in Environmental Management**	**Periods : 9**
Legal aspects – Stockholm Conference – The Earth Summit: The Rio Declaration and Agreements - National and International standards for environmental quality. MINAS, BIS – Rational for Environmental Legislation – Industrial policy statement of the Government of India - Legal and Regulatory aspects in India - Environmental audit		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books
1. Gramlay, G. M., Energy, Macmillan Publishing Co., New York, 1975.
2. Rused, C. K., Elements of Energy Conservation, McGraw-Hill Book Co., 1985.
3. Krentz, J. H., Energy Conservation and Utilisation, Allyn and Bacur Inc., 1976.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	-	2	3
CO2	1	-	3	2	2	2
CO3	-	1	-	1	2	2
CO4	1	1	3	3	-	-
CO5	-	-	3	2	2	3

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester :**III**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ38	**GROUNDWATER FLOW AND CONTAMINANT TRANSPORT**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to
	CO1 To know about the contaminant sources and its types
	CO2 To differentiate the type of flow of contaminant
	CO3 To understand the interaction between soil and pollutant
	CO4 To create models based on the transport mechanisms
	CO5 To understand the remediation methods for different type of contamination

UNIT – I	**Introduction**	**Periods : 9**
Water movement in the subsurface; Groundwater and the hydrologic cycle; The groundwater environment; Types of aquifers; Sources of contamination		**CO1**
UNIT – II	**Flow Anlysis**	**Periods : 9**
Saturated flow: continuity equation; Darcy's Law; Equation of flow; Analytical solutions and numerical modeling; Unsaturated flow; Ground water sampling methods and analyses.		**CO2**
UNIT – III	**Contaminant Transport**	**Periods : 9**
Transport of contaminants; Transport equation; Dispersion and diffusion in porous media; Reaction terms; Analytical solutions		**CO3**
UNIT – IV	**Soil Pollutant Chemistry**	**Periods : 9**
Soil chemistry; Groundwater quality; Common soil minerals and components; Forces at soil-water interfaces; Adsorption and surface complexation models; Interaction of non-polar compounds with soils; Soilchemical kinetics		**CO4**
UNIT – V	**Modelling**	**Periods : 9**
Modelling Groundwater Pollution; Coupling of contaminant-soil interactions with transport; Reaction and transport of trace metals, ligands and non polar organic solutes		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Todd, D.K., Groundwater Geology, 2nd Ed., John Wiley, NY, 2001
2. Domenico, P.A., and Schwartz, F.W., Physical and Chemical Hydrogeology, JohnWiley and Sons, New York, 1990.
3. Grathwohl, P., Diffusion in Natural Porous Media: Contaminant Transport, Sorption desorption and Dissolution Kinetics, Kluwer Academic, Boston, 1998
4. Appelo, C.A.J., and Postma, D., Geochemistry, Groundwater and Pollution, A.A.Balkema Publishers, Rotterdam, 1993.
5. Freeze, R.A., and Cherry, J.A., Groundwater, Prentice Hall, Englewood Cliffs, NewJersey, 1979

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	-
CO2	3	3	2	2	3	2
CO3	3	3	3	2	3	2
CO4	2	1	1	3	3	2
CO5	2	-	1	3	2	-

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M.Tech. (Environmental Engineering)**						
Semester :**III**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ39	**AEROSOL SCIENCE AND TECHNOLOGY**	3	0	0	3	40	60	100
Prerequisite								

Course Outcomes	At the end of the course, students will be able to	
	CO1	To gain knowledge about the aerosol formation
	CO2	To understand the concept of aerosol dynamics and migration
	CO3	To know about the reactor designs for aerosol production
	CO4	To understand about the aerosol transport mechanicsms
	CO5	To understand the application of aerosols in industries

UNIT – I	**Aerosol Physics**	**Periods : 9**
Fundamental properties of particulate systems - physics of aerosols, size distributions,		**CO1**
UNIT – II	**Aerosol Mechanics**	**Periods : 9**
Mechanics and transport of particles: diffusion, inertia, external force fields. Visibility and light scattering		**CO2**
UNIT – III	**Aerosol Dynamics**	**Periods : 9**
Particle formation ,coagulation, nucleation, condensation – Applications to sampling		**CO3**
UNIT – IV	**Environmental Applications**	**Periods : 9**
Particle formation and growth dynamics, aerosol reactor design engineering, and applications to environmental aerosols		**CO4**
UNIT – V	**Applications to Engineered Systems**	**Periods : 9**
Nanoparticle synthesis, atmospheric aerosols, combustion aerosols, pharmaceutical aerosols		**CO5**

Lecture Periods : 45	**Tutorial Periods : 0**	**Practical Periods : 0**	**Total Periods : 45**

Reference Books

1. Friedlander, S K , Smoke Dust and Haze, Oxford University Press, New York, 2000
2. Hinds, W C., Aerosol Technology: Properties, Behavior and Measurement of Airborne Particles, Wiley-Interscience, New York., 1999
3. Seinfeld, J H and Pandis, S N., Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley, New York, 1998

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	3	2	-
CO2	3	-	1	2	1	-
CO3	2	1	-	3	2	2
CO4	1	1	2	3	3	2
CO5	1	-	2	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low