REGULATION 2015

M.TECH – ENVIRONMENTAL ENGINEERING

CURRICULUM AND SYLLABUS

SEMESTER – I

S.No	Code	Subject Name	L	T	P	C
1	MMA107	Statistics for Environmental Engineers	4	0	0	4
2	MER101	Environmental Chemistry	3	0	0	3
3	MER102	Environmental Microbiology	3	0	0	3
4	MER103	Air Pollution and Control	3	0	0	3
5	MER104	Water and Sewage Conveyance	3	0	0	3
6	MER1L1	Environmental Engineering Lab	0	0	4	2
		Total	16	0	4	18

SEMESTER – II

S.No	Code	Subject Name	L	T	P	C
1	MER201	Solid and Hazardous Waste Management	3	0	0	3
2	MER202	Physical and Chemical Treatment of Water and Wastewater	3	1	0	4
3	MER203	Biological Treatment of Wastewater	3	0	0	3
4	MER204	Environmental Impact Assessment	3	0	0	3
5	MER2E1	Elective – I	3	0	0	3
6	MER2E2	Elective – II	3	0	0	3
7	MER2L1	Unit Operations and Unit Processes Laboratory	0	0	4	2
		Total	18	1	4	21

SEMESTER – III

S.No	Code	Subject Name	L	T	P	C
1	MER3E3	Elective – III	3	0	0	3
2	MER3E4	Elective – IV	3	0	0	3
3	MER3E5	Elective – V	3	0	0	3
4	MER3P1	Project Work (Phase – I)	0	0	12	6
		Total	9	0	12	15

SEMESTER – IV

S.No	Code	Subject Name	L	T	P	C
1	MER4P1	Project Work (Phase – II)	0	0	24	12
		Total	0	0	24	12

Total Credits for the Programme – 66

LIST OF ELECTIVES

S.No.	Code	Subject Name	L	T	P	C
1	MER051	Environmental Quality Modeling	3	0	0	3
2	MER052	Instrumental Monitoring of Environment	3	0	0	3
3	MER053	Remote Sensing and GIS for Environmental Applications	3	0	0	3
4	MER054	Ecological Engineering	3	0	0	3
5	MER055	Ground Water Contamination and Transport Modelling	3	0	0	3
6	MER056	Environmental Bio Technology	3	0	0	3
7	MER057	Indoor Air Quality	3	0	0	3
8	MER058	Environmental Policies and Legislation	3	0	0	3
9	MER059	Environmental Engineering Structures	3	0	0	3
10	MER060	Mass Transfer In Air – Water Soil Interaction	3	0	0	3
11	MER061	Marine Pollution Monitoring	3	0	0	3
12	MER062	Industrial Wastewater Management	3	0	0	3
13		Research Methodology	3	0	0	3

MMA107 STATISTICS FOR ENVIRONMENTAL ENGINEERS

L	T	P	C
4	0	0	4

OBJECTIVE

To Train the students in the analysis of Environmental data using Statistical tools

COURSE OUTCOMES (COs)

CO1- To make them understand the measures of Central tendency and Dispersion for grouped and ungrouped Data.

CO2- To know the basics of estimation theory and Curve fitting by Principles of least squares and Regression lines.

CO3- To understand about Sampling distributions

CO4- To improve the knowledge on Design of Experiments and Analysis of variance

CO5- To know about the Statistical Policy Control and Statistical quality control

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2			S		M					W		
CO3	S	M		S								
CO4				S			W					
CO5	S	M										

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT I **9**

Empirical Statistics

Types of Sampling – Description of Discrete and continuous data – measures of Central tendency and Dispersion for grouped and ungrouped Data – Measures of position- Box and Whisker plot.

UNIT-II **9**

Estimation Theory

Unbiased estimators – Methods of movements – Maximum Likelihood estimation – Curve fitting by Principles of least squares – Regression lines.

UNIT-III **9**

Testing of Hypothesis

Sampling distributions – Type-I and Type-II errors – Tests based on normal, t, X^2 and F distributions for testing of mean, Arians and proportions-Test for independence of attributes and goodness of fit.

UNIT-IV **9**

Design of Experiments

Analysis of variance – one –way and two way classifications – completely randomized design-Randomized block design – Latin square designs.

UNIT-V **9**

Statistical Policy Control

Statistical quality control – Statistical process control – X and R or S, control chart – Attributes control chart – P-Chart and U-Chart – Control chart Performance.

Total Periods : 45

REFERENCES:

1.Montgomery, D.C and Runger .G.C..," Applied Statistics and probability for Engineers", Wiley Student Edition.2007.

2.Walpole,R.E.Myers, R.H,Mters,S.L.and ye.K."Probability and statistics for engineers and scientists " Pearson education, Asia ,8th edition,2007.

3.Mann.P.S."Introductory Statistics" John wiley and sons, Inc 5th edition,2004.

4.Johnson.R.A.and gupta,C.B." Miller and Freund's Probability and statistics for Engineers ," Pearson education,Asia,7th edition,2007.

MER101 **ENVIRONMENTAL CHEMISTRY**

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students in the area of water air and soil chemistry and train them in the laboratory in the determination of pollutants present in air,water, wastewater and soil.

COURSE OUTCOMES (COs)

CO1-To make them understand the fundamentals of chemistry, mainly green Chemistry and chromatographic principles.

CO2- To know the basics of degradation principles, mainly degradation of pesticides, food stuffs etc.

CO3- To understand about the basics of aquatic chemistry and redox reactions

CO4- To improve the knowledge on the fundamentals of atmospheric Chemistry and various regions of atmosphere

CO5- To know about the soil Chemistry,salt and ion exchange theory

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S			W					S			
CO2	S	S							M		W	
CO3		M		S								
CO4						M			S			
CO5		M		W							S	

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Fundamentals

Colloids – Redox Potentials – Partition Co-Efficient – Beer – Lambert's Law – Limitations UV Visible Spectroscopy – Basic Principle – Application – Atomic Absorption Spectroscopy – Principles- Applications Gas Chromatograph Principles And Applications – Principles Of Green Chemistry - Error Analysis of Environmental Data.

UNIT-II **9**

Degradation

Transport and Transformation Of Chemicals – DO, BOD And COD – Photo Catalysis – Degradation of Food Stuffs, Detergents, Pesticides And Hydrocarbons.

UNIT-III **9**

Aquatic Chemistry

Metals, Complex Formation, Oxidation And Reduction And Sorption – Eh – PH Diagrams-Chemical Speciation – QSAR – Risk Evaluation Of Chemicals.

UNIT-IV **9**

Atmospheric Chemistry

Regions Of Atmosphere- Chemical And Photochemical Reactions – Photochemical Smog , Ozone Layer Depletion – Green House Gases And Global Warming – Acid Rain.

UNIT-V **9**

Soil Chemistry

Soil Properties Clay Minerals – Acid – Base And Ion Exchange Reactions In Soil – Salt affected Soil And Its Remediation

Total Periods : 45

REFERENCES:

1.C.N. Sawyer, P.L. MacCarty and G.F. Parkin , Chemistry for Enviromental Engineering and Science , Tata MeGraw – Hill, fifth edition, New Delhi, 2003.
2.G.W. Vanloon and S.J. Duffy "Environmental Chemistry - a global perspective oxford university press, New York ,2000.
3.D.W. Connell, Basic concepts of Environmental Chemistry , Lewis publishers, New York, 1997.
4.Colin Baird ,"Environmental Chemistry" , Freeman and Company, New York, 1997.
5. S.E. Manathan, Environmental Chemistry , Sixth Edition, Lewis Publishers, New York, 1994.

MER 102 ENVIRONMENTAL MICROBIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students in microbiology and its applications in environmental engineering, and to train them in experiments related to microbiological examination of water.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of classification of micro organisms,its culturing modes.

CO2- To know the basics of microbiology of environment and the distribution of microorganisms on land,air,water.

CO3- To understand about the metabolism of micro organisms and various modes of respiration in detail.

CO4- To improve the knowledge on the Biodegradation of toxic pollutants and its mechanisms.

CO5- To know about the basics of the branch of toxicology and the term ecotoxicology

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S								S			
CO2	S			M						W		
CO3		S			W				S			
CO4		S							M			
CO5		M		W						W	S	

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Classification of microorganisms-prokaryotic, eukaryotic, structure, characteristics, nucleic acids-DNA, RNA, replication. Culturing of microorganisms, Recombinant DNA technology.

UNIT-II **9**

Microbiology of Environment

Distribution of microorganisms - Water ,air and Soil, indicator organisms ,Coli forms –Fecal coliforms, E. coli, Streptococcus, Clostridium, Significance in water Algae in water supplies – problems and control, Concentration and detection of Virus, Transmissible diseases.

UNIT-III **9**

Metabolism of Microorganisms

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism-aerobic and anaerobic-respiration, fermentation, glycolysis, Kreb’s cycle, hexose

monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.

UNIT-IV **9**

Role of Microorganisms in Wastewater Treatment

Microbiology of biological treatment processes-aerobic and anaerobic, Biodegradation of toxic pollutants-mechanisum-- α-oxidation, β-oxidation, nitrification and denitrification, eutrophication.

UNIT-V **9**

Toxicology

Ecotoxicology – Toxicants and toxicity, factors influencing toxicity, effects-acute, chronic, concentration response relationships, test organisms, toxicity testing, bioconcentration, bioaccumulation, biomagnifications, bioassay, biomonitoring**.**

Total Periods : 45

REFERENCES:

1.Maier, R.M., I.L. Pepper and C.P. Gerba, "Environmental Microbiology", Academic Press, New York, 1999.

2.Tortora G.J, B.R. Furke, and C.L. Case, "Microbiology-An Introduction" (4^{th} Ed.),.BENJAMIN /Cummings Pulb. Co.,Inc., California,1992.

3.Frank C.Lu and Sam Kacew, LU's Basic Toxicology,Taylor & Francis, London(4^{th} Ed), 2002.

4.Baker .K.H.and D.S.Herson .Bioremediation, McGraw – Hill Inc., Newyork, 1994 .

MER103 AIR POLLUTION AND CONTROL

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on various methods of control of particulate and gaseous air pollutants

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of air quality management classification of micro organisms,its culturing modes.

CO2- To understand about the methods of particulate control like gravitational and centrifugal filters

CO3-.To understand in detail about the phenomenon of adsorption and absorption thus explaining more on control of gaseous air contaminants.

CO4- To improve the knowledge on the emerging trends of air pollution control and discuss in detail about automobile air pollution.

CO5- To know about the basics of the standards of noise pollution and methods to prevent air pollution.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S					M					W	
CO2	S			M								
CO3								S				
CO4				S					W			
CO5		M		S					S			

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Air resource management system – Air quality management – Scales of air pollution problem – Sources and classification of pollutants and their effect on human health vegetation and property - Global implications of air pollution – Meteorology Fundamentals – Atmospheric stability – Micrometeorology – Atmospheric turbulence-mechanical and thermal turbulence – wind profiles – Atmospheric Diffusion – Atmospheric diffusion theories – Steady-state atmospheric diffusion equation – Plume rise – Diffusion models – Software applications – Ambient air quality and emission standards – Air pollutions indices – Indoor Air Pollutants – models – Air Quality Sampling and Monitoring.

UNIT-II **9**

Control of Particulate Contaminants

Settling chambers – Filters, gravitational, Centrifugal – multiple type cyclones, prediction of collection efficiency, pressure drop, wet collectors, Electrostatic Precipitation theory – ESP design – Operational Considerations – Process Control and Monitoring – Case Studies.

UNIT-III **9**

Control of Gaseous Contaminants

Absorption – principles – description of equipment-packed and plate columns – design and performance equations – Adsorption – principal adsorbents – Equipment descriptions – Design and performance equations – Condensation – design and performance equation – Incineration – Equipment description – design and performance equations – Biological Air Pollution Control Technologies – Bio-Scrubbers, Biofilters – Operational Considerations – Process Control and Monitoring-Case Studies.

UNIT-IV **9**

Emerging Trends

Process Modification – Automobile Air Pollution and its control – Fuel Modification – Mechanical Particulate Collectors – Entrainment Separation - Internal Combustion Engines – Membrane Process – Ultraviolet Photolysis – High efficiency Particulate Air Filters – Technical & Economic Feasibility of selected emerging technologies for Air pollution control – Control of Indoor Air Quality – Radio active pollution and its control.

UNIT-V **9**

Noise Control

Noise Standards – Measurement – Modeling – Control and preventive measures.

Total Periods : 45

REFERENCES:

1.Lawrence K.Wang, Norman C Perelra, Yung- Tse Hung, “Air Pollution Control Engineering”, Tokyo, 2004.
2.Noel de Nevers, Air Pollution Control Engg.,McGraw-Hill, New York, 1995.
3.David H.F Liu, Bela G.Liptak “Air Pollution”, Lewis Publishers, 2000.
4.Anjaneyulu.Y, “Air Pollution & Control Technologies”, Allied Publishers (P) Ltd, India, 2002.

MER104 WATER AND SEWAGE CONVEYANCE

L	T	P	C
3	0	0	3

OBJECTIVES

To educate the students in detailed concepts related to water transmission mains, water distribution system, sewer networks and storm water drain, with emphasis on computer application

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of hydraulic engineering and the various fluid flow phenomenon.

CO2- To understand about the methods of water transmission and distribution and the economics related to water transmission

CO3-.To understand in detail about the waste water collection and conveyance and also the maintenance of sewers and design of sewer outfalls

CO4- To improve the knowledge on the planning and estimation of storm water flow

CO5- To know about the basics of the Case Studies and Computer applications for water transmission.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S									W		
CO2	S	M		M		S					W	
CO3		M						S				
CO4	S					S			W			
CO5		M		S								

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Principles of Hydraulics

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, major and minor head loss, formula for estimation of head loss – pumping of fluids – selection of pumps – Flow measurement.

UNIT-II **9**

Water Transmission and Distribution

Planning factors – Water transmission main design – pipe material – economics – water hammer analysis; water distribution pipe networks - methods for analysis and optimization - Laying and maintenance, insitu lining – appurtenances – corrosion prevention – minimization of water losses – leak detection.

UNIT-III **9**

Wastewater Collection and Conveyance

Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.

UNIT-IV **9**

Storm Water Drainage

Planning – run-off estimation, rainfall data analysis, storm water drain design – rain water harvesting

UNIT-V **9**

Case Studies and Computer Applications

Computer applications for water transmission, water distribution and sewer design.

Total Periods : 45

REFERENCES:

1.G.S.Bajwa, Practical Handbook on Public Health Engineering, Deep Publishers, Shimla, 2003.
2."Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Gol, New Delhi, 1999.
3."Manual on sewerage and Sewage Treatment', CPHEEO, Ministry of Urban Development, Gol, New Delhi, 1993.
4.B.A. Hauser, Practical Hydraulics Handbook, Lewis Publishers, New York, 1991.

MER1L1 ENVIRONMENTAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE

To conduct laboratory studies on water and wastewater treatment units.

COURSE OUTCOMES:

- **CO1 -** To know about about the basic water sample analysis techniques used in water as well as waste water testing.
- **CO2 -** To know the principle of Air quality analysis to analyse major components of air like SO_2,NO_3 etc
- **CO3** – Having a deep knowledge about soil analysis techniques .
- **CO4** – With a true wisdom about serial dilution techniques and methods to prepare pure culture.
- **CO5 -** Having a sound knowledge in the bacteriological analysis of waste water.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S					S						M

CO2		S			M				S			
CO3		S				S					M	
CO4	S		M	W		S						
CO5		S			W				S			

Course Assessment Methods:

Direct		**Indirect**	
1	Observation Book	1	Course and Survey
2	Record Book	2	Faculty Survey
3	Model Examination	3	Industry
4	End Semester Examinations	4	Alumni

Environmental Chemistry Laboratory

1. **Physical and Chemical Analysis of Water** **12**
   Ph, Conductivity, Turbidity, Solids, Chlorides, Sulphates, Alkalinity, Fluorides, Nitrate and heavy metals.

2. **Physical and Chemical Analysis of Wastewater** **8**
   Phosphate, COD, BOD, Organic and ammonical nitrogen, Oil & grease.

3. **Air Quality Analysis** **6**
   SPM, SO_2, CO, NO_X

4. **Soil Analysis** **4**
   pH, Conductivity, Cation exchange capacity, Sodium Absorption ratio

30

Environmental Microbiology Laboratory

1. Preparation of media, serial dilution and plating, Growth curve 6
2. Sampling of Microorganisms from air, water and soil, staining-simple and gram staining. 6
3. Effect of pH, temperatures and nutrients on growth of bacteria 2
4. Bacteriological analysis of water – Coli forms and streptococcus fecalis by MPN and membrane filter techniques 10
5. Study of aquatic organisms – Algae, Protozoa and fungi 6

MER201 SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the principles involved in the management of municipal solid waste and hazardous wastes- from source identification up to disposal.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of solid and hazardous wastes and also the types, need and sources of solid and hazardous wastes.

CO2- To understand about the methods of waste characterisation and source reduction and to study the various methods of generation of wastes.

CO3-.To understand in detail about the storage, collection and transport of wastes. and also to study about the methods used for handling and segregation of wastes.

CO4- To improve the knowledge on the waste processing techniques which includes incineration, solidification and stabilization of hazardous wastes

CO5- To know about the basics of the waste disposal options and also a detailed study on the disposal in landfills and also to learn about landfill remediation.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				S				M			
CO2	S			M					S			
CO3			M			S						
CO4	S						S		W			
CO5		M			S				S			

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

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UNIT-I **9**

Introduction

Types and Sources of solid and hazardous wastes-Need for solid and hazardous waste management- Elements of integrated waste management and roles of stakeholders- Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, plastics and fly ash, financing waste management.

UNIT-II **9**

Waste Characterisation and Source Reduction

Waste generation rates and variation-Composition, physical, chemical and biological properties of solid wastes- Hazardous Characteristics- TCLP tests- waste sampling and characterization plan- source reduction of wastes- Recycling and reuse- waste exchange.

UNIT-III **9**

Storage, Collection and Transport of Wastes

Handling and segregation of wastes at source- storage and collection of municipal solid wastes- Analysis of collection systems- Need for transfer and transport- Transfer stations Optimizing Waste allocation- compactability, storage, labeling and handling of hazardous wastes- hazardous waste manifests and transport.

UNIT-IV **9**

Waste Processing Techniques

Objectives of waste processing- material separation and processing technologies- biological and chemical conversion technologies-method and controls of composting- thermal conversion technologies and energy recovery- incineration- solidification and stabilization of hazardous wastes- treatment of biomedical wastes.

UNIT-V **9**

Waste Disposal

Waste disposal options- Disposal in landfills- Landfill Classification, types and methods- site selection- design and operation of sanitary landfills, secure landfills and landfill bioreactors- leachate and landfill gas management- landfill closure and environmental monitoring- closure of landfills- landfill remediation.

Total Periods : 45

REFERENCES:

1.George Tchobanoglous, Hilary Theisen and Samuel A, Vigil “Integrated Solid Waste Management, McGraw- Hill International edition, New York, 1993.

2.CPHEEO “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.

3.Micheael D. Lagrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, McGraw- Hill International edition, New york, 2001.
4.Vesilind P.A., Worrell W and Reinhart, Solid Waste Engineering, Thomson Learning Inc., Singapore, 2002.

MER202 PHYSICAL AND CHEMICAL TREATMENT OF WATER AND WASTEWATER

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the student on the working principles and design of various physical and chemical treatment systems for water and wastewater.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of waste water treatment .To learn about the various Pollutants in water and waste water and also to study about their characteristics.

CO2- To understand about the methods of waste characterization , source reduction and to study the various methods of generation of wastes.

CO3-.To understand in detail about the various principles of chemical treatment which include precipitation coagulation etc.

CO4- To improve the knowledge on the Selection of unit operation and processes and to study the design oriented aspects of sand filters and other treatment processes.

CO5- To know about the basics of the design of industrial waste water treatment and reclamation processes.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M					W		
CO2				M			M		S			
CO3	S					S						
CO4							S		W			
CO5	S	M			S		M			W		

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Pollutant in water and wastewater – characteristics, standards for performance – significant and need for physic – chemical treatment.

UNIT-II **9**

Physical Treatment Priniciples

Principles of screening – mixing, equalizations –sedimentation – filtration –modeling – backwashing –evaporation-incineration- gas transfer-mass transfer coefficients. Adsorption-isotherms-principles, equilibrates and kinetics, reactors, regeneration, membrane separation, reverse osmosis, nano filtration ultra filtration and hyper filtration – electro dialysis, distillation – stripping and crystallization-recent advances.

UNIT-III **9**

Chemical Treatment Principles

Principles of chemical treatment – coagulation flocculation – precipitation –floatation, solidification and stabilization- disinfection .ion exchange, electrolytic methods -Solvent extraction –advanced oxidation / reduction –recent advances.

UNIT-IV **9**

Design of Conventional Treatment Plants

Selection of unit operation and processes – design of conventional water treatment plant units – aerators –chemical feeding –flocculation –clarifier – filters –rapid sand filter, slow sand filter, pressure filter-chlorinators. Displacement and gaseous type. layouts- flowcharts –hydraulic profile –O & M aspects- case studies , residue management – up gradation of existing plants – recent advances.

UNIT-V **9**

Design of Industrial Water Treatment and Reclamation

Selection of process –design of softeners – demineralisers –wastewater reclamation – reverse osmosis plants –residue management – O & M aspects –recent advances –case studies.

Total Periods : 45

REFERENCES:

1.Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse Tata McGraw-Hill, New Delhi, 2003.
2.Manual on water supply and Treatment CPHEEO, Ministry of Urban Development ,GOI, New Delhi,1999.
3.Lee ,CC and Shun dar Lin , Handbook of Environmental Engineering Calculations , Mc Graw-hill,Newyork , 1999.
4.Qasim,S.R motely, E.N., Zhu, G. water works Engineering – planning ,design and operation,PrenticeHall,New Delhi, 2002.
5.Casey, T.J.Unit treatment processes in water and wastewater Engineering, John Wiley and Sons, London1993.

MER203 BIOLOGICAL TREATMENT OF WASTEWATER

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on principles and design of various biological treatment units used for wastewater treatment.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of biological treatment and its significance aerobic and anaerobic waste water treatment along with its kinetic studies.

CO2- To understand about the methods of aerobic treatment of wastewater which includes the design of trickling filter, rotating biological contactor, activated slide process

.

CO3-.To understand in detail about the anaerobic treatment of wastewater which includes the design of attached and suspended growth, along with UASB.

CO4- To improve the knowledge on the sludge treatment and disposal and the recent advancements in this field.

CO5- To know about the operations, maintenance, management and case studies related to biological treatment of waste water.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M					W		
CO2		S		M					M			
CO3	S					S						
CO4							S		M			
CO5	S	M							M	W		S

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

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UNIT-I **9**

Introduction

Objectives of biological treatment – significant – aerobic and anaerobic treatment – kinetics of biological growth-Factor affecting growth – attached and suspended growth-Determination of kinetics coefficient for organics removal – biodegradability assessment-selection of process.

UNIT-II **9**

Aerobic Treatment of Wastewater

Design of sewage treatment plant units – screen chamber, grit chamber with proportional flow weir, sedimentation tank- Trickling filter, Rotating Biological contactor, activated slide process & variations, aerated lagoons waste stabilization ponds –nutrients removal systems- natural treatment systems –disinfected disposal option- reclamation and reuse –flow charts, layouts hydraulic profile-recent advances.

UNIT-III **9**

Anaerobic Treatment of Wastewater

Attached and suspended growth, design of units – UASB, up flow filters fluidized beds-septic tanks and disposal –nutrient removal systems –layouts and hydraulic profile-recent advances.

UNIT-IV **9**

Sludge Treatment and Disposal

Design of sludge management facilities, slude thickening, sludge digestion, biogas generation, sludge dewatering (mechanical and gravity)- upgrading existing plants-ultimate residue disposal- recent advances.

UNIT-V **9**

Operations,Maintenance, Management and Case Studies

Operational problems-trouble shooting, planning, organizing and controlling of plants operations- capacity building, case studies on sewage treatment plants- sludge management facilities.

Total Periods : 45

REFERENCES:

1.Arecivala, S.J., Wastewater treatment for pollution control, TMH, New Delhi 1998.

2.Manual on “Sewerage and sewage treatment” CPHEEO, ministry of Urban development, Gol, New Delhi 1999.
3.Metcalf & Eddy, INC , “wastewater Engineering treatment and Reuse. Third edition Tata McGraw-hill publishing company limited, New Delhi, 2003.
4.Qasim S.R. Wastewater Treatment Plant, Planning, Design & Operation Technomic Publications, Newyork,1994.

MER204 ENVIRONMENTAL IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the scope, steps involved and various methods related to assessment of environmental impact due to development projects.

COURSE OUTCOMES (COs)

CO1- To make them understand the basics of EIA and its limitations across sectoral issues and terms of references in EIA. It also includes the study of participation of Public and Non-Governmental Organizations in environmental decision making.

CO2- To understand about the methods and components of EIA and to learn about the expert systems.

CO3-To understand in detail about the prediction tools for EIA along with the mathematical modeling for impact prediction.

CO4- To improve the knowledge on the ethical and quality aspects of Environmental Impact Assessment.

CO5- To know in detail about the Case studies of EIA related to the various sectors in a country like infrastructure, sources of energy etc.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M					W		
CO2		S		M					M			
CO3	S			S		M						
CO4							S		M			
CO5	S							M	S			

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni

5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Environment Impact Assessment (EIA) - Environmental Impact statement – EIA in Project Cycle – Legal and Regulatory aspects in India according to Ministry of Environment and Forests – Types and Limitations of EIA- cross sectoral issues and terms of references in EIA- participation of Public and Non-Governmental Organizations in environmental decision making.

UNIT-II **9**

Components and Methods

Components of EIA – Processes – screening – scoping – setting – analysis - mitigation. Matrices-Networks –Checklists – connections and combinations of processes – Cost benefit analysis - Analysis of alternatives - Software packages for EIA-Expert systems in EIA.

UNIT-III **9**

Prediction, Assessment of Impacts and Reporting

Prediction tools for EIA-Mathematical modeling for impact prediction-Assessment of impacts-air-water-soil-noise-biological-socio-cultural environments-Cumulative Impact Assessment-Documentation of EIA findings-planning-organization of information and visual display materials-Report preparation.

UNIT-IV **9**

Environmental Management Plan

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.

UNIT-V **9**

Case Studies

Case studies related to the following sectors-Infrastructure-Mining-industrial-Thermal Power – River valley and Hydroelectric-Nuclear Power.

Total Periods : 45

REFERENCES:

1.Lawrence, D.P., Environmental Impact Assesment - Practical solutions to recurrent problems, Wiley- Interscience, New Jersey, 2003.

2.Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London,1999.

3.Canter, L.W., Environmental Impact Assessment , McGraw- Hill, New York,1996.

4.Biswas, A.K. and Agarwala, S.B.C. Environmental Impact Assessment for Developing Countries, Butterworth Heinemann, London,1994.

5. The World Bank Group, Environmental Assessment Source Book Vol. I, II and III. The World Bank, Washington,1991.

MER2L1 UNIT OPERATIONS AND UNIT PROCESSES LABORATORY

L	T	P	C
0	0	4	2

(Prerequisite: Physical and Chemical treatment of water and wastewater, and biological treatment of wastewater)

OBJECTIVE

To conduct laboratory studies on water and wastewater treatment units.

COURSE OUTCOMES:

CO1 - To Know about coagulation and sedimentation tanks and factors affecting sedimentation process

CO2 - To Know the principle of Laser and its application in Engineering and medicine.

CO3 – Having a deep knowledge about the filtration processes and filter media.

CO4 – With a true wisdom about hardness removal methods in water and adsorption kinetics studies in waste water.

CO5 - Having a sound knowledge in the biological treatment process and disinfection process methods.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S								S			W
CO2		S			M	W						
CO3		S										W
CO4		S	M	W		S			S			
CO5		S			W							

Course Assessment Methods:

Direct		Indirect	
1	Observation Book	1	Course and Survey
2	Record Book	2	Faculty Survey
3	Model Examination	3	Industry
4	End Semester Examinations	4	Alumni

LIST OF EXPERIMENTS

1. Coagulation and Flocculation.
2. Batch Studies for Sedimentation.
3. Characteristics of Filter media.

4. Studies on Filtration.
5. Water softening.
6. Adsorption studies/ Kinetics.
7. Silt Density Index.
8. Reverse Osmosis.
9. Kinetics of suspended growth process (activated sludge process).
10. Kinetics of attached growth process (Rotating Biological Contractors).
11. Sludge volume Index.
12. Anaerobic Reactor Systems/ Kinetics.
13. Advanced Oxidation Processes.
14. Chlorine Demand Estimation. Total periods-60

REFERENCES:

1.Metcalf & Eddy, Inc. 'Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, Tata McGraw- Hill Publishing Company Limited, New Delhi 2003.
2.Lee, CC & Shun dar Lin, Hand book of Environmental Engineering Calculations, Mc Graw Hill, New York,1999.
3.Casey T.J. Unit treatment processes in water and wastewater engineering, John Willeys Sons, London, 1993.

ELECTIVES

MER051 ENVIRONMENTAL QUALITY MODELLING

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the basic principles,development and application of air and water quality models with computer applications.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of mathematical Modeling and explain how modeling can be used as as a tool in assessing environmental quality.

CO2- To understand about the methods of application of these models in simulation, parameter estimation and experimental design.

CO3-.To understand in detail about the water quality modeling process ,dissolved oxygen models and models on Groundwater.

CO4- To improve the knowledge on the emerging trends of air pollution modeling and prediction,performance and its utilization.

CO5- To know about the various case studies on air quality modeling and water quality modeling and other software package applications.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S									W		
CO2		M		S		S						
CO3	S		S			M			S			
CO4				M					S			
CO5	S	M			S							

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Basics of mathematical Modeling- Modeling as a tool. Procedures of model development. Importance of model building. Characteristics of deterministic models. Classical approach to constrained and unconstrained optimization. State of the art in environmental engineering systems models-climate and system modeling-Erosion and sediment transport.

UNIT-II **9**

Computer Based Solutions

Formulation of linear optimization models. Linear programming. Sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models-simulation, parameter estimation and experimental design.

UNIT-III **9**

Water Quality Modelling

Rivers and streams water quality modeling-river hydrology and flow-low flow analysis-dispersion and mixing-flow, depth; water quality modeling process-model sensitivity-assessing model performance; Models for dissolved oxygen, pathogens; Groundwater modeling.

UNIT-IV **9**

Air Quality Modelling

Air pollution modeling and prediction, modeling technique, modeling for non reactive pollutants, single source short term impact; multiple sources and area sources, model performance, accuracy and utilization.

UNIT-V **9**

Case Studies

Software package applications: Air quality modeling and water quality modeling.

Total Periods : 45

REFERENCES:

1. John Wainwright and Mark Mulligan, Environmental Modelling Finding Simplicity in Complexity, John Wiley and sons Ltd, USA, 2004

2. Dynamic Modeling of Environmental Systems by Deaton and Wine brake, Wiley & Sons, 2002.

3. Steven C. Chapra, Surface water quality modeling, McGraw-Hill Inc., New York, 1997.

4. Boubel R.W., Fox, D.L., Turner D.B.& Stern, A C. "Fundamentals of Air Pollution, Academic Press, New York,1994.

MER052 INSTRUMENTAL MONITORING OF ENVIRONMENT

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the various instruments used for analysis of air water and soil.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of various Instrumental methods in monitoring the environment.

CO2- To understand about the various Spectroscopic Methods of determining the precision and accuracy of the instrument**.**

CO3-.To understand in detail about the Chromatographic methods of separation and the classification of these methods in detail..

CO4- To improve the knowledge on the various Electro and Radio Analytical Methods of instrumentation .

CO5- To know about the various Continuous Monitoring Instruments such as NDIR analyzers

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S			S					S	W		W

CO2		S				W						
CO3	S	S		M				W				
CO4									M		S	
CO5	S	M		S					S			

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Instrumental Methods, Selection of method, Precision and Accuracy, Errors in measuring signals, Noise/signal ratio, base line drift, indicator tubes.

UNIT-II **9**

Spectroscopic Methods

Electromagnetic radiation, matter radiation interactions; Colorimetry and spectrophotometry, fluorimetry, nephelometry and turbidimetry, flame photometry Atomic Absorption Spectrometry (AAS), Atomic Emission Spectrometry (AES)- Inductively coupled plasma (ICP) and Direct Current Plasma (DCP) Spectrometry. ICP- MS (Mass spectrometry).

UNIT-III **9**

Chromatographic Methods

Classical methods, Column, Paper and thin layer chromatography (TLC),gas chromatography (GC),GC-MS,High performance liquid chromatography (HPLC) and ion chromatography (IC).

UNIT-IV **9**

Electro And Radio Analytical Methods

Conductometry, potentiometry, coulometry, amperometry polarography, neutron activation analysis (NAA), X-ray fluorescence (XRF) and X-ray diffraction (XRD) methods

UNIT-V **9**

Continuous Monitoring Instruments

Non-dispersive infra-red (NDIR)analyzer for CO, Chemiluminescent analyzer for NOx, fluorescent analyzer for SO2,auto analyzer for water quality using flow injection analysis, permeation devices.

Total Periods : 45

REFERENCES:

1.Willard.H. Merritt, L., Dean, D.A.and Settle. F.A. "Instrumental methods of analysis, 7th Edn. Words Worth, New York, 2004.

2.Ewing 'Instrumental Methods of Chemical Analysis, 5th Edn., McGraw-Hill,New York, 1995.

MER053 REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATION

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the principles and application of remote sensing and GIS in environmental engineering.

COURSE OUTCOMES (COs)

CO1- To make them understand the principles of Electro Magnetic Radiation and also the concepts of remote Sensing

CO2- To understand about the Remote Sensing Platforms, various sensors used and also about the various Indian space programmed satellite data products.

CO3-.To understand in detail about the Data Processing and image processing techniques and softwares used in GIS.

CO4- To study about the introduction to GIS concepts and GIS softwares

CO5- To know about the applications of Remote Sensing and GIS in environment, conservation of resources, coastal zone etc.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S					S				S		
CO2			M			M	S		S	S		
CO3	S	M			S					S		
CO4					S				W			
CO5	S					S			S	S		

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni

5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Principles of Electro Magnetic Radiation

Concepts of remote Sensing – Energy sources and radiation principles, Energy interactions in the atmosphere – Spectral reflectance of earth surface features

UNIT-II **9**

Remote Sensing Platforms

Aerial photographs, photographic Systems – visual infra red and microwave sensing – active and passive sensors – satellites and their sensors, Indian space programmed satellite data products

UNIT-III **9**

Data Processing

Photogrammetric – satellite data analysis – visual interpretation equipments – digital image processing – image rectification, enhancement, classification, data merging and biophysical modeling – image processing software

UNIT-IV **9**

Geographic Information System

Introduction to GIS concepts – Data base structure – Data analysis – GIS software

UNIT-V **9**

Remote Sensing and GIS Applications

Management and monitoring of environment, conservation of resources, coastal zone management – limitations

Total Periods : 45

REFERENCES:

1.Lillesand, T.M. and Kiefer, R.W., Remote Sensing and image interpretation, John Wiley and Sons, New York,2 004.

2.Burrough,P.A.and McDonnell, R.A., Principles of Geographic information systems, Oxford University press, New York, 2001.

3.Linz. and Simonet, Remote Sensing of Environment, Addison Wesley publishing Company, New Jersey,1998.

MER054 **ECOLOGICAL ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the principles of ecology as applied to environmental engineering.

COURSE OUTCOMES (COs)

CO1- To make them understand the introduction to Ecology and Ecological Engineering and its application in all other fields.

CO2- To understand about the Principles, components and characteristics of Systems approach in Ecological Engineering

CO3-.To understand in detail about the Ecological Engineering Processes and determination of sustainable loading of ecosystems

CO4- To improve the knowledge on the emerging trends of ecotechnology for waste treatment and also the applications of ecological engineering for marine systems

CO5- To know about the case studies of integrated ecological engineering systems and their commercial prospects.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S					S			S			
CO2		W		M				S				M
CO3	S										S	
CO4				W			S		M			
CO5		M							S			

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction to Ecology and Ecological Engineering

Aim, scope and applications of ecology – Development and evolution of ecosystems – principles and concepts pertaining to communities in ecosystem – Energy flow and material cycling in ecosystems – productivity in ecosystems – Rationale of ecological engineering and ecotechnology – classification of ecotechnology – principles of ecological engineering

UNIT-II **9**

Systems Approach in Ecological Engineering

Principles, components and characteristics of systems – Classification of systems – Structural and functional interactions of environmental systems – Environmental systems as energy systems – Mechanisms of steady maintenance in open and closed systems – Modelling and ecotechnology – Elements of modeling – Modelling procedure – Classification of ecological models – Applications of models in ecotechnology – Ecological economics.

UNIT-III **9**

Ecological Engineering Processes

Self – organizing design and processes – Multi seeded microcosms – Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems

UNIT-IV **9**

Ecotechnology for Waste Treatment

Ecosanitation – principles and operation of soil in infiltration systems – Wetland and ponds – Source separation systems – Aqua cultural systems – Agro ecosystems – Detritus based treatment for solid wastes – Applications of ecological engineering for marine systems.

UNIT-V **9**

Case Studies

Case studies of Integrated Ecological Engineering Systems and their commercial prospects

Total Periods : 45

REFERENCES:

1.Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and practice. Lewis Publishers, New Yark.2003.

2.Etnier, C. and Guterstan, B., Ecological Engineering for Wastewater Treatment, Lewis Publishers, New York,1997.

3.White, I.D., Mottershed, D.N. and Harrison, S.J., Environmental Systems – An Introductory Text, Chapman Hall,Landon.1994.

4.Mitsch, J.W. and Jorgensen, S.E., Ecological Engineering – An Introduction to Ecotechnology, John Wiley & sons, New York. 1989.

MER055 GROUND WATER CONTAMINATION AND TRANSPORT

L	T	P	C

MODELING

3	0	0	3

OBJECTIVE

To educate the students on the hydraulics related ground water contamination and modeling ground water quality.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of Ground water and the various hydrologic cycles.

CO2- To understand about the various steady state hydrologic budgets and various case studies associated with it.

CO3-.To understand in detail about the development of Ground Water resources and Aquifers.

CO4- To improve the knowledge on the basics of Chemical equilibrium and Geochemical interpretation of ^{14}C Dates

CO5- To know about the basics of the Transport process in solute transfer and hydro chemical behavior of contaminants in the ground water.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S				M				W		
CO2		S	S						M			
CO3	S	S						S	S	W		
CO4									M			
CO5	S	M				S		W				

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Ground water and the hydrologic cycles – Ground water as resources – Ground water contamination –Water quality standards-Sources of contamination-Land disposal of solid wastes – Sewage disposal on Land. Ground water and geologic processes. Physical properties and

principles-Darcy's Law- Hydraulic Head and Fluid Potential- Piezometers and Nestes. Hydraulic conductivity and permeability- Homogeneity and Anisotropy – Porosity and voids Ratio- Unsaturated flow and the water table- steady state flow and transient flow – Compressibility and effective stress – Transmissivity and storability – Equations of ground water flow – Limitations of Darcian Approach – Hydro dynamic dispersion – Case Studies.

UNIT-II **9**

Hydrologic Cycle and Flow Nets

Flow nets – Graphical construction – Flow nets by numerical simulation. Steady state Regional Ground Water flow – steady state hydrologic budgets – Fluctuations in ground water levels – Case Studies.

UNIT-III **9**

Resource Evaluation

Development of Ground Water resources – Exploration for Aquifers – the response of Ideal acquifers to pumping – Measurement of parameters – Laboratory tests - Piezometer test – Pumping tests – Estimation of saturates Hydraulic conductivity – Numerical simulation for aquifer yield prediction – Artificial recharge and induced infiltration – Land subsidence – Sea water intrusion –Case Studies.

UNIT-I V

Chemical Properties and Principles

Constituents – Chemical equilibrium _ Association and Dissociation of dissolved species – effects of concentration gradients – Mineral dissolution and solubility – Oxidation and reduction process – Ion exchange and Adsorption – Environmental isotopes – Field Measurment of Index parameters- Hydro chemical facies – Ground water in carbonate terrain – Ground Water in crystalline rocks- ground water in complex sedimentary systems – Geochemical interpretation of ^{14} C Dates – Process rates and molecular diffusion.

UNIT-V **9**

Solute Transport

Transport process – non-reactive constituents in homogeneous media and Heterogeneous media – Transport in Fracture media – Hydro chemical behavior of contaminants- trace metals – Trace nonmetals – Nitrogen, organic substances- Measurement of parameters – Velocity – Dispersivity – chemical partitioning.

Total Periods : 45

REFERENCES:

1.Randall J. Charbeneau, "Ground water Hydraulics and Pollutant transport " Prentice Hall,Upper Saddle.

2.Todd David Keith , Ground water Hydrology, second edition , john Wiley and sons New York, 1980.
3.Allen Freeze, R. and John A. Cherry , "Ground Water ", Prentice Hall, Inc.1979.

MER056 ENVIRONMETAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the principles and application of biotechnology in environmental engineering with special reference to waste treatment.

COURSE OUTCOMES (COs)

CO1- To make them understand the of principles and concepts of environmental biotechnology.

CO2- To understand about the concept of Environmental biotechnology and its detoxification methods , biotransformation of metals

CO3-.To understand in detail about the microbial technology for waste treatment and the biotechnological remedies for environmental pollution.

CO4- To improve the knowledge on the emerging trends of Recombinant DNA Technology and its application in genetic engineering.

CO5- To know about the environmental effects,patents and ethics of microbial technology which includes the safe use of animals in EBT.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S					S			S			
CO2	S			M		S			M			
CO3	S							S		W		
CO4	S					S			M			
CO5	S			S					M			

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Principles and concepts of environmental biotechnology – usefulness to mankind, current status.

UNIT-II **9**

Detoxification Of Environmental Pollutants

Degradation of high concentrated toxic pollutants – halogenated ,non-halogenated petroleum hydrocarbons, metals, mechanisms of detoxification – oxidation, dehalogenation, biotransformation of metals ,biodegradation of solid wastes.

UNIT-III **9**

Microbial Technology For Waste Treatment

Biotechnological remedies for environmental pollution – decontamination of ground water system, subsurface environment – reclamation concepts – bioremediation. Production of proteins – biofertilizers . Physical, chemical and microbiological factors of composting – health risk – pathogens – odour management –Microbial cell / enzymes technology – adapted microorganisms – biological removal of nutrients – algal biotechnology and application in agriculture – role of extracellular polymers. Biogas Technology-case studies.

UNIT-IV **9**

Recombinant DNA Technology and Genetic Application

Concept of rDNA technology – expression vectors – cloning of DNA –mutation – construction of microbial strains, radioactive probes , protoplast fusion technology- applications.

UNIT-V **9**

Ethical and Regulatory Issues

Environmental effects and ethics of microbial technology – safety of genetically engineered organisms – microbial containment – Risk assessment, IPR- patents.

Total Periods : 45

REFERENCES:

1.Chaudhury, G.R. ”Biological degradation and Bioremediation of toxic chemicals” Dioscorides press, Oregon, 1994.

2.Martin A.M,”Biological degradation of Wastes”, Elsevier Applied Science,London, 1991

Blaine Metting .F (Jr.) Soil Microbiology Ecology ,Marcel Dekkar Inc, 1993.

3.Wainwright M, An Introduction to environmental Biotechnology, 1999.

4.Old, R.W. and Primrose, S.B. Principles of Gene Manipulation 3rd Ed. Blackwell Sci. Publ., Cambridge, 1985.

MER057 **INDOOR AIR QUALITY**

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on air pollution and control in the indoor environment.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of Design and operation of buildings for improvements of public health associated with indoor air quality.

CO2- To understand about the air pollutants in indoor environments and its characteristics, consequences.

CO3-.To understand in detail about the classification and control of pollutants and case studies associated with it.

CO4- To improve the knowledge on the Concepts and tools in indoor air quality along with the statistical models associated with it.

CO5- To know about the basics of the Indoor air pollution from outdoor sources.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S						M		S			
CO2	M	S		M					S			
CO3	S										S	
CO4	S								M			
CO5		M				S			S			

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Indoor activities of inhabitants – residence time. Levels of many pollutants in indoor and outdoor air. Design and operation of buildings for improvements of public health.IAQ policy issues: Sustainability; indoor air quality as a basic human right

UNIT-II **9**

Indoor Air Pollutants

Air pollutants in indoor environments, private residences, offices, schools sand public buildings, factors that govern pollutant indoors concentrations, including ventilation. Characteristics, Consequences.

UNIT-III **9**

Control of Pollutants

Control of several pollutant classes, such as radon ,toxic organic gases, combustion byproducts, and microorganisms such as molds and infectious bacteria. Case study by an exploration of public policy related to indoor air.

UNIT-IV **9**

Concept and Tools

Concepts and tools: exposure, material-balance models, statistical models ventilation.

UNIT-V **9**

Indoor Air Pollution from Outdoor Sources

Indoor air pollution from outdoor sources: particulate matter and ozone ;Combustion byproducts; Radon and its decay products. Volatile organic compounds: odors and sick-building syndrome, Humidity Bio-aerosols: infectious disease transmission. Special indoor environments: A/C units in indoor: museums -labs; Measurement methods, Control Technologies, Control strategies.

Total Periods : 45

REFERENCES:

1.Thaddes Godish, Indoor air and Environment Quality, CRC press,2000.

2.Nazaroff W.W and L Aivarez-Cohen, Environmental Engineering Science Wiley Sons, New York, 2001.

3.Moroni Marco , Seifet Bernd and Lindrall Thomas, Indoor Air Quality: A Comprehensive Reference Book, Elsvier Science .Vol.3,1995.

MER058 ENVIRONMENAL POLICIES AND LEGISLATION

L	T	P	C
3	0	0	3

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of environmental law and its relation with other disciplines of law.

CO2- To understand about basics of Indian Constitution and Environment and about various pollution control policies

CO3-.To understand in detail about the Administrative regulation –India and to learn about the constitution of various state Pollution control boards .

CO4- To improve the knowledge on the various Pollution Control Laws and its amendments.

CO5- To know about the relevant notifications in environmental (protection) act 1986 and their amendments in the subsequent years.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	M								S			S
CO2	M			M		S						S
CO3	M						S		S			
CO4	M						S		M			S
CO5	S	M						S				

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Basics of jurisprudence- environmental law relation with other disciplines-criminal law-common law-relevant section of the code of civil procedure, criminal procedure code –Indian Penal Code.

UNIT-II **9**

Indian Constitution And Environment

Introduction –fundamental rights-directive principles of state polices-Article 48 (A)and 51-A(g) Judicial enforceability – constitution and Resources management and pollution control- Indian forest policy(1990)-Indian environmental policy(1992).

UNIT-III **9**

Adminstrative Regime and Legal Regime

Administrative regulation –constitution of pollution control boards powers, functions accounts audit etc.-formal justice delivery mechanism higher and lower of judiciary-constitutional remedies writ jurisdiction article 32,226 136 special reference to mandamus and certiorari for pollution abatement- equitable remedies for pollution control.

UNIT-IV **9**

Pollution Control Laws

Administrative regulation under recent legislation s in wear pollution control water (prevention & control of pollution) Act 1974 as amended by amendment Act 1988. water (prevention and control of pollution)Ruler 1975 water (prevention & control or pollution) Cess Act . 1977 as amended by amendment Act 1987 and relevant notifications.

UNIT-V **9**

Environmental (Protection) Act 1986

Relevant notifications in connection with hazardous wastes (management and handling) biomedical wastes(management and management and handling), Nosing pollution , Eco-labelling, and E.I.A

Total Periods : 45

REFERENCES:

1.Constitution of India Esastern Book Company Lucknow 12 th Edn. 1997.
2.onstitutional Law of India- J.N.Pandey 1997 (31 st Edn.) Central Law Agency Allahabad.
3.Administrative Law U.P.D.Kesari 1998. Universal Book Trade Delhi.
4.Environmental Law H.N. Tiwari, Allahabad Law. Agency 1997.
5.Environmental, A.,Divan and Noble M. Environmental Law and Policy in India (cases,Materials and Statues) 1991 Tripathi Bombay.
6. Environmental Policy.Forest Policy. Bare Acts- Government Gazette Notification.

MER059 ENVIRONMENTAL ENGINEERING STRUCTURES

L	T	P	C
3	0	0	3

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of Structural design of Concrete, Prestressed Concrete, Steel and Cast iron etc

CO2- To understand about the methods of analysis and design of water tanks and the types of cement roofing system

CO3-.To understand in detail about the design of special purpose structures like underground reservoirs and swimming pools.

CO4- To improve the knowledge on the repair and rehabilitation of structures and also diagonising and identification of the cause and damage,.

CO5- To know about the exposure on steel, lattice structures used in water and sewerage works.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2	S			M		S				W		

CO3	S	W						S				
CO4	S					S			W			
CO5	S	M		S								

Course Assessment Methods:

Direct		**Indirect**	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Design of Pipes

Structural design of a) Concrete b) Prestressed Concrete c) Steel and d) Castiron piping mains, sewerage tanks design - anchorage for pipes - massive outfalls - structural design and laying - hydrodynamic considerations. Advances in the manufacture of pipes.

UNIT-II **9**

Analysis and Design of Water Tanks

Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete. IS Codes for the design of water retaining structures. Design of circular, rectangular, spherical and Intze type of tanks using concrete. Design of prestressed concrete cylindrical tanks - Economic analysis - introduction to computer aided design and packages.

UNIT-III **9**

Design of Special Purpose Structures

Underground reservoirs and swimming pools, Intake towers, Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks etc. - effect of earth pressure and uplift considerations - selection of materials of construction.

UNIT-IV **9**

Repair and Rehabilitation of Structures

Diagonising the cause and damage, identification of different types of structural and non-structural cracks - repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

UNIT-V **9**

Exposure on Steel, Lattice Structures used in Water and Sewerage Works

Total Periods : 45

TEXT BOOKS:

1.Reinforced Concrete by P .Dayaratnam.
2.Prestressed Concrete by Krishna Raju, Tata McGraw-ill Publishing Co. 2nd Edition 1988.
3.Reinforced Concrete by N.C.Sinha & S.K.Roy - S.Chand and Co. 1985.

REFERENCES:

1.Hulse R., and Mosley, W.H., "Reinforced Concrete Design by Computer", Macmillan Education Ltd., 1986.
2.Ramaswamy, G.S., "Design and Construction of Concrete shell roofs", CBS Publishers, India, 1986.
3.Green, J.K. and Perkins, P.H., "Concrete liquid retaining structures", Applied Science Publishers, 1981.

MER060 MASS TRANSFER IN AIR-WATER-SOIL INTERACTION

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on the mechanism of material transfer between environmental components - air, water and soil.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals and occurrences of chemical equilibrium and thermal equilibrium at enviror1mental interfaces

CO2- To understand about the mass transfer theories and mass transfer coefficients along with environment fundamentals of heat transfer.

CO3-.To understand in detail about the exchange rates between air and water and also the water interface of lakes and oceans.

CO4- To improve the knowledge on the exchange rates between water and the earthern material .

CO5- To know about the basics of the exchange rates between air and soil and to study about the turbulence above the air - soil interface

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S		M								
CO2		S		M								
CO3	S			S				S				
CO4		S							W			
CO5	S	M		S								

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey

2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Equilibrium at Environmental Interface

Ideal solutions - air - water equilibrium occurrences - pure gases in contact with water pure liquid in contact with air - partition coefficient for the air - water system. Earthern solid - waste equilibrium occurrences - pure solid and liquid chemicals in contact with water and earthern solids. Earthern solid - air equilibrium occurrences - water - liquid chemical equilibrium occurrences - thermal equilibrium at enviror1mental interfaces.

UNIT-II **9**

Transport Mechanisms

Diffusion and mass transfer - molecular diffusion - eddy diffusion - mass transfer theories - mass transfer coefficients - binary mass transfer coefficients in two phases and two resistance theory of interphase mass transfer turbulence in the environment fundamentals of heat transfer - analogy theories of momentum, heat and mass transfer.

UNIT-III **9**

Exchange Rates between Air and Water

Desorption of gases and liquids from aerated basins and rivers - completely mixed basin - plug flow basin - gas exchange rates between the atmosphere and the surface of rivers - exchange of chemical across the air - water interface of lakes and oceans.

UNIT-IV **9**

Exchange Rates between Water And the Earthern Material

Dissolution of chemicals on the bottom of flowing streams - geometric forms - stream bottom mass transfer coefficients - natural convection dissolution - the upsurge of chemicals from the sediment - water interface of lakes - a Fikian analysis - allnual upsurge rate at sediment - water interface - mass transfer coefficients at the sediment water interface. Flux of chemicals .between sediment and the overlying seawater movement of chemicals through the benthic boundary layer.

UNIT-V **9**

Exchange Rates between Air and Soil

Turbulence above the air - soil interface - the Richardson number - chemical flux rates through the lower layer of the atmosphere - Thronthwaite - Holzman equation evaporation of liquid chemicals spilled on land - chemical flux rates through the upper layer of earthern material.

Total Periods : 45

REFERENCES:

1.Thibodeaux, L.J, "Environmental Chemo dynamics: Movement Of Chemicals In Air, Water and Soil", edition 2., Wiley - Interscience, New York, 1996.

2.Cusssler, E.L, "Diffusion: Mass Transfer In Fluid Systems, "Cambridge University press, 1994.

MER061 MARINE POLLUTION MONITORING

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on aspects of marine pollution and methods of water quality assessment and marine pollution control

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of General features of oceans and principles of marine geology

CO2- To understand about the Living resources in and around the oceans

CO3-.To understand in detail about the planning and preparation of marine Surveying and sea surveying which includes the oceanographic instrumentation.

CO4- To improve the knowledge on the emerging trends of marine pollution applications of remote sensing and GIS in marine studies

CO5- To know about the control strategies of marine pollution associated with sustainable development.

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S						M					
CO2				M		S						
CO3	S						M			S		
CO4						S			W			
CO5		M				S						

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		

6	End Semester Examinations		

UNIT-I **9**

Oceanography

General features of ocean- Conservation laws- Wave characteristics and theories- Sediment transport- Tides- ocean Currents- Thermocline circulation- General circulation of ocean waters, Tsunamis, Storm Surge- Principles of Marine geology

UNIT-II **9**

Coastal Environment

Living resources- coral reefs, mangroves, seagrass, seaweeds, fishery potential- nonliving resources- manganese nodules, heavy minerals- Beaches, Estuaries, Lagoons- Shoreline changes

UNIT-III **9**

Marine Surveying

Sea surveying planning and preparation- Oceanographic instrumentation- Hydrographic Surveying- Underwater surveying- Measurement of physical properties of ocean water- sea bad sampling

UNIT-IV **9**

Marine Pollution and Monitoring

Physiochemical properties of sea water- Sources of marine pollution and impacts on coastal ecosystems, Oil pollution- oil spill detection, dispersion, impacts on adjacent area- Oil spill modeling, mitigation measures- Oil exploration and their effects- Marine outfalls- Impacts of Ports and Harbour on marine water quality- dredging- Human intervention in estuarine ecosystem- sea water classification- Physical modeling in Coastal Engineering-Ocean monitoring satellites- Applications of Remote sensing and GIS in marine studies

UNIT-V **9**

Marine Pollution Control

National and International treaties, protocols in marine pollution- Exclusive Economic Zone- Sustainable development.

Total Periods : 45

REFERENCES:

1.Kennish, M.J., Pollution impacts on Marine Biotic Communities, CRC press New York,1998.
2.Newman, M.C., Roberts Jr. M.H., Male R.C.(Editors), Coastal and Estuarine Risk Assessment, Lewis Publishers, Washington,D.C.,2002.
3.U.S. Army Corps of Engineers, Shore protection Manual, Washington D.C.,2002.

MER062 INDUSTRIAL WASTEWATER MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE

To educate the students on complete management principles related to individual Waste water-starting from wastewater source identification up to reuse concepts.

COURSE OUTCOMES (COs)

CO1- To make them understand the fundamentals of uses of water by industry-sources and types of industrial wastewaters .

CO2- to understand about the methods of prevention vs. control of industrial pollution including the various benefits and barriers

CO3-.To understand in detail about the Industrial Wastewater Treatment and all the processes in detail.

CO4- To improve the knowledge on the emerging trends of wastewater reuse and residual management

CO5- To know about the case studies which involves the various industrial manufacturing processes

CO/PO Mapping

S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S				S						
CO2		S		M		S					W	
CO3	S							S				
CO4	S					S			W			
CO5		M		S								

Course Assessment Methods:

Direct		Indirect	
1	Internal Tests	1	Course and Survey
2	Assignments	2	Faculty Survey
3	Seminar	3	Industry
4	Quiz	4	Alumni
5	Online test		
6	End Semester Examinations		

UNIT-I **9**

Introduction

Industrial scenario in India- Industrial and Environment-Uses of water by industry-Sources and types of industrial wastewater- Industrial wastewater and environmental impacts-regulatory

requirements for treatment of industrial wastewater-Industrial waste survey-Industrial Wastewater generation rates, characterization and variables-Population equivalent-Toxicity of Industrial effluents and Bioassay tests.

UNIT-II **9**

Industrial Pollution Prevention

Prevention Vs control of Industrial Pollution-Benefits and Barriers-Source reduction techniques-Waste audit-Evaluation of Pollution Prevention options-Environmental statement as a tool for Pollution Prevention-Waste minimization Circles.

UNIT-III **9**

Industrial Wastewater Treatment

Equalisation- Neutralisation- Oil separation-Flotation-Precipitation-Heavy metal Removal - Refractory organics separation by adsorption-Aerobic and anaerobic biological treatment-Sequencing batch reactors-High Rate reactors-Chemical Oxidation - Ozonation- Photocatalysis-Wet Air Oxidation-Evaporation-Ion Exchange-Membrane Technologies - Nutrient removal.

UNIT-IV **9**

Wastewater Reuse and Residual Management

Individual and Common Effluent Treatment Plants-Joint treatment of industrial Wastewater-Zero effluent discharge Systems-Quality requirements for Wastewater reuse-Industrial reuse-Disposal on Water and land-Residuals of industrial Wastewater treatment-Quantification and Characteristics of Sludge- Thickening, digestion, conditioning, dewatering and disposal of sludge-Management of RO rejects.

UNIT-V **9**

Case Studies

Industrial manufacturing Process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles-Tanneries-pulp and paper-metal finishing-Petroleum Refining-Pharmaceuticals-Sugar and Distilleries-Food Processing-fertilizers-Thermal Power Plants and Industrial Estates.

Total Periods : 45

REFERENCES:

1.Eckenfelder,W.W., “Industrial Water Pollution Control”, McGraw-Hill, 1999.

2.Arceivala, S.J., “Wastewater Treatment for Pollution Control”, Tata McGraw-Hill. 1998.

3.Frank Woodard Industrial Waste treatment Handbook,Butterworth Heinemann,New Delhi, 2001.

4.World Bank Group, “Pollution Prevention and Abatment Handbook-Towards Cleaner Production,World Bank and UNEP,Washington D.C.1998.

5.Paul L.Bishop “Pollution Prevention;- Fundamentals and practice”, McGraw-Hill International, 2000

RESEARCH METHODOLOGY

Objectives

- To Get adequate knowledge about research concepts
- To describe mathematical modeling and simulation
- To understand experimental modeling
- To get knowledge about the interpretation of result

Course Outcomes after successful completion of this course, the students should be able to

CO 1: To describe research concepts.
CO 2: To Get adequate knowledge about mathematical modeling
CO 3: To describe experimental modeling
CO 4: To understand analysis of results.
CO 5: To know about report writing

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak							
COs	Programme Outcomes(POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	S	M				M	M
CO2	S	M				M	M
CO3	S	M				M	M
CO4	S	M				M	M
CO5	S	M				M	M

ASSESSMENT METHOD:

DIRECT		**INDIRECT**	
1.	Internal Test	**1.**	Student exit survey
2.	Assignment	**2.**	Faculty Survey
3.	Seminar	**3.**	Industry
4.	Online Test	**4.**	Alumni
5.	End Semester Exam		

1. RESEARCH CONCEPTS 9

Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental).

Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

2. MATHEMATICAL MODELING AND SIMULATION 9

Concepts of modeling, Classification of Mathematical Models, Modeling with Ordinary differential Equations, Difference Equations, Partial Differential equations, Graphs, Simulation, Process of formulation of Model based on Simulation.

3 EXPERIMENTAL MODELING 9

Definition of Experimental Design, Examples, and Single factor Experiments, Guidelines for designing experiments. Process Optimization and Designed experiments, Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design.

4 ANALYSIS OF RESULTS 9

Parametric and Non-parametric, descriptive and Inferential data, types of data, collection of data (normal distribution, calculation of correlation coefficient), processing, analysis, error analysis, different methods, analysis of variance, significance of variance, analysis of covariance, multiple regression, testing linearity and non-linearity of model.

5 REPORT WRITING 9

Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, references, tables, figures, conclusion, appendices.

TOTAL: 45

TEXT BOOKS

1. Wilkinson K. L, Bhandarkar P. L, „Formulation of Hypothesis", Himalaya Publication.
2. Schank Fr.,"Theories of Engineering Experiments", Tata Mc Graw Hill Publication.

REFERENCE BOOKS

1. Douglas Montgomery, "Design of Experiments", Statistical Consulting Services, 1990.
2. Douglas H. W. Allan, "Statistical Quality Control: An Introduction for Management", Reinhold Pub Corp, 1959.
3. Cochran and Cocks, „Experimental Design", John Willy & Sons.
4. John W. Besr and James V. Kahn, „Research in Education", PHI Publication.
5. Adler and Granovky, "Optimization of Engineering Experiments", Meer Publication.
6. S. S. Rao, „Optimization Theory and Application", Wiley Eastern Ltd., New Delhi, 1996.