



SHIVAJI UNIVERSITY, KOLHAPUR
M.Tech. (Environmental Science and Technology)
Course Structure
Semester I

Sr. No.	Subject Code	Subject Title	Contact hours			Credits
			L	T	P	
1	ESTC 10	Research Methodology (Audit)	2	-	-	-
2	ESTC 11	Physico-Chemical and biological treatment processes	4	-		4
3	ESTC 12	Environmental Chemistry and microbiology	4	-		4
4	ESTC 13	Solid waste management	3	1		4
5	ESTE 1	Elective-I	3	-		3
6	ESTE 2	Elective-II	3	-		3
7	ESTS 1	Seminar -I	-	-	2	2
8	ESTC 14	Laboratory- I Water Quality analysis	-	-	2	1
9	ESTC 15	Laboratory-II Environmental Chemistry and microbiology	-	-	2	1
10	ESTC 16	Laboratory-III Solid waste management	-	-	2	1
		Total	19	1	8	23
Total Contact hours per week = 28						

Elective I

ESTE - 11 Energy and Environment

ESTE - 12 Environmental Toxicology

ESTE - 13 Disaster management and risk analysis

Elective II

ESTE - 21 Optimization Techniques

ESTE - 22 Environmental Economics

ESTE - 23 Environmental Statistics and experimental design

Semester II

Sr. No.	Subject Code	Subject Title	Contact hours			Credits
			L	T	P	
1	ESTC 20	Air pollution and Control	4	-	-	4
2	ESTC 21	Industrial waste treatment	3	1	-	4
3	ESTC 22	Advanced water and waste water treatment	3	1	-	4
4	ESTE 3	Elective-I	3	-	-	3
5	ESTE 4	Elective-II	3	-	-	3
6	ESTS 2	Seminar -II	-	-	2	2
7	ESTC 23	Laboratory- I Air pollution and Control	-	-	2	1
8	ESTC 24	Laboratory-II Wastewater characterization	-	-	2	1
9	ESTC 25	Laboratory-III Specific Treatment Lab	-	-	2	1
		Total	16	2	8	23
Total Contact hours per week = 26						

Elective III

- ESTE - 31 Environment management Systems
- ESTE - 32 Numerical methods and Statistics
- ESTE - 33 Remote sensing and GIS Application in Environmental Engineering
- ESTE - 34 Environmental sanitation

Elective IV

- ESTE – 41 Operation and maintenance of environmental facilities
- ESTE – 42 Project management
- ESTE – 43 Environmental Biotechnology

SHIVAJI UNIVERSITY, KOLHAPUR
M.Tech. (Environmental Science and Technology)
Course Structure
Semester III

Course Code	Course	Teaching Scheme			
		L	T	P	Credits
T 31	* Industrial Training	-	-	**2	4
S 32	Dissertation Phase-I	-	-	**5	10
	Total	-	-	7	14
	**Total Contact hours per week/students = 2 & 5 respectively for T31 & S32				

* 8 Weeks at the end of First Year (Summer)

** Average contact hours/week/student

Semester IV

Course Structure and Scheme of Evaluation
Semester IV

Course Code	Course	Teaching Scheme			
		L	T	P	Credits
D 42	Dissertation Phase-II	-	-	5	20
	Total	-	-	5	20
	Total Contact hours per week = 5				

M. Tech (Environmental Science and Technology)
(ESTC-10) Research Methodology

Teaching Scheme: L: 2 T: -- Credits: --

1	Research Methodology: An Introduction	Hrs
	Objectives of Research, Types of Research, Research Methods and Methodology, Defining a Research Problem, Techniques involved in Defining a Problem	4
2	Research Design Need for Research Design, Features of Good Design, Different Research Designs, Basic Principles of Experimental Designs, Sampling Design, Steps In Sampling Design, Types of Sampling Design, Sampling Fundamentals, Estimation, Sample size Determination, Random sampling	6
3	Measurement and Scaling Techniques Measurement in Research, Measurement Scales, Scales, Sources in Error, Techniques of Developing Measurement Tools, Scaling, Meaning of Scale, Scale Construction Techniques	4
4	Methods of Data Collection and Analysis Collection of Primary and Secondary Data, Selection of appropriate method, Data Processing Operations, Elements of Analysis, Statistics in Research, Measures of Dispersion, Measures of Skewness, Regression Analysis, Correlation	4
5	Techniques of Hypotheses, Parametric or Standard Tests Basic concepts, Tests for Hypotheses I and II, Important parameters, Limitations of the tests of Hypotheses, Chi-square Test, Comparing Variance, as a non-parametric Test, Conversion of Chi to Phi, Caution in Using Chi- square test	4
6	Analysis of Variance and Co-variance ANOVA, One way ANOVA, Two Way ANOVA, ANOCOVA, Assumptions in ANOCOVA, Multivariate Analysis Technique, Classification of Multivariate Analysis, factor Analysis, R-type Q Type Factor Analysis, Path Analysis	4
	Interpretation and Report	1

M. Tech (Environmental Science and Technology)
(ESTC-11) Physico-Chemical and Biological Treatment Processes

Teaching Scheme: L: 4 T: - Credits: 4

Unit 1

Mass transport processes, Mass balance analysis, types of reactions, reaction kinetics, Configurations of ideal and non-ideal reactors, principles of ideal reactor design. Basic principle of mass transfer, Gas-liquid mass transfer, Two film theory Introduction to process selection.
6 hr

Unit 2

Coagulation processes, stability of colloids and destabilization, coagulants, Flocculation theory, orthokinetic and perikinetic Design of slow and rapid mixers. Sedimentation, particle settling theory, types of settling and related theory, types of clarifier, high rate clarification, design of clarifiers
8 hr

Unit 3

Introduction to depth filtration, filtration processes, principal mechanisms of filtration, filter hydraulics, backwash hydraulics, Rate control patterns and methods, design and operation of slow sand, rapid sand and dual media filters.
5 hr

Unit 4

Adsorption processes, causes and types of adsorption, influencing factors, adsorption equilibria and development of adsorption isotherms, activated carbon adsorption kinetics, analysis and design of GAC and PAC contactors.

Ion exchange, exchange materials, exchange capacity, ion exchange chemistry and reactions, applications for hardness and TDS removal, design of ion exchange softener, Introduction to membrane processes
8 hr.

Unit 5

Disinfection, modes of disinfection, mechanisms, factor influencing, ideal disinfectant, chemistry of chlorination, ozone chemistry, estimation of ozone dosage, UV disinfection, Estimation of UV dose. Corrosion processes, electrochemical nature of corrosion, types of corrosion, methods of corrosion control.
6 hr

Unit 6

Objectives and fundamentals of biological treatment, types of biological treatment processes. Conventional activated sludge process, process kinetics and design considerations, process control measures, operational problems, Introduction to modifications. Trickling filter, classification, process design considerations. Fundamentals of anaerobic treatment, general design considerations, types of anaerobic reactors.

7hr

References:

1. Theory and Practice of water and Wastewater treatment – Ronald Droste.
2. Environmental engineering – Peavy, Rowe and Technological.
3. Physico-chemical processes of water purification – Weber
4. Wastewater Engineering treatment and reuse– Metcalf Eddy

M. Tech (Environmental Science and Technology)
(ESTC-12) Environmental Chemistry and Microbiology

Teaching Scheme: L: 4 T: - Credits: 4

Unit 1

Chemistry of pollutants in the Atmosphere: Solid, liquid, gaseous and radioactive pollutants in the atmosphere, formation of physical processes of pollutants in the atmosphere, Effects of temperature, solar radiation and wind current on the various pollutants, Effect of gravitational force and rain scrubbing on air pollutants, Chemical properties of air pollutants chemisorptions, effect of solar radiation on acidic basic characteristics, reducing, oxidizing properties of air pollutants. **6 hr**

Unit 2

Chemistry of pollutants in the water (Hydrosphere), Characteristics of water as a solvent. Interaction of water with organic, Inorganic species(Natural & Anthropogenic),Determination of water quality parameters, physical, chemical, biological and physiological parameters.

Water Treatment Technology: water and process waste water & its composition Detection, estimation and removal of heavy toxic metals pesticides, organic residues, oxidizing, and reducing agents in Waste Water. Reduce Recycle and Reuse of heavy toxic metals Ion exchange, catalytic conversion, stream gas stripping cooling & chilling, Organic pollutants in waste water & treatment technology Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments Activated sludge process. **8hr**

Unit 3

Air pollution control Engineering, Control of particulate matter Gravity setting, fabric filters, centrifugal impactors, Electrostatic precipitators, scrubbers limitations of these techniques with reference to chemistry of pollutants. Control of gaseous pollutants. Absorption, Adsorption, Condensation (cold trapping) Chemical conversions of gaseous pollutants. Control of specific gaseous pollutants, SO₂, H₂S, CO, CO₂, NO, NO₂. **6 hr**

Unit 4

Instrumental methods of pollutant analysis, Spectroscopic techniques, AAS, NAA, GCMS, HPLC,Electro analytical techniques, EEM-608, Industrial waste management and environmental audit, environmental sensing techniques. **5 hr**

Unit 5

Bacteria : classification and characteristics of bacteria, cell morphology, growth rate curve, culture techniques, Gram staining, microscopic methods, MPN, Plate count and membrane filter techniques, Algae: classification, symbiosis, factors affecting algal growth, control of algae, Fungi, moulds, protozoa , population dynamics, role of microbes, in biological waste treatment, significance of F/M ratio, acclimatization of bacteria, bioassay tests, aerobic and anaerobic metabolism. **8 hr**

Unit 6

Structure of prokaryotic and eukaryotic cells, Types and metabolic classification of micro organisms, Microbial metabolism, respiration and energy generation, ; enzyme kinetics and regulation; Bacterial genetics; structure of DNA nad RNA ; transcription and translation; Gene expression and regulation; Gene transfer and recombinant DNA technology. **7 hr**

References

- 1) Chemistry for Environmental Engineers - Swayer and McCarty
- 2) Outlines of Biochemistry - Conn and Stump
- 3) Microbiology - Pelzar and Reid
- 4) Microbiology for Sanitary Engineers - Ray MaKinney

M. Tech (Environmental Science and Technology)
(ESTC-13) Solid Waste Management

Teaching Scheme: L: 3 T: -1 Credits: 4

Unit 1

Solid waste management: Objectives, Functional elements, Environmental impact of mismanagement. Solid waste: Sources, Types, Composition, Quantities, Physical, Chemical and Biological properties. **6 hr**

Unit 2

Solid waste generation rate: Definition, Typical values for Indian cities, Factors affecting. Storage and collection: General considerations for waste storage at source, Types of collection systems. Transfer station: Meaning, Necessity, Location, Economic analysis. Transportation of solid waste: Means and methods, Routing of vehicles. **7 hr**

Unit 3

Sorting and material recovery: Objectives, Stages of sorting, Sorting operations, Guidelines for sorting for material recovery, Typical material recovery facility for a commingled solid waste. **6 hr**

Unit 4

Composting of solid waste: Principles, Methods, Factors affecting, Properties of compost, Vermicomposting. Energy recovery from solid waste: Parameters affecting, Biomethanation, Fundamentals of thermal processing, Pyrolysis, Incineration, Advantages and disadvantages of various technological options. Landfills: Definition, Essential components, Site selection, Land filling methods, Leachate and landfill gas management. **8 hr**

Unit 5

Biomedical Waste: Generation, identification, storage, collection, transport, treatment, common treatment and disposal, occupational hazards and safety measures. Biomedical waste legislation in India **6 hr**

Unit 6

Indian scenario: Present scenario and measures to improve system for different functional elements of solid waste management system. Elements of financial management plan for solid waste system. **7 hr**

References

- 1) Manual on municipal solid waste management – Government of India publication.
- 2) Integrated solid waste management – George Tchobanoglous.
- 3) Solid waste management – A. D. Bhide.
- 4) Solid waste management handbook – Pavoni.

M. Tech (Environmental Science and Technology)
(ESTS-1) Seminar

Teaching Scheme: L: 2
Contact hrs : 2 Hrs./Week/student

Credits: 2

The topic of seminar shall be based on area of Environmental Engineering & preferably considering new ideas, concepts, technologies & developments in the field of Environmental Sciences & Technologies. At least two oral presentations and submission of report in soft & hard copies is expected. Students shall deliver Seminar on the State-of-the-Art topic in front of Examiners and Student-colleagues. Prior to presentation, he/she shall carry out the detailed literature survey from Standard References such as International Journals and Periodicals, recently published reference Books etc. and submit a report on the same along with computer based presentation copy to the concerned examiner/guide at the end of the seminar. The assessment shall be based on selection of topic, its relevance to the present context, report documentation and presentation skills. Guide should spare for 2hrs /week/student for seminar

M. Tech (Environmental Science and Technology)
(ESTC-14) Laboratory- I
Water Quality analysis

Teaching Scheme: P: 2

Credits: 1

A performance based on Experiments, or assignment or Visit report

M. Tech (Environmental Science and Technology)
(ESTC-14) Laboratory- II
Environmental Chemistry and microbiology

Teaching Scheme: P: 2

Credits: 1

A performance based on Experiments, or assignment or Visit report

M. Tech (Environmental Science and Technology)
(ESTC-14) Laboratory- III
Solid waste management

Teaching Scheme: P: 2

Credits: 1

A performance based on Experiments, or assignment or Visit report

M. Tech (Environmental Science and Technology)

(ESTC-20) Air Pollution and Control

Teaching Scheme: L: 4 T: - Credits: 4

Unit 1

Physics of atmosphere, Solar radiation, Wind circulation, Lapse rate, Inversion, Stability conditions, Pasquill stability model, maximum mixing depth, Wind rose, Plume behavior, Heat island effect, Green house effect, Rain drop formation, Visibility, Photochemical reaction.

6 hr

Unit 2

Dispersion of pollutants in the atmosphere, eddy diffusion model, the Gaussian dispersion model, point source, Line source, maximum ground level concentration, Determination of stack height, sampling time corrections, Effects of inversion trap.

7 hr

Unit 3

Particulate matter; Definitions of different particulate matter, Distribution and source of SPM, Terminal settling velocity, Hood and duct design, Particulate collection design.

7 hr

Unit 4

Control equipment for particulate matter; Settling chamber, Cyclone, Wet collectors, Fabric filter, Electrostatic precipitator, Problems on design of equipment, Component detailing collection efficiency.

8 hr

Unit 5

General control of Gaseous pollutants, Principles of absorption, Adsorption, Basic design of absorption and adsorption units, Incineration and after burner, Control of sulphuric dioxide, NO_x.

5 hr

Unit 6

Automobile source; Emission of pollutants from automobiles, Reduction of emissions by different methods, Alternative fuels and their utilizations.

Strategy for effective control of air pollution in India.

7hr

References

1. Air Pollution – Wark and Warner.
2. Air Pollution Vol. I and II– Stern.
3. Air Pollution and Control– Martin Crawford.

M. Tech (Environmental Science and Technology)
(ESTC- 21) Industrial Waste treatment

Teaching Scheme: L: 3

T: - 1

Credits: 4

Unit 1

Water use in industry, Industrial water quality requirements, Deterioration of water quality, Classification and characterization of Industrial wastewater, Monitoring of wastewater flow in industries, Quality and quantity variations in waste discharge, Water budgeting. **6 hr**

Unit 2

Waste volume reduction, Waste strength reduction, Neutralization, Proportioning, Equalization. Reuse and recycling concepts. **5 hr**

Unit 3

Treatment techniques for removal of specific pollutants in industrial , wastewaters, e.g., oil and grease, cyanide, fluoride, calcium, magnesium, toxic organics, heavy metals, radioactivity

6hr

Unit 4

Treat ability aspects of raw industrial wastewater with domestic sewage, Partially treated industrial wastewater with domestic sewage, Completely treated industrial wastewater with domestic sewage. Stream and Effluent standards **6 hr**

Unit 5

Common Effluent treatment plant: Concept, Objectives, Methodology, Cost benefit analysis, Design, Operation and maintenance. **7 hr**

Unit 6

Classification of industries. Manufacturing processes, Water usage, Sources, Quantities, and characteristics of effluents, Pollution effects, Methods of treatment, utilization and disposal, in industries viz. sugar, distillery, dairy, pulp and paper mill, fertilizer, tanning, steel industry, textile, petroleum refining, chemical and power plant. **10 hr**

References

- 1) Theories and Practices of Industrial waste treatment- Nelson Nemerow.
- 2) Waste water treatment: M.N.Rao & Datta.
- 3) IS Standard guide for treatment and disposal of various industries.

M. Tech (Environmental Science and Technology)
(ESTC-22) Advance water and wastewater treatment

Teaching Scheme: L: 3 T: -1 Credits: 4

Unit 1

Gas transfer: Aeration systems, Energy requirement, Design of aeration systems. Membrane **5hr**

Unit 2

Filtration, Terminology, Process classification, Membrane configurations, Membrane operation for micro filtration, Ultra filtration and Reverse osmosis, Area requirement, Membrane fouling and its control, Application of membranes. Electro dialysis: Theory, Area and power requirement, Disposal of concentrate waste streams. **8 hr**

Unit 3

Grit removal: Types of grit chambers, Characteristics, quantities, processes and disposal of grit, Design of grit chambers, Flotation: Objective, Types of flotation systems, Design considerations. Chemical precipitation for removal of phosphorous, heavy metals and dissolved inorganic substances. **6 hr**

Unit 4

Microbial growth kinetics, Modelling suspended and attached growth treatment processes. Suspended growth processes for biological nitrification and de- nitrification, Biological nitrogen and phosphorous removal. **6 hr**

Unit 5

Anaerobic sludge blanket processes, Design considerations for Up flow Anaerobic Sludge Blanket process. Theory and design of Sludge treatment, sludge thickening, sludge drying, incineration, aerobic and anaerobic digestion of sludge. **7 hr**

Unit 6

Wetland and aquatic treatment systems; Types, application, Treatment kinetics and effluent variability in constructed wetlands and aquatic systems, Free water surface and subsurface constructed wetlands, Floating plants (water hyacinths and duckweed), Combination systems, Design procedures for constructed wetlands, Management of constructed wetlands and aquatic systems. **8 hr**

References

1. Wastewater Engineering treatment and reuse– Metcalf Eddy.
2. Theory and Practice of water and Wastewater treatment – Ronald Droste.
3. Physico-chemical processes of water purification – Weber
4. Wastewater Treatment for Pollution Control – Soli Arceivala.

M. Tech (Environmental Science and Technology)
(ESTS-2) Seminar

Teaching Scheme: L: 2
Contact hrs : 2 Hrs./Week/student

Credits: 2

The topic of seminar shall be based on area of Environmental Engineering & preferably considering new ideas, concepts, technologies & developments in the field of Environmental Sciences & Technologies. At least two oral presentations and submission of report in soft & hard copies is expected. Students shall deliver Seminar on the State-of-the-Art topic in front of Examiners and Student-colleagues. Prior to presentation, he/she shall carry out the detailed literature survey from Standard References such as International Journals and Periodicals, recently published reference Books etc. and submit a report on the same along with computer based presentation copy to the concerned examiner/guide at the end of the seminar. The assessment shall be based on selection of topic, its relevance to the present context, report documentation and presentation skills. Guide should spare for 2hrs /week/student for seminar

M. Tech (Environmental Science and Technology)
(ESTC-23) Laboratory- I
Air pollution and Control

Teaching Scheme: P: 2

Credits: 1

A performance based on Experiments, or assignment or Visit report

M. Tech (Environmental Science and Technology)
(ESTC-24) Laboratory- II
Wastewater characterization

Teaching Scheme: P: 2

Credits: 1

A performance based on Experiments, or assignment or Visit report

M. Tech (Environmental Science and Technology)
(ESTC-25) Laboratory- III
Specific Treatment Lab

Teaching Scheme: P: 2

Credits: 1

A performance based on Experiments, or assignment or Visit report

M. Tech (Environmental Science and Technology)
(ESTE-11) Energy and Environment

Teaching Scheme: L: 3 T: - Credits: 3

Unit 1

Energy Crisis: Historical events, energy requirement of society in past and present situation, availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability.
5hr

Unit 2

Non-conventional energy sources: Hydel power plant, tidal energy, biomass energy, wind energy, Hydrogen as a source of energy, energy conversion technologies, their principles, equipment and suitability in context of India. Environmental impacts of these technologies. **6hr**

Unit 3

Solar Energy option: Sun as source of energy, direct methods of solar energy collection, process of photovoltaic energy conversion, solar energy conversion technologies and devices, their principles, working and application, environmental impacts of solar energy. **6hr**

Unit 4

Biomass option: Concept of biomass energy utilization, types of biomass energy, conversion processes, biogas production, biomass gasification process and technologies, environmental impacts of biomass energy. **8hr**

Unit 5

Energy Storage: Types of energy storage, devices for sensible and latent heat storage, energy storage in dry batteries, nickel-cadmium batteries, secondary heat storage, chemical storage, environmental consequences of energy storage systems. **7hr**

Unit 6

Heat Energy recovery systems: Approaches to waste Energy Utilization, Equipment, Utilization System, objective, principles of heat transfer, Gas to Gas heat transfer, Gas to Liquid heat transfer, Recovery of waste heat in coil coating, Non-conventional liquid fuels, Heat recovery by Cogeneration.
8hr

References

1. Bewik M.W.M. - Handbook of organic waste conversion.
2. Bokris J.O. - Energy, the solar hydrogen alternative.
3. Rai G.D - Non-conventional Energy Sources.
4. Sukhatme S.P.- Solar Energy.
5. Kiang Y. H.- Waste Energy Utilization Technology.

M. Tech (Environmental Science and Technology)
(ESTE- 12) ENVIRONMENTAL TOXICOLOGY

Teaching Scheme: L: 3 T: - Credits: 3

Unit 1

Introduction to Environmental Toxicology : Definition, classification, origin and general nature of toxicants in environment, factors affecting toxicity, nutritional and non nutritional food supplements and their effects, mutagenesis, teratogenesis, carcinogens, hallucinogens, phytotoxins and animal toxins.

7hr

Unit 2

Systematic and Eco-toxicology : Toxic response of different body systems likes respiratory, gastro-intestinal tract, Liver, kidney, immune system, reproductive system. Problems and approach, Environmental distribution of chemicals in air, water, sediments, soil and biota; Effects of toxicants on ecosystem, Detoxification of toxicants in resistant biota.

8 hr

Unit 3

Experimental methods for measuring toxicity; Types of bioassays (Ames test, bioluminescence, algal toxicity, gene induction etc.), the interaction of chemicals with ecosystems; Methods for assessing the impacts of chemicals on ecosystems (toxicity tests, field assessment, special analyses such as biomarkers, bioaccumulation, mesocosm and microcosm studies).

6 hr

Unit 4

Biotransformation, bioaccumulation and bio-magnification of toxicants, Toxicants absorption and distribution of toxicants in animal body, Bio-transformation of toxicants, antidotes treatment and their detoxification of toxicants, Bio-accumulation, Bio-magnification.

8 hr

Unit 5

Environment and health and environmental stress : Basic principles of environmental health, community health, impact of changing environment on biota, effect of stress on environment, adaptations and tolerance level of various organisms and stress factors, micro-organisms of extreme environment. Occupational health hazards : Stress, man, machine and environment, ergonomics and occupational physiology and Hazards of working environment safety management of occupational hazards.

8 hr

Unit 6

Ecological risk assessment process and evaluation of human exposure, Case studies related to accidental discharge of pollutants and their impacts on the ecology and inhabitants of the surrounding areas.

5 hr

References

1. Principles of Ecotoxicology, Edited by : G. C. Butler
2. Basic Environmental Toxicology, Edited by: Cockerham, shane, CRC Press.
3. Environmental Toxicology by Wright.
4. A. P. H. A. Ed. 1992.
5. Modern Toxicology by Gupta and Salunkhe.

M. Tech (Environmental Science and Technology)
(ESTC-13) Disaster Management and Risk Analysis

Teaching Scheme: L: 3 T: - Credits: 3

Unit 1: **Hrs**
Disaster: Definition, Classification, Natural and Anthropogenic, Accidents, Disaster Profile of India. Geo-climatic and Social conditions, past records, Vulnerable areas of the country, national Response approach
6hr

Unit 2
Risk assessment, Contingency Planning, Major Natural disasters, Earth Quake Cyclone, Flood Epidemics, Check list-Agencies, Personnel Equipment, Materials, Services and Time management
7hr

Unit 3
Prediction and forecasting, disaster preparedness, data base assessment of Disaster relief and Rehabilitation measures, Mobilization of men and Material
7hr

Unit 4
Legal frame work, Trigger mechanism – Water. Climate and Geologically Related Chemical, Industrial, Nuclear, GIS enabled Disk net
6 hr

Unit 5
Maps Special and non special data. Activities, Agencies, Resources and Funds, Implementation and Monitoring Flood Hazard Map
7hr

Unit 6
Quick response flow chart, Emergency operation center, Emergency support Functions, Disaster specific modules
7hr

Reference Books:

1. “National Disaster Response Plan”, A Document prepared by Department of Agriculture and Cooperation.
2. “Concept of Trigger Mechanism”, Govt. Of India, Ministry of Home Affairs, February 2001, Publication.
“Water and Climate related Disasters”, Govt. of India, Ministry of Home affairs, Publication.

M. Tech (Environmental Science and Technology)
(ESTE – 21) Optimization Techniques

Teaching Scheme: L: 3 T: - Credits: 3

Unit 1

Optimization problem statement, Classification of optimization problems. Classical optimization theory: Unconstrained optimization, Constrained optimization with equality and inequality, Method of Lagrange multipliers, kuhn- Tucker conditions. **8hr**

Unit 2

Linear programming: Construction of LP model, Simplex method, Big M and two phase methods, Special cases, Duality and sensitivity analysis, Economic interpretation of duality. **6hr**

Unit 3

Non-linear programming: Unconstrained optimization techniques, Classification of methods, Dichotomous optimization method, Steepest ascent, Newton method, Constrained optimization, Separable and quadratic programming. **7hr**

Unit 4

Dynamic programming: Multistage decision process, recursive relationships, Principle of optimality, Computational procedure in DP, DP applications, Problem of dimensionality. **6hr**

Unit 5

Genetic algorithm: Introduction, Representation of decision variables, Objective function and constraints, GA operators. Introduction to Simulated annealing, Neural network based optimization and optimization of fuzzy systems. **8hr**

Unit 6

Scope of Computer application in Environmental Science and Engineering, Applications of optimization techniques to Environmental systems. **5hr**

References

1. Engineering optimization – S. S. Rao
2. Operation research – Taha.
3. Genetic algorithm – Goldberg.

M. Tech (Environmental Science and Technology)

(ESTE- 23) Environmental Statistics and Experimental Designs

Teaching Scheme: L: 3

T: -

Credits: 3

Unit 1.

Basic concepts: Variable, quantitative, discrete, continues, data: Data representation, tabulation, diagrammatic representation. Measures of central tendency and dispersion, mean, median, mode, percentiles, range, variance, standard deviation, coefficient of variation measures skewness and kurtosis. **7hr**

Unit 2.

Probability: sample space, events, equally likely out comes probability of events (frequency approach). Addition and multiplication Theorems and condition probability. **6 hr**

Unit 3.

Standard distributions : Binomial, Poisson, normal, exponential. Computation of mean, variance and probability distribution function and generating function. Model sampling, simulation study. Correlation and regression: scatter plot, correlation coefficient, properties, rank correlation. Linear regression: Fitting of line and plane of regression. **8 hr**

Unit 4.

Methods of sampling: Simple Random sampling with and without replacement. Sampling distribution and standard deviation of sample mean. Testing of hypothesis: Null and alternative hypothesis, types of errors, critical region. Testing of equality of proportion and for equality of means when variances are known and unknown. P-value chi-square test of goodness of fit and of independence. **8 hr**

Unit 5

Basic concepts in Experimental Designs: Unit, treatment, Lay out of the experiment. Principles of designs of experiments, randomization, replication and local control. typical applications of experimental designs. **4 hr**

Unit 6

Analysis of variance: One way and two way classification. Mathematical model assumptions. Hypotheses, and their testing. ANOVA table . Standard designs : CRD, RBD and LSD, Lay-out, model, analysis, advantages. **8 hr**

References :

1. Biostatistics : A foundation for Analysis in the Health Sciences 7/ Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Cochran& cox: experimental designs.
3. Goon, Gupta& Das gupta: Fundamentals of statistics Vol. I & II
4. Kempthorne: The design and analysis of experiment.
5. "Geostatistics with Applications in Earth Sciences" By D.D. Sarma National Geophysical Research Institute (Council of Scientific and industrial Research) Hyderabad India

- Publication: Capital Publishing Company New Delhi Kolkata,
6. Rechar A. Johnson: Probability and Statistics for Engineers.
 7. Hogg and Tanis : Probability and Statistical Inference.
 8. Douglas C. Montgomery : Design and Analysis of Experiments.

M. Tech (Environmental Science and Technology)
(ESTC 31) Environment Management System

Teaching Scheme: L: 3 T: - Credits: 3

Unit 1

Ecological aspects: Salient features of major Eco Systems, Energy Transfer, Population Dynamics, Ecological imbalance, Preservation of Biodiversity. Land Pollution, Water Pollution due to sewage, industrial effluents and leachate, Groundwater contamination and control measures. Pollution due to Nuclear Power Plants, Radioactive Waste, Thermal pollution, causes and control. **Noise Pollution:** Decibel Levels, Monitoring, Hazards, Control measures **7 hr**

Unit 2

Environmental Impact Assessment (EIA) Definitions and Concept, Scope, Objectives, Ty] impacts, Elements of EIA, Baseline studies, Methodologies of EIA, Prediction of impacts a methodology, Uncertainties in EIA, Status of EIAs in India **7 hr**

Unit 3

Environmental Auditing: Definitions and concepts, Scope and Objectives, Types of audit, Accounts audit, Environmental audit statement, Qualities of environment auditor. Environmental Impact Statement (EIS), Sustainable development. **6 hr**

Environmental Management Plan: Definition, Importance, Development, Structuring, Monitoring, Cost aspects. Strategy for siting of Industries

Unit 4

Environmental Ethics:

Ethics in society, Environmental consequences, Responsibility for environmental degradation, Ethical theories and codes of Ethics, Changing attitudes **4 hr**

Unit 5

ISO and ISO 14000 Series

Introduction, Areas covered in the series of standards, Necessity of ISO certification. Environmental management system: Evolution, Need, Elements, Benefits, ISO 14001 requirements, Steps in ISO 14001 certification, ISO 14001 and sustainable development, Integration with other systems (ISO 9000, TQM, Six Sigma), Benefits of integration **7 hr**

Unit 6

Environmental Legislation

Water (prevention and control of pollution) act 1974, The environmental act 1986, The Noise Pollution (Regulation and Control) Rules, 2000. Environmental economics, Environmental Labelling, Life-Cycle Assessment **9 hr**

Reference Books:

1. "Environmental Impact Assessment", Canter (U.S.A) Mc Graw Hill publications, 1996.
2. "Environmental Auditing", Published by CPCB. New Dehli.
3. "Environmental Audit", A.K. Mhaskar, .Media Enviro Publications, 2002.
4. "ISO Standards".
5. "Environment Management Centre Website".
6. "Ecology", E.P. Odum. (Second edition)Oxford and IBH publishing Co.Pvt.Ltd, 1975.

M. Tech (Environmental Science and Technology)

(ESTE - 33) Remote Sensing and GIS Application in Env. Engg.

Teaching Scheme: L: 3

T: -

Credits: 3

Unit 1

Concepts of remote sensing; Energy sources and Radiation principles, spectral characteristics of earth's surface and of atmosphere. Sensors and their characteristics; Radiometers, cameras, multi-spectral scanners and microwave systems. Aerial and satellite platforms. **7hr**

Unit 2

Optical, infrared and microwave imagery, Analysis of imagery, Visual and machine interpretation of imagery, Ground truth data, Digital image processing. **6hr**

Unit 3

Application of remote sensing – Land use and Land cover mapping, biodiversity, forestry and agriculture, soil erosion, water resources, wetland mapping, Wild life ecology, Environmental assessment, Environmental management, Urban and regional planning, Monitoring natural disasters. **8hr**

Unit 4

Fundamentals of GIS: Definition, Components, spatial data, thematic characteristics, rasters and vectors, databases and database management. **6hr**

Unit 5

Data input and Editing: Data stream, data encoding, map digitization and conversion, data analysis, network and surface analysis in GIS, analytical modelling, forms of GIS output, decision support systems, GIS project design and management. **6hr**

Unit 6

GIS applications: Forestry, Bio-diversity, Environment, Soil resource management, Hydrological modelling, Public utilities (water distribution, sewerage, solid waste management). **7hr**

References

1. Remote Sensing and Image Interpretation – Lillesand and Kiefer.
2. Introduction to the physics and techniques of Remote Sensing – Elachi.
3. Geographical Information System Vol. I and II– Longley.
4. An Introduction to GIS – Ian Haywood.

M. Tech (Environmental Science and Technology)
(ESTE-34) Environmental Sanitation

Teaching Scheme: L: 3

T: -

Credits: 3

Unit 1

Ecology, man and his environment, types of ecosystem, food chain and web, population dynamics, imbalance of ecosystem causes and effects, Energy flow in nature, Non-conventional energy sources. **6 hr**

Unit 2

Vital Statistics, Sources, population growth and its control, factors affecting, infant mortality, Morbidity rates. **5 hr**

Unit 3

Transmission of diseases through air, water and food, control and prevention of diseases, Vectors as disease carriers, Vector and weed control, Pesticide use, Mosquito and its control, house fly and its control, Rodent control. **7 hr**

Unit 4

Sanitation aspects in food processing, dairy, public places, slaughterhouse, swimming pool, and industry. Building by laws for sanitation, Rural sanitation, Low-cost sanitation, Privies, Waterless toilet. **7 hr**

Unit 5

Basic elements of good housing, substandard housing and its effects, Ventilation and air-conditioning, house plumbing and drainage, backflow prevention, indirect waste piping. Industrial hygiene, sources of dust and gaseous pollutants, occupational hazard, exposure tolerance, protective measures, Legal control. **8 hr**

Unit 6

Noise Pollution, Decibel scales, Noise characteristics & measurement, Levels of noise and standards, Control measures of community and industrial noise. **7 hr**

References:

- 1) Environmental Sanitation – Salvador.
- 1) Municipal Sanitation – Ethers and Steel.
- 2) Modern concepts of Ecology – H. D. Kumar.
- 3) Environmental Engineering and Sanitation – Salvato.

M. Tech. in Environmental Science and Technology

(ESTE-41) Operation and Maintenance of Environmental Facilities

Teaching Scheme: L: 3 Credits: 3

Unit 1

Introduction

Need of Operation and Maintenance (O & M), Basic principles, corrective and preventive maintenance, Detailed planes, drawings, operation manuals, computer usage in O and M. **6hr**

Unit 2

Water Supply system

Intakes pumps, transmission pipes, water treatment process control, Quantity and quality monitoring. **6hr**

Unit 3

Water distribution system

Loss of carrying of pipes, pipe breaks and leakages, leak detection, record keeping, O and M of Appurtenances, Use of network models in O and M. **7hr**

Unit 4

Wastewater facilities

Sewerage system, Inspection methods, Manual and television, Cleaning and Rehabilitation, Safety in sewer inspection, O and M of wastewater treatment plant, Monitoring and operational problems, Corrective measures. **8hr**

Unit 5

Air pollution control facilities

Regular inspection of devices, SPM control equipment, Gravity settlers, Cyclone Separators, Bag filters, Scrubbers, Electrostatic precipitator, Gaseous control devices, Incinerators and their trouble shooting. **8hr**

Unit 6

Planning and Management

Organizational structure, work Planning, preparation and scheduling, cost estimates. **5hr**

References

1. "CPHEEO Manual On Water Supply And Treatment"
2. "CPHEEO Manual ON Sewerage And Sewage Treatment"
3. Industrial air pollution control system - Neumann

M. Tech (Environmental Science and Technology)**(ESTC-42) Project Management****Teaching Scheme: L: 3 T: - Credits: 3**

Unit 1	Hrs
Introduction to project management, necessity, project lifecycle, key stake holders, management process groups and their responsibilities, concepts of project initiation	3 hr
Unit 2	
Project planning, scope, work breakdown structure, scheduling, PM planning software, cost estimating and planning, responsibility matrix, resource allocation and leveling/smoothing, Risk planning, procurement plans, communication and quality planning	6 hr
Unit 3	
Project implementation, developing project team, team structure, leadership styles, relationship building, negotiating conflict, motivation and ethics. Project closure and post project analysis	8 hr
Unit 4	
Project quality concepts, planning and assuring project quality, quality audit, SWOT analysis, quality control tools	6 hr
Unit 5	
Risk management, identification, analysis, prioritizing, tools and techniques for acceptance, avoidance and mitigation and documentation	8 hr
Unit 6	
Global Project management, preparation, planning challenges, politics, culture and law, pitfall avoidance, control and closure, Computerized project management	9 hr

Reference Books:

1. "Practical Project Management", R. G. Ghattas and Sandra.
2. "Planning, Performing and Controlling", Angus Robert and Norman Gundersen.
3. "Project Principles and Applications", Moder and Phillips.
4. "Project Management with CPM, PERT and Precedence Diagrams", VN.
5. "Engineering Management", Stoner. PHI
6. "A Text book of Management", A.S.Deshpande.
7. "Essentials of Management", Koontz, Dounell and Weigrick. TMH
8. "Management and Organization", Kast and Rosinweig. TMH
9. "Quantitative Techniques in Management - Vol. I", L.C. Jhamb. Eurasia.

M. Tech (Environmental Science and Technology)

(ESTE - 43) Environmental Biotechnology

Teaching Scheme: L: 3

T: -

Credits: 3

Unit 1.

Concept of Environmental Biotechnology and Environmental Engineering, scope and importance. Genetic engineering structure of DNA, RNA, Replication of DNA, genetic code, Transcription, Protein synthesis. **5hr**

Unit 2.

Introduction to Genetic Engineering and Recombinant DNA Technology(RDT), Restriction endonucleases, Steps in gene cloning, c DNA and genomic library, Chemical synthesis of gene, Polymerase Chain Reaction (PCR), Vectors and their types, Selection of recombinant clones. **7hr**

Unit 3.

Microbiology of waste water treatment. a) Aerobic processes : Activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds. b) Anaerobic processes : Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactor. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industry. **8hr**

Unit 4.

Air pollution and its control through biotechnology, Biotechnology in reduction of CO₂ emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications. **5hr**

Unit 5.

Microbiology of degradation of xenobiotic in environment – ecological considerations, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Biological detoxification of cyanide, oxalate, urea, petrochemical industry effluents, toxic organics, phenols. **7hr**

Unit 6.

Bioremediation, Types of bioremediations, Bioaugmentation for bioremediation, Bioreactors, Bioremediation of herbicides, pesticides, hydrocarbons, oil spills. Novel methods of pollution control – Vermitechnology, Methane production, Root zone treatment, Membrane technology, Biodegradable plastics. **8hr**

References :

1. Microbial Biotechnology: A. N. Glazer and H. Nikaido .
2. Molecular Biotechnology : Gleek and Pasternack.
3. Biotechnology : A Text Book of Industrial Microbiology, T. D.Brock,
4. Industrial Microbiology : Prescott and Dunn.
5. Biotechnology : B. D. Singh , Kalyani Publishers.

Semester-III

T 31 Industrial Training:

Teaching Scheme Examination Scheme

Contact hrs : 2 Hrs./Week/student

Credit: 4

8 Weeks at the end of First Year and as a part of evaluation at the end of third semester student should submit the report for the 8 week industrial training and give presentation to the concern guide, concern guide should spare 1hrs/week/student

Semester-III & IV

S 32 and D 42 Dissertation Project Phase I & II

The student shall be allowed to submit the dissertation phase I report only after the completion of minimum 50% work of the total project with intermediate /partial results of the dissertation project to the concern guide and the dissertation phase II report only after the full-fledge demonstration of his /her work to the concerned guide. Assessment of the dissertation shall be based on design & implementation aspects, documentation & presentation skills, utility of the dissertation work & publications based on the same.

For the dissertation phase I and phase II concern guide should guide to each student minimum for 2 hrs per week till the final submission of the dissertation of the concern student.

List of Equivalent Subjects

M. Tech. Part I Environmental Science and
Technology –Sem.- I

Code	Subjects from pre-revised syllabus	Code	Subjects from revised
		ESTC10	Research Methodology (Audit)
ESTC1.	Introduction to environmental science and ecology	ESTC11	Physico-Chemical and biological treatment processes
ESTC2.	Environmental Chemistry and microbiology	ESTC12	Environmental Chemistry and microbiology
ESTC3	Energy and environment	ESTC13	Solid waste management
ESTE 1	Elective-I Optimization techniques	ESTE21	Optimization techniques
ESTE 2	Elective-II Industrial waste treatment	ESTE11	Energy and environment
ESTL 1	Seminar -I	ESTS1	Seminar -I

Sem.-II

Code	Subjects from prerevised	Code	Subjects from revised
ESTC4	Physico-Chemical and biological treatment processes	ESTC20	Air pollution and Control
ESTC5	Air pollution and Control	ESTC21	Industrial waste treatment
ESTC6	Environmental Management systems	ESTC22	Advanced water and waste water treatment
ESTE3.	Elective-I Solid waste management	ESTE31	Elective- I Environmental Management systems
ESTE4	Elective-II Advanced water and waste water treatment	ESTE41	Elective-II Operation and maintenance of Environmental facilities
ESTL2.	Seminar -II	ESTS2	Seminar -II

Note –

New concepts & specialized areas are developing in the field of Environmental Science and technology For acquainting students to them, new subjects are included in the curriculum. Therefore wherever possible an equivalent subjects are given in revised course to the subjects of pre-revised course

M. Tech (Environmental Sci. & Technology) - Semester III

Sr. No	M. Tech (Environmental Sci. & Technology) Semester III Pre-revised syllabus	M. Tech (Environmental Sci. & Technology) Semester III Revised syllabus
1	Industrial Training	Industrial Training
2	Dissertation Phase – I	Dissertation Phase-I

M. Tech (Environmental Sci. & Technology) - Semester IV

Sr. No	M. Tech (Environmental Sci. & Technology) Semester IV Pre-revised syllabus	M. Tech (Environmental Sci. & Technology) Semester IV Revised syllabus
1	Dissertation Phase – II	Dissertation Phase-II