SHIVAJI UNIVERSITY, KOLHAPUR

M.Tech. (Environmental Science and Technology)

Course Structure

Semester I

Applicable For
Academic Year 2016-17

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	Remote Sensing and GIS Applications in Environmental Engineering	4	-		4
4	ESTC 13	Solid and Hazardous Waste Management	3	1		4
5	ESTE 1	Elective-I	3	-		3
6	ESTE 2	Elective-II - **Open Elective ***	3	-		3
7	ESTS 1	Seminar -I	-	-	2	2
8	ESTC 14	Laboratory- I Water Quality Analysis	-	-	2	1
9	ESTC 15	Laboratory-II Remote Sensing and GIS Applications in Environmental Engineering	-	-	2	1
10	ESTC 16	Laboratory-III Solid and Hazardous Waste Management	-	-	2	1
		Total	1	1	8	23
Total Contact hours per week = 28						

Elective I

ESTE-11 Energy and Environment

ESTE - 12 Environmental Toxicology

ESTE - 13 Environmental Chemistry and Microbiology

* **Students from M.Tech any branch of Department of Technology Can opt for this Elective.**

Elective II: choose from list on next page

Semester –I Open Elective*)

Sr.No.	Elective-II (Open Elective*)	Branch
1	E15(V) Digital System And Testing	Electronics Technology
2	E 15 (V)Mixed Signal ASIC Design	
3	E 15 (E) Automotive Embedded Systems	
4	FTE-21: Advances in processing of dairy Technology	Food Technology
5	FTE-22: Food rheology and texture	
6	FTE-23: Advances in cereals and pulses processing technology	
7	ETE 2 Fuel and Combustion Technology	Energy Technology
8	ETE 2Solar Passive Architecture	
9	ETE 2Energy storage systems	
10	ESTE-21 Optimization Techniques	Environmental Science and Technology
11	ESTE-22 Design of Energy Efficient Building	
12	ESTE-23 Operational Health and Safety Management	
13	CS515 Advanced Operating Systems	Computer Sci. &Technology
14	CS515 Real Time Systems	
15	CS515 Web Engineering	

Minimum Number of students for selection of Elective -8
Minimum Number of students for selection of Elective -36*
Preference will be given to core branch

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	Environment Management Systems	3	1	-	4
3	ESTC 22	Advanced Water and Wastewater Treatment	3	1	-	4
4	ESTE 3	Elective-III	3	-	-	3
5	ESTE 4	Elective-IV - **Open Elective ***	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 Industrial Waste Treatment

ESTE - 32 Environmental Policies and Legislation

ESTE - 33 Environmental Sanitation

Elective IV: Choose from list on next page

* **Students from M.Tech any branch of Department of Technology Can opt for this Elective.**

Semester –II (Open Elective*)

Sr.No.	Elective-IV (Open Elective*)	Branch
1	E 25 (V) VLSI in Signal Processing	Electronics Technology
2	E25(E) High Performance Networks	
3	E 25 (E) High Speed Digital Design	
4	FTE-41: Recent developments in processing of plantation crops	Food Technology
5	FTE-42: Simulation and modeling in food processing	
6	FTE-43: Project management for food processing industries	
7	ETE 4-1 Power Co-generation	Energy Technology
8	ETE 4-2 Energy modeling and project Management	
9	ETE 4-3 The New Energy Technologies	
10	ESTE-41 Operation and Maintenance of Environmental Facilities	Environmental Science and Technology
11	ESTE-42 Rural Water Supply and Sanitation	
12	ESTE-43 Environmental Biotechnology	
13	CS525 Geographical Information Systems	Computer Sci. &Technology
14	CS525 Artificial Intelligence and Natural Language Processing	
15	CS525 System modeling and simulation	

Minimum Number of students for selection of Elective -8
Minimum Number of students for selection of Elective -36*
Preference will be given to core branch

(Semester III)

Sr. No.	Subject Code	Subject Title	Contact hours			Credits
			L	T	P	
1	T31	*Industrial Training	-	-	**2	4
2	S32	Dissertation Phase-I	-	-	**5	10
		Total	-	-	7	14
**Total Contact hours per week/students = 2 &5 respectively for for T31 & S32						

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

* OR

* Industrial Training will be split in two slots of four weeks during semester III.

** Average contact hours/week/student

(Semester IV)

Sr. No.	Subject Code	Subject Title	Contact hours			Credits
			L	T	P	
1	D 42	Dissertation Phase- II	-	-	5	20
		Total	-	-	**5**	**20**
Total Contact hours per week = 5						

Shivaji University, Kolhapur First Year M. Tech Environmental Science and Technology(Semester I)	
1.ESTC 10Research Methodology (Audit)Research Methodology (Audit)	
Old Syllabus	**New Syllabus**
Teaching Scheme: L: 2 hrs/weekT: -- Credits: --	Teaching Scheme : L : 2 hrs/weekT: -- Credits: --
	Course Objective: 1. To provide knowledge of basic concepts of research and its methodologies 2. To prepare project proposal
	Course Outcome: 1. Able to know the basic concepts of research. 2. Able for select and define appropriate research problem and parameters for writing a research report and thesis. 3. Understand measurement and Scaling Techniques 4. Able to analysis of Variance and Co-variance.
Unit 1 **4 HRS** **Research Methodology: An Introduction** Objectives of Research, Types of Research, Research Methods and Methodology, Defining a Research Problem, Techniques involved in Defining a Problem	**Unit 1** **4 HRS** **Research Methodology: An Introduction** Objectives of Research, Types of Research, Research Methods and Methodology, Defining a Research Problem, Techniques involved in Defining a Problem
Unit 2 **6 HRS** **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	**Unit 2** **6 HRS** **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
Unit 3 **4 HRS** **Measurement and Scaling Techniques** Measurement inResearch,MeasurementScales,Scales,SourcesinError, Techniques ofDevelopingMeasurementTools,Scaling,Meaning ofScale, ScaleConstructionTechniques.	**Unit 3** **4 HRS** **Measurement and Scaling Techniques** Measurement inResearch,MeasurementScales,Scales,SourcesinError, Techniques ofDevelopingMeasurementTools,Scaling,Meaning ofScale, ScaleConstructionTechniques.
Unit 4 **4 HRS** **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	**Unit 4** **4 HRS** **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

Unit 5 **4 HRS** **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	**Unit 5** **4 HRS** **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
Unit 6 **4 HRS** **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	**Unit 6** **4 HRS** **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
InterpretationandReport **1**	**InterpretationandReport** **1**
	References: 1. Research Methodology: R. Panneerselvam, Prentice Hall Publication ,2004 2. Research Methodology: Methods and Techniques by C. R. Kothari New Age International Publishing,second edition 3. Statistical Methods for Research Workers , Fisher R. A. Macmillan Pub Co, 1970

2.ESTC-11Physico-Chemical and Biological Treatment ProcessesPhysico-Chemical and Biological Treatment Processes	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 4 hrs/weekCredits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 4 hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge and concepts of physical, and chemicalprocesses used for water and wastewater treatment. 2. To provide knowledge for design water and wastewater treatment plant.
	Course Outcome: 1. Able to know various processes used in water and wastewater treatment. 2. Able for various design crireria with design procedure forwater and wastewater treatment plant.

	3. Understanding of basic principle of mass transfer. 4. Able to learnmechanisms and modes of disinfection.
Unit 1 **6 HRS** 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.	**Unit 1** **6 HRS** 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.
Unit 2 **8 HRS** 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.	**Unit 2** **8 HRS** 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.
Unit 3 **5 HRS** 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.	**Unit 3** **5 HRS** 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.
Unit 4 **8 HRS** 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.	**Unit 4** **8 HRS** 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.
Unit 5 **6 HRS** 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.	**Unit 5** **6 HRS** 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.
Unit 6 **7 HRS** Objectives and fundamentals of biological treatment, types of biological treatment processes. Conventional activated sludge process, process kinetics and design considerations, process control measures,	**Unit 6** **7 HRS** 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.	operational problems, Introduction to modifications. Trickling filter, classification, process design considerations. Fundamentals of anaerobic treatment, general design considerations, types of anaerobic reactors.
References: 1. Theory and Practice of water and Wastewater treatment – Ronald Droste. 2. Environmental engineering – Peavy, Rowe and Tchnologous. 3. Physico-chemical processes of water purification – Weber 4. Wastewater Engineering treatment and reuse– Metcalf Eddy	**References:** 1. Theory and Practice of water and Wastewater treatment – Ronald Droste. 2. Environmental engineering – Peavy, Rowe and Tchnologous. 3. Physico-chemical processes of water purification – Weber 4. Wastewater Engineering treatment and reuse– Metcalf Eddy

3.ESTC-12Environmental Chemistry and MicrobiologyRemote Sensing and GIS Applications in Environmental Engineering	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 4 hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 4 hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide necessary knowledge of the principles, applications, trends, and pertinent issues ofgeographical information systems and sciences, including remote sensing (RS). 2. To provide knowledge of various Application of remote sensing and GIS
	Course Outcome: 1. Ability to know the basicremote sensing and GIS 2. Knowledge of Application of remote sensing and GIS in various fields. 3. Develop a critical awareness of the strengths and limitations of monitoring using Remote Sensing 4. Widerrole of Remote Sensing and GIS in environmental modeling and monitoring.
Unit 1 6 HRS 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 currant on the various pollutants, Effect of gravitational force and rain scrubbing on air pollutants, Chemical	**Unit 1 7 HRS** 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.

properties of air pollutants chemisorptions, effect of solar radiation on acidic basic characteristics, reducing, oxidizing properties of air pollutants.	
Unit 2 **8 HRS** 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.	**Unit 2** **6 HRS** Optical, infrared and microwave imagery, Analysis of imagery, Visual and machine interpretation of imagery, Ground truth data, Digital image processing.
Unit 3 **6 HRS** Air pollution control Engineering, Control of particulate matter Gravity setting, fabric filters, centrifugal imp actors, 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, SO_2, H_2S, CO, CO_2, NO, NO_2.	**Unit 3** **8 HRS** 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.
Unit 4 **5 HRS** 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.	**Unit 4** **6 HRS** Fundamentals of GIS: Definition, Components, spatial data, thematic characteristics, rasters and vectors, databases and database management.
Unit 5 **8 HRS** 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	**Unit 5 6 HRS** 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.

of F/M ratio, acclimatization of bacteria, bioassay tests, aerobic and aerobic metabolism.	
Unit 6 **7 HRS** Structure of prokryotic and eukryotic 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.	**Unit 6** **7 HRS** GIS applications: Forestry, Bio-diversity, Environment, Soil resource management, Hydrological modelling, Public utilities (water distribution, sewerage, solid waste management).
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	**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.

4.ESTC-13Solid Waste Management	**Solid and Hazardous Waste Management**
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/week T : 1 hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3 hrs/week T : 1 hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge of Solid wastemanagement. 2. To provide knowledge biomedical and Hazardous Wastes generation and management.
	Course Outcome: 1. Ability to know the functional elements of solid waste with management. 2. Able to knowbiomedical and HazardousWastes management. 3. Knowledge for solving and communication skills to specific problems in order to practice the role of health and safety professionals in managing hazardous materials and wastes. 4. Understand fundamental principles of existing and emerging technologies for the treatment of waste and

	recovery of value from waste.
Unit 1 **6 HRS** Solid waste management: Objectives, Functional elements, Environmental impact of mismanagement. Solid waste: Sources, Types, Composition, Quantities, Physical, Chemical and Biological properties.	**Unit 1** **6 HRS** Solid waste management: Objectives, Functional elements, Environmental impact of mismanagement. Solid waste: Sources, Types, Composition, Quantities, Physical, Chemical and Biological properties. Indian scenario.
Unit 2 **7 HRS** 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.	**Unit 2** **7 HRS** 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.
Unit 3 **6 HRS** 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.	**Unit 3** **4 HRS** 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..
Unit 4 **8 HRS** 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.	**Unit 4** **8 HRS** 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.
Unit 5 **6 HRS** Biomedical Waste: Generation, identification, storage, collection, transport, treatment, common treatment and disposal, occupational hazards and safety measures. Biomedical waste legislation in India	**Unit 5** **7 HRS** Biomedical Waste: Generation, identification, storage, collection, transport, treatment, common treatment and disposal, occupational hazards and safety measures. Biomedical waste legislation in India. E-waste management.
Unit 6 **7 HRS** 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.	**Unit 6** **8 HRS** Definition and identification of Hazardous Wastes, Sources and Characteristics of hazardous wastes, Hazardous waste in municipal waste, Hazardous waste regulations and legislations, Minimization of Hazardous wastes, Handling and storage of Hazardous wastes, Hazardous Waste Treatment technologies, Physical, chemical & thermal methods of stabilizations, Solidification, Chemical Fixation & encapsulation, Incineration of Hazardous waste landfills, Reclamation of Hazardous waste landfill sites.Radioactive waste management
References:	**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.	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.

5.ESTE-1Elective – I -ESTE-11 Energy and Environment	**Energy and Environment**
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To teach renewable and non renewable energy resources with energy crisis. 2. To teach Energy Storage and Heat Energy recovery systems
	Course Outcome: **1.** Get knowledge ofenergy crisis with renewable and non renewable energy resources. **2.** Get idea about variousEnergy Storage system with Energy recovery systems. **3.** Learn variousnon-conventional energy sources. **4.** Understanding concept biomass energy utilization.
Unit 1 **5 HRS** 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.	**Unit 1** **5 HRS** 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
Unit 2 **6 HRS** 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.	**Unit 2** **6 HRS** 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.
Unit 3 **6 HRS** 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.	**Unit 3** **6 HRS** 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.

Unit 4 **8 HRS** 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.	**Unit 4** **8 HRS** 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.
Unit 5 **7 HRS** 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.	**Unit 5** **7 HRS** 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.
Unit 6 **8 HRS** 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.	**Unit 6** **8 HRS** 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.
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.	**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.
ESTE-1Elective – I –ESTE-12 Environmental ToxicologyEnvironmental Toxicology	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge of experimental methods for measuring toxicity. 2. To provide knowledge of Environment and health and environmental stress.
	Course Outcome: 1. Able to understand Environmental Toxicology and experimental methods for measuring toxicity.

	2. Good knowledge of Ecological risk assessment process and Environment and health and environmental stress. 3. Identify the significance and applications of toxicology. 4. Understand Occupational health hazards.
Unit 1 **7 HRS** 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, hellucinogens, phytotoxins and animal toxins.	**Unit 1** **7 HRS** 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, hellucinogens, phytotoxins and animal toxins.
Unit 2 **8 HRS** 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.	**Unit 2** **8 HRS** 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.
Unit 3 **6 HRS** 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).	**Unit 3** **6 HRS** 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).
Unit 4 **8 HRS** 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.	**Unit 4** **8 HRS** 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.
Unit 5 **8 HRS** 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.	**Unit 5** **8 HRS** 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.

Unit 6 **5 HRS** 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.	**Unit 6** **5 HRS** 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.
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.	**Refrences-** 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.

ESTE-1Elective – I –ESTE-13 Disaster Management and Risk AnalysisEnvironmental Chemistry and Microbiology	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide necessary knowledge of chemistry of pollutants in the atmosphere and water with water treatment technology. 2. To provide knowledge about bacterial structure.
	Course Outcome: 1. Able to know chemistry of pollutants in the atmosphere and water with water treatment. 2. Able to get knowledge about bacterial structure. 3. Understanding of chemistry of pollutants in the water. 4. Able to use instrumental methods of pollutant analysis.
Unit 1 **6 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.	**Unit 1** **6 HRS** 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 currant 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.

Unit 2 **7 HRS** Risk assessment, Contingency Planning, Major Natural disasters, Each Quake Cyclone, Flood Epidemics, Check list-Agencies, Personnel Equipment, Materials, Services and Time management	**Unit 2** **8 HRS** 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.
Unit 3 **7 HRS** Prediction and forecasting, disaster preparedness, data base assessment of Disaster relief and Rehabilitation measures, Mobilization of men and Material	**Unit 3** **6 HRS** Air pollution control Engineering, Control of particulate matter Gravity setting, fabric filters, centrifugal imp actors, 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, SO_2, H_2S, CO, CO_2, NO, NO_2.
Unit 4 **6 HRS** Legal frame work, Trigger mechanism – Water. Climate and Geologically Related Chemical, Industrial, Nuclear, GIS enabled Disk net	**Unit 4** **5 HRS** 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.
Unit 5 **7 HRS** Maps Special and non special data. Activities, Agencies, Resources and Funds, Implementation and Monitoring Flood Hazard Map	**Unit 5** **8 HRS** 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 aerobic metabolism.
Unit 6 **7 HRS** Quick response flow chart, Emergency operation center, Emergency support Functions, Disaster specific modules.	**Unit 6** **7 HRS** Structure of prokryotic and eukryotic 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.
References- 1. "National Disaster Response Plan", A Document prepared by Department of Agriculture and Cooperation. 2. "Concept of Trigger Mechanism",Gpvt. Of India, Ministry of Home Affairs, February 2001, Publication. "Water and Climate related Disasters", Govt. of India, Ministry of Home affairs, Publication.	**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

6.ESTE-2Elective – II -ESTE – 21Optimization TechniquesOptimization Techniques	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To study of optimization problems, Linear programming, Non-Linear programming, dynamic programming. 2. To study of genetic algorithm and scope of optimization techniques to environmental systems.
	Course Outcome: 1. An ability to formulate, and solve problems on environmental systems. 2. An ability to apply effectively optimization techniques in environmental systems. 3. Develop ability to challenging engineering problems that involve constrained resource allocation. 4. Understand the scope of Computer application in Environmental Science and Engineering.
Unit 1 **8 HRS** 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.	**Unit 1** **8 HRS** 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.

Unit 2 **6 HRS** Linear programming: Construction of LP model, Simplex method, Big M and two phase methods, Special cases, Duality and sensitivity analysis, Economic interpretation of duality.	**Unit 2** **6 HRS** Linear programming: Construction of LP model, Simplex method, Big M and two phase methods, Special cases, Duality and sensitivity analysis, Economic interpretation of duality.
Unit 3 **7 HRS** Non-linear programming: Unconstrained optimization techniques, Classification of methods, Dichotomous optimization method, Steepes ascent, Newton method, Constrained optimization, Separable and quadratic programming.	**Unit 3** **7 HRS** Non-linear programming: Unconstrained optimization techniques, Classification of methods, Dichotomous optimization method, Steepes ascent, Newton method, Constrained optimization, Separable and quadratic programming.
Unit 4 **6 HRS** Dynamic programming: Multistage decision process, recursive relationships, Principle of optimality, Computational procedure in DP, DP applications, Problem of dimensionality.	**Unit 4** **6 HRS** Dynamic programming: Multistage decision process, recursive relationships, Principle of optimality, Computational procedure in DP, DP applications, Problem of dimensionality.
Unit 5 **8 HRS** 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.	**Unit 5** **8 HRS** 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.
Unit 6 **5 HRS** Scope of Computer application in Environmental Science and Engineering, Applications of optimization techniques to Environmental systems.	**Unit 6** **5 HRS** Scope of Computer application in Environmental Science and Engineering, Applications of optimization techniques to Environmental systems.
References- 1. Engineering optimization – S. S. Rao 2. Operation research – Taha. 3. Genetic algorithm – Goldberg.	**References-** 1. Engineering optimization – S. S. Rao 2. Operation research – Taha. 3. Genetic algorithm – Goldberg.

ESTE-2Elective – II –ESTE – 22 Environmental EconomicsDesign of Energy Efficient Buildings	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To teach Green Buildings within the Indian Context. 2. To provide knowledge of Energy management options with

	various rating systems.
	Course Outcome: 1. Able to understand green building with Sustainable Site Selection as well as Orientation and Building envelop. 2. Able to use various concepts like energy and water conservation with additional knowledge of different rating systems for building. 3. Able to study of energy management options. 4. Understanding of various water conservation techniques.
Unit 1 6HRS Introduction – Ecology and Economics, Interlinking between Economy and Environment, Definition, scope and importance of Environment Economics, Environment Economics and Ecological Economics, Ecological Technologies, Natural resource valuation and accounting, valuation of tangible and intangible.	**Unit 1 6HRS** **Introduction** Green Buildings within the Indian Context, Sustainable Site Selection, Orientation, Building envelop, Building plan layout,Design of Doors and windows, Natural ventilation, Solar energy, Use of solar energyfor water heating, Solar concentrators, Solar photovoltaic panels, Direct and indirectlighting, comparison of various lighting devices- electric tubes, incandescent lamps,CFL and LED lamps, Indirect lighting devices like Light Tubes, Thermal Transmittance of Building
Unit 2 8 HRS Economics of Environmental Protection: Theory of Public goods, Market Inefficiency and Market failure, Externalities - Property Rights and Externalities , Non-Convexities and Externalities, Pigouvian taxes and subsidies, , Common Property Rights, The Problem of Social Cost , marketable pollution permits and mixed instruments (the charges and standards approach), Coase's bargaining solution and collective action. Economic Instruments for Environmental Protection, Command & Control versus Incentives and Subsidies - Available Policy Options - Effectiveness of these instruments, International Comparisons.	**Unit 2 6HRS** Buildings and climate, Cost Effective vs. Energy efficiency in buildings.Energy efficient buildings, Forms of energy, Embodied and Life cycle energy, Energy Efficiency in Building materials. Building Materials from Agro andIndustrial waste, Biomass resources, treated thatch, Concept of Embodied Energy, Embodied energy of various common building materials, Thermal propertiesof building components, Thermal storage, emissivity, reflectivity, Selection of materials and surface treatment for, Ventilation & lightening, Positioning of openings, Day lighting , Active and Passive Architecture,
Unit 3 8 HRS Environmental Evaluation: Economic principles of cost benefit analysis; Measurement of Environmental economic value of Renewable and Non-Renewable Resources ; Methods of valuation - Contingent Valuation Method, Travel Cost methods, Hedonic Market Methods. Market based instruments for controlling pollution; Cost of controlling greenhouse gases; Carbon trading and CDM mechanisms. Systems of Integrated environmental accounting ; Green accounting. Economic Growth and the Environment, Environmental Kuznets'	**Unit 3 8 HRS** Energy management options -Energy audit and energy targeting - Technological options for energy management Energy efficient lighting -Terminology -Cosine law of luminance –Types of lamps -Characteristics-Design of illumination systems -Good lighting practice -Lighting control -Steps for lighting energy conservation. Overview of the significance of energy use and energy processes in building -Indoor activities and environmental control -Internal and external factors on energy use and the attributes of the factors -

curve, Foreign Direct Investment Inflow and the Environmental quality.	Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications Thermal comfort -Ventilation and air quality -Air-conditioning requirement -Visual perception -Illumination requirement -Auditory requirement.
Unit 4 7HRS Environmental Economics and Sustainable Development: Definition, concept and dimensions of Sustainability, Issues in Sustainable Development, Guiding principles of Sustainable Development, Strategic Planning for Sustainable Development, Sustainability Indicators. Models of Sustainability, Environmental Sustainability Index (ESI). Economic Reforms and Sustainable Development. National and Global Challenges of Sustainable Development, Instruments for implementing sustainability- Finding Right Prices, The Hardwick- Solow Rule, Critical Rental Capital; Safe Minimum Standard; Steady State Principles. Policy Implications for implementing sustainability.	**Unit 4 6HRS** Climate, solar radiation and their influences -Sun-earth relationship and the energy balance on the earth's surface -Climate, wind, solar radiation, and temperature -Sun shading and solar radiation on surfaces -Energy impact on the shape and orientation of buildings. Rain water harvesting, potable water and bore well recharging methods, Minimization of water use, Dual flush, waterless urinals, smart controlled water taps, Segregation and treatment of wastewater, Various treatment technologies like septic tank, Anaerobic filter, CWTS, biogas plants advanced treatment options like carbon bed, reverse osmosis, electrodialysis, ion exchange, recycling of treated wastewater for different non potable purpose,
Unit 5 6 HRS Eco-technologies and Environmental Economics: Eco-technology and its relevance to development of economics and evolution of environment, importance of eco-technology in reducing consumption of resources , minimizing production of wastes , reducing cost of products and in protection and conservation of natural resources; Classification of eco-technology; Need of extensive and vigorous research and development of Eco-technology on the basis of ecology principles.	**Unit 5 8 HRS** Building Form –Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, Grouping of buildings. Building Fabrics -Windows and doors, Floors, Walls, Masonry, Ecological walling systems, Thermal Properties of construction material. Infiltration and ventilation, Natural ventilation in commercial buildings, passive cooling, modeling air flow and ventilation, Concepts of daylight factors and day lighting, daylight assessment, artificial lighting, New light sources. Cooling buildings, passive cooling, mechanical cooling. Recycling of Building materials.
Unit 6 5 HRS Environmental Economics, Eco-politics and Accounting : Polluter Pays Principle, Trade and Eco-politics , Pollution Export, Trans-boundary issues, Developmental priorities - Pre independence and Post-independence period - in India, Role of NGOs, Individuals , and Women in environmental protection in India. Rehabilitation and Resettlement Issues , Government Policies and Social Awareness for the Protection of Environment.	**Unit 6 6 HRS** Green Building Various softwares and Various rating systems LEED criteria, USGBS, CIII-Godrej Green rating, GRIHA,ASHRAE, CDM and Carbon trading, Environmental clearance of buildings. Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP, Energy awareness, monitoring energy consumption, Building Environmental Assessment-environmental criteria -assessment methods -assessment tools (e.g. LEED). Ecohomes, Sustainablearchitecture and urban design –principles of environmental

	architecture. Benefits of green buildings –Energy Conservation Building code -NBC -Case Studies –Green Buildings in Auroville and Dakshina Chitra, Tamil Nadu, India.
References- Allen V. Kneese and James L. Sweeney, eds. **Handbook of Natural Resource and Energy Economics**, Chapters 2,12,14,17, North Holland,1985. Bhattacharya, R.N. 2001. Environmental Economics: An Indian Perspective, Oxford University Press. Brundtland,G.H. 1987. Our Common Future: The World Commission on Environmental and Development. Oxford, UK: Oxford University Press.34.	**References-** 1. "Alternative Building Materials and Technologies"Rao 2. Krieder and A. Rabl, Heating and Cooling of Buildings -Design forEfficiency, McGraw Hill, 1994. 3. S.M. Guinnes and Reynolds, Mechanical and Electrical Equipment for Buildings, Wiley, 1989 4. Shaw, Energy Design for Architects, AEE Energy Books, 1991 5. ASHRAE, Handbook of Fundamentals, Atlanta, 1997 6. Public Technology, Inc. (1996). Sustainable Building Technical Manual: GreenBuilding Design, Construction, and Operations. Public Technology, Inc., Washington,DC. 7. Sim Van Der Ryn, Stuart Cowan, "Ecological Design", Island Press (1996) 8. Dianna Lopez Barnett, William D. Browning ,"A Primer on Sustainable Building", 9. Rocky Mountain Green Development Services,. 10. The HOK Guidebook to Sustainable Design, Sara Mendler and William Odell, JohnWiley. 11. David A. Gottfried, Sustainable Building Technical Manual., Public Technology Inc 12. Richard D. Rush, . Building System Integration Handbook., New York: John Wiley &Sons 13. Ben Farmer &HentieLouw., Companion to Contemporary Architectural Thought,London & New York: Routledge 14. Peter Noever (ed)., Architecture in Transition: Between Deconstruction and NewModernism., Munich: Prestel.

ESTE-2Elective – II –ESTE – 23 Environmental Statistics and Experimental DesignsOperational Health and Safety management	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To get knowledge of principles of safety management. 2. To enable the students to learn about various functions and

	activities of safety division.
	Course Outcome: 1. Able to understanding of principles of safety management. 2. Able to work as safety engineer in industry 3. Interpret and apply legislative requirements for industrial standards with best practices in a variety of workplaces. 4. Be able to make aware about the hazards, causes of accidents to the site employees.
Unit 1 **7 HRS** 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 measuresskewness and kurtosis.	**Unit 1** **6 HRS** Hazards and causes of accidents, safety measures Physical , Chemical , Biological and Ergonomical Hazards ,Industrial Hazards, Electrical Hazards and Hazards in Construction IndustryFire and other Hazards Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Safe use of machines and tools
Unit 2 **6 HRS** Probability: sample space, events, equally likely out comes probability of events (frequency approach). Addition and ultiplication Theorems and condition probability**.**	**Unit 2** **7 HRS** Safety legislation and standards for construction industry, Organization for safety, site management, safety manual and check lists Safety officer, safety committee, safety training, safety audit **Techniques of Environmental Safety** Elements of a health and safety policy and methods of its effective implementation and review. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents-Principles of quality management systems in health and safety management.
Unit 3 **8 HRS** Standard distributions : Binomial, Poisson, normal, expon- ential. 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.	**Unit 3** **5 HRS** Safety precautions and practices in various construction activities like excavation, concreting,scaffold erection and dismantle, concreting, steel erection and demolition of structures, Organising for safety, Health and Enviornment. Organisation : Structure, Function and responsibilities Safety Committee : Structure and function Safety and Health training, Stress and Safety.
Unit 4 **8 HRS** 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	**Unit 4** **8 HRS** Occupational hazards and personal protective equipment Legislative measures in industrial safety: Factories Act, 1948, Workman's Compensation Act, 1943,

errors, critical region. Testing of equality of proportion and for equality of means when variances are known and unknown. P-value chi-squre test of goodness of fit and of independence.	Employees State Insurance Act, 1948. Mines Act , Air (Prevention and control) Pollution Act, 1981, Water (Prevention and Control) Pollution Act, 1974, Boiler Vessels Act. Child Labour and Women Employee Act. The factories rules, History, Provisions under the factories Act and rules made there under with amendments, Functions of safety management. ILO Convention and Recommendations in the furtherance of safety, health and welfare.
Unit 5 **4 HRS** 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.	**Unit 5** **7 HRS** Management of accidents Principles of accidents prevention : Definition : Incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc. Accident Prevention : Theories / Models of accident occurrences, Accident and Financial implications, Hazard identification and analysis, fault tree analysis, Eventtree analysis, failure modes and effects analysis, Job safety analysis - examples, Plant safety inspection - objectives and types check procedure inspection report.
Unit 6 **8 HRS** 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.	**Unit 6** **7 HRS** **Education and Training** Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Importance of training-identification of training needs- Principles and methods of effective training methods –programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training – safety training to workers.Feedback and evaluation mechanism.
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&Dasgupta: 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	**References-** 1. Safety and Health in Construction, ILO, 1992 2. Construction hazard & Safety handbook, R Hudson and R W King, Butterworths 3. R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006) 4. Slote.L, Handbook of Occupational Safety and Health, John Willey and Sons, NewYork.

Company New Delhi Kolkata, 6. Rechard A. Johnson: Probability and Statistics for Engineers. 7. Hogg and Tanis : Probability and Statistical Inference. 8. Douglas C. Montgomery : Design and Analysis of Experiments.	5. Industrial Safety -National Safety Council of India. 6. Frank P Lees - Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London (1991). 7. National Safety Council, "Accident Prevention Manual for IndustrialOperations", N. S. C. Chicago, 1988. 8. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, NewYork, 1980. 9. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997. 10. John Ridley, "Safety at Work", Butterworth & Co., London, 1983. 11. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973

7.ESTS-1Seminar-ISeminar-I	
Old Syllabus	**New Syllabus**
Teaching Scheme : P : 2 hrs/Week/studentCredits: 2	Teaching Scheme : P : 2 hrs/Week/studentCredits: 2
	Course Objective: 1. Providing knowledge of effective oral presentations. 2. To motivation about presentations skills.
	Course Outcome: **1.** Be able to understand the reading, understanding the research paper and able to develop skill tosummarize it with optimum words. **2.** Able to give presentation on allotted research topic. **3.** Able to recognize the need for lifelong learning. **4.** Understanding and given preference to new ideas, concepts, technologies in Environmental engineering.
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	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	present context, report documentation and presentation skills. Guide should spare for 2hrs /week/student for seminar	

8.ESTC-14 Laboratory- I Water Quality analysisWater Quality analysis	
Old Syllabus	**New Syllabus**
Teaching Scheme : P : 2 hrs/week Credits: 1	Teaching Scheme : P : 2 hrs/week Credits: 1
	Course Outcome: Ability to take samples, analyze and interpret the results of water samples.
A performance based on Experiments, or assignment or Visit report	A performance based on Experiments, or assignment or Visit report
9.ESTC-15Laboratory- IIEnvironmental Chemistry and microbiologyRemote sensing and GIS applications in environmental Engineering	
Teaching Scheme : P : 2 hrs/week Credits: 1	Teaching Scheme : P : 2 hrs/week Credits: 1
	Course Outcome: Able to know use of various equipments in Remote sensing and GIS like GPS, DGPS and learn how to practical implementation in various environmental fields.
A performance based on Experiments, or assignment or Visit report	A performance based on Experiments, or assignment or Visit report
10.ESTC-16Laboratory- III Solid waste managementSolid and Hazardous waste management	
Teaching Scheme : P : 2 hrs/week Credits: 1	Teaching Scheme : P : 2 hrs/week Credits: 1
	Course Outcome: Be able to design and optimize techniques in treatment after study of physical and chemical analysis of Solid and Hazardous waste.
A performance based on Experiments, or assignment or Visit report	A performance based on Experiments, or assignment or Visit report

Shivaji University, Kolhapur First Year M. Tech Environmental Science and Technology (Semester II)	
1.ESTC-20Air Pollution and Control	**Air Pollution and Control**
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 4hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 4hrs/week Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide the basic knowledge of air pollution and its control. 2. To develop a skill of design and operation of control devices for gaseous and particulate pollutants.

	Course Outcome: 1. Able to define air pollution and its control 2. Understanding design skills andoperation of control devices for gaseous and particulate pollutants. 3. Understand reduction of emissions from automobile source by different methods and Alternative fuels and their utilizations. 4. Ability to use the basic and advance air pollution knowledge in research and development.
Unit 1 6 HRS Physics of atmosphere, Solar radiation, Wind circulation, Lapse rate, Inversion, Stability conditions, Pasquil stability model, maximum mixing depth, Wind rose, Plume behavior, Heat island effect, Green house effect, Rain drop formation, Visibility, Photochemical reaction.	**Unit 1 6 HRS** Physics of atmosphere, Solar radiation, Wind circulation, Lapse rate, Inversion, Stability conditions, Pasquil stability model, maximum mixing depth, Wind rose, Plume behavior, Heat island effect, Green house effect, Rain drop formation, Visibility, Photochemical reaction.
Unit 2 7 HRS 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.	**Unit 2 7 HRS** 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.
Unit 3 7 HRS Particulate matter; Definitions of different particulate matter, Distribution and source of SPM, Terminal settling velocity, Hood and duct design, Particulate collection design.	**Unit 3 7 HRS** Particulate matter; Definitions of different particulate matter, Distribution and source of SPM, Terminal settling velocity, Hood and duct design, Particulate collection design.
Unit 4 8 HRS Control equipment for particulate matter; Settling chamber, Cyclone, Wet collectors, Fabric filter, Electrostatic precipitator, Problems on design of equipment, Component detailing collection efficiency.	**Unit 4 8 HRS** Control equipment for particulate matter; Settling chamber, Cyclone, Wet collectors, Fabric filter, Electrostatic precipitator, Problems on design of equipment, Component detailing collection efficiency.
Unit 5 5 HRS General control of Gaseous pollutants, Principles of absorption, Adsorption, Basic design of absorption and adsorption units, Incineration and after burner, Control of sulphuric dioxide, NOx.	**Unit 5 5 HRS** General control of Gaseous pollutants, Principles of absorption, Adsorption, Basic design of absorption and adsorption units, Incineration and after burner, Control of sulphuric dioxide, NOx
Unit 6 7 HRS 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.	**Unit 6 7 HRS** 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.
References- 1. Air Pollution – Wark and Warner.	**References-** 1. Air Pollution – Wark and Warner.

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

2.ESTC-21Industrial Waste treatmentEnvironmental Management systems	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3hrs/week T:1 Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week T:1 Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To study of ecological aspects and study of Environmental impact Assessment. 2. To study of Environmental Management Plan and ISO and ISO 14000 series
	Course Outcome: 1. Understanding ecological aspects and Environmental management systems. 2. Able to getting knowledge Environmental Management Plan and ISO and ISO 14000 series. 3. Develop an understanding of the differences in the structure and function of different types of ecosystems 4. Appreciate the purpose and role of EIA in the decision-making process with technical and social/political limitations of EIA.
Unit 1 **6 HRS** 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.	**Unit 1** **6 HRS** **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
Unit 2 **5 HRS** Waste volume reduction, Waste strength reduction, Neutralization, Proportioning, Equalization. Reuse and recycling concepts.	**Unit 2** **8 HRS** **Environmental Impact Assessment (EIA)** Definitions and Concept, Scope, Objectives, Types of impacts, Elements of EIA, Baseline studies, Methodologies of EIA, Prediction of impacts and its methodology, Uncertainties in EIA, Status of EIAs in India Components - screening - setting - analysis - prediction of impacts - mitigation. Matrices -Networks - Checklists. Importance assessment

	techniques - cost benefit analysis -analysis of alternatives - methods for Prediction and assessment of impacts - air - water -soil - noise - biological - cultural - social - economic environments. Standards and guidelines for evaluation. Public Participation in environmentaldecision-making. EIA related to the following sectors - Infrastructure –construction and housing Mining –Industrial - Thermal Power - River valley and Hydroelectric – coastal projects-Nuclear Power. EIA for coastal projects.
Unit 3 **6 HRS** Treatment techniques for removal of specific pollutants in industrial , wastewaters, e.g., oil and grease, cyanide, fluoride, calcium, magnesium,toxic organics, heavy metals, radioactivity	**Unit 37 HRS** **Environmental Auditing:** Definitions and concepts, Scope and Objectives, Features of Effective auditing -programme Planning - Definition –Organisation of Auditing Programme - pre visit data collection Audit Protocol - Onsite Audit - Data Sampling- Inspections - Evaluation and presentation Exit Interview – Audit Report - Action Plan – Othertypes of Audits - Management of Audits -Waste Management Contractor Audits - Related Audits. Life cycle analysis,Environmental audit statement, Qualities of environment auditor. Environmental Impact Statement (EIS), Sustainable development. **Environmental Management Plan:** Definition, Importance, Development, Structuring, Monitoring, Cost aspects. Strategy for siting of Industries
Unit 4 **6 HRS** 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	**Unit 45 HRS** **Environmental management systems (EMS),** problems andstrategies, planning, decision-makingand management dimensions; Review of political, ecological and remedial actions; Future strategies, multidisciplinary approaches, Environmental policies and legislation in developed anddeveloping countries including India; Policies regarding Air, water, land, forestry, wild life, biodiversity, energy, human resources and multidimensional pollution; Role of internationalenvironmental institutions like U.N. etc.
Unit 5 **7 HRS** Common Effluent treatment plant: Concept, Objectives, Methodology, Cost benefit analysis, Design, Operation and maintenance.	**Unit 5** **7 HRS** **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,OSHA 18000 SHE Audits Introduction to Geographical Information System (GIS) and Remote Sensing inEnvironmental Management. Role of remote sensing and GIS in Environmental Impact Assessment. Geo-indicatorsand environmental indicators. Cleantechnologies.
Unit 6 **10 HRS** 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.	**Unit 6** **7 HRS** 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 **Environmental Ethics:** Ethics in society, Environmental consequences, Responsibility for environmental degradation, Ethical theories and codes of Ethics, Changing attitudes **Socio-Economic Impact Assessment** Definition of social impact assessment. Social impact assessment model and the planningprocess. Rationale and measurement for SIA variables. Relationship between social impactsand change in community and institutional arrangements. Individual and family levelimpacts.
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.	**References-** 1. "Environmental Impact Assessment", Canter (U.S.A) McGraw 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.

3.ESTC-22Advance water and wastewater treatmentAdvance Water and Wastewater Treatment	
Old Syllabus	**New Syllabus**

Teaching Scheme : L : 3hrs/week T: 1 Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3hrs/week T: 1 Credits: 4 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1) To understanding of gas transfer concept and membrane filtration. 2) To study of Grit removal, Flotation, Chemical precipitation and Microbial growth kinetics with Theory and design of Sludge treatment and wetlands.
	Course Outcome: 1. Understanding gas transfer concept and membrane filtration. 2. Get knowledge about various technologies in Advance water and wastewater treatment. 3. Understand Design of aeration and grit chamber. 4. Knowledge of Modeling suspended and attached growth treatment processes.
Unit 1 **5 HRS** Gas transfer: Aeration systems, Energy requirement, Design of aeration systems. Membrane	**Unit 1** **5 HRS** Introduction,Gas transfer: Aeration systems, Energy requirement, Design of aeration systems.
Unit 2 **8 HRS** Membrane 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.	**Unit 2** **8 HRS** Membrane 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.
Unit 3 **6 HRS** 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.	**Unit 36 HRS** 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
Unit 4 **6 HRS** Microbial growth kinetics, Modelling suspended and attached growth treatment processes. Suspended growth processes for biological nitrification and de- nitrification, Biological nitrogen and phosphorous removal.	**Unit 46 HRS** Microbial growth kinetics, Modelling suspended and attached growth treatment processes. Suspended growth processes for biological nitrification and de- nitrification, Biological nitrogen and phosphorous removal.
Unit 5 **7 HRS**	**Unit 5** **7 HRS**

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.	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.
Unit 6 **8 HRS** 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.	**Unit 6** **8 HRS** 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.
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.	**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.

4.ESTE 3-Elective III -31Environmental Management SystemsIndustrial Waste Treatment	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/week Credits: 3 Evaluation Scheme: CIE (25 + 25) SEE 50 Minimum Passing Marks 40	Teaching Scheme : L : 3 hrs/week Credits: 3 Evaluation Scheme: CIE (25 + 25) SEE 50 Minimum Passing Marks 40
	Course Objective: 1. To identify, characterize and develop alternative treatment options for industrial waste 2. To manufacturing process study and water requirement with wastewater generation and conventional and non conventional techniques for treatment of industrial waste
	Course Outcome: 1. To know characteristics of industrial wastewater. 2. To understand water budget of industry with wastewater generation and conventional and non conventional techniques for treatment of industrial waste. 3. Able to plan location of industries, industrial estates and common effluent treatment plants. 4. Be able to carryout industrial water budgeting and performance studies for treatment plant.

Unit 1 **7 HRS** **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	**Unit 1** **6 HRS** 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.
Unit 2 **7 HRS** **Environmental Impact Assessment (EIA)** Definitions and Concept, Scope, Objectives, Types of impacts, Elements of EIA, Baseline studies, Methodologies of EIA, Prediction of impacts and its methodology, Uncertainties in EIA, Status of EIAs in India	**Unit 2** **5 HRS** Waste volume reduction, Waste strength reduction, Neutralization, Proportioning, Equalization. Reuse and recycling concepts.
Unit 36 HRS **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. **Environmental Management Plan:** Definition, Importance, Development, Structuring, Monitoring, Cost aspects. Strategy for siting of Industries	**Unit 3** **6 HRS** Treatment techniques for removal of specific pollutants in industrial , wastewaters, e.g., oil and grease, cyanide, fluoride, calcium, magnesium,toxic organics, heavy metals, radioactivity
Unit 44 HRS **Environmental Ethics:** Ethics in society, Environmental consequences, Responsibility for environmental degradation, Ethical theories and codes of Ethics, Changing attitudes	**Unit 4** **6 HRS** 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
Unit 5 **7 HRS** **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	**Unit 5** **7 HRS** Common Effluent treatment plant: Concept, Objectives, Methodology, Cost benefit analysis, Design, Operation and maintenance.
Unit 6 **9 HRS** 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	**Unit 6** **10 HRS** 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.
References- 1. "Environmental Impact Assessment", Canter (U.S.A) McGraw 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.	**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.

ESTE 3-Elective III -32 Remote Sensing and GIS Applications in Environmental Engineering	**Environmental PoliciesandLegislation**
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/ week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3 hrs/ week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge and make students familiar with environmental issues and laws. 2. To provide knowledge of National and International policies, legislation related environmental.
	Course Outcome: At the end of course student will be able to 1. Understand the relation between constitution and environmental protection. 2. Able to Know aspects towards Environmental protection. 3. Study of Environmental Legislation and policies. 4. Understand various Environmental related Case laws.
Unit 1 **7 HRS** 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.	**Unit 1** **8 HRS** **Introduction** Ancient Indian aspects towards Environmental protection- Historical development of various Environmental Legislations- sustainable development-pre and post independence period , Indian Constitution and Environment Protection, National environmental policies, Institutionalframework (SPCB/CPCB/MoEF), environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Riodeclaration,Various five year plans and the provision for Environment in these plans, National and International

	perspectives.
Unit 2 **6 HRS** Optical, infrared and microwave imagery, Analysis of imagery, Visual and machine interpretation of imagery, Ground truth data, Digital image processing.	**Unit 2** **7 HRS** **Environmental policies** –Policies for conservation and protection of natural resources like National water policy,sustainable developmental policy, National forest policy, other policies related toenvironment also personal properties and monuments, conflict between environmental protection and development, conservation strategy- management of natural resources, Evolving of new principles- Precautionary Principle and Polluter Pays Principle – Concept of absolute liability .
Unit 3 **8 HRS** 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.	**Unit 3** **8HRS** **Prevention and control of Pollution-** Role of central and state governments-Water Act,1974, Air Act,1981,Environment (Protection) Act**,**1986,Noise pollution and its control, Disposal of waste, laws on waste disposal and its control-Municipal Solid Waste Management Rules, Hazardous Waste Rules, Biomedical Waste Handling Rules– responsibilities of generators and role of Pollution Control Boards, Coastal Zone Regulation, Wildlife Protection Act 1972, Forest Conservation Act 1980, Amendments in various laws- Evaluation for strength and weakness of present Legal system.
Unit 4 **6 HRS** Fundamentals of GIS: Definition, Components, spatial data, thematic characteristics, rasters and vectors, databases and database management.	**Unit 4** **5HRS** **International Law and Environment Protection-** Trans –boundary pollution hazards, International convections in the development of Environmental Laws and its policy- from Stockholm to recent convections, IPCC, WHO and other international guidelines. Functions and powers of ministry of Environment and forest and pollution control Boards in centre and state
Unit 5 6 HRS 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.	**Unit 5 6 HRS** **Common law aspects of Environmental Protection-**Remedies under other laws – IPC, CRPC, CPC , Public Liability Insurance Act, Public Interest Litigation- Supreme Court Judgments in Landmark cases. Environmental Ethics,Role of NGO's in Environmental planning and education.
Unit 6 **7 HRS** GIS applications: Forestry, Bio-diversity, Environment, Soil resource management, Hydrological modelling, Public utilities (water distribution, sewerage, solid waste management).	**Unit 6** **6 HRS** Constitution and environment, role of Judiciary on environmental issues-Executive and legislative powers and their limitations.Case laws- Principles of case laws, statutory interpretations, site

	selection, land use planning, town planning act. Environmental management plan, environment management cells, rehabilitation and remediation. ISO: 14000 – its need, procedure to be followed to obtain ISO: 14000 certification, implicationsof ISO.
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.	**References-** 1. CPCB, "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997. 2. Shyam Divan and Armin Roseneranz "Environmental law and policy in India "Oxford University Press, New Delhi, 2001. 3. GregerI.Megregor, "Environmental law and enforcement", Lewis Publishers, London. 1994. 4.Pollution législation – A.K. Mhaskar, M/s. Media Enviro, Pune 5. Environmental Audit – An overview, A. K. Mhaskar – M/s. Media Enviro, Pune. 6. Matter Hazardous Laws Explained. A. K. Mhaskar M/s. Media Enviro, Pune 7. Environmental impact assessment Larry W Canter McGraw Hill International Edition, New York 1996. 8. Environmental Impact Assessment, Lauren David P., Willy Interscience, New Jersey. 9. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International editions.
ESTE 3-Elective III -33EnvironmentalSanitationEnvironmentalSanitation	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3 hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge of ecology and ecosystem. 2. To provide knowledge of transmission of diseases through air, water and food, control and prevention of diseases
	Course Outcome: 1. Able to know types of ecosystem,various food chain and web, population dynamics, imbalance of ecosystem.

	2. To understandMosquito and its control, house fly and its control, Rodent control. 3. Able to know Sanitation aspects in public places. 4. Understand basic elements of good housing.
Unit 16 HRS 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.	**Unit 16 HRS** 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.
Unit 25 HRS Vital Statistics, Sources, population growth and its control, factors affecting, infant mortality, Morbidity rates.	**Unit 25 HRS** Vital Statistics, Sources, population growth and its control, factors affecting, infant mortality, Morbidity rates.
Unit 37 HRS 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.	**Unit 37 HRS** 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.
Unit 47 HRS 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.	**Unit 47 HRS** 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.
Unit 58 HRS 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.	**Unit 58 HRS** 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.
Unit 67 HRS Noise Pollution, Decibel scales, Noise characteristics & measurement, Levels of noise and standards, Control measures of community and industrial noise.	**Unit 67 HRS** Noise Pollution, Decibel scales, Noise characteristics & measurement, Levels of noise and standards, Control measures of community and industrial noise.
Refrences- 1) Environmental Sanitation – Salvador. 1) Municipal Sanitation – Ethers and Steel. 2) Modern concepts of Ecology – H. D. Kumar. 3) Environmental Engineering and Sanitation – Salvato.	**Refrences-** 1) Environmental Sanitation – Salvador. 1) Municipal Sanitation – Ethers and Steel. 2) Modern concepts of Ecology – H. D. Kumar. 3) Environmental Engineering and Sanitation – Salvato.

5.ESTE-4-Elective-IV-41Operation and Maintenance of Environmental Facilities	**Operation and Maintenance of Environmental Facilities**
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/ week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3 hrs/ week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	1. To study the importance of good Operation & Maintenance and use ofoperation manuals. 2. To study operation and maintenance of water, wastewater treatment systems and air pollution control devices.
	Course Objective: 1. To provide knowledge about Need of Operation and Maintenance. 2. To provide knowledge of Planning and Management.
	Course Outcome: 1. Understanding plan, prepare and schedule daily operations and inspections. 2. Able to identify, analyze and solve the operational problems. 3. Understand and carryout preventive maintenance. 4. Develop skills for handling the emergency situations related to the failures andeffective resource planning required for O& M
Unit 1 **6 HRS** **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.	**Unit 1** **6 HRS** **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.
Unit 2 **6 HRS** **Water Supply system** Intakes pumps, transmission pipes, water treatment process control, Quantity and quality monitoring.	**Unit 2** **6 HRS** **Water Supply system** Intakes pumps, transmission pipes, water treatment process control, Quantity and quality monitoring.
Unit 3 **7 HRS** **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.	**Unit 3** **7 HRS** **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.
Unit 4 **8 HRS** **Wastewater facilities**	**Unit 4** **8 HRS** **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.	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.
Unit 5 **8 HRS** **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.	**Unit 5** **8 HRS** **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.
Unit 6 **5 HRS** **Planning and Management** Organizational structure, work Planning, preparation and scheduling, cost estimates.	**Unit 6** **5 HRS** **Planning and Management** Organizational structure, work Planning, preparation and scheduling, cost estimates.
References- 1. "CPHEEO Manual On Water Supply And Treatment" 2. "CPHEEO Manual ON Sewerage And Sewage Treatment" 3. Industrial air pollution control system - Neumann	**References-** 1. "CPHEEO Manual On Water Supply And Treatment" 2. "CPHEEO Manual ON Sewerage And Sewage Treatment" 3. Industrial air pollution control system - Neumann

ESTE-4- Elective-IV-42Project Management Rural water supply and sanitation	
Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3 hrs/week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge of environment and scope of sanitation in rural areas. 2. To provide knowledge of Specific Problem in rural water supply and Treatment.
	Course Outcome: 1. Understand magnitude of problems of rural water supply and sanitation. 2. Able to identify and understand rural issues of water supply and sanitation. 3. Acquiring skills and understanding about the development of these projects with cost effectiveimplementation and operation

	& maintenance. 4. Ability in effective resource planning for rural environmental projects.
Unit 1 3 HRS Introduction to project management, necessity, project lifecycle, key stake holders, management process groups and their responsibilities, concepts of project initiation	**Unit 1 5 HRS** Concept of environment and scope of sanitation in rural areas. Magnitude of problems of ruralwater supply and sanitation. Population to be covered, difficulties. National policy.
Unit 2 6 HRS Project planning, scope, work breakdown structure, scheduling, PM planning software, cost estimating and planning, responsibility matrix, resource allocation and leveling/smoothening, Risk planning, procurement plans, communication and quality planning .	**Unit 2 7 HRS** Planning of water supply system: Design population and demand loads. Various approaches of Planning of water supply schemes in rural areas.
Unit 3 8 HRS Project implementation, developing project team, team structure, leadership styles, relationship building, negotiating conflict, motivation and ethics. Project closure and post project analysis.	**Unit 3 8 HRS** Selection and Development of preferred sources of water: springs, Wells, infiltration wells, radial wells and infiltration galleries, collection of raw water from surface source. Specific practices and problems encountered in rural water supply, Rainwater Harvesting, Groundwater Recharge.
Unit 4 6 HRS Project quality concepts, planning and assuring project quality, quality audit, SWOT analysis, quality control tools.	**Unit 4 6 HRS** Specific Problem in rural water supply and Treatment: Source Sustainability, Slippage, WaterQuality, Operation and Maintenance. Low cost treatment, appropriate technology for watersupply and sanitation.Improved methods and compact systems of treatment: Brief Details of multi-bottom settlers(MBS), diatomaceous earth filter, cloth filter, slow sand filter, chlorine diffusion cartridges.Water supply during fair, festival and emergencies.
Unit 5 8 HRS Risk management, identification, analysis, prioritizing, tools and techniques for acceptance, avoidance and mitigation and documentation.	**Unit 5 8 HR** Treatment and Disposal of Waste-water/sullage: Community latrines: Different types and location of latrines, various methods of collection anddisposal of night soil.Simple waste water treatment units and systems in rural areas such as stabilization ponds, septictanks, Imhoff tank, soak pit etc. Disposal of waste water soak pits and trenches.
Unit 6 9 HRS Global Project management, preparation, planning challenges, politics, culture and law, pitfall avoidance, control and closure, Computerized	**Unit 6 6 HRS** Disposal of Solid Wastes. Composting, land filling, incineration, rural health. Other specificissues and problems encountered in rural sanitationBiogas plants: Definition, Objective, Methodology and

project management.	Construction, operation and Maintenance,Economic analysis, Benefits, Shortcoming
References- 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.	**References-** 1.Water supply for rural areas and small communities, Publication W. H. O. Geneva, 1959. 2.Rural water supply and sanitation, Wright Forest b., second Edition, Wiley Eastern New Delhi1956. 3. Low cost waste water treatment technology, Trivedi R. K., KaulS., ABD publications, Japan2001. 4. Rural Water Supply in developing countries, International development research centre.

ESTE-4- Elective-IV-43Environmental BiotechnologyEnvironmental Biotechnology

Old Syllabus	**New Syllabus**
Teaching Scheme : L : 3 hrs/ week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40	Teaching Scheme : L : 3 hrs/ week Credits: 3 Evaluation Scheme: CIE SEE Minimum Passing Marks (25 + 25) 50 40
	Course Objective: 1. To provide knowledge of Genetic Engineering and Recombinant DNA Technology. 2. To teach air pollution and its control through biotechnology.
	Course Outcome: 1. Understand basic concepts in Environmental Biotechnology. 2. Able to know microbiology of waste water treatment. 3. Understanding air pollution control through biotechnology. 4. Able to study of various types of bioremediations.
Unit 15 HRS Concept of Environmental Biotechnology and Environmental Engineering, scope and importance. Genetic engineering structure of DNA, RNA, Replication of DNA, genetic code, Transcription, Protein synthesis.	**Unit 15 HRS** Concept of Environmental Biotechnology and Environmental Engineering, scope and importance. Genetic engineering structure of DNA, RNA, Replication of DNA, genetic code, Transcription, Protein synthesis.
Unit 27 HRS Introduction to Genetic Engineering and Recombinant DNA	**Unit 27 HRS** 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.	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.
Unit 38 HRS 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.	**Unit 38 HRS** 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.
Unit 45 HRS Air pollution and its control through biotechnology, Biotechnology in reduction of CO2 emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications.	**Unit 45 HRS** Air pollution and its control through biotechnology, Biotechnology in reduction of CO2 emission, Bioscrubbers, Biobeds, Biotrickling filters and their applications.
Unit 57 HRS Microbiology of degradation of xenobiotic in environment – ecological considerations, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Biological detoxification of cynide, oxalate, urea, petrochemical industry effluents, toxic organics, phenols.	**Unit 57 HRS** Microbiology of degradation of xenobiotic in environment – ecological considerations, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Biological detoxification of cynide, oxalate, urea, petrochemical industry effluents, toxic organics, phenols.
Unit 68 HRS 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.	**Unit 68 HRS** 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.
Refrences- 1. Microbial Biotechnology: A. N. Glazer and H. Nikaids . 2. Molecular Biotechnology :Gleek and Pasternack. 3. Biotechnology : A Text Book of Industrial Microbilogy, T. D.Brock, 4. Industrial Microbiology :Presscott and Dunn. 5. Biotechnology : B. D. Singh , Kalyani Publishers.	**Refrences-** 1. Microbial Biotechnology: A. N. Glazer and H. Nikaids . 2. Molecular Biotechnology :Gleek and Pasternack. 3. Biotechnology : A Text Book of Industrial Microbilogy, T. D.Brock, 4. Industrial Microbiology :Presscott and Dunn. 5. Biotechnology : B. D. Singh , Kalyani Publishers.

6.ESTS-2 Seminar-II	**Seminar-II**
Old Syllabus	**New Syllabus**
Teaching Scheme : P : 2 hrs/Week/studentCredits: 2	Teaching Scheme : P : 2 hrs/Week/studentCredits: 2
	Course Objective: 1. Providing knowledge of effective oral presentations. 2. To motivation about presentations skills.
	Course Outcome: 1) Be able to understand the reading, understanding the research paper and able to develop skill to summarize it with optimum words. 2) Able to give presentation on allotted research topic. 3) Able to recognize the need for lifelong learning. 4) Understanding and given preference to new ideas, concepts, technologies in Environmental engineering.
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	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

7.ESTC-23 Laboratory- I Air pollution and Control	**Air pollution and Control**
Old Syllabus	**New Syllabus**
Teaching Scheme : P : 2 hrs/week Credits: 1	Teaching Scheme : P : 2 hrs/week Credits: 1
	Course Outcome: Demonstration andexperiments to improve knowledge of air pollution measuring devises handling on site actually.
A performance based on Experiments, or assignment or Visit report	A performance based on Experiments, or assignment or Visit report

8.ESTC-24 Laboratory- IIWastewater characterizationWastewater characterization	
Teaching Scheme : P : 2 hrs/week Credits: 1	Teaching Scheme : P : 2 hrs/week Credits: 1
	Course Outcome: An ability to take samples, analyze and interpret the results of wastewater samples.
A performance based on Experiments, or assignment or Visit report	A performance based on Experiments, or assignment or Visit report
9.ESTC-25 Laboratory- III Specific Treatment LabSpecific Treatment Lab	
Teaching Scheme : P : 2 hrs/week Credits: 1	Teaching Scheme : P : 2 hrs/week Credits: 1
	Course Outcome: Ability to take samples, analyze and interpret the results of water and wastewater samples.
A performance based on Experiments, or assignment or Visit report	A performance based on Experiments, or assignment or Visit report

(Semester III)

Shivaji University, Kolhapur First Year M. Tech Environmental Science and Technology (Semester III)		
Sr.No	**M. Tech (Environmental Sci. & Technology) Semester III Pre-revised syllabus**	**M. Tech (Environmental Sci. & Technology) Semester III Revised syllabus**
	Teaching Scheme : P : 2 hrs/week Credits: 4	Teaching Scheme : P : 2 hrs/week Credits: 4
1	**Industrial Training**	**Industrial Training**
	Industrial Training of Eight weeks at the end of First Year, Evaluation at end of III semester on the basis given report and Presentation to concern Guide.	Industrial Training of Eight weeks at the end of First Year OR Industrial Training will be split in two slots of four weeks during semester III. Evaluation at end of III semester on the basis given report and Presentation to concern Guide.
2	**Dissertation Phase – I**	**Dissertation Phase – I**
	Teaching Scheme : P : 5 hrs/week Credits: 10	Teaching Scheme : P : 5 hrs/week Credits: 10

(Semester IV)

Shivaji University, Kolhapur First Year M. Tech Environmental Science and 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**
	Teaching Scheme : P : 5 hrs/week Credits: 20	Teaching Scheme : P : 5 hrs/week Credits: 20

Dissertation Phase – I and Dissertation Phase – II (III and IV Semester)

Student shall 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.Dissertation phase II report submit only after full-fledge demonstration of his/her work to the concern guide. Assessment of the dissertation shall be based on design and implementation aspects, documentation and presentation skills, utility of the dissertation work and publications based on the same.

Annex. -Semester I

ESTC-14Water Quality analysis

Performance based on

A) List of Experiments:- (Any Six)

1. Determination of pH
2. Determination of Alkalinity
3. Determination of Hardness
4. Determination of Chlorides
5. Determination of Chlorine demand and Residual Chlorine
6. Determination of Turbidity
7. Determination ofFluorides
8. Determination of Sulphates
9. Determination of MPN
10. Determination of Iron

OR

B) Site visit to water treatment plant and report

OR

C) Assignments

ESTC-15Remote sensing and GIS applications in environmental Engineering

A. Assignment based on units

OR

B. Practicals based on :
   a) GPS Survey and Use of MAPSEND software
   b) Visual Interpretation of imagery and aerial photographs
   c) Digital Interpretation of imagery and aerial photographs
   d) Image Processing on IDRISI and CARTALINX
   e) Preparation of Thematic maps

OR

C. Practicals on GPS and DGPS

ESTC-16Solid and Hazardous Waste Management

A. Analysis of Solid Waste of ward/ village/specified area - (Any 4**)**
   [1] Collection of Samples of Solid Waste
   [2] Determination of Composition
   [3] Bulk Density Measurement
   [4] Physical Characteristic (% by weight)
   [5] Chemical Characteristics:
   [6] Toxic Material Content
   [7] Determination of Moisture Content

OR

B. Visit waste processing and disposal sites in the city

OR

C. Assignment based on units

Semester II

ESTC-23Air Pollution and Control

A. Performance based on

1. Determination of Suspended Particulate Matter in the Atmosphere (High Volume Method)
2. Measurement of Meteorological parameters like Wind, Pressure, Temperature and Humidity
3. Sampling and analysis of sulphur dioxide in ambient air and Stack
4. Sampling and analysis of Nitrogen dioxide in ambient air and Stack
5. Sampling and analysis of Particulate Matter (PM10) in ambient air and Stack

6. Determination of PM2.5 in ambient air Gravimetric Method
7. Sampling and analysis protocol for ozone in ambient air
8. Sampling and analysis protocol for ammonia in ambient air
9. Sampling and Analysis of Benzo(a)pyrene& other PAHs in Ambient Air
10. Sampling and analysis of Lead, Nickel and Arsenic in ambient air and Stack
11. Determination of trace elements in Particulate matter sampled through air and soil

OR

B. Site visit to wastewater treatment plant and report

OR

C. Assignments

ESTC-24 WastewaterCharacterization

A. Performance based on

List of Experiments: - (Any Six)

[1] Determination ofDissolved Oxygen
[2] Determination of Biochemical Oxygen Demand
[3] Determination of Chemical Oxygen Demand
[4] Determination of Different Forms of Solids
[5] Determination of Sludge Volume Index
[6] Determination of Conductivity
[7] Determination of Heavy Metals
[8] Determination of Phosphate
[9] Determination of Nitrates
[10] Study of Various types of Micro Organisms
[11] Determination of Oil & Grease
[12] Determination of Volatile Acids
[13] Determination of Optimum Dose of Alum Using Jar Test Apparatus

OR

B. Site visit to wastewater treatment plant and report

OR

C.Assignments

ESTC-25Specific Treatment Lab

Performance based on Experiments, or assignment or Visit report at particular Industry/Institute.