KOLHAPUR INSTITUTE
OF TECHNOLOGY'S
COLLEGE OF
ENGINEERING
(AUTONOMOUS),
KOLHAPUR

Curriculum for

M. Tech Programme

in

Environmental Engineering

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

M. TECH (ENVIRONMENTAL ENGINEERING)

Programme Education Objectives

I. Work in Environmental Engineering field which is involved with various aspects of planning, design, construction and operation of Environmental Engineering systems.

II. Contribute to the academic and research in the field of environmental engineering.

Programme Outcomes

At the end of program student will be able to

PO1 independently carry out research /investigation and development work to solve practical problems

PO2 write and present a substantial technical report/document

PO3 demonstrate a degree of mastery over the Environmental Engineering knowledge higher than civil and environmental engineering bachelor program

Kolhapur Institute of Technology's

College of Engineering (Autonomous), Kolhapur

Teaching and Evaluation scheme for

M.Tech Program in Environmental Engineering

Semester - I

Course Code	Course	Teaching Scheme				Evaluation Scheme			
						Component	Marks		
		L	T	P	Credits		Max. Marks	Min. for Passing	
PENV0101	Air Pollution Control	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV0102	Solid &Hazardous Waste Management	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV0103	Physico Chemical Processes for Water & Wastewater	3	-	-	3	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV01**	Professional Elective I	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV01**	Professional Elective II	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV0161	Audit Course I: Research Methodology	2			-	ESE	100	40	40
PENV0131	Environmental Monitoring Lab. I	-	-	4	2	ISE	50	20	
						ESE (OE)	50	20	
PENV0132	Environmental Monitoring Lab. II	-	-	2	1	ISE	50	20	
						ESE (OE)	50	20	
PENV0141	Seminar	-	-	2	1	ISE	100	40	
	Total	**15+2**	**4**	**8**	**23**	**Total Credit: 23 Total Contact Hours/Week: 27 + 2 hrs**			

List of Professional Electives:

Course Code	**Elective – I**	Course Code	**Elective – II**
PENV0121	Industrial Health and Safety	PENV0124	Environmental Management
PENV0122	Optimization Techniques	PENV0125	Operation and Maintenance of treatment Plants
PENV0123	Project Management	PENV0126	Green Building

Kolhapur Institute of Technology's

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Teaching and Evaluation scheme for

M.Tech Program in Environmental Engineering

Semester - II

Course Code	Course	Teaching Scheme				Evaluation Scheme			
						Component	Marks		
		L	T	P	Credits		Max. Marks	Min. for Passing	
PENV0201	Industrial Waste Treatment	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV0202	Biological Wastewater Treatment	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV0203	Environmental Impact Assessment & Legislation	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV02**	Professional Elective III	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV02**	Professional Elective IV	3	1	-	4	ISE 1	10	20	40
						MSE	30		
						ISE 2	10		
						ESE	50	20	
PENV0261	Audit Course II: Statistics and Data Driven Techniques	2	-	-	-	ESE	100	40	40
PENV0231	Treatability Studies Lab. I	-	-	2	1	ISE	50	20	
						ESE (OE)	50	20	
PENV0232	Treatability Studies Lab. II	-	-	4	2	ISE	50	20	
						ESE (OE)	50	20	
PENV0241	Pre-Dissertation Seminar	-	-	2	1	ISE	100	40	
PENV0242	Mini Project	-	-	2	1	ISE	50	20	
	Total	**15+2**	**5**	**10**	**25**	**Total Credit: 25 Total Contact Hours/Week: 30 + 2 hrs**			

List of Professional Electives:

Course Code	Elective – III	Course Code	Elective – IV
PENV0221	Remote Sensing & GIS	PENV0224	Environmental Management System
PENV0222	Watershed Management	PENV0225	Noise Pollution & Control
PENV0223	Environmental Modeling & Simulation	PENV0226	Environment Geotechnology

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Teaching and Evaluation scheme for

M.Tech Program in Environmental Engineering

Semester - III

Course Code	Course	Teaching Scheme				Evaluation Scheme		
						Component	Marks	
		L	T	P	Credits		Max. Marks	Min. for Passing
PENV0341	Industrial Training (During Summer Term)	-	-	-	2	ISE 1	50	20
PENV0351	Dissertation Phase I	-	-	5	2	ISE 1	50	20
		-	-		4	ISE 2	100	40
PENV0352	Dissertation Phase II	-	-		4	ESE (OE)	100	40
	Total	**-**	**-**	**5**	**12**		**300**	**120**
						Total Credit: 12 **Average Contact Hours/Week/Student: 5 hrs**		

Kolhapur Institute of Technology's

College of Engineering (Autonomous), Kolhapur

Teaching and Evaluation scheme for

M.Tech Program in Environmental Engineering

Semester - IV

Course Code	Course	Teaching Scheme				Evaluation Scheme		
						Component	Marks	
		L	T	P	Credits		Max. Marks	Min. for Passing
PENV0451	Dissertation Phase III	-	-	5	4	ISE 1	100	40
		-	-		4	ISE 2	100	40
PENV0452	Dissertation Phase IV	-	-		8	ESE (OE)	200	80
	Total	**-**	**-**	**5**	**16**		**400**	**160**
						Total Credit: 16 Average Contact Hours/Week/Student: 5 hrs		

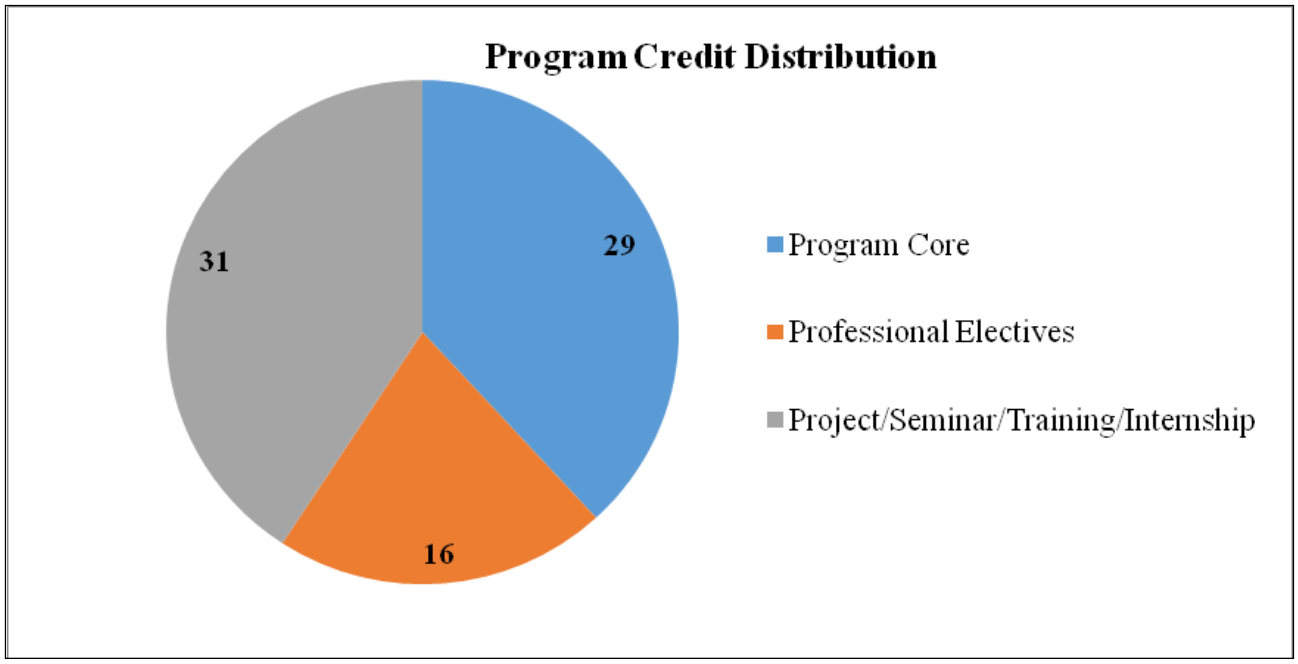
Kolhapur Institute of Technology's

College of Engineering (Autonomous), Kolhapur

Program Credit Distribution for

M.Tech Program in Environmental Engineering

Curriculum Component	Credits
Program Core	29
Professional Electives	16
Project/Seminar/Training/Internship	31
Total	**76**



Title of the Course: Air Pollution Control **Course Code:** PENV0101	**L** **3**	**T** **1**	**P**	**Credit** **4**

Course Pre-Requisite: knowledge of engineering mathematics, Environmental chemistry and fluid mechanics

Course Description: Introduction to sources of air pollution, effects of air pollution on health of human, animals and plant, local and global atmospheric changes, basic meteorological processes, air quality modeling, technology for air pollution control, legal provisions and standards

Course Objectives:

1. Understand the influence of various meteorological parameters on spread of air pollutants
2. Learn various models and softwares for dispersion air pollutants in the atmosphere.
3. Develop the skills needed to successfully design air pollution control equipment in order to meet the stipulated standards.

Course Learning Outcomes:

CO		Bloom's Cognitive	
		level	Descriptor
CO1	Analyze air pollution issues for research and development, industry, and consultancy activities.	4	Analyze
CO2	Solve engineering problems associated with the design and operation of air pollution control equipments	5	Solve
CO3	Demonstrate knowledge of legal and other measures for control of air pollution	3	Demonstrate

CO-PO Mapping:

CO	**PO**		
	PO1	**PO2**	**PO3**
CO1	1		
CO2	1		
CO3			1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1:--- Introduction to Air pollution Scales of air pollution and current scenario, Classification of air pollutants, Particulates and gaseous pollutants, Sources of air pollution, Measurement units, criteria air pollutants and their effects, Photochemical reactions, Source inventory , Sampling and Analysis of air pollutants- ambient, stack and automobile exhaust	**8 Hrs.**
Module 2:--- Meteorology and Air Pollution The Earth's atmosphere: structure, composition and energy balance Wind circulation, Types of wind, Wind speed and direction, Wind rose diagram, Lapse rates, Stability of atmosphere, Inversion and its types, Plume behavior, Maximum Mixing Depth, Change in pressure with altitude, Cyclones and anticyclones, Types of humidity, Precipitation & its relation to removal of air pollutants	**8 Hrs.**
Module 3:--- Dispersion of Air Pollutants Theories on modeling of Air pollutants - Gaussian model(point source), Plume Rise – causes, significance, equations for estimation, Plume downwash, Standard deviations of plume, Stability classes Gaussian model for line source, Box model , Problems based on these models to predict the concentrations of air pollutants, Introduction to various softwares based on these models for air quality monitoring	**8 Hrs.**
Module 4:--- Control Equipment for Particulate Matter Distribution and source of SPM, Terminal settling velocity, Particulate removal mechanisms, Control Equipment for Particulate Matter - Settling chamber, Cyclone, Wet collectors, Fabric filter, Electrostatic precipitator, Problems on design of equipment, Component detailing and collection efficiency	**7 Hrs.**
Module 5:--- Control of Gaseous pollutants Control of gaseous pollutant , Principles of absorption, Adsorption, condensation, combustion/ incineration and after burner, Control of SO2, Control of NOx	**5 Hrs.**
Module 6:--- Air Quality management Status of air pollution in India, Ambient Air quality standards, Air pollution Index, Stack emission limits, Control of air pollution due to automobiles, measures for reduction of emissions, Alternative fuels, Air (Prevention & Control of Pollution) Act,1981, International treaties for control of air pollution	**4 Hrs.**
Textbooks: 1) K. Wark, C.F. Warner & W.T. Davis Air Pollution Control: its Origin and Control, Addision-Wesley, (1998). 2) Stern A.C., "Air Pollution Vol. I and II", Allied Publishers Limited, 1st Edition, 1994. 3) Martin Crawford, "Air Pollution and Control", Tata McGraw Hill Publication, 1st Edition, 1976.	
References: 1. Air Pollution and Control Technologies by Anjaneyulu, D", Allied Publishers,	

Mumbai, 2002

2. Environmental Pollution Control Engineering by Rao, C.S., Wiley Eastern Ltd., New Delhi, 1996
3. Industrial Air Pollution Control Systems by W.L.Heumann, McGraw-Hill, New York, 1997
4. Environmental Engineering by Peavy S.W., Rowe D.R. and Tchobanoglous G, McGraw Hill, New Delhi, 1985
5. Environmental Engineering Vol. II by Garg, S.K, Khanna Publishers, New Delhi
6. Fundamentals of Air Pollution by Richard W.Boubel, D.L.Fox, D.B.Turner& A.C.Stern, Reed Elsevier India Pvt. Ltd., New Delhi,

Module wise Measurable students Learning Outcomes:

At the end of the course, the students will be able to

UO1 Classify the sources of air pollutants and Describe the various impacts of air pollution at national and global levels

UO2 Describe the role of various meteorological parameters in dispersion of air pollutants

UO3 Predict concentration of air pollutants using various dispersion models

UO4 Design control equipments for removal of particulate matter

UO5 Recommend suitable techniques for control of gaseous pollutants

UO6 Judge the air quality status and suggest control measures for air pollution in given area

Title of the Course: SOLID & HAZARDOUS WASTE MANAGEMENT Course Code: PENV0102	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite: Students must have knowledge about environmental pollution sources as well as their respective laws & rules. Causes of pollution , can identify various remedial measures. Various industrial operations & their requirements.
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Course Description:
This course will provide basic knowledge about solid & hazardous waste, their respective sources, present problems, remedial measures available. It also provides basic knowledge about laws related to these wastes.

Course Objectives:

1. Understand various sources of solid waste.
2. Learn the respective legislations related to solid waste.
3. Know the treatments used for solid waste.
4. Learn various disposal methods used for various solid waste.

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Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	List the sources of solid waste.	1	Remembering
CO2	Compare disposal methods for solid waste with respect to their properties.	2	Understanding
CO3	Make use of various legislations in solid waste management	3	Applying
CO4	Identify appropriate treatment technology for different solid wastes	3	Applying

CO / PO Mapping

CO / PO	PO 1	PO 2	PO 3
CO1		2	
CO2			2
CO3	3		
CO4	3		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:--- Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options. Characterization of waste, compatibility and flammability of chemicals, fate and transport of chemicals, health effects.	8**Hrs.**
Unit 2:--- Municipal solid waste rules, hazardous waste rules, biomedical waste handling rules, fly ash rules, recycled plastics usage rules, batteries rules	5 **Hrs.**
Unit 3:--- Defining risk and environmental risk, methods of risk assessment, case studies., measures, health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options,	6 **Hrs.**
Unit 4:--- Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physico-chemical processes for hazardous wastes (soil vapor extraction, air stripping, chemical oxidation); ground water contamination and remediation.	7**Hrs.**
Unit 5:--- Biochemistry of microbial metabolism; aerobic biodegradation of municipal solid waste: composting and vermi-composting; anaerobic biodegradation of municipal solid waste: waste to energy options, other methods; bioremediation - fundamentals.	7 **Hrs.**
Unit 6:--- Sanitary landfill site selection, , Landfill site design, operation, maintenance and precautions, leachate and its control, control of contamination of ground water. Operation monitoring. Rehabilitation, Closure & end-use	7 **Hrs.**

Textbooks:

1. Tchobanoglous G., Theisen H. and Vigil S.A., "Integrated Solid Waste Management", McGraw-Hill International editions.

2. Bhide A.D. and Sundaresan B.B., "Solid Waste Management, Collection, Processing and Disposal", Nagpur.

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References:

1. Vesilind P.A., Worrell W. and Reinhart D.R., "Solid Waste Engineering", Thomson Books.
2. "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, Government of India.
3. Management and Handling Rules for: municipal solid waste, biomedical waste, hazardous waste and radioactive wastes, Government of India Publications.
4. Solid Waste Management Hand Book – Pavoni
5. Composting – Gottas

Unit wise Measurable students Learning Outcomes: Students will…

Unit 1- Able to recall & Identify various sources of solid waste.

Unit 2- Choose & Make use of respective legislation related to solid waste.

Unit 3- Able to Identify & Demonstrate effects & risk associated with solid waste.

Unit 4- Able to Recall & Choose appropriate chemical treatments of solid waste.

Unit 5- Able to Recall & Choose biological treatments of solid waste.

Unit 6- Able to Compare & Choose disposal method for solid waste.

Title of the Course: PHYSICO- CHEMICAL PROCESSES FOR WATER & WASTEWATER TREATMENT Course Code: PENV0103	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite:
Students must aware about present water and wastewater pollution problems and its related environmental problems. Importance of treatment and the standards should be well known to students.

Course Description:
Students will understand the advance treatments of water and wastewater such as Coagulation, Flocculation & Settling, Aeration, Reactors & Reaction Kinetics, Filtration, Membrane Processes, Adsorption, Ion exchange, Disinfection.

Course Objectives:

1. To provide the necessary knowledge and concepts of physical, and chemical processes used for water and wastewater treatment.
2. To provide the necessary knowledge of design and operation of water and wastewater treatment plant.
3. Understand and design the advanced water and wastewater treatment in the form of filtration and adsorption.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	provide the necessary knowledge and concepts of physical, and chemical processes used for water and wastewater treatment.	2	Cognitive
CO2	provide the necessary operation and design of water and wastewater treatment plant.	3	Cognitive
CO3	design the advanced water and wastewater treatment for membrane filtration and adsorption process.	3	Psychomotor

CO-PO Mapping

	PO1	PO2	PO3
CO1	-	-	2
CO2	1	1	3
CO3	1	1	3

Assessments :

Teacher Assessment:
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1: Reactors ,Reaction Kinetics & Water Treatment: Aeration Types of reactions, reaction kinetics, Configurations of ideal and non-ideal reactors. **Aeration** Principles of aeration, Gas-liquid mass transfer, two film theory, Aeration in water and wastewater treatment, Types of aerator, Design of aeration systems	**6 Hrs.**
Unit 2:--- Coagulation, Flocculation & Settling 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, clarifiers, high rate clarification, design of clarifiers, Design of grit chamber.	**8 Hrs.**
Unit 3:---Filteration Introduction to depth filtration, filtration processes, principal mechanisms of filtration, filter hydraulics, backwash hydraulics, Rate control patterns and methods, design and operation of rapid sand and dual media filters	6 **Hrs.**
Unit 4:---Membrane Processes Membrane Filtration: Terminology, Process Classification, Membrane configuration, Specific membrane problems such as fouling and its control, application of membranes, Electrodialysis: Theory, Disposal of concentrate waste streams.	**6 Hrs.**
Unit 5:---Adsorption & Ion exchange 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** Ion exchange, exchange materials, exchange capacity, ion exchange chemistry & reactions, applications for hardness & TDS removal, design of ion exchange softener.	**9 Hrs.**
Unit 6:--- Disinfection Disinfection, modes of disinfection, mechanisms, factors influencing, ideal disinfectant, chemistry of chlorination, Disinfection with ozone: chemistry, modeling, estimation of ozone dosage. UV disinfection: system components, modeling, Estimation of UV dose Corrosion processes, electrochemical nature of corrosion, types of corrosion, methods of corrosion control.	**7 Hrs.**

Reference Books:

1. "Theory and Practice of Water and Wastewater Treatment", Droste, Ronald L., John Wiley & Sons Publication, 1997, 1st Edition.
2. "Environmental Engineering", Peavy, Rowe and Technologies.
3. "Physico-Chemical Processes of Water Purification", Weber.
4. "Wastewater Engineering Treatment and Reuse", Metcalf And Eddy, Tata McGraw Hill Publication, 1979, 2nd Edition.

References:

1] Wastewater manual

Unit wise Measurable students Learning Outcomes: Students will..

1 understand and apply the reaction kinetics of processes involved and study & design the aeration system of water treatment.

2 study & design settling tank, flocculation and grit chamber.

3 apply the filtration principles for filter design.

4 apply the advanced filtration principles for membrane filter design.

5 be able to select design GAC and PAC due to the understanding regarding its details and be able to select a proper process in case of Ion Exchange.

6 understand and apply the disinfection process as per requirement.

Title of the Course: Industrial Health and Safety	**L**	**T**	**P**	**Credit**
Course Code: PENV0121	**3**	**1**	**-**	**4**

Course Pre-Requisite:

- Students shall have knowledge of physics and chemistry.
- Students shall have knowledge of industrial management, building bye laws.

Course Description:

The course is designed to train and provide expert human resource to safety management and expected to bring direct benefits to industry and society. The course develops entry level skills in industrial safety, health, and environmental awareness. Course will help the students to obtain work in a variety of safety-related fields to include accident investigation, monitoring and enforcement of codes, ergonomics, and Occupational Safety Health Administration (OSHA) requirements.

Course Objectives:

At the end of course students will be able to

1. Understand the importance of maintaining a safe workplace, safety standards compliance with regulatory requirements and within engineering limits.
2. Define the role of safety in the industry, organization and business community.
3. Recognize the effects of exposures to chemical, physical, biological and ergonomic agents in the workplace.
4. Know the policies, procedures and equipments needed to deal with hazardous materials and situations.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Analyze** different types of exposure effects, exposure guidelines and basic workplace monitoring. ***(L4) Cognitive***	4	Cognitive
CO2	**Combine** the knowledge of the types of hazards, planning, organization and training needed to work safely with hazardous materials. ***(L5) Cognitive***	5	Cognitive
CO3	**Demonstrate** a perceptive of workplace injury prevention, risk management and accident-incident investigations to describe the appropriate regulations that apply. ***(L2) Psychomotor***	2	Psychomotor

CO-PO Mapping:

CO	**PO-1**	**PO-2**	**PO-3**
CO1			2
CO2			2
CO3			1

Assessments :

Teacher Assessment:

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Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three Units) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.	
Course Contents:	
Unit 1: Safety Audit History of Safety movement, Evolution of modern safety concept, Purpose and Overview of Audit Systems, Scope and Background, Intended Audience, Period of Applicability, Organization of the Document, Components of safety audit, types of audit, audit methodology, audit checklist and report, review of inspection, scrutiny of accident and safety records, check list, identification of unsafe acts of workers and unsafe conditions.	**7 Hrs.**
Unit 2: Accident Investigation and Reporting Concept of an accident, Accident causation, Reportable and non reportable accidents, Principles of accident prevention, Theories of accidents, Accident investigation and analysis, Accident reporting, Domino sequence, Supervisory role, Role of safety committee, Cost of accident.	**6 Hrs.**
Unit 3: Hazard, Risk Issues and Hazard Assessment Hazard (physical, chemical, biological and ergonomic), Hazard monitoring, Risk issue, Approaches for establishing risk acceptance levels, Risk estimation, Checklist analysis, What-if analysis, Job Safety Analysis (JSA), Safety review, Preliminary hazard analysis (PHA), Human error analysis, Hazard operability studies (HAZOP), Permissible exposure limits, Safety warning systems, Methods of control, Training and education.	**7 Hrs.**
Unit 4: Occupational Physiology Man as a system component, Allocation of functions, Efficiency, Occupational work capacity, Evaluation of physiological requirements of jobs, Parameters of measurements, Categorization of job heaviness, Work organization, Stress, Strain, Fatigues, Shift work, Personal hygiene, Work permit, Confines spaces, Occupational Safety Health Administration (OSHA) requirements.	**5 Hrs.**
Unit 5: Fire Protection and Plant and Machine Layout Sources of ignition, Fire triangle, Principles of fire extinguishing, Active and passive fire protection systems, Various classes of fires (A, B, C, D, E), Types of fire extinguishers, Material Safety Data Sheets (MSDS), Classification of hazardous chemicals, Storage and handling of chemicals, Handling, Safety precautions, Good housekeeping. Plant and Machine layout, Site selection, Factors affecting, Lighting, Ventilation, Body dimensions, Passages, Staircases, Auxiliary facilities.	**8 Hrs.**
Unit 6: Occupational Health Problems in Different Types of Industries Health and safety considerations, Personal protective equipments, Construction, Textile, Steel, Food processing, Pharmaceutical, Occupational health and safety considerations in wastewater treatment plants.	**7 Hrs.**
Textbooks: 1. Blake, R. B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973. 2. Colling D.A., "Industrial Safety Management and Technology", Prentice Hall, New Jersey. 3. Goetsch, D. L., "Occupational Safety and Health for Technologists, Engineers and Managers", Prentice Hall, New York.	
References: 1. "Guidance on Technical Audits and Related Assessments for Environmental Data	

Operations", EPA QA/G-7, US Environment Protection Agency, Washington, DC 20460
2. Heinrich, H.W., "Industrial Accident Prevention", McGraw Hill Publication, New York.
3. Kausek, J., "The Management System Auditor's Handbook", 2006.
4. National Safety Council and Associate (Data) Publishers Pvt. Ltd., "Industrial Safety and Pollution Control Handbook
5. Pain, S. W., "Safety, Health, and Environmental Auditing: A Practical Guide", Published: April 26, 2010 by CRC Press.
6. Petersen, D., "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.

Unit wise Measurable students Learning Outcomes:

At the end of course students will be able to

1. Recognize the importance of safety audit including an outline of the legal system and hierarchy of legislation.
2. Apply the knowledge and principles of accident prevention techniques and practical skills required for prevention of injury in the workplace environment.
3. Develop theoretical and practical understanding of the recognition, evaluation and management of occupational hygiene and related safety hazards.
4. Apply logical and rational processes to critically analyze issues related to OHS and think creatively in the generation of solutions to problems.
5. Design safety discipline to safeguard against the fire and plant layout related hazards.
6. Carry out industry based assessment and the development of novel ways of solving problems.

Title of the Course: OPTIMIZATION TECHNIQUES	L	T	P	Credit
Course Code: PENV0122	3	1	-	4

Course Pre-Requisite:
Students must have knowledge about numerical and mathematical rules and its use in solving problems by correlating constants and parameters with each other.

Course Description:

Students will understand the importance of optimization of parameters such as maximization of profits and minimization of wastes in the field of environment. They will study the basics of logical techniques of optimization for solving industrial and engineering problems. Also the students can optimize the environmental systems i.e. waste minimization, solid waste management, utilization of water etc.

Course Objectives:

1. Understand the significance and scope of optimization in Environmental engineering.
2. Study the formulation by correlating parameters of technical, engineering problem in mathematical model.
3. Learn to solve transportation problems, Assignment problems, Job sequencing using modified techniques.
4. Acquire the knowledge to solve numerical differentiation and integration using modified techniques.
5. Study network techniques and genetic algorithm techniques for application in projects of Environmental Engineering to get optimum results.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Construct simple mathematical models for various problems of profit maximization and waste minimization.	3	Cognitive
CO2	Determine simple logical solutions for the mathematical models formulated and transportation problems, Assignment problems, Job sequencing.	6	Cognitive
CO3	Develop and analyze network techniques projects of water treatment, waste water treatment, laboratory research work and for optimum results.	5	cognitive

Mapping of Course Outcome to Program Outcome

Course Outcome	Program Outcome		
	PO1	**PO2**	**PO3**
CO1		**2**	
CO2			**1**
CO3	**2**		

Assessments :

Teacher Assessment:

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ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit1:--- Introduction: Birth of O. R., Methodology, Scope and Limitations, Types of O.R. Models, Applications, Use of computers in O. R., 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	4 **Hrs.**
Unit2:--- **Linear Programming**: Construction of LP model, Simplex method, Big M and two phase methods, Transportation and Assignment problems, Duality and sensitivity analysis **Non-linear Programming**: Unconstrained optimization techniques, Classification of methods, steepest ascent, Newton method, constrained optimization, Separable and quadratic programming.	10 **Hrs.**
Unit3:--- Dynamic Programming: Multistage decision process, recursive relationships, Principle of optimality, Computational procedure in DP, DP applications, Problem of dimensionality.	6 **Hrs.**
Unit4:--- Numerical differentiation and Numerical integration: Numerical solution of ordinary differential equation, Systems of ordinary differential equations, Runge – Kutta Method, Trapezoidal rule, Simpson's rule, Gauss – Siedel method, Jacobian method	**7 Hrs.**
Unit5:--- Network Modeling: Fundamentals of CPM / PERT networks; CPM – construction of networks, critical path, forward and backward pass, floats & their significance, crashing for minimum cost and optimum and minimum duration, resource allocation and leveling. PERT – Time Estimates, Construction of Networks, Probability of completing projects by given date.	**7 Hrs.**

Unit6:--- Genetic Algorithm, Neural Networks and Fuzzy Systems: Introduction, Representation of decision variables, Objective function and constraints, GA operators, neural network based optimization, Optimization of fuzzy systems.	6 **Hrs.**

Textbooks:

1. Introduction to O.R., 6/e (with floppy disk) – Hamdy A. Taha, (PHI)
2. Quantitative Techniques in Management, 2/e - N.D. Vora. (TMH)
3. Introduction to O.R., 7/e (with CD) – Hillier & Lieberman (TMH)
4. Operations Research – Hira& Gupta.
5. Operations Research – J.K. Sharma. (Mac Millan)
6. Operations Research – S.D. Sharma
7. Optimization in Operation Research – Ronald L. Rardin (Pearson education)
8. Genetic algorithm – Goldberg

References:

Unit wise Measurable students Learning Outcomes: Students will..

1. Explain significance of operation research in Environmental Engineering and apply effective and economic transportation model for solid waste management and assignment problem.

2. Formulate practical situations and problems in mathematical model and solve them with simple logical techniques of linear and non-linear programming.

3. Develop multistage decision process with the help of dynamic programming for optimality.

4. Assess for Numerical solutions of ordinary differential equation, Systems of ordinary differential equations,

5. Develop effective network model to handle the large project by dividing it into small activities for successful completion.

6. Develop genetic algorithm and represent decision variables for optimization of fuzzy systems.

Title of the Course: PROJECT MANAGEMENT Course Code:PENV0123	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite: Students must have basic knowledge about fundamentals of Science. Basic mathematical ability , units , & fundamentals of engineering projects.

Course Description:

Students will understand various components of project management, their applications in projects. Also understands use of various techniques like CPM & PERT in project planning & Scheduling.

Course Objectives:

1. Acquire knowledge of essentials of Project Management.
2. Learn the Components of Project Management.
3. Identify the importance of softwares in Project Management.
4. Learn planning & organizing in Project Planning.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Extend their knowledge in the field of Project Management.	2	Understanding
CO2	Identify respective components of Project Management & apply them in practice.	3	Applying
CO3	Identify choose appropriate software in Project Management.	3	Applying
CO4	Solve practical project related problems.	3	Applying

CO / PO	PO 1	PO 2	PO 3
CO1		**2**	
CO2			**2**
CO3			**3**
CO4			**3**

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:--- Factors Governing Modern Business, Effective Project Management, definition of project, Attributes of Project, Strategic Planning, Project Life Cycle, considerations for RFP, Project Process, Project Balancing, Project Environment, Programme and Portfolio.	6 **Hrs.**
Unit 2:--- Project planning involves establishing the Work Breakdown Structure and mapping this structure to the established OBS. Furthermore, a project budget and Cost Breakdown Structure are developed and mapped to the OBS and WBS. Specific methodologies for planning include: • The Critical Path Method (CPM) • The Program Evaluation and Review Technique (PERT) • The Graphical Evaluation and Review Technique (GERT)	8 Hrs.
Unit 3:--- Project control process Updating schedule, Approaches to schedule control, Resource considerations. Project cost estimates, Budget, Actual cost, Cost Forecasting, Managing cash flows	6 **Hrs.**
Unit 4:--- Project Monitoring includes configuration and metrics used to monitor the progress of a project throughout its life. Based on the information gathered through the Project Monitoring system, corrective action may be required to keep a project on track. The Project Control section of the course describes techniques to help realign projects. Corrective action may be needed in many areas such as project scope, product performance, project schedule, and project budget.	8**Hrs.**
Unit 5:--- Project Learning is recognized by organizations as one of the most important factors for success in current and future projects. Through life-cycle and post-mortem analysis, the project manager may identify areas to be emphasized or more closely managed in future projects. Such areas include: • Resource allocation,	6**Hrs.**

• Risk and uncertainty, • Budget constraints, • Project feasibility, and • Change management.	
Unit 6:--- Responsibilities and skills, Delegation, Managing Change, Develop and effectiveness of project team, Ethics, Conflicts on Projects, Time Management. Personal communication, Effective listening, Meeting, Presentations and Report preparation, Types of Project organizations- their merits and demerits, SWOT analysis	6**Hrs.**

Textbooks:

1. Project Management & Control by P.C.K.RAO
2. Project Management by S.Chaudhary.
3. Jack Gido, James P Clements, Project Management, Cengage Learning India Pvt. Ltd., 2nd Reprint 2011, ©2007

References:

4. Project Management by William G Ramroth
5. Project Management by Harvey Maylor
6. Project Management by Paul Roberts

Unit wise Measurable students Learning Outcomes: Students will…

Unit 1- Able to Apply & Develop work breakdown process in the Project.

Unit 2- Study & Take part in Planning process.

Unit 3- Able to Identify & Select appropriate tool for Project control.

Unit 4- Able to Examine the Project at different stages of Project.

Unit 5- Able to Analyze any project at any point of time.

Unit 6- Able to upgrade managerial skills.

Title of the Course: ENVIRONMENTAL MANAGEMENT	L	T	P	Credit
Course Code: PENV0124	3	1	-	4

Course Pre-Requisite: Students must have basic knowledge about fundamentals of Science. Basic mathematical ability, Details of environmental systems.

Course Description:

Students will understand various components of environmental management, their applications in projects. Also understands use of various techniques like Env Audit. Policy making & its analysis in project planning.

Course Objectives:

1. Acquire knowledge of essentials of Environmental Management
2. Learn the Principles & Components of Environmental management
3. Know the working of organizations in the field of environment & their scope
4. learn environmental economics & utilization of RS & GIS in the field of environment

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain important points in the field for implementing Environmental Management.	2	Understanding
CO2	Identify respective components & apply the principles of Environmental management in practice	3	Applying
CO3	Identify different organizations & their scope in Environmental Management.	3	Applying
CO4	Analyze environmental economics & applications of RS GIS in environmental field	4	Analyzing

CO / PO	PO 1	PO 2	PO 3
CO1		**2**	
CO2		**2**	
CO3			**3**
CO4			**3**

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:--- Definition of Environmental Management, Principles of Environmental Management, Nature, Scope and Components of Environmental Management, Policies and Legal Aspect of Environmental Management	06 **Hrs.**
Unit 2:--- Environmental Audit: Definition of Environment Audit and its importance for industries. Environmental management system audits, Types of audits, General audit methodology and basic structure of audit. Elements of an audit process and its importance. Concept of ISO14001	08**Hrs.**
Unit 3:--- Environmental Policy Analysis- Macro level and Micro level, Methods of Policy Analysis, steps involved, Environmental Management Plan (EMP), Components of EMP, Preparation of EMP, Case Study.	06 **Hrs.**
Unit 4:--- Environmental Economics, Estimation of Costs and Benefits, Cost-Benefit Analysis. Interest Calculations, Present and future worth of Projects, Financial Aspects of Project, DPR and other feasibility Reports, Case Study.	08 **Hrs.**
Unit 5:--- Organization for Environmental Management, Example, Organizational Design, Institutionalization of Environmental management in India, Ministry of Environment and Forest, Central Pollution Control Boards, State Pollution Control Boards, Local Bodies, their scopes, Organizational and Functional issues, **Related Issues in Environmental Management.**	06 **Hrs.**
Unit 6:--- Environmental Information Systems, Global, National, Unit level Systems, Applications, Geographic Information System (GIS) and Remote Sensing in Environmental Management	06 **Hrs.**

Textbooks:

- Environmental Management By Bala Krishnamoorthy
- Applied Ecology And Environmental Management Second Edition By: Edward I Newman (University Of Bristol)
- Corporate Environmental Management By John Darabaris

- Environmental Management by Virginia H. **Dale**

References:

1. Burke, Gwendolyn, Ben Ramnarine Singh and Louis Theodore. 2000. Handbook of Environmental Management and Technology. New York: John Wiley.
2. Friedman, Frank. 2000. Practical Guide to Environmental Management. Washington, D.C.: Environmental Law Institute
3. Mackenthun, Kenneth M. 1999. Basic Concepts in Environmental Management. Boca Raton, Fl: Lewis
4. Paruccini, M. (Ed.). 1994. Applying Multiple Criteria Aid for Decision to Environmental Management. Boston: Kluwer Academic Publishers.
5. Rietbergen-Mccracken, Jennifer and Hussein Abaza (Eds.). 2000. Economic Instruments for Environmental Management: A Worldwide Compendium of Case Studies. London: Earthscan.
6. Environmental Science For Environmental Management by Timothy O'riordan
7. Environmental Management For Sustainable Development, Second Edition By C.J. Barrow
8. Environmental Management: Principles And Practice By C.J.Barrow (Kindle Edition - Mar 14, 2007) - Kindle Book
9. Environmental Management In Practice: Vol 3 By Luc Hens, Paul Compton Edited By Bhaskar Nath (Kindle Edition - Dec 7, 2002) - Kindle Book
10. GIS For Environmental Management By Robert Scally
11. Environmental Management Readings And Case Studies By Lewis Owen

Unit wise Measurable students Learning Outcomes: Students will…

Unit 1- Able to Choose & Explain various components in EM.

Unit 2- Explain & Take part in Auditing process.

Unit 3- Able to Make use of policy analysis in EM.

Unit 4- Able to analyze any project in Env Economical consideration.

Unit 5- Able to Recall & Select respective organization for their professional work.

Unit 6- Able to Identify & Select proper method for information generation.

Title of the Course: Operation and Maintenance of Treatment Plants **Course Code:** PENV0125	**L**	**T**	**P**	**Credit**
	3	1	-	4

Course Pre-Requisite:

- Students shall have knowledge of Water Supply Engineering.
- Students shall have knowledge of Wastewater Engineering.
- Students shall have knowledge of Air Pollution and Control.

Course Description:

Operation and Maintenance of Environmental Facilities deals with the operation of environmental facilities like water supply facilities, water treatment plants, water distribution systems, wastewater treatment plants, wastewater collection systems, air pollution control equipments and their maintenance.

Course Objectives:

At the end of course students will

1. Know the necessity of maintenance of environmental facilities.
2. Study measures to avoid failures in pipe systems.
3. Understand the criteria of operation & its purpose for water treatment plants, wastewater treatment plants and air pollution control equipments.
4. Learn the importance of planning and scheduling in maintenance activities.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Recall the types of maintenance of equipments.	1	Remembering
CO2	Illustrate the operation of air pollution control equipments.	2	Understanding
CO3	Select the appropriate remedies for problems in transmission pipes, water treatment plants and wastewater treatment plants.	3	Applying

Mapping of COs to POs:

CO	**Programme Outcomes**		
	1	**2**	**3**
1		1	
2		2	
3			2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three Units) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.	
Course Contents:	
Unit 1:--- Introduction Need of O and M, Types of Maintenance - Corrective and Preventive, Data: Detailed Plans, Drawings, Operation Manuals, Log Books, Computer Usage in O and M, Strategy for good O & M, Improvement in O & M.	**4 Hrs.**
Unit 2:--- Water Intakes O & M of Water Supply Facilities: Intakes, Pumps, Transmission Pipes, Water Treatment Units Maintenance, Algae Control, Quantity and Quality Monitoring.	**8 Hrs.**
Unit 3:--- Water Distribution Systems Water Distribution System: Loss of Carrying Capacity of Pipes, Pipe Breaks & Leakages, Leak Detection, O and M of Appurtenances- Valves, Pipe Joints, Water Meters, Water Audit, Energy Audit.	**8 Hrs.**
Unit 4:--- Wastewater Facilities O & M of Wastewater Facilities: Sewerage System and Appurtenances, Inspection Methods, Manual and Television, Cleaning and Rehabilitation, Safety in Sewer Inspection, O and M of Wastewater Treatment Plant- Activated Sludge Process, Trickling Filters, Monitoring and Operational Problems, Corrective Measures, MBBR, MBRs, UASB, Treatment Plant Performance Monitoring,	**8 Hrs.**
Unit 5:--- Air Pollution Control Facilities Air Pollution Control Facilities: Regular Inspection of Devices, Operation and Maintenance of Particulate Matter Control Equipments, Gravity Settlers, Cyclone Separators, Bag Filters, Scrubbers, Electrostatic Precipitator, Gaseous Control Devices.	**8 Hrs.**
Unit 6:--- O & M Planning O and M planning: Organizational Structure, Work Planning, Preparation and Scheduling, Inventory, Cost Estimates, Wastewater Treatment Plant Staff Training	**4 Hrs.**
Textbooks: 1. CPHEEO manual on Water Supply and Treatment 2. CPHEEO manual on Sewerage and Sewage Treatment 3. A manual on Operation and Maintenance of Water Supply Systems by CPHEEO 4. Manual on Sewerage and Sewage Treatment Systems Part B O & M 2013 5. Air Pollution M N Rao, H V N Rao	
References: 1. Industrial Air Pollution Control Systems – Neumann 2. O & M of Water treatment plant –Charles R Cox 3. Guidelines for Operation and Maintenance of Effluent Treatment Plants by MPCB	
Unit wise Measurable students Learning Outcomes: At the end of course students will be able to : Define Corrective and Preventive Maintenance. : Explain the need of Operation Manuals in maintenance. 2.1: Summarize the maintenance activities of pumps at water intakes. 2.2: Explain the operation and maintenance of water treatment units. 3.1: Interpret the functions of appurtenances in Water Distribution System. 3.2: Summarize the causes of failures and preventive measures for pipelines. 4.1: Recall the measures for maintenance of wastewater treatment plants. 4.2: Explain the functional requirements of advanced wastewater treatment methods.	

5.1: Explain the mechanism of pollutant removal in air pollution control equipments.
5.2: Illustrate the maintenance of air pollution control equipments.
: Tell the necessity of planning, scheduling, inventory control in maintenance of treatment plants.
: Plan the scheduling of maintenance activities.

Title of the Course: GREEN BUILDING Course Code: UENV0126	L	T	P	Credit
	03	01		04

Course Pre-Requisite: Students must have knowledge of various components and services of the building. The students must know the detailed design of these elements.

Course Description:

The students will study various aspects of energy and resource conservation required for a building. Accordingly they will decide various building elements to fulfill the various elements to fulfill the various criteria.

Course Learning Objectives:

1. To train the students regarding various components climate and their effects on human health
2. To study the various elements of the building regarding energy efficiency and thermal properties.
3. To understand the use of water in the building and study the various methods of minimization of water.
4. To study the various aspects of indoor air quality and various ways to improve it.
5. To study the various guidelines for accreditation of buildings by various organizations.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain the climatic factors affecting building planning	2	Understanding
CO2	Plan the various building elements for conservation of natural resources like water,energy,land	3	Applying
CO3	Analyze the building with respect to accreditation criteria.	4	Analyzing

CO-PO Mapping:

	Programme Outcomes		
	1	**2**	**3**
CO1		1	
CO2			2
CO3			2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Module 1:--- Introduction, Climate, various components of climate, various climatic zones and their characteristics , comfort conditions for human health, various climatic factors affecting the comfort conditions., Requirements of buildings in various climatic zones. Sustainable Site Selection, Solar path diagrams, wind rose and their effects on planning of buildings, Orientation, Building envelop, Building plan layout, Design of Doors and windows, Natural ventilation,	6 **Hrs.**
Module 2:--- Active and Passive Architecture, Natural ventilation and air conditioning, Hybrid system of active and passive refrigeration and air conditioning. Thermal properties of building components, Thermal storage, emissivity, reflectivity, Selection of materials and surface treatment for improvement in thermal comfort daylighting, Improment of daylighting factor by various methods Concept of Embodied Energy, Embodied energy of various common building materials, Energy audit of building,	6 **Hrs.**
Module 3:--- **Water Efficiency** Water Efficient Landscaping –Rain water harvesting, Design of rainwater harvesting system for a building, Minimization of water use, various plumbing fixture to reduce use of water, 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 exchanger, Recycling of treated wastewater for different non potable purpose, Domestic solid waste – Segregation, various treatment alternatives like earthworm composting.	8 **Hrs.**
Module 4:--- Indoor Environmental Quality: Various parameters of indoor air, Volatile Organic Compounds, concentration and sources of VOC, Low- VOC Emitting Materials - Adhesives & Sealants, Paints & Coatings, Carpet Systems, Use of natural products, Wood & Agro-fiber Products like coconut, jute, bamboo and their use as interiors	6 **Hrs.**

Module 5:--- Recycling of Building materials, Existing Walls, Floors & Roof, Interior Non-Structural Elements. Construction Waste Management, Materials Reuse, Recycled Content,, Use of fly ash, foundry sand and other inert solid wastes in buildings Life cycle analysis, Construction phase, operation phase, demolition, Impact on environment and land use.	**6 Hrs.**
Module 6:--- Green Rating of building, USGBC and ISGBC, LEED criteria, GRIHA rating system, CDM and Carbon trading, Environmental clearance of buildings. Introduction to ECBC(Energy Conservation Building Code) with provisions for Building Envelope	6 **Hrs.**
Textbooks: 1. Building Planning and Design -- Shah, Kale 2. Building Planning **3. Handbook of Energy conscious buildings** **4. Energy Conservation Building Code** **5. National Building Code** .	
References: **1. LEED Criteria 2009 version** **2. GRIHA Manuals by TERI**	
1. Tutorials: a) Study of various climatic zones. b) Design of Building envelope for a given data with ECBC Complaince e) Design of wastewater treatment facility for a single building f) Design of solid waste management facility for a building premises. g) Case Study of a single building Complying to IGBC -New building rating system and ECBC.	
Module wise Measurable students Learning Outcomes: **MLO1 Students will be able to understand climatic factors and plan the envelope of the building.** **MLO 2 Students will be able to understand the importance of thermal factors and implement them in planning of building** **MLO 3 Students will be able apply various techniques of water reuse and solid waste management** **MLO 4. Students will be choose appropriate design to maintain healthy indoor air quality** **MLO 5 Students will be able to identify and utilize reusable materials in building construction..** **MLO 6 Students will be able to analyse the building on various accreditation criteria for green buildings..**	

Title of the Course: Research Methodology	**L**	**T**	**P**	**Credit**
Course Code: PENV0161	**2**	**-**	**-**	**2**

Course: There are no Pre-Requisite for this course

Course Description: This course will provide an opportunity for participants to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches.

Course Objectives:

1. Defending the use of Research Methodology
2. Judging the reliability and validity of experiments
3. Perform exploratory data analysis
4. Draw conclusions from categorical data
5. Using computer-intensive methods for data analysis
6. compare statistical models

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Defend the use of Research Methodology	Affective domain	Defend
CO2	Judge the reliability and validity of experiments	Psychomotor	Judge
CO3	perform exploratory data analysis	Psychomotor	analysis
CO4	draw conclusions from categorical data	Psychomotor	conclude
CO5	Use computer-intensive methods for data analysis	Psychomotor	data analysis
CO6	Drawing conclusions from statistical test results & compare statistical models	Psychomotor	compare

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**
CO1	3	1	1
CO2	3	1	1
CO3	1	1	2
CO4	1	2	2
CO4	1	3	1
CO5	3	1	1
CO6	3	1	1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	-
MSE	-
ISE 2	-
ESE	100

ESE: Assessment is based on 100% course content

Course Contents:	
Unit I: Introduction to Research An Introduction, Meaning of Research , Objectives of Research, Motivation in Research, Types of Research, Research Approaches , Significance of Research , Research Methods versus Methodology Research and Scientific Method , Importance of Knowing How Research is Done , Research Process Criteria of Good Research, Problems Encountered by Researchers	5 **Hrs.**
Unit II: Research Design Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs	4 **Hrs.**
Unit III: Sampling Design Need for sampling, Population, Sample, Normal distribution, Steps in sampling, Systematic bias and Sampling error, Characteristics of good sample design, Probability sampling and Random sampling, Determination of sample size	4 **Hrs.**
Unit IV: Results and Analysis Importance and scientific methodology in recording results, importance of negative results, Different ways of recording, industrial requirement, artifacts versus true results, types ofanalysis (analytical, objective, subjective) and cross verification, correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc	**4Hrs.**
Unit V : Measurement and Scaling Techniques Introduction, Concept of measurement - Measurement of scale, Developing measurement scale, Criteria of good measurement tools, Error measurement. Concept of Scaling, Classification, Approaches of scale construction, Types of scales - Rating scale, Ranking scale, Arbitrary scale, Differential scale, Summated scale, Cumulative scale, Factor scale.	3 **Hrs.**
Unit VI: Data Collection and Analysis of Data Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Data Processing Operations, Problems in Processing, Elements/Types of Analysis	4 **Hrs.**

Textbooks:

1. Books: C. R. Kothari, "Research Methodology", New Age international, 2004.
2. Deepak Chopra and Neena Sondhi, "Research Methodology : Concepts and cases", Vikas Publishing House, New Delhi, 2008.
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", 2nd Edition, Sage Publisher, 2011.

Unit wise Measurable students Learning Outcomes:

1. Recall research terminology

2. Be aware of the ethical principles of research, ethical challenges and approval processes
3. Describe quantitative, qualitative and mixed methods approaches to research
4. Identify the components of a literature review process
5. Critically analyze published research
6. Discuss Research Methodology

Title of the Course: **ENVIRONMENTAL MONITORING LAB I**	L	T	P	Credit
Course Code:PENV0131	0	0	4	2

Course Pre-Requisite:

Environmental chemistry and instrumentation

Course Description:

Students will be demonstrated with use of equipments in laboratories and hands-on practice in the field for water quality monitoring

Course Objectives:

1. To provide hands-on practice for analyzing the water and wastewater by physical, chemical and instrumental methods.
2. To provide fundamental knowledge of laboratory skills.
3. To impart knowledge of microbiology and bacterial identification.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Carry out** water/wastewater quality analysis through physical, chemical, biological and advanced instrumental methods.	3	Applying
CO2	**Design** and **conduct** experiments, **analyse** and **interpret** data acquired from the experiments.	3, 6	Applying Creating
CO3	**Identify** types of cells, bacteria by using proper staining methods.	4,5	Analyzing Evaluating

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE is based on experimental work/performance in laboratory/assignment/declared test/etc.

ESE: Assessment is based on oral.

Mapping of CO to PO:

CO	**PO**		
	1	**2**	**3**
CO1	1	-	1
CO2	1	-	1
CO3	1	-	1

Course Contents:

List of Experiments

i. Physico-chemical analysis of water & wastewater:
   a. pH
   b. Hardness and Alkalinity
   c. Conductivity
   d. Solids
   e. Dissolved oxygen
   f. Chlorides
   g. Residual chlorine and free chlorine
   h. BOD and COD
   i. Fluoride
   j. Iron and Manganese

ii. Microbiology
   a. Cell Types – Eukaryotic and Prokaryotic
   b. Gram staining
   c. Bacterial cultures
   d. MPN

iii. Instrumental Methods: Calibration and Operation of Flame photometer, Spectrophotometer, Atomic Absorption Spectrophotometer and Colorimeter

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, *"Environmental Engineering",* McGraw-Hill book company, , International edition, 1985.
2. Pelczar, Jr, M.J., E.C.S., Krieg, R.Noel., and PelczarMerna Foss. "Microbiology", Tata McGraw Hill Publishing Company Limited, 5th edition., 1996.
3. Sawyer. C.N. And McCarty. P.L., *"Chemistry for Environmental Engineers",* Tata McGraw-Hill Publishing Company Limited, 5th Edition, 2003.

References:

1. Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
2. Metcalf and Eddy *"Wastewater Engineering Treatment and Reuse",* Tata McGraw Hill Publication, 6th Reprint. 2003.

Title of the Course: Environmental Monitoring Lab. II	**L**	**T**	**P**	**Credit**
Course Code: PENV0132	**0**	**0**	**2**	**1**

Course Pre-Requisite:
Environmental chemistry and instrumentation, air pollution & control

Course Description:
Students will be demonstrated with use of equipments in laboratories and hands-on practice in the field for Ambient air quality monitoring and meteorological parameters monitoring

Course Objectives:
To monitor various meteorological parameters influencing dispersion of air pollutants
To analyze quality of ambient air and stack emissions.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Measure various meteorological parameters using various instruments	6	Measure
CO2	Design and conduct experiments for monitoring of air	5	Design, conduct
CO3	Design and conduct experiments for solid waste characterization	3,6	Apply & Create

CO-PO Mapping:

CO	**PO**		
	1	**2**	**3**
CO1	3		
CO2	3		
CO3	3		

Assessments :
Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:
1. Study of various meteorological parameters
2. Study of Fine Dust Sampler
3. Ambient air monitoring
4. Study of stack monitoring kit
5. Stack flue gas monitoring
6. Study of automobile exhaust analyzer

7. Ambient noise level measurements
8. Sampling of MSW by Four Quadrant Method
9. Analyzing Physical properties of MSW
10. Proximate & Ultimate analysis of MSW

Title of the Course: Seminar **Course Code:** PENV0141	**L** **0**	**T** **0**	**P** **02**	**Credit** **1**

Course Pre-Requisite:

Course Description:

Course Objectives:

1. Encourage students to investigate new research from various academic disciplines which focuses on environmental problems.
2. Create awareness amongst students about the inovative technical/industrial projects which may form a basis for their dissertation works.
3. Develop an attribute of effective communication through effective presentations.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Comprehend about the current materials, tools and techniques in the area of environmental engineering and keep abreast in current technologies.	2	Understand
CO2	**Identify** and **contrast** the assumptions, thesis and arguments that exist in the research papers of various authors.	1, 4	Remember, Analyse
CO3	**Recognize** and **compose** effective written and oral communication, giving appropriate consideration to audience, context, format and textual evidence.	1, 6	Remember, Create

CO-PO Mapping:

CO	**1**	**2**	**3**
CO1	1		
CO2			
CO3		3	1

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	**Marks**
ISE	100

ISE is based on information/literature collected, presentation, fundamental concepts, interaction and report.

ISE is based on information/literature collected, presentation, fundamental concepts, interaction and report.

ISE is based on information/literature collected, presentation, fundamental concepts, interaction and report.

Course Contents:

The students shall collect information on the topic relevant to Environmental Engg., by referring to research articles from journals and conferences. Students should deliver minimum of ***three*** presentations on chosen topic with a view of enhancing their presentation skills on technical presentation. A detailed report is to be submitted. Academicians and professional from the Civil and Environmental engineering are also invited to deliver lectures field related issues and share their professional experience.

Title of the Course: Industrial Waste Treatment **Course Code:** PENV0201	**L** **3**	**T** **1**	**P**	**Credit** **4**

Course Pre-Requisite: Environmental chemistry, Unit operations and processes in Environmental Engineering

Course Description: This course is intended to make students aware about the sources and characteristics of waste generated from various industries, various techniques of waste minimization and their applications, joint treatment of industrial waste and sewage, treatment options for wastewater along with flow sheet and concept of Common effluent treatment

Course Objectives:

1. Learn the manufacturing process, water requirement and pollution aspects of various industries
2. Understand the benefits and techniques of waste minimization in industries
3. Study the various options for treatment of industrial waste
4. Understand the treatment required for removal of specific pollutants from industrial waste.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Apply various techniques for waste minimization	3	Apply
CO2	Select alternative treatment for industrial waste to meet disposal standards	5	Select
CO3	Recommend treatment required for removal of specific pollutants	6	Recommend

CO-PO Mapping:

CO	**PO**		
	PO1	**PO2**	**PO3**
CO1			1
CO2			1
CO3			1
CO4			
CO5			

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks

ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1:---Sources, Characteristics and Effects of Industrial Waste Classification of Industries, General water requirements in industry, Sources and characteristics of industrial wastewater, Effects of untreated industrial wastewater	**3Hrs.**
Module -2:--- Waste Minimization and Treatment options Waste minimization - 4 R concepts, Waste volume and strength reduction, Zero discharge concepts , Classification of treatment, Treatment flow sheet development, Neutralization, Equalization, Proportioning , Effluent standards, Joint treatment of industrial wastewater and sewage	**6Hrs.**
Module 3:--- Treatment for Removal of specific pollutants Removal of Oil & grease, Floatation, removal of Heavy metals and Cyanide, Removal of radioactive substances, Removal of toxic substances and refractories, Applications of adsorption and membrane filtration	**7 Hrs.**
Module -4 Agro-based Industries Manufacturing processes, Water usage, Sources, quantities and characteristics of effluents (process stream and combined), Pollution effects, Waste Reduction/Reclamation/Byproduct recovery, Utilization, Alternative methods of treatment, and disposal for various Agro-based industries: Sugar, Distillery, Dairy, Pulp and paper mill, Textile	**10 Hrs.**
Module -5 Non agro-based industries Manufacturing processes, Water usage, Sources, Quantities, and characteristics of effluents (process stream and combined), Pollution effects, Waste Reduction/Reclamation/Byproduct recovery, Utilization, Alternative methods of treatment, and disposal for i) Chemical industries: Pharmaceutical, Fertilizer and Tannery ii) Engineering industries: Steel & Foundries, Sponge iron unit, Alumina/aluminum manufacturing unit, Copper smelter iii) Thermal power plants	**10Hrs.**
Module 6:--- Treatment and Disposal System Treatment and disposal of waste from small scale industries- Concept of Common Effluent Treatment Plant- Objectives, Design, Operation and maintenance, cost distribution, benefits, Introduction to Project report preparation for waste treatment and disposal system of industries, Prefeasibility, feasibility and detailed project reports	4 **Hrs.**

Textbooks:

1. "Theories and Practices of Industrial Waste Treatment", Nelson Nemerow, Wiley

Publication Company,

2. Industrial Waste Treatment contemporary practice an vision for future", Nelson Nemerow Elsevier Science & Technology Books, 2006

References:

1. W .W. Eckenfelder Jr., "Industrial Water Pollution Control", McGraw-Hill Book Company, New Delhi, 2000.
2. Industrial Waste Treatment by A.D Patwardhan
3. "Wastewater Engineering Treatment and Reuse", Metcalf And Eddy, Tata McGraw Hill Publication
4. A Handbook of Effluent treatnment plant by Mehajabin Shaikh, Enviro Media
5. MOEF standards Guide for Treatment and Disposal of Waste from Various Industries".
6. H.M.Freeman, "Industrial Pollution Prevention Hand Book", McGraw-Hill Inc., New Delhi,
7. "Pollution Prevention: Fundamental & Practice", Bishop, P.L.,McGraw-Hill, 2000.
8. "Industrial Pollution Prevention", T.T.Shen, Springer, 1999.
9. "Industrial Wastewater Systems Hand book", R.L.Stephenson and J.B.Blackburn, Jr., Lewis Publisher, New Yark, 1998
10. Lee, C.C. and Shun dar Lin. Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
11. Casey T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wileys Sons, London, 1993.
12. David W.Hendricks, „Water Treatment Unit Processes: Physical and Chemical", CRC Press, Boca Raton, 2006.

Module wise Measurable students Learning Outcomes:

At the end of the course, the students will be able to

UO 1.1 Apply various methods for waste minimization in industries

UO 1.2 Classify the treatment options and develop treatment flow

UO 2 Identify and suggest treatment methods for removal of specific pollutants for industrial waste

UO 3 Design appropriate treatment system for agro based industrial wastewater

UO 4. Design appropriate treatment system for chemical and Engineering industrial wastewater.

UO 5 Apply the knowledge for preparation of feasibility study and report preparation for various treatment facilities and CETP

Title of the Course: Biological Wastewater Treatment	**L**	**T**	**P**	**Credit**
Course Code: PENV0202	**3**	**1**	**-**	**4**

Course Pre-Requisite:

- Wastewater treatment at graduate level and Unit Operations and Processes in environmental Engineering.

Course Description:

This course develops the fundamentals and applications of aerobic and anaerobic biological unit processes for the treatment of municipal and industrial wastewater. The principles of activated sludge, aeration and clarifier design, fixed film reactors, anaerobic treatment, solids handling and treatment, land treatment, and nutrient removal are presented. This course uses concepts from microbiology and the basic principles of stoichiometry, energetics, and microbial kinetics are used to support the design of biological unit processes.

Course Objectives:

The course objectives are to:

1. To provide in-depth knowledge for the analysis and evaluation of biological and natural treatment processes of wastewater treatment critically.
2. 2. To enhance the technical competency to apply the acquired knowledge for conduct of research and addressing the problems of industry/society related biological wastewater treatment.
3. 3. To inculcate the qualities of critical thinking and independent judgement to e**valuate** and **design** biological wastewater treatment facilities.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	**Understand and Apply** the acquired knowledge of biological and natural processes for identifying appropriate wastewater treatment system.	2, 3	Understanding Applying
CO2	**Analyze** and **evaluate** the performance of biological and natural wastewater treatment facilities by critical thinking and independent judgement.	4,5	Analyzing Evaluating
CO3	**Design** the biological wastewater treatment facilities.	6	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**
CO1	-	-	1
CO2	-	-	2
CO3	-	-	3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Objectives and fundamentals of biological treatment Objectives and fundamentals of biological treatment, types of biological treatment processes, Microbial growth kinetics	**4 Hrs.**
Unit 2: Modeling suspended growth treatment processes Modeling suspended growth treatment processes Activated Sludge Process (ASP): Configurations and variations, Cyclic ASP, Process design and operating parameters, Operational problems, Evaluation of Biokinetic Parameters. Biological nitrification and denitrification. Design and operation of aerated lagoon, oxidation ditch, and facultative waste stabilization pond, Membrane bioreactor.	**9 Hrs.**
Unit 3: Modeling attached growth treatment processes Modeling substrate removal in attached growth treatment processes. Process, design considerations and operational problems for attached Growth aerobic biological treatment systems: Trickling filters and Rotating biological contactors. Secondary clarification	**6 Hrs.**
Unit 4: Anaerobic processes Anaerobic processes, Process fundamentals, Growth kinetics, General design considerations, Types of anaerobic reactors. Process, design and operation of anaerobic lagoon, anaerobic filter and Upflow anaerobic sludge blanket systems	**7 Hrs.**
Unit 5: Sludge treatment and disposal Sludge treatment and disposal – characteristics, thickening, Sludge Digestion (anaerobic and aerobic), and disposal, Types of anaerobic digester and their selection, Design and operation of digesters. Stream and Effluent standards. Wastewater reclamation and reuse, Application of treated waste water on land for irrigation, Effect of dissolved solids	**6 Hrs.**
Unit 6: Wetland and aquatic treatment systems Wetland and aquatic treatment systems: Types, application, Treatment kinetics and effluent variability in constructed wetlands and aquatic systems, Free water surface and subsurface constructed wetlands, Floating plants (water hyacinths and duckweed), Combination systems, Design procedures for constructed wetlands, Management of constructed wetlands and aquatic systems	**8 Hrs.**

Textbooks:

1. Wastewater Engineering Treatment and Reuse, Metcalf And Eddy, Tata McGraw Hill Publication, 1979, 4th Edition.
2. Manual on design of Constructed Wetland, US EPA
3. Manual on Sewerage and Sewage Treatment Systems, Part A (Engineering), Third Edition, Published by CPHEEO in collaboration with JICA

References:

1. "Theory and Practice of Water and Wastewater Treatment", Droste, Ronald L., John Wiley & Sons Publication, 1997, 1st Edition.
2. "Environmental Engineering", Peavy, Rowe and Technologous MGH.
3. "Environmental Engineering", Sincero. A.P. And Sincero. G.A., Prentice Hall of India Private Limited, 1996, 1st Edition.
4. "Wastewater Treatment for Pollution Control and Reuse", Arceivala S.J. and

Asolekar, Tata McGraw Hill Publication, 2002, 2nd Edition.

Unit wise Measurable students Learning Outcomes:

At the end of course students will be able to

1. **Understand concepts of** biological treatment processes.
2. Understand and apply modeling, simulation and design of suspended growth biological wastewater treatment processes for conventional and specific pollutants
3. Understand and apply modeling, simulation and design of attached growth biological wastewater treatment processes
4. Understand and apply modeling, simulation and design of anaerobic biological wastewater treatment processes
5. Apply fundamental scientific concepts for treatment of sludge.
6. Apply fundamental scientific concepts and detailed technical understanding of the constructed wetland for domestic wastewater treatment.

Title of the Course: ENVIRONMENTAL IMPACT ASSESSMENT AND LEGISLATIONS Course Code: ENV0203	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite: Students must have knowledge of various environmental pollution and their treatment alternatives.

Course Description:
The students will study the predictions of impacts on various environmental resources and the various legal provisions for protection of environment.

Course Objectives:

1. To train the students regarding various aspects of Environmental Impact Assessment
2. To understand the various methodologies for assessing impact of a project.
3. To study the various EIA case studies.
4. To understand the various national policies and programs regarding environment.
5. To study the provisions of various environmental acts, rules and notifications regarding environmental protection.
6. To study the various global and legal aspects of environmental pollution.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Choose the methodology for EIA studies for a developmental project.	1	Remembering
CO2	Plan and Develop an EIA report for a particular project as per the guidelines given in the rules.	3	Applying
CO3	Compare the various projects with respect to their impacts on environment.	2	Understanding
CO4	Develop the provisions for environmental matter as applicable as per the various policies of the government.	3	Applying
CO5	Identify the various legal provisions applicable to the various industries according to the various environmental legislations.	3	Applying
CO6	Develop the various global and local issues regarding environmental protection.	3	Applying

CO / PO	PO 1	PO 2	PO 3
CO1		**2**	
CO2		**2**	
CO3			**3**
CO4			**3**
CO5			**2**
CO6			**2**

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:--- Frame work of Impact assessment scope and contents of EIA, methodologies and techniques of EIA. **Attributes, Standards and Value functions**. EIA Notification history & present scope, Public participation in EIA. LCA.	6 **Hrs.**
Unit 2:--- Environmental Impact Assessment – Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme.	6 **Hrs.**
Unit 3:-- EIA Case Studies –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants.	4 **Hrs.**
Unit 4:--- Environmental Policy: Pre & Post Independence Period; From Stockholm to Johannesburg Declaration (Rio) and Role of Government –NITI Ayog and the functioning. Forest Policy - Conservation strategy - Water Policy; Conservation of Natural Resources and its Management; NGT & its provisions.	6**Hrs.**
Unit 5:--- Prevention and Control of Pollution: Pollution of Water, Sources, Legal Control, The Water (P & CP)Act, 1974 and Rules, The Water Cess Act and the rules Pollution of Air : The Air (P & CP) Act, 1981 and the rules– Environment Protection Act, 1986 & Various rules under EPA.	**10 Hrs.**
Unit 6 International Law and Environmental Protection: International conventions in the development of Environmental Laws and its Policy - From Stockholm to recent conventions (Special Emphasis on Major conventions & Protocols) - Control on Marine Pollution; Common Law aspects of Environmental Protection; Various supreme court judgments regarding environmental protection	6 **Hrs.**

Textbooks:

1. Armin Rosencranz - Environmental Law and Its Policy in India.
2. P. Leelakrishnan - Environmental Law in India /Cases.
3. Lal's commentaries on Water and Air Pollution laws along with Environment (Protection) Act and Rules, 1986.
4. Canter L., (1995), "Environmental Impact Assessment", McGraw Hill.
5. Jain R.K., Urban L.V., Stacey G.S., (1977), "Environmental Impact Analysis – A New Dimension in Decision Making", Van Nostrand Reinhold Co.
6. Clark B.C. Bisett and Tomlinson P, (1985), "Perspective on Environmental Impact Assessment", Allied Publishers.

References:

1. Simon Ball Stuart Bell - Environmental Law.
2. Sanjay Upadhyay and Videh Upadhyay - Handbook on Environmental Laws.
3. S. Shantha Kumar- Introduction to Environmental Law.
4. Relevant Bare Acts/Notifications.

Tutorials:

1. Assignments based on each Unit.
2. Preparation of summery EIA report any one project.
3. Use of various models & predict the impacts on environment as per the data given in case studies.
4. report of any one public hearing.

Unit wise Measurable students Learning Outcomes: students will…..

ULO1. Identify the fundamentals of EIA
ULO2. List the scope & components of EIA
ULO3. Analyze various EIA case studies.
ULO4. Analyze the pre & post independent policies of Govt of India.
ULO5. Study the various pollution prevention acts in India.
ULO6. Compare international pollution control policies with Indian policies.

Title of the Course: REMOTE SENSING & GIS Course Code: PENV0221	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite: Students must have knowledge about fundamentals of Science, basic mathematical ability, computational ability, basic computer skills & imagination.

Course Description:

This course will provide basics related to remote sensing technology used in engineering field, various methods of remote sensing, its practical use. Also it provides exposure to basics of GIS its use in day to day experiences. Introduction to basic GIS softwares.

Course Objectives:

1. Acquire knowledge of fundamentals of Remote Sensing & GIS.
2. Learn the importance of platforms, sensors & image interpretation.
3. Know the working of different GIS softwares.
4. Learn applications of RS & GIS in environmental engineering.

Course Learning Outcomes.

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	List the applications of RS & GIS in environmental field	1	Remembering
CO2	Extend their knowledge in the field in remote sensing & GIS.	2	Understanding
CO3	Identify appropriate GIS software tool for use.	3	Applying
CO4	Compare between respective platforms, sensors & image interpretation techniques	4	Analyzing

CO / PO	PO 1	PO 2	PO 3
CO1			**2**
CO2			**2**
CO3			**1**
CO4	**3**		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:--- Definition of remote sensing and its components – Electromagnetic spectrum – wavelength regions important to remote sensing – Wave theory, Particle theory, Stefan-Boltzman and Wein's Displacement Law – Atmospheric scattering, absorption – Atmospheric windows spectral signature concepts – typical spectral reflective characteristics of water, vegetation and soil.	8 **Hrs.**
Unit 2:--- Types of platforms – orbit types, Sun-synchronous and Geosynchronous – Passive and Active sensors – resolution concept – Pay load description of important Earth Resources and Meteorological satellites – Airborne and space borne TIR and microwave sensors.	6**Hrs.**
Unit 3:--- Types of Data Products – types of image interpretation – basic elements of image interpretation - visual interpretation keys – Digital Image Processing – Pre-processing – image enhancement techniques – multispectral image classification – Supervised and unsupervised.	6 **Hrs.**
Unit 4:--- Introduction – Maps – Definitions – Map projections – types of map projections – map analysis – GIS definition – basic components of GIS – standard GIS softwares – Data type – Spatial and non-spatial (attribute) data – measurement scales – Data Base Management Systems (DBMS).	6**Hrs.**
Unit 5:--- Data models – vector and raster data – data compression – data input by digitization and scanning – attribute data analysis – integrated data analysis – Modeling in GIS Highway alignment studies – Land Information System.	8**Hrs.**
Unit 6:--- GIS applications: Forestry, Bio-diversity, Environment, Soil resource management, Hydrological modelling, Public utilities (water distribution, sewerage, solid waste management).	6 **Hrs.**

Textbooks:

1. Anji Reddy, M. (2001). Textbook of Remote Sensing and Geographical Information System. Second edn. BS Publications, Hyderabad.

2. Ian Heywood (2000). An Introduction to GIS. Pearson Education Asia.

References:

1. Lillesand, T.M., Kiefer, R.W. and J.W.Chipman. (2004). Remote Sensing and Image Interpretation. V Edn. John Willey and Sons (Asia) Pvt. Ltd., New Delhi. Pp:763.

2. Lo. C.P.and A.K.W.Yeung (2002). Concepts and Techniques of Geographic Information Systems. Prentice-Hall of India Pvt. Ltd., New Delhi. Pp:492.

4. Peter A.Burrough, Rachael A.McDonnell (2000). Principles of GIS. Oxford University Press.

Unit wise Measurable students Learning Outcomes: Students will…

Unit 1- Able to Recall & Demonstrate various concepts of Remote Sensing.

Unit 2- Select & Demonstrate appropriate platform & Sensor.

Unit 3- Able to Take part in data interpretation.

Unit 4- Able to Recall & Explain various concepts of GIS.

Unit 5- Able to Select respective data input technique.

Unit 6- Able to Utilize RS & GIS in environmental application.

Title of the Course: WATERSHED MANAGEMENT Course Code: PENV0222	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:
Students must have knowledge about natural resources available and environmental impact of disaster and famine. Accordingly students must be aware of utilization of water, soil, air and surroundings towards approach of greenery.

Course Description:
Students will understand the importance of utilization of natural resources for better living of human being. They will study the basic techniques of sustainable development. The course also includes advanced methods of watershed development in accordance with water storage and utilization, soil and land development, water harvesting methods and modern techniques of farming.

Course Objectives:

1. Understand the significance, concept, necessity& scope of watershed Management and sustainable management practices.
2. Study general, scientific &engineering approaches regarding proper planning & utilization of water.
3. Learn Socio – Economic Aspects of Watershed Management.
4. Acquire the knowledge standard watershed model based on standard modeling approaches and classifications.
5. Study storm water drainage system design, flood routing, flood control and reservoir operation, Drought assessment and mitigation planning.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Assess Socio – Economic Aspects of Watershed Management through community participation, water legislation and implementations.	6	Cognitive
CO2	Prepare standard watershed model based on standard modelling approaches and classifications.	5	Cognitive
CO3	Develop and analyze storm water drainage system design, flood routing, flood control and reservoir operation, Drought assessment and mitigation planning.	5	cognitive

Mapping of Course Outcome to Program Outcome

Course Outcome	Program Outcome		
	PO1	PO2	PO3
CO1			1
CO2		2	
CO3	2		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:--- 9 **Hrs.**

Introduction to Watershed Management

Concept of watershed, Introduction to watershed management, Watershed management policies and decision making, Place in environment, Global effects, Status in India, Historical background

Sustainable Watershed Management Practices

Sustainable integrated watershed management, Natural resources management, agricultural practices, Integrated farming, Soil erosion and conservation, Reclamation of saline soils, Watershed Management Practices in different Regions, Short term and long term strategic planning

Unit 2:--- 6 **Hrs.**

Integrated Approach of Watershed Management

Introduction, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system, Groundwater - potential & harvesting, well construction.

Unit 3:--- 5 **Hrs.**

Socio – Economic Aspect of Watershed Management

Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Role of NGOs and International agencies

Unit 4:--- 10**Hrs.**

Modeling of Watershed

Standard modeling approaches and classifications, Concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall- runoff process, subsurface flows and groundwater flow

Management of Water Quality

Water quality and pollution, Types and sources of pollution**,** Water quality

modeling, Environmental guidelines for water quality	
Unit 5:--- **Storm Water, Flood and Drought Management** Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, Drought assessment and classification, drought analysis techniques, drought mitigation planning.	**6 Hrs.**
Unit 6:--- **Advanced Techniques in Watershed Management** Applications of Geographical Information System (GIS) and Remote Sensing in Watershed Management	4 **Hrs.**

Textbooks:

1. Murty, J.V.S. "Watershed Management", New Age Intl., New Delhi 1998
2. Murthy, J.V.S., Watershed Management in India, Wiley Eastern, New Delhi, 1994
3. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad, 1995
4. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner, 2000
5. Hydrology & Soil Conservation Engineering - GhanshamDas , Prentice Hall of India
6. Manual of Soil & Water Conservation Practices - Gurumal Singh, Oxford & IBH Publishing Company
7. Soil & Water Conservation Engineering - R. Suresh, Standard Publishers

References: Report ofWatershed Management for Badri Village of Bihar

Unit wise Measurable students Learning Outcomes: Students will be able to .

Unit-1 Explain significance and scope of watershed Management for sustainable development.

Unit-2 Apply concepts of integrated water resources management, conjunctive use of water resources, rainwater harvesting.

Unit-3 ApplySocio–Economic aspects of watershed management through community and Private sector participation, Socio-economy.

Unit-4 Develop standard watershed model based on standard modelling approaches and water quality models.

Unit-5 Assess for design storm water drainage system, flood routing flood control Drought assessment, drought analysis techniques, drought mitigation planning.

Unit-6 Apply advanced techniques in Watershed Management, Geographical Information System (GIS) and Remote Sensing in Watershed Management.

Title of the Course: ENVIRONMENTAL MODELING AND SIMULATION Course Code: PENV0223	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:
Students must have knowledge about numerical and mathematical rules and its use in solving problems by correlating constants and parameters with each other. Also students must be aware of concept and units for preparing mathematical model and correlated concepts of Environmental engineering.

Course Description:
Students will understand the importance of formulation of mathematical model for various applicationsin the environmental processes. They will study the pollution caused by disposal of waste in surface, sub surface water as well as on ground. The syllabus also includes Ph model, BOD model, and Modelling of Toxicity.

Course Objectives:

1. Understand the concepts of modeling and simulation in Environmental engineering.
2. Study the concepts of various mathematical models of physical systems related to water quality.
3. Learn to correlate parameters for modeling in surface water quality of rivers, streams, lakes, reservoirs.
4. Understand modeling for underground water quality, pH modeling and transport of contaminants in ground water.
5. Acquire the knowledge of developing mathematical model for various environmental systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Analyze mathematical parameters with the help of models in various water quality problems.	6	Cognitive
CO2	Asses the water quality models and simulates them in various fields of pollution control.	5	Cognitive
CO3	Develop the mathematical model for water quality of surface and subsurface water, river and stream water, lakes and reservoir water.	5	cognitive

Mapping of Course Outcome to Program Outcome

Course Outcome	Program Outcome		
	PO1	PO2	PO3
CO1	2		
CO2		2	
CO3			1

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Fundamentals & Mathematical model of physical systems Fundamentals: Mass balance principle, Reaction kinetics (types of reaction, rate and order of reaction, Effect of temperature), Analysis of experimental data, Determination of rate constants Mathematical model of physical systems- Hydraulic models of natural systems (Types of reactors), CFSTR, PFR Models, Ideal flow models, Mass balance applications	9**Hrs.**
Unit 2:--- **Modelling Water quality in Environment** Modelling Water quality in Environment: Transport phenomena, Advection, diffusion, dispersion, Dispersion and mixing in streams, Air/water interface, Gas transfer (agitated and stagnant), pH modelling.	6 **Hrs.**
Unit 3:--- **Surface water quality modelling** Surface water quality modelling-, Water quality in rivers & streams, Point and non-point sources, BOD model, Point source Streeter –Phelp equation, Nitrogenous BOD modelling, Sediment oxygen demand, Stream quality modeling using QUAL2E	6 **Hrs.**
Unit 4:--- **Water quality of lakes & reservoirs** Water quality of lakes & reservoirs- Hydraulic behavior, Effect of physical processes on Water quality, Modelling of lakes & reservoirs, 1D model, Vertical	8 **Hrs.**

modelling, Ecological modelling, Significance, Eutrophication in flowing water.	
Unit 5:--- **Subsurface water quality modelling** Subsurface water quality modelling: Transport of non reactive& reactive contaminant in Ground water, Gaussian plume model	**5 Hrs.**
Unit 6:--- **Microbe / Substrate modelling and pH modelling** Microbe / Substrate modelling: bacteria growth, substrate utilization, Microbial kinetics, batch and CSTR, toxicant modelling in flowing water. pH modelling, Toxics substance model in CSTR, Bio-concentration and Bioaccumulation model.	6 **Hrs.**

Textbooks:

1. Surface water quality modelling - Steven Chopra, McGraw hill
2. Water quality modelling; modification - Tchobanoglous (Addision& Wesley Edward Schroedar)
3. Environmental Engineering - Sincero and Sincero
4. USEPA: www.epa.gov.in QUAL2E model
5. Metcalf & Eddy. Waste Water Engg. Treatment & Disposal, Tata McGraw - Hill Pub.

References: Water Quality Modelling by Muler

Unit wise Measurable students Learning Outcomes: Students will..

Unit-1 Explain significance of mass balance principle in reactor design and. Hydraulic models of natural systems.

Unit-2 Demonstrate model of water quality in Environment, Transport phenomena and ideal flow models.

Unit-3 Apply concepts of Surface water quality for rivers & streams, Point and non-point sources, BOD model.

Unit-4 Develop the mathematical model for water quality of lakes and reservoirs, BOD model, stream quality modelling.

Unit-5 Analyze and design the subsurface water quality model for transport of contaminant in Ground water.

Unit-6 Develop toxicant model of water, pH modelling and Bio-concentration and Bioaccumulation model.

Title of the Course: Environmental Management System	**L**	**T**	**P**	**Credit**
Course Code: PENV0224	**3**	**1**	**-**	**4**

Course Pre-Requisite:

- Students shall have knowledge of Legal Requirements for different elements of environment.
- Students shall have knowledge of waste treatment and minimization processes in industries.

Course Description:

Environmental Management System (EMS) based on ISO 14001: 2004 is a management system voluntarily implemented by organization in order to reduce the negative impacts on environment and to enhance environmental performance. The course syllabus is based on the requirements given by ISO 14001: 2004 standard, which are to be satisfied by the organization to have EMS & necessary certification.

Course Objectives:

At the end of course students will

1. Know the basic terms of Environmental Management System.
2. Study the requirements for planning, implementation and checking of Environmental Management System.
3. Understand the competence requirements of auditor for Environmental Management System Audit.
4. Learn the importance of Management Review in Environmental Management System.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Demonstrate the requirements for Planning, Implementation, Checking & Review of Environmental Management System as per ISO 14001: 2004.	2	Understanding
CO2	Develop the checklist for evaluation of Environmental Management System documents.	3	Applying
CO3	Analyze the implementation of EMS as per the requirements of ISO 14001:2004.	4	Analyzing

Mapping of COs to POs:

Course Outcomes	**Programme Outcomes**		
	1	2	3
CO1		2	
CO2		2	
CO3		2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.	
Course Contents:	
Unit 1:--- Introduction to ISO 14001 Definitions, Purpose, Scope, ISO 14001 family, Deming's PDCA Cycle, General requirements, EMS Elements	**4 Hrs.**
Unit 2:--- Planning Environmental policy, Compliance, Continual improvement, Pollution prevention Planning, Aspects, Aspects Procedure, Aspects list, Significant Aspect determination, Significant aspects/impacts list, Legal and other requirements, Listings of applicable legal and other requirements, Appropriate instructions for compliance, Permits, Objectives and targets, List of objectives and targets, Related action plans	**8 Hrs.**
Unit 3:--- Implementation Structure & Responsibility, Job descriptions, Organizational charts, Competence, Training, Awareness, Communications, Specific work instructions, Records of communication and correspondence, Documents, procedures, and manuals, Document control, , Operational control, Critical operations/aspects listing/matrix, Specific work instructions, Emergency plans and protocols.	**8 Hrs.**
Unit 4:--- Checking Monitoring and measurement, - Objectives and target action plans, Records of monitoring and measurement data collected, including calibration records, Evaluation of Compliance, Nonconformance and corrective/preventive action, Corrective action reports, Records, Control of records, Internal Audit.	**7 Hrs.**
Unit 5:--- Auditing and Management Review Terms and definitions, Principles of Audit, Managing Audit Programme, Audit Activities, Preparation of Audit Reports, Audit Follow-up, Competence of Auditors, Evaluation of Auditors, Necessity of Management Review, Management Review Meeting, Continual Improvement, Opportunities of Improvement.	**8 Hrs.**
Unit 6:--- ISO 14001: 2015 standard Introduction Introduction, Leadership, Planning, Support, Operation, Performance Evaluation, Improvement	**5 Hrs.**
Textbooks: 1.ISO 14001:2004 Environmental management systems -Requirements with guidance for use 2. ISO 14004: 2004 Environmental management systems-General guidelines on principles, systems and support techniques 3. ISO 19011:2002 Guidelines for quality and/or environmental management systems auditing 4. ISO 14001:2015 Environmental management systems -Requirements with guidance for use	
References: 1. IEMA approved Advanced Environmental Management Systems Auditors Course Manual by Confederation of Indian Industry Environment Management Division	
Unit wise Measurable students Learning Outcomes: At the end of course students will be able to 1.1: Define the basic concepts of Environmental Management System. 1.2: Tell the benefits of Environmental Management System. : Explain the approach for identification of significant aspects. : Illustrate the need of identification of applicable Legal Requirements. 3.1: List the different clauses under Implementation. 3.2: Interpret the necessity of Standard Operating Procedures. 4.1: Summarize the elements for checking of Environmental Management System.	

4.2: Identify the Corrective Actions & Preventive Actions. 5.1: Classify the audit process in various activities. 5.2: Interpret the competence requirements of Auditor. 6.1: Tell the necessity of Management Review in EMS. 6.2: Explain the role of Management Preventative in Review of EMS.

Title of the: Noise Pollution and Control	**L**	**T**	**P**	**Credit**
Course Code: PENV0225	**3**	**1**		**4**

Course Pre-Requisite: Knowledge of engineering mathematics

Course Description: This course is intended to make students aware about the sources of noise, factors influencing its propagation, measurement of noise, various effects on human(auditory & non auditory), animals, plants and structures, ambient and exposure standards, health monitoring with respect to noise, assessment of Noise Induced Hearing Loss, various engineering and non engineering measures for control, legal provisions

Course Objectives:

1) Learn the various indices for measurement of community noise
2) Learn the various techniques of noise control in community and industries as well as their applications.
3) Study the permissible limits, standards and other legal provisions for control of noise.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Calculate various indices like Leq, L_{DN} , L_{NP} based on noise monitoring data	3	Calculate
CO2	Recommend various measures control for noise for industries and community	6	Recommend
CO3	Compare the measured noise level with permissible limit	6	Compare

CO-PO Mapping:

CO	**PO**		
	PO1	**PO2**	**PO3**
CO1	2		1
CO2			1
CO3		1	1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Module 1:--- Sound Transmission and measurement Sound- characteristics, Sound transmission and Characteristics of sound wave, Measurement of sound with respect to sound pressure, Sound power and sound intensity, Units of measurement, Sound Level Meter, Factors influencing sound transmission in outdoor atmosphere	**8 Hrs.**
Module 2:--- Sources and effects of Noise Definition of noise, Sound Vs. Noise, nuisance of noise in India, Sources of noise and classification, Infrasonic and ultrasonic sound, Threshold of hearing, Threshold of pain, Anatomy of human ear and mechanism of hearing, Effects of noise - effects on human health, auditory effects, physiological and psychological effects, effects on animals, effects on wild life, effects on plants, effects on structures	**7 Hrs**
Module 3:--- Community noise Sources and characteristics of community noise, Common noise levels, Measurement of community noise, Equivalent noise, Average Day & Night noise, Noise Pollution Levels, Noise Percentile	**7 Hrs**
Module 4:--- Industrial noise Types, sources and characteristics of industrial noise, Noise levels generated in various industrial operations, Measurement of industrial noise, OSHA exposure standards, Exposure measurement, Use of Dose meter, Health Monitoring, Procedure of Audiometric testing, Interpretation of Noise Induced Hearing Loss from audiogram	**6 Hrs.**
Module 5:--- Control of noise Engineering control of noise, noise reduction at source, acoustical absorbance devices, Enclosure, barrier, Various types of mufflers, Reduction at receiving end, Non engineering control of noise, Active Noise Reduction, Administrative control of noise, Personal protective Equipments for noise, Strategy for control of noise, Control of community noise, Frequency analyzer and octave band analysis	**6 Hrs**
Module 6:--- Legal Provision for control of noise Legal provisions for control of noise under Noise Pollution (Regulation & Control) Rules, 2000 and its amendment in 2010, Case studies in India and abroad	**6Hrs.**
Textbooks:	

1. Noise Pollution and Control Strategy by S.P. Singhal, Narosa Publishing House, 2005
2. Noise Pollution – S.K.Agrawal- APH Publishing carporation, New Delhi. 2009

References:

1. Handbook of Environmental management and technology by Gwendolyn Holmes, Ben Ramnasiue singh and Louis Theodore (A Wiley – Enter science publication)
2. Standard Hand book of Environmental Engineering by Robert A. Corbett (McGraw Hill Inc.)
3. Industrial Pollution by N. Irving Sax (Van Nostrand Reinhold Company)
4. Environmental issues and programme by I. Mohan (Ashish publishing house)
5. Environmental Engineering by G.N.Pandey and G.C. Carney (Tata McGraw Hill)
6. Some thought on Environmental and law by C.S. Mehta (RBSA Publisher)
7. IS code for practice for noise reduction in industrial buildings IS: 3483, 1965
8. Soil & Noise pollution: Dr B.K.Sharma & Dr. H.Kaur, Goel Publishing House, Krishana Prakashan mandir, Meerut

Module wise Measurable students Learning Outcomes:

At the end of the course, the students will be able to

UO 1	Solve problems based on sound measurement and conversion of units
UO 2	Classify sources of noise and explain various effects of noise
UO 3	Develop various indices used for community noise from given data
UO 4	Compare noise exposure of person to permissible exposure standards and identify NIHL
UO 5	Suggest suitable measures for control of noise in industries and community and PPEs
UO 6.1	Discuss various legal provisions for control of noise

Title of the Course: Environmental Geotechnology	L	T	P	Credit
Course Code: PENV0226	3	1	-	4

Course Pre-Requisite:

- Students shall have knowledge of fundamentals of Geotechnical Engineering
- Students shall have knowledge of seepage and flow of liquid in soil

Course Description:

Environmental Geotechnology is based application of various soil properties for treatment and disposal of solid, liquid and other types of waste in to soil environment.

Course Objectives:

At the end of course students will

1. Know the behavior of soil in contact with wastes.
2. Study the effect of decomposed waste on soil.
3. Understand the waste control systems.
4. Learn the applications of geosynthetics for containment of waste.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Interpret the behaviour of soil in complex Env. Condition.	2	Cognitive
CO2	Demonstrate the requirements for Planning, and design of waste control systems.	2	Cognitive
CO3	Identify the type of geosynthetic required for landfill site	3	Cognitive

Mapping of Course Outcome to Program Outcome

Course Outcome	**Program Outcome**		
	PO1	**PO2**	**PO3**
CO1			**2**
CO2	**2**		
CO3		**2**	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three units)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three units) covered after MSE.

Course Contents:	
Unit 1: - Fundamentals of Geoenvironmental Engineering, Scope of Geoenvironmental Engineering, Role of soil in Geoenvironmental applications, Importance of Soil physics, soil chemistry, hydrogeology, biological process, Sources and types of ground contamination, Impact of ground contamination on geoenvironment.	4 Hrs.
Unit 2: - Subsurface disposal of refuse, geotechnical considerations, load bearing capacity of compacted water fills, settlement of structures on uncompacted rubbish, criteria for geotechnical construction on sanitary landfills, ground improvement techniques in land fill areas, leachate contamination, control of gas generator geomembranes in solid waste disposal.	8 Hrs.
Unit 3: - Environmental cycles and their interaction, soil water environment interaction relation to geotechnical problems, pollution effect on soil behavior and foundations, effect of bacteria, pore fluid on soil water behavior, load factor versus environmental factor, environmental technology and public concerns.	8 Hrs.
Unit 4: - Geotechnical and geohydrological aspects of hazardous waste management, hazardous waste control and storage system, evaluation of effects of hazardous waste disposal sites upon ground water aquifers, environmental geotechnical considerations.	8 Hrs.
Unit 5: - Environmental effects caused by pile driving and their control, dynamic response of soil under environmental stress, contribution of environmental stress such as hazardous waste acid rain, tree cutting etc. to mechanism of landslides, subsidence and sink holes in soils including dispersive clays, case studies.	8 Hrs.
Unit 6: - Contaminant site remediation, Site characterization, risk assessment of contaminated site, remediation methods for soil and ground water, contaminant analysis, water content and permeability measurements, electrical and thermal property evaluation, some examples of in-situ remediation.	4 Hrs.
Textbooks: 1. Soil Mechanics and Foundation Engineering by B.C. Punmia 2. Geotechnical Engg. by Venkatramaiha 3. Geotechnical Engg. by Purshottamraj. 4. Geotechnical Engg. by Kasmalkar 5. Soil Mechanics and Foundation Engineering by S.K.Garg.	
Reference Books: 1. Introduction to Environmental Geotechnology by Hsai Pang Fang, CRC press, Boca Raton, New York 2. Geo Environmental Engineering by Sharma & Reddy.	
Unit wise Measurable students Learning Outcomes: At the end of course students will be able to 1. Define the basic concepts of Environmental Geotechnology. 2. Explain the geotechnical considerations and parameters for sanitary Landfill. 3. List the pollution effects on soil and foundations. 4. Evaluation of effects of hazardous waste disposal sites upon ground water aquifers. 5. Classify the environmental stress factors contributing to mechanism of landslides,	

subsidence and sink holes.

6. Do contaminant analysis, site characterization and site remediation.

Title of the Course:Statistics and Data Driven Techniques (Audit Course) **Course Code:PENV0261**	**L**	**T**	**P**	**Credit**
	2*	**-**	**-**	**-**

Course Pre-Requisite:

- Students shall have knowledge of Mathematics, Algebra and Statistics.
- Students shall have knowledge of Computer and Microsoft office tools.

Course Description:

The objective of the course is to introduce students to computational methods for solving problems in environmental engineering (both for modeling and experimental work). The idea has been to impart insight into various statistical and computational tools, that too without resort to undue technicality and verbosity. The course provides students with the necessary background to enable them to use basic computational tools and gain a fundamental understanding of numerical methods. It also introduces them to basic computer programming, softwares and inculcates a systematic logical thought process towards problem solving.

Course Objectives:

At the end of the course students will be able to

1. Understand classical statistical and computational methods available for solving engineering problems.
2. Familiarize with the computer as an engineering tool and to improveprogramming skills.
3. Emphasize fundamental understanding of the methods based on concepts previously acquiredin mathematics and algebra.
4. Determine errors associated with scientific computing and the interpretation of results.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Formulate** and solve complex problems associated with environmental engineering using knowledge of higher mathematics and statistics. ***(L5) Cognitive***	5	Cognitive
CO2	**Select** appropriate methods to work out mathematical models using analytical techniques and computational skills. ***(L6) Cognitive***	6	Cognitive
CO3	**Create** competency in utilizing the available resources and softwares effectively and optimally in the research and professional career. ***(L7) Psychomotor***	7	Psychomotor

CO-PO Mapping:

CO	**PO-1**	**PO-2**	**PO-3**
CO1			3
CO2			2
CO3			1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	-
MSE	-
ISE 2	-
ESE	100

ESE: Assessment is based on 100% course content.	
Course Contents:	
Unit 1: Database Design and Presentation Spreadsheet Tools, Features and functions, Using formulas and functions, Data storing, Data analysis, Types of charts, graphs and other features, Classification, Objectives, Rules, Modes of classification, Tabulation, Objectives, Components of Table, Requisites of a good statistical table, types of tables.	**4 Hrs.**
Unit 2: Statistical Survey and Data Collection Introduction, Planning of a statistical survey, Collection of data, Primary and secondary data, Methods of collecting primary data, Sources of secondary data, Unit of inquiry, Ways of collection of data, Processing of data.	**4 Hrs.**
Unit 3: Statistical Techniques Measure of central tendency, Measure of dispersion, Statistical Series, Probability concepts,Frequency distribution, Grouped frequency distribution, Cumulative frequency distribution, Bivariate frequency distribution, Test of significance, Selection of suitable technique, Error analysis.	**5 Hrs.**
Unit 4:Regional Statistical Analysis Joint and marginal distribution, Curve fitting, Least square method, Covariance, Correlation, Regression, Simple correlation, Linear and Non-Linear correlation, Measures of correlation, Multiple regression analysis, Stepwise regression analysis, Use of computers in correlation and regression analysis.	**5 Hrs.**
Unit 5: Linear Programming Problem (LPP) Objective function and constraints, Formulation of linear optimization models, Graphical method, Simplex method, Special cases of Simplex method, Big M method, Two phase method, Sensitivity analysis, Transportation model, Assignment model, Variants.	**5 Hrs.**
Unit 6: Advanced Computational Techniques Introduction to Genetic Algorithm (GA), Artificial Neural Network (ANN), Fuzzy Logic, Other Data Driven Methods, Hydroinformatics, Softwares used in Environmental Engineering.	**4 Hrs.**

Textbooks:

1. Goldberg, D. E., "Genetic Algorithms", Pearson Education India, 2006.
2. Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 2008.
3. Gupta, S. C., and Kapoor, V. K., "Fundamentals of Applied Statistics", Sultan Chand and Sons, New Delhi.
4. Gupta, S. C., and Kapoor, V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi.
5. Rao, S. S., "Optimization Theory and Application", Wiley Eastern Ltd., New Delhi.
6. Sancheti, D. C., and Kapoor, V. K., "Statistics (Theory, Methods and Applications", Sultan Chand & Sons, New Delhi.
7. Taha, H. A., "Operations Research: An Introduction", Prentice – Hall of India, New Delhi.

References:

1. Abbott, M. B., "Hydroinformatics – Information Technology and the Aquatic Environment", Avebury Technical, Aldershot, 1991.
2. Adeli, H., and Hung, S., "Machine Learning – Neural Networks, Genetic Algorithms and Fuzzy Systems", John Wiley, New York, 1995.

3. Freund, J.E., and Miller, I.R., "Probability and Statistics for Engineers", Prentice – Hall of India, New Delhi.
4. Govindraju, R. S., and Rao, A. R., "Artificial Neural Networks in Hydrology, Kluwer Academics Publishers, Dordrecht, 2000.
5. Holder, R. L., "Multiple Regression in Hydrology", A Book by Institute of Hydrology, ISBN: 09485-40001.
6. Kapoor. V. K., "Problems and Solutions in Operations Research", Sultan Chand & Sons, New Delhi.
7. Montgomery, D. C., and Runger, G. C., "Applied Statistics and Probability for Engineers", Wiley India.

Unit wise Measurable students Learning Outcomes:

At the end of Unit students will be able to

1. Illustrate the use of spreadsheets to analyze and present the data.
2. Classify the primary and secondary methods of collecting systematic data for the process of statistical investigation.
3. Apply fundamental concepts of probability and statistical properties to compare two or more series with regard to their variability to trace precise relationships.
4. Measure the degree or extent to which two or more variables fluctuate with reference to one another.
5. Determine an optimum program of inter-dependent activities in view of available resources for obtaining a particular objective.
6. Identify appropriate advanced techniques for modeling, simulation and validation effectively and optimally in their research and professional career.

Title of the Course: **Treatability Studies Lab -I**	L	T	P	Credit
Course Code:PENV0231	0	0	2	1

Course Pre-Requisite:

Environmental chemistry, instrumentation and Unit Operations and Processes in Environmental Engineering

Course Description:

Students will be demonstrated with use of equipments in laboratories and hands-on practice in the field for water quality monitoring

Course Objectives:

1. To provide exposure to the techniques and tools for the design and conduct of the experiments.
2. To provide an opportunity to contribute individually/in groups to the development of experimental set ups by applying the acquired technological knowledge.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Plan** and **design** experiments by applying the acquired knowledge on techniques and tools.	6	Creating
CO2	**Carry out** experimental studies for characterization, parameter estimation, and performance evaluation independently and in teams.	3	Applying
CO3	**Analyze, critique, and interpret** experimental results through application of modern engineering tools and **conclude** based on the results.	4,5	Analyzing Evaluating

CO-PO Mapping:

CO	**1**	**2**	**3**
CO1	2	-	1
CO2	2	-	1
CO3	2	-	1

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks

ISE	50
ESE	50

ISE is based on experimental work/performance in laboratory/assignment/declared test/etc.

ESE: Assessment is based on performance and oral.

Course Contents:

List of Experiments

1. Determination of overall mass/gas transfer coefficient
2. Determination of order of reaction and reaction rate coefficient
3. Jar test for determination of coagulant/s dose for the removal of turbidity
4. Physical and chemical characteristics of sand as filter media
5. Determination of head loss in depth filter
6. Development of adsorption isotherm with activated carbon/natural adsorbent
7. Determination of exchange capacity of resin
8. Performance evaluation of resin for hardness removal

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, International edition, 1985.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003,
3. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.

References:

1. Sincero A, P and Sincero G, A, "Environmental Engineering A Design approach", PHI learning private limited, 2004.
2. 2. Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
3. 3. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
4. 4. Quasim, S. R., "Water treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

Title of the Course: Treatability Studies Lab II	L	T	P	Credit
Course Code:PENV0232	0	0	4	2

Course Pre-Requisite:

Environmental chemistry, instrumentation and Unit Operations and Processes in Environmental Engineering

Course Description:

Course Objectives:

1. To develop skills to extract information pertinent to plan, design and conduct experiments.
2. To impart knowledge of modern engineering and IT tools for prediction, analysis, design and modelling of complex environmental systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Plan, design,** and **conduct** experiments using appropriate techniques and tools to demonstrate research skill individually/groups.	6	Creating
CO2	**Understand** and **Apply** modern engineering and IT tools for simulation/design of real problems.	3	Understanding Applying
CO3	**Analyze, critique,** and **interpret** results of experimental studies on performance evaluation and characterization studies.	4,5	Analyzing Evaluating

CO-PO Mapping:

CO	**1**	**2**	**3**
CO1	2	-	1
CO2	2	-	1
CO3	2	-	1

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE is based on experimental work/performance in laboratory/assignment/declared test/etc.

ESE: Assessment is based on oral.

Course Contents:

List of Experiments

i. Determination of BOD rate constant for domestic and industrial wastewater
ii. Development of laboratory scale Activated Sludge Process (ASP) and Determination of MLSS, MLVSS and sludge volume index
iii. Evaluation of bio-kinetic parameters for aerobic treatment
iv. Performance evaluation of aerobic sequential batch reactor for treating domestic wastewater
v. Evaluation of effluent quality for land application
vi. Evaluation of impact of effluent disposal on soil
vii. Study and application of EPANET/WATERCAD/SEWERCAD/STORMCAD for simple case studies.
viii. Development of spreadsheet based simulation/analysis/design modules for water/wastewater treatment system/solid waste processing units/air quality modelling.

Textbooks:

1. Hammer M, J and Hammer M, J, "Water and Wastewater Technology", PHI learning private limited, 6th Edition, 2008.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003,
3. Lee C, C and Lin S, D, "Hand book of environmental engineering calculations", McGraw Hill Publication, 2nd Edition. 2007

References:

1. Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
2. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
3. Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.
4. User manuals of EPANET, WATERCAD, WATERGEMS, SEWERCAD, Qual2e, MODFLOW etc.

Title of the Course: Pre-Dissertation Seminar **Course Code:** PENV0241	**L** **0**	**T** **0**	**P** **2**	**Credit** **1**

Course Pre-Requisite:

Course Description:

Course Objectives:

1. Inspire students to learn new research from a various academic areas covering various environmental issues.
2. Create awareness amongst students about the recent trends in technical/industrial research projects that can be undertaken for their dissertation works.
3. Develop the attribute of effective communication (written and oral) through effective presentations.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Evaluate and synthesize the confirming and opposing evidences from research papers in order to draw conclusions consistent with the topic.	5	Evaluate
CO2	Summarize gaps in the research areas related to environmental engineering based on a thorough literature review of research papers from recognized authors/journals and prepare project proposals.	2	Understand
CO3	Demonstrate effective written and oral communication, giving appropriate consideration to audience, context, format and textual evidence.	3	Apply

CO-PO Mapping:

CO	**1**	**2**	**3**
CO1	2	2	-
CO2	3	1	-
CO3	-	3	-

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	**Marks**
ISE	100

ISE is based on concept selected, information/literature collected, presentation, fundamental concepts, interaction and report.

Course Contents:

The students shall collect information on the probable topic of his/her dissertation by referring to research papers from journals and conferences. Students should deliver minimum of ***three*** presentations on chosen topic with a view of enhancing their presentation skills on technical presentation. A detailed report is to be submitted

Title of the Course: Mini Project **Course Code:** PENV0242	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**

Course Pre-Requisite:

Course Description:

Course Objectives:

1. Acquire knowledge to conduct research.
2. Develop experimental setup to solve problem, do testing and validation of the results.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Formulate a real world problem and develop its requirements		Create
CO2	Develop a design solution for a set of requirements		Apply
CO3	Test and validate the conformance of the problem		Evaluate
CO4	Express technical ideas, strategies and methodologies in written & oral form		Apply

CO-PO Mapping:

PO	**1**	**2**	**3**
CO1	**1**		
CO2	**2**		
CO3	**2**		
CO4		**1**	

Assessments :

Teacher Assessment:

Assessment	**Credits**	**Marks**
ISE	1	50

ISE for Mini Project is based on the efforts by the student for formulating problem, developing design solution, testing and validation of the solution and presentation

Course Contents:

Students are expected to carry out independent research work on the given topic. It is expected that the student shall do formulation of the small research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of results thus obtained.

The students are required to submit the report.

Title of the Course: Industrial Training **Course Code:** PENV0341	**L** **0**	**T** **0**	**P** **4**	**Credit** **2**

Course Pre-Requisite:

Course Description:

Course Objectives:

1. To provide an opportunity for student to work in collaborative and multidisciplinary environment.
2. To expose the students to real life environmental engineering problems encountered in industry/society.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain the function of environmental management systems.	2	Understand
CO2	Identify the requirements of environmental systems for improved performance.	3	Apply
CO3	Take part in group work for efficient operation of environmental systems.	4	Analyze

CO-PO Mapping:

PO	**1**	**2**	**3**
CO1	2	2	
CO2		2	
CO3	2		

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	**Marks**
ISE	50

ISE is based on extent of objectives defined, work done at the organization, outcome of training, and quality of report. Departmental Evaluation Committee shall carry out the evaluation.

Course Contents:

The objective of this training is to expose the students to industry environment and practices. Students will be sent to leading Environmental Engineering organizations/Research laboratories/Design Consultancy organizations to undergo a rigorous training for a minimum period of one month during summer term/vacation.

Title of the Course: Dissertation Work	**L**	**T**	**P**	**Credit**
Course Code: PENV0351, PENV0352, PENV0451, PENV0452	**0**	**0**	**05**	**26**

Course Pre-Requisite:

Course Description:

Course Objectives:

1. Acquire knowledge to solve real world problems of societal concerns.
2. Impart flexibility to the student to have increased control over his/ her learning.
3. Teachers would serve as mentor/facilitator of inquiry and reflection rather than as an instructor.
4. Enhance student's learning through increased interaction with peers and colleagues.

Course Learning Outcomes:

5

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
Phase I & II			
CO1	Conceive and divide a project into suitable phases to hypothesize the end objectives of the project.	4,5	Analyze Evaluate
CO2	Express the abstract of a project (Written/Oral) in a professional, well-structured style using suitable section headings in good English.	2	Understand
Phase III & IV			
CO3	Reevaluate initial hypotheses/synopsis considering literature evidence and collaborative discussion with the goal of making considered judgments.	5	Evaluate
CO4	Analyse, Experiment and judge the progress of achieving the set objectives of the project	4,5	Analyze Evaluate
CO5	Develop the capacity to observe judiciously and propose and defend opinions and ideas with tact and conviction.	5	Evaluate

CO-PO Mapping:

PO	**1**	**2**	**3**
CO1	**1**		
CO2	**1**		
CO3	**1**		
CO4	**3**		
CO5	**3**		

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	**Credits**	**Marks**
Dissertation Phase I ISE I	2	50
Dissertation Phase I ISE II	4	100
Dissertation Phase II ESE	4	100
Dissertation Phase III ISE I	4	100

Dissertation Phase III ISE II	4	100
Dissertation Phase IV ESE	8	200

ISE for dissertation phase I is based on the efforts by the student for synopsis preparation. It shall be evaluated using the parameters extent of literature review, scope defined, objectives, fundamental concepts, quality of presentation, and interaction during presentation, effort/work done, quality of report and interaction with guide.

ISE for dissertation phase II is based on the progress made during the semester for the objectives defined in the synopsis and the report submitted by the students. It shall be evaluated through progress seminar(s) at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.

ISE shall be conducted by Departmental Post-Graduate Committee (DPGC).

ESE for dissertation phase II shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

ISE for dissertation phase III is based on the work done by the student during fourth semester. It shall be evaluated using the parameters extent of work done after phase II, quality of presentation, interaction during presentation, and interaction with guide.

ISE for dissertation phase IV is based on the work done during the semester and the report submitted by the students. It shall be evaluated through progress seminar(s) at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.

ISE shall be conducted by Departmental Post-Graduate Committee (DPGC).

ESE for dissertation phase IV shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

Course Contents:

The third semester is completely devoted to dissertation work which is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained.

In fourth semester, the students continue their dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The students are required to submit the dissertation work in the form of report as per the institute rule.