E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

NAGAPATTINAM– 611 002.

(Affiliated to Anna University, Chennai |Accredited by NAAC with 'A++'Grade
Accredited by NBA | Approved by AICTE, New Delhi)

REGULATIONS-R2024
M.E. ENVIRONMENTAL ENGINEERING

First Year – First Semester Curriculum

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	MAX.MARKS		
							CA	ES	TOTAL
Theory Courses									
2401EV101	Environmental Statistics	FC	4	0	0	4	40	60	100
2402EV102	Environmental Chemistry & Microbiology	PCC	3	0	0	3	40	60	100
2402EV103	Transport of Water and wastewater	PCC	3	0	0	3	40	60	100
2402EV104	Physico-Chemical Treatment systems	PCC	4	0	0	4	40	60	100
2402EV105	Air and Noise Pollution Control	PCC	3	0	0	3	40	60	100
2401RMX01	Research Methodology and IPR	RMC	3	0	0	3	40	60	100
	Audit Course I	AUC	2	0	0	0	100	0	100
Laboratory Courses									
2402EV106	Environmental Process Monitoring Laboratory	PCC	0	0	4	2	60	40	100
TOTAL			**20**	**04**	**04**	**22**	**390**	**410**	**800**

2401EV101	STATISTICS FOR ENVIRONMENTAL ENGINEERS	L	T	P	C
		4	0	0	4

PREREQUISITE:

Basic Mathematics and Environmental Science

COURSE OBJECTIVES:

1. To study and understand the concepts of Statistical methods and its applications in Engineering.
2. To study the effect of estimation theory, testing of hypothesis, correlation and regression, randomized design, and multivariate analysis

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Utilize apply probability theory and random variable concepts to model and analyze environmental data, make informed decisions, and assess uncertainty in environmental engineering applications.
CO2:	Employ stochastic process models to describe and analyze time-dependent environmental phenomena, assess uncertainty, and make informed decisions in environmental engineering applications.
CO3:	Leverage estimation theory to assess the accuracy and precision of estimates.
CO4:	Employ hypothesis testing techniques to evaluate hypotheses about environmental data, make statistical inferences, and draw conclusions about environmental phenomena.
CO5:	Utilize non-parametric testing techniques to analyze environmental data that do not meet the assumptions of parametric tests, make statistical inferences, and draw conclusions about environmental phenomena.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	3	3	-	-	-	-	-
CO2	3	3	2	-	-	3	3	-	-	-	-	-
CO3	3	3	2	-	-	3	3	-	-	-	-	-
CO4	3	3	2	-	-	3	3	-	-	-	-	-
CO5	3	3	2	-	-	3	3	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	2	1	-

COURSE CONTENTS:

MODULE I	PROBABILITY AND RANDOM VARIABLE	12 Hours

Probability concepts – Random Variables – Moment generating function – Standard distributions – Binomial - Poisson - rectangular or Uniform – Normal - Exponential distributions - Functions of random variables – Two dimensional random variables.

MODULE II	STOCHASTIC PROCESSES	12 Hours

Classification – Stationary and Random process – Markov process – Markov chains – Transition probability – Classification of Markov chain – Limiting distribution – First passage time – Poisson process – Birth and death process.		
MODULE III	**ESTIMATION THEORY**	**12 Hours**
Estimation: Point and Interval estimates for population parameters of large sample and small samples, determining thesample size- unbiased Estimators- Maximum Likelihood Estimation-Curve Fitting by Principle of Least square		
MODULE IV	**TESTING OF HYPOTHESIS- PARAMETRIC TESTS**	**12 Hours**
Hypothesis testing: one sample and two sample tests for means and proportions of large samples z-test, one sample and two sample tests for means of small sample t-test, F-test for two sample standard deviations. ANOVA one and two-way classification.		
MODULE V	**NON-PARAMETRIC TESTS**	**12 Hours**
Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit. Sign test for paired data. Rank sum test. Comparing two populations. Mann – Whitney U test and Kruskal Wallistest.		
		TOTAL: 60 Hours

REFERENCES:

1. *Jay L. Devore, "Probability and Statistics For Engineering and the Sciences", Thomson and Duxbury, 2002.*
2. *Richard Johnson." Miller & Freund"s Probability and Statistics for Engineer", Prentice – Hall, Seventh Edition,2007.*
3. *Gupta S.C. and Kapoor V.K." Fundamentals of Mathematical Statistics", Sultan and Sons, 2001.*
4. *Dallas E Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press,1998.*
5. *Jay L. Devore, "Probability and Statistics For Engineering and the Sciences", Thomson and Duxbury, 2002.*

2402EV102	ENVIRONMENTAL CHEMISTRY & MICROBIOLOGY	L	T	P	C
		3	0	0	3

PREREQUISITE:

Basic Chemistry and Biology

COURSE OBJECTIVES:

1. The objective of the course is to provide students with basic concepts from environmental chemistry and microbiology for understanding and solving environmental problems.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Utilize the principles of aquatic chemistry in the water treatment.
CO2:	Solve the issues related to atmospheric and soil pollution.
CO3:	Identify the microorganism and its characteristics.
CO4:	Make use of knowledge on indicator microorganism to identify the pollutants.
CO5:	Plan for a clean environment with the help of microbial applications.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	3	3	-	-	-	-	-
CO2	3	2	1	-	-	3	3	-	-	-	-	-
CO3	3	2	1	-	-	3	3	-	-	-	-	-
CO4	3	2	1	-	-	3	3	-	-	-	-	-
CO5	3	2	1	-	-	3	3	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	2	1	-

COURSE CONTENTS:

MODULE I	ENVIRONMENTAL AQUATIC CHEMISTRY	9 Hours

Stoichiometry and mass balance-chemical equilibria, acid base, solubility product (Ksp), chemical kinetics, fate of chemicals and typical pollutants in aquatic environment, - characteristics of water pollution, volatilization, coagulation, partitioning, hydrolysis, photochemical transformation– Degradation of pesticides and surfactants - Metals, complex formation, oxidation and reduction.

MODULE II	ATMOSPHERIC AND ENVIRONMENTAL SOIL CHEMISTRY	9 Hours

Atmospheric structure – major air pollutants – oxides of carbon, nitrogen, sulphur – Hydrocarbons - chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, Acid rain- origin and composition of particulates, evolution of soil chemistry- contaminants in soil – soil decontamination – inorganic soil components- primary soil minerals, secondary soil minerals, nature and composition of soil-clays- ion-exchange reactions in soil – agricultural chemicals in soil, Heavy metals- Chemical speciation and their toxicity- humic substances- retention of pesticides and other organic substances by humic substances – Nano materials, CNT, titania, composites , applications

MODULE III	CLASSIFICATION AND CHARACTERISTICS OF MICROORGANISMS	9 Hours

Classification and distribution of microorganisms – aerobic and anaerobic cultures, synchronous and asynchronous culture, batch, fed batch and continuous culture. measurement of growth, factors affecting growth. extremophiles: Microbial interactions - chemo lithotrophic organisms and biogeochemical cycles – Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics - importance (NO_3 respiration, SO_4 respiration, Halo respiration).

MODULE IV	**MICROORGANISMS AS INDICATORS OF POLLUTANTS**	**9 Hours**

Water borne pathogens and their effects, transmission of pathogens, - total coliforms, E-coli, streptococcus, clostridium, concentration and detection of virus, factors influencing toxicity. effects – acute, chronic, test organisms – toxicity testing, microbial toxicology and degradation of xenobiotics - bioconcentration – bioaccumulation, biomagnification, bioassay, biomonitoring, bioleaching. - emerging Contaminants biodegradation – factors affecting biodegradation.

MODULE V	**APPLICATIONS OF MICROORGANISMS FOR CLEAN ENVIRONMENT**	**9 Hours**

Microbial assessment of water quality, microbes as bio-indicators, potability of water, treatment of municipal water. solid and liquid based treatment, biological (aerobic, anaerobic, primary, secondary & tertiary) treatment. Nutrients removal – BOD, nitrogen, phosphate, nitrification and denitrification, eutrophication – causes and effects, removal of pathogens from water and wastewater – bacteria, protozoa, virus – methods – physical, chemical and biological.

TOTAL: 45 HOURS

REFERENCES:

1. *Chemistry for Environmental Engineering and Science, Sawyer,C.N., MacCarty, P.L. and Parkin, G.F Tata McGraw – Hill, Fifth edition, New Delhi (2003).*
2. *Environmental Chemistry', Freeman and company, New York, (2012).*
3. *Hand Book of Environmental Microbiology, S.C.Bhatia, Vol 1, 2 and 3, Atlantic Publisher,2008*
4. *Textbook of Environmental Microbiology, Pradipa K. Mohapatra, I.K. International Publishing House pvt. Ltd., 2008*
5. *A Textbook of Microbiology, R.C. Dubey and D. K. Maheswari S. Chand & CompanyLtd – New Delhi, 2013*

2402EV103	TRANSPORT OF WATER AND WASTEWATER	L	T	P	C
		3	0	0	3

PREREQUISITE:

1. Fluid Mechanics
2. Hydraulic Engineering

COURSE OBJECTIVES:

1. To educate the students in detailed design concepts related to water transmission mains, waterDistribution system, sewer networks and storm water drain
2. To educate the students in computer application on design.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Utilize the various principles for the flow measurements
CO2:	Plan for the water transmission and distribution
CO3:	Develop a wastewater conveyance system by quantity estimation and designing of components
CO4:	Design a storm water drainage system
CO5:	Make use for advanced software for water transmission, water distribution and sewer design

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	3	3	-	-	-	-	-
CO2	3	3	2	-	-	3	3	-	-	-	-	-
CO3	3	3	2	-	-	3	3	-	-	-	-	-
CO4	3	3	2	-	-	3	3	-	-	-	-	-
CO5	3	3	2	-	-	3	3	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	3	2	-
CO2	3	2	-
CO3	3	2	-
CO4	3	2	-
CO5	3	2	-

COURSE CONTENTS:

MODULE I **GENERAL HYDRAULICS AND FLOW MEASUREMENT** **8 Hours**

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor heads losses, Carrying Capacity–Flow measurement.

MODULE II **WATER TRANSMISSION AND DISTRIBUTION** **10 Hours**

Need for Transport of water and wastewater-Planning of Water System –Selection of pipe materials, Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics-economics; Specials, Jointing, laying and maintenance, water hammer analysis; water distribution pipe networks Design, analysis and optimization – appurtenances– corrosion prevention – minimization of water losses – leak detection Storage reservoirs.

MODULE III **WASTEWATER COLLECTION AND CONVEYANCE** **10 Hours**

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

MODULE IV	**STORM WATER DRAINAGE**	**9 Hours**
Necessity- - combined and separate system; Estimation of storm water run-off Formulation of rainfall intensity durationand frequency relationships- Rational methods.		
MODULE V	**CASE STUDIES AND SOFTWARE APPLICATIONS**	**8 Hours**
Use of computer software in water transmission, water distribution and sewer design – EPANET2.0, LOOP version 4.0,SEWER, BRANCH, Canal ++ and GIS based software.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Shimla, 2003*
2. *"Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, NewDelhi, 1999.*
3. *"Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban*

2402EV104	**PHYSICO-CHEMICAL TREATMENTSYSTEMS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

PREREQUISITE:

Basic Physics and Chemistry

COURSE OBJECTIVES:

1. To remove suspended solids, organic compounds, heavy metals, and other contaminants from water or wastewater to meet regulatory standards.
2. o design treatment systems that optimize energy use, minimize chemical consumption, and reduce operational costs.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Develop a conveyance system to transport water to treatment plants.
CO2:	Apply the treatment principles for treatment of water and wastewater.
CO3:	Design the components of the municipal water treatment plant.
CO4:	Design the treatment units of the industrial water treatment plant.
CO5:	Design the components of the municipal wastewater treatment plant.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	3	3	-	-	-	-	-
CO2	3	3	2	-	-	3	3	-	-	-	-	-
CO3	3	3	2	-	-	3	3	-	-	-	-	-
CO4	3	3	2	-	-	3	3	-	-	-	-	-
CO5	3	3	2	-	-	3	3	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	3	3	-
CO2	3	3	-
CO3	3	3	-
CO4	3	3	-
CO5	3	3	-

COURSE CONTENTS:

MODULE I **INTRODUCTION** **12 Hours**

Pollutants in water and wastewater – characteristics, Standards for performance - Significance of physico-chemical treatment – Need for Transport of water and wastewater-Planning of Water System –Selection of pipe materials, Water transmission main design- gravity and pumping main; Selection of Pumps-characteristics- economics; Specials, Jointing, laying and maintenance, water hammer analysis; water distribution pipe networks Design, analysis and optimization – appurtenances –corrosion prevention – minimization of water losses – leak detection Storage reservoirs.

MODULE II **TREATMENT PRINCIPLES** **12 Hours**

Physical treatment - Screening – Mixing, Equalization – Sedimentation – Filtration – Evaporation – Incineration – gas transfer – mass transfer coefficient Adsorption – Isotherms – Membrane separation, Reverse Osmosis, Nano filtration, ultrafiltration and hyper filtration electro dialysis, distillation – stripping and crystallization – Recent Advances. Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation solidification and stabilization – Disinfection, Ionexchange, Electrolytic methods, Solvent extraction – advanced oxidation /reduction – Recent Trends

MODULE III **DESIGN OF MUNICIPAL WATER TREATMENT PLANTS** **12 Hours**

Planning factors – Design of sanitary sewer; partial flow in sewers, economics of sewer design; Wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers ;Selection of Treatment – Design of municipal water treatment plant Modules – Aerators – chemical feeding – Flocculation – clarifier – tube settling – filters – Rapid sand filters, slow sand filter, pressure filter, dual media Disinfection - Displacement and gaseous type - Flow charts – Layouts – Hydraulic Profile, PID - construction and O&M aspects – case studies, Residue management – Up gradation of existing plants –

Recent Trends.		
MODULE IV	**DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS**	**12 Hours**
Design of Industrial Water Treatment Modules- Selection of process – Design of softeners – Demineralizers –Reverse osmosis plants –Flow charts – Layouts –Hydraulic Profile, PID - construction and O&M aspects – case studies, Residue management – Up gradation of existing plants – Recent Trends.		
MODULE V	**DESIGN OF WASTEWATER TREATMENT PLANTS**	**12 Hours**
Design of municipal wastewater treatment Modules-screens-detractors-grit chamber-settling tanks- sludge thickening- sludge dewatering systems-sludge drying beds - Design of Industrial Wastewater Treatment Modules- Equalization- Neutralization-Chemical Feeding Devices-mixers- floatation Modules-oil skimmer Flow charts – Layouts –Hydraulic Profile, PID, construction and O&M aspects – case studies, Retrofitting - Residue management –Up gradation of existing plants – Recent Trends.		
		TOTAL: 60 HOURS

REFERENCES:

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.

2. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall,New Delhi, 2002.

3. Lee, C.C. and Shundar Lin, Handbook of Envrn EnggCalculations, Mc Graw Hill, NewYork, 1999.

2402EV105	**AIR AND NOISE POLLUTION CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

PREREQUISITE:

	Environmental Science

COURSE OBJECTIVES:

1. Understand the causes, effects, and control measures for air and noise pollution.
2. Develop the ability to analyze environmental data, evaluate pollution control technologies, and propose effective solutions.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Apply their knowledge of air pollution sources, effects, and control measures to analyze and address real-world air pollution challenges.
CO2:	Utilize their knowledge of air pollution monitoring and modeling techniques to assess air quality and predict pollution trends
CO3:	Implement the particulate pollutant control technologies to design, implement, and evaluate effective strategies for reducing particulate emissions in various industrial and environmental settings.
CO4:	Execute the gaseous pollutant control technologies to design, implement, and evaluate effective strategies for reducing gaseous emissions in various industrial and environmental settings.
CO5:	Utilize their knowledge of noise pollution control measures to design, implement, and evaluate effective strategies for mitigating noise pollution

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	3	3	-	-	-	-	-
CO2	3	3	2	-	-	3	3	-	-	-	-	-
CO3	3	3	2	-	-	3	3	-	-	-	-	-
CO4	3	3	2	-	-	3	3	-	-	-	-	-
CO5	3	3	2	-	-	3	3	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	3	2	-
CO2	3	2	-
CO3	3	2	-
CO4	3	2	-
CO5	3	2	-

COURSE CONTENTS:

MODULE I **INTRODUCTION** **9 Hours**

Structure and composition of Atmosphere – Sources and classification of air pollutants – Effects of air pollutants on human health, vegetation & animals, Materials & Structures – Effects of air Pollutants on the atmosphere, Soil & Water bodies – Long- term effects– Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories-Indoor Air Pollution

MODULE II **AIR POLLUTION MONITORING AND MODELLING** **9 Hours**

Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants -Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns-Transport & Dispersion of Air Pollutants – Modelling Techniques – Air Pollution Climatology.

MODULE III **CONTROL OF PARTICULATE POLLUTANTS** **9 Hours**

Factors affecting Selection of Control Equipment; Gas Particle Interaction, – Working principle, Design and performance equations of Gravity Separators, cyclones, Fabric filters, Particulate Scrubbers,

Electrostatic Precipitators – Operational Considerations - Costing of APC equipment –. Recent Advances		
MODULE IV	**CONTROL OF GASEOUS POLLUTANTS**	**9 Hours**
Factors affecting Selection of Control Equipment -Working principle, Design and performance equations of Absorption, Adsorption, Condensation, Incineration, Bio-scrubbers, Bio-filters –Control Technologies - SO_2, NOx, CO, H_2S; VOC, Process control and Monitoring - Operational Considerations - Costing of APC Equipment –Emerging Trends		
MODULE V	**NOISE POLLUTION**	**9 Hours**
Sources and Effects of Noise Pollution – Measurement –Equivalent Noise Level- Ambient and Source Noise Standards-Occupational Noise-Sampling of ambient and industrial Noise- Statistical Analysis of Noise Control and Preventive measures.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Noel de Nevers, "Air Pollution Control Engg", Mc Graw Hill, New York, 2016*
2. *Daniel Vallero "Fundamentals of Air Pollution", Fourth Edition, 2008.*
3. *Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 2004.*
4. *P.K.Behera, S.K.Sahu, Environmental Monitoring and Analysis, Dominant publishers and Distributors, New Delhi, 2009*
5. *Central Pollution Control Board Guidelines for real time sampling and analysis 2013.*

2401RMX01	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

PREREQUISITE:

1. Writing and Communication

	2. Critical Thinking

COURSE OBJECTIVES:

	1. To design and conduct research studies, including selecting appropriate methodologies, collecting and analyzing data, and drawing valid conclusions.
	2. To gain a comprehensive understanding of intellectual property concepts, including patents, copyrights, and trademarks, and their implications for researchers.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Formulate research problem.
CO2:	Analyze literature review and find research gaps to finalize research objectives.
CO3:	To follow research ethics
CO4:	To understand that today's world is controlled by computer, information technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5:	To understand about IPR and filing patents in R & D.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	1	1	-	-	-	-	-
CO2	3	3	2	1	-	1	1	-	-	-	-	-
CO3	-	-	-	-	-	-	-	3	-	3	2	1
CO4	3	3	2	-	-	1	1		-	-	-	-
CO5	3	3	3	-	-	1	1	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	-	3
CO2	-	-	3
CO3	-	-	3
CO4	-	-	3
CO5	-	-	3

COURSE CONTENTS:

MODULE I	**RESEARCH PROBLEM FORMULATION**	**9 Hours**
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations		
MODULE II	**LITERATURE REVIEW**	**9 Hours**
Effective literature studies approaches, analysis, plagiarism, and research ethics.		
MODULE III	**TECHNICALWRITING /PRESENTATION**	**9 Hours**
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, apresentation and assessment by a review committee.		
MODULE IV	**INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)**	**9 Hours**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
MODULE V	**INTELLECTUAL PROPERTY RIGHTS (IPR)**	**9 Hours**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.
TOTAL: 45 HOURS
REFERENCES:
1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step-by-Step Guide for beginners" 2010

2402EV106	**ENVIRONMENTAL PROCESS MONITORING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
PREREQUISITE:					
	Basic Chemistry Laboratory				
COURSE OBJECTIVES:					
	1. To acquire hands-on experience in conducting various environmental engineering experiments and analyses.				

	2. To apply theoretical concepts learned in environmental engineering courses to real-world laboratory settings.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Analyze water samples for various physical, chemical, and biological parameters, interpret the results, and assess water quality based on established standards.
CO2:	Analyze wastewater samples for various physical, chemical, and biological parameters, interpret the results, and assess the effectiveness of wastewater treatment processes.
CO3:	Analyze, and interpret air samples for a variety of pollutants, including particulate matter, gaseous pollutants, and volatile organic compounds.
CO4:	To effectively collect, analyze, and interpret soil samples for various physical, chemical, and biological properties, and assess soil quality and suitability for different land uses.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	3	3	-	-	-	-	-
CO2	3	3	3	2	1	3	3	-	-	-	-	-
CO3	3	3	3	2	1	3	3	-	-	-	-	-
CO4	3	3	3	2	1	3	3	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	3	3	-
CO2	3	3	-
CO3	3	3	-
CO4	3	3	-

LIST OF EXPERIMENTS:

1.Good Laboratory Practices, Quality control, calibration of Glassware

2.Sampling and Analysis of water (pH, alkalinity, hardness chloride, Sulphate, turbidity EC, TDS, nitrate, fluoride)

3.Wastewater analysis (BOD, COD, Phosphate, TKN, Oil & Grease, Surfactant and heavy metals).

4. Analysis of air pollutants

5.Sampling and characterization of soil (CEC & SAR, pH and K).

TOTAL: 60 HOURS

REFERENCES:

1. APHA, Standard Methods for the Examination of Water and Wastewater, 21st Ed.

2. Washington, 2005.

3. Laboratory Manual for the Examination of water, wastewater soil Rump, H.H. and Krist, H.

4. Second Edition, VCH, Germany, 1992.