



Two-Year Postgraduate Programme

Master of Environmental Science

Faculty of Applied Sciences

Parul University

Vadodara, Gujarat, India

Faculty of Applied Sciences
Master of Environmental Science

1. Vision of the Department

The vision of an Environmental Science department typically revolves around understanding, preserving, and improving the health of the planet and its ecosystems and promoting sustainable development by conducting research and implementing practices that balance environmental, social, and economic needs.

2. Mission of the Department

M1 Working towards the preservation and protection of natural ecosystems, biodiversity, and endangered species.

M2 Promoting the sustainable use of natural resources such as water, soil, air, and energy to ensure their availability for future generations.

M3 Conducting scientific research to enhance our understanding of environmental processes, pollution sources, and the impacts of human activities on the environment.

M4 Organizing training programs for farmers, milk producers & unemployed youth.

M5 Studying climate change impacts, developing strategies to mitigate its effects, and promoting adaptation measures to cope with changing environmental conditions.

3. Program Educational Objectives

The statements below indicate the career and professional achievements that the M.Sc. Environmental Science curriculum enables graduates to attain.

PEO 1	Demonstrate advanced knowledge, skills, and competencies in environmental science, enabling them to analyze and address complex environmental challenges.
PEO 2	Proficient in integrating knowledge from various scientific disciplines to understand and solve environmental problems, fostering a holistic and interdisciplinary mindset.
PEO 3	Engagement with communities, fostering environmental awareness, education, and empowerment, and contributing to community-based sustainable development.
PEO 4	High ethical standards and demonstrate a commitment to social and environmental responsibility in their professional practice, promoting sustainable and equitable solutions.

4. Program Learning Outcomes

Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	Disciplinary Knowledge	Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PLO 2	Critical Thinking and Problem Solving	Identify the problem by observing the situation closely, take actions and analytical skills to design the solutions.
PLO 3	Social Competence	Exhibit thoughts and ideas effectively, build effective interactive and presenting skills to meet global competencies.
PLO 4	Research-related Skills and Scientific Temper	Infer scientific literature, build sense of enquiry and identify and consult relevant sources to find answers.
PLO 5	Trans-disciplinary Knowledge	Create new conceptual, theoretical and specific approaches to address a common problem.
PLO 6	Personal and Professional Competence	Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PLO 7	Effective Citizenship and Ethics	Demonstrate empathetic social to professional ethics and responsibility.
PLO 8	Environment and Sustainability	Understand the impact of the scientific solutions in societal and environmental contexts.
PLO 9	Self-directed and Life-long learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

5. Program Specific Learning Outcomes

PSO 1	Recent Research trends	Demonstrate advanced skills in employing quantitative and qualitative research methods, data collection, analysis, and synthesis, with an emphasis on addressing real-world environmental challenges.
PSO 2	Evaluation and Analysis	Adept at collaborating with professionals from diverse fields to develop holistic and sustainable solutions.

5. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	28
Semester-2	28
Semester-3	28
Semester-4	14
Total Credits:	98

Category wise Credit distribution of the programme	
Category	Credit
Major Core	98
Minor Stream	00
Multidisciplinary	00
Ability Enhancement Course	00
Total Credits:	98

6. Program Curriculum

Semester 1

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	11211111	Principles of Environmental Science	4	4	0	-
2	11211117	Marine Ecology & Wetlands	4	4	0	-
3	11211118	Advanced Monitoring and Analytical Techniques for Environmental Science	4	4	0	-
4	11211119	Environmental Toxicology and Occupational Health	4	4	0	-
5	11211120	LAB-1 Environmental Monitoring and Quantitative Analysis	4	0	6	-
6	11211121	LAB-2 Biodiversity Ecological Studies and Toxicology	4	0	6	-
7	11211130	Ecology and Biodiversity	4	4	0	-
Total			28	20	12	
Semester 2						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
8	11211161	Environmental Pollution & Control Techniques	4	4	0	-
9	11211163	Solid Waste Management	4	4	0	-
10	11211164	Disaster Management	4	4	0	-
11	11211169	Environmental Biotechnology	4	4	0	-
12	11211170	Lab-1 Environmental Biotechnology	4	0	6	-
13	11211168	Solid waste management (Lab-2)	4	0	6	-
14	11211165	Water & Waste Water Treatment	4	4	0	-
Total			28	20	12	0
Semester 3						

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
15	11211211	Remote Sensing and GIS	4	4	0	-
16	11211212	Environmental Policies and Legislations	4	4	0	-
17	11211213	Research Methodology, Scientific Writing and Statistical Techniques	4	4	0	-
18	11211214	Environmental Management System and Audit	4	4	0	-
19	11211217	Lab-1 Remote Sensing and GIS	4	0	6	-
20	11211218	Lab-2 Scientific Writing and Statistical Analysis	4	0	6	-
21	11211216	Environmental Economics and Blue Economy	4	4	0	-
Total			28	20	12	0
Semester 4						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
22	11211261	Internship/Dissertation/ Research Work/ Training	12.00	0	22	0
23	11211262	Seminar	2.00		2	
Total			14.00	0	24	0

ANNEXURE-III

Semester 1

- a. Course Name: Principles of Environmental Science**
- b. Course Code: 11211111**
- c. Prerequisite:** Should be familiar with the basics of environmental science.
- d. Rationale:** Acquire knowledge about the environment.
- e. Course Learning Objective:**

CLOBJ 1	Explore and assess sustainable practices, including renewable energy and conservation strategies, to address environmental challenges.
CLOBJ 2	Develop analytical skills to assess environmental problems, interpret data, and propose effective scientific solutions.
CLOBJ 3	Comprehend the intricate relationships within ecosystems, examining interactions between organisms and their environment.
CLOBJ 4	Analyze and evaluate key environmental concerns such as climate change, pollution, and resource depletion on a global scale.
CLOBJ 5	Understand environmental policies and advocate for change by navigating their implications within communities and governments.

f. Course Learning Outcomes:

CLO 1	Understanding the basic concept of sustainability and its impact on environment
CLO 2	Understanding and analyzing the various components of environment and their protective measures
CLO 3	Compare various components of the environment and interfaces
CLO 4	Analyze environmental concerns of the present and their solutions
CLO 5	Evaluation and analysis of various environmental movements and environmental conservation techniques

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Multidisciplinary nature of Environmental Science Definition, scope and importance, Need for public awareness. Institutions in Environment, People in Environment	25%	15
2	Unit 2: Ecosystems and Material Cycles in Ecosystem: Ecosystem: Structure and function. Energy flow in an ecosystem: food chains, food webs and ecological succession. Material Cycles: Water or Hydrological Cycle, Carbon Cycle, Nitrogen Cycle, Oxygen Cycle.	25%	15
3	Unit 3: Human Communities and the Environment: Population, Ethics, Urbanization, Industrialization. Environmental movements: Chipko, SilentValley, Bishnoi Movement, Save Silent Valley Movement, Appiko Movement, Narmada Bachao Andolan	25%	15
4	Unit 4: Environmental Education Need, Objectives and Scope of Environmental Education. Evolution and	25%	15

	Development of Environmental Education. Role of Media in Environmental Education		
	Total	100%	60

i. Text Book and Reference Book:

1. Kaushik, A and Kaushik, C. (2004). Perspectives in Environmental Studies. New Age International (P) Limited, Publishers.
2. Bharucha, E. (2004). Textbook for Environmental Studies. University Grant Commission.
3. Saravanan, K. (2005). Principles of Environmental Science and Technology. New Age International (P) Limited, Publishers.
4. Singh, Y.K. (2006). Environmental Science. New Age International (P) Limited, Publishers.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi

a. Course Name: Marine Ecology & Wetlands

b. Course Code: 11211117

c. Prerequisite: Should be Familiar with Basics of marine flora & fauna.

d. Rationale: Acquire knowledge about biodiversity of marine ecosystems.

e. Course Learning Objective:

CLOBJ 1	Understand nutrient cycles and their impact on ecosystem health.
CLOBJ 2	Understand the dynamics of marine and wetland ecosystems, focusing on interactions and functions.
CLOBJ 3	Explore diversity in these environments and understand species adaptations.
CLOBJ 4	Evaluate habitats, identify threats, and propose conservation strategies.
CLOBJ 5	Analyze human influence and develop sustainable management practices.

f. Course Learning Outcomes:

CLO 1	Understand various material cycles in the ecosystem
CLO 2	Understand the behavioral adaptations and the species richness of the flora and fauna
CLO 3	Compare various components of the marine environment and interfaces
CLO 4	Analyze the risks and understand their mitigation techniques
CLO 5	Conclude environmental movements and environmental conservation

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-**

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Marine Ecosystem General characteristics of ocean- Classification of Oceanic environment. Abiotic Factors - Characteristics of Seawater, Salt Composition, Effects of Abiotic Factors on Organisms in the Ocean, Ocean Circulation, Surface Currents, Waves, Tides, Threats to Marine Water Quality and Marine Environments. Coral Reefs: Importance of coral reefs, threats and conservation. Effect of climatological factors on the marine ecosystem Coastal Development – mangroves, sea weeds aquaculture, fishing, salt pans.	25%	15
2	Unit 2: Coastal Management Importance of Coast: Coastal forms and process, Depositional landforms, Long shore drifts Coastal Management – coastal protection, beach management, dune stabilization, controlling coastal hazards. Impact of eco-tourism on coastal flora and fauna Coastal Regulation Zone (CRZ) and LEZ and the regulations and law	25%	15
3	Unit 3: Wetland and their management Wetlands- concept, classification, importance, uses and threats to the wetlands, Productivity and development of Wetlands. Ramsar convention and National Wetland Policy Important wetlands of India and Gujarat National River linking plan: ecological and economic impacts. Environmental aspects of Sardar Sarovar dam	25%	15
4	Unit 4: Biotic Components and Marine Resources Biotic Factors - interactions among living organisms, Classification of Organisms, Trophic (feeding) Relationship,	25%	15

	Ecological Pyramid, Imbalances in Marine Environments. Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones).		
	Total	100%	60

i. Text Book and Reference Book:

1. Keddy P.A (2000). Wetland Ecology: Principles and Conservation. Cambridge University.
2. Levinton J. S(2008). Marine Biology: Function, Biodiversity, Ecology. Oxford University Press UK.
3. Ambast R S (2003). Modern Trends in Applied Aquatic Ecology. Springer.
4. Souvorov, A.V. 1999. Marine Ecogonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
5. Closs, G., Boulton A. A and Downes B. (2004) Freshwater Ecology: A Scientific Introduction. Blackwell Publishing.

a. Course Name: Advanced Monitoring and Analytical Techniques for Environmental Science

b. Course Code: 11211118

c. Prerequisite: Should be familiar with basic of Environmental Monitoring Techniques

d. Rationale: Acquire knowledge about the various methods used for the monitoring and analysis of various techniques

e. Course Learning Objective:

CLOBJ 1	Interpret and communicate complex environmental data effectively, considering the ethical and regulatory aspects of environmental monitoring.
CLOBJ 2	Evaluate the reliability and limitations of various monitoring techniques, considering factors such as precision, accuracy, and sensitivity.
CLOBJ 3	Demonstrate a comprehensive understanding of advanced monitoring technologies and analytical techniques employed in environmental science.
CLOBJ 4	Apply critical thinking skills to evaluate and select appropriate monitoring methods for specific environmental parameters.
CLOBJ 5	Design and implement advanced monitoring plans to assess environmental quality and identify potential risks.

f. Course Learning Outcomes:

CLO 1	Utilization of analytical instrumentations
CLO 2	Demonstrate sampling and analysis of various pollutants and contaminants
CLO 3	Evaluating the outputs of analytical data
CLO 4	Apply molecular biological techniques in pollution management and industrial applications
CLO 5	Construct the skills for instrumentation & analysis for conducting research

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	

4	0	0	4	20	20	-	60	-	100
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L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Monitoring of Flora and Fauna, Biological indicators in the Environment, Effect of pollutants on animals and plants, Monitoring - Air, Water, Soil, Marine fauna and flora, Wetland fauna and flora	25%	15
2	Unit 2: Biological Monitoring Monitoring of Different Groups of Microorganisms: Bacteria, Fungi, Algae. Biomarkers, Molecular techniques for Identification	25%	15
3	Unit 3: Spectroscopy and Microscopy Spectroscopy Technique: Principle and application of UV visible spectrometer, AAS and Plasma Emission Spectroscopy. Mass Spectroscopy: Principle of MALDI. Types of Detectors Microscopic Techniques: Principle and applications of Light, Phase contrast and Fluorescence Microscopy, Principle and applications of SEM and TEM Immuno-techniques and Radio-isotopic technique	25%	15
4	Unit 4: Chromatographic and Electrophoresis techniques Principle and applications of Native-PAGE, SDS-PAGE, Agarose and 2D gel	25%	15

	Electrophoresis. Capillary electrophoresis and its applications. Principle, methodology and applications of gel – filtration, ion –exchange and affinity Chromatography; Thin layer and High-Performance Thin Layer Chromatography (HPTLC). Gas chromatography, High performance liquid chromatography (HPLC).		
	Total	100%	60

i. Text Book and Reference Book:

1. Pelczar M.J, Chan E.C.S and Krieg N.R. (1993). Microbiology Tata Mecgrahill New Delhi
2. Fifield F.W and Haines P. J. (2000) Environmental analytical chemical. Black well Science, pp 490.
3. Skog D.A., Holler E.J. and Crpuch S.R. (2007) Principals of Instrumental analysis, Thomson learning, Baba BarkhaNath Printers, Haryana, pp 1039.
4. Ahmad, R., Cartwright, M., & Taylor, F. (2001). Analytical methods for environmental monitoring. Harlow, England: Prentice Hall.
5. Analytical Methods for Environmental Monitoring (2001) Pearson; 1st edition,. Taylor, F.,Cartwright, M., Ahmad R

a. Course Name: Environmental Toxicology and Occupational Health

b. Course Code: 11211119

c. Prerequisite: Should be familiar with basic of toxicology and occupational health hazards

d. Rationale: Comprehensive understanding of the interactions between environmental contaminants, human health, and occupational exposures,

fostering the knowledge and skills needed to assess and manage the impact of toxic substances on both the environment and individuals

e. Course Learning Objective:

CLOBJ 1	Define and explain the key principles and concepts of environmental toxicology, including dose-response relationships, bioavailability, and mechanisms of toxicity.
CLOBJ 2	Recognize and categorize common environmental contaminants, such as pollutants, chemicals, and hazardous substances, and understand their sources, pathways, and persistence in the environment.
CLOBJ 3	Analyze and assess occupational health hazards associated with exposure to specific chemicals and pollutants in various workplace settings.
CLOBJ 4	Apply risk assessment methodologies to evaluate the potential health risks associated with exposure to environmental contaminants and workplace hazards.
CLOBJ 5	Interpret toxicological data, including data on exposure levels, toxicity studies, and epidemiological investigations, to draw conclusions about the health impacts of environmental contaminants.

f. Course Learning Outcomes:

CLO 1	Study of relationship between various contaminants and their dose-response.
CLO 2	Identification and analysis of various environmental contaminants, their sources, and their behavior in different environmental compartments.

CLO 3	To assess and analyze occupational health hazards associated with exposure to specific chemicals and pollutants in diverse workplace settings.
CLO 4	Application of risk assessment methodologies to quantify and evaluate the potential health risks associated with exposure to environmental contaminants and occupational hazards.
CLO 5	To demonstrate the ability to interpret toxicological data, including exposure levels, toxicity studies, and epidemiological investigations, to draw informed conclusions about the health impacts of environmental contaminants.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Principles of Toxicology: Definition and branches of toxicology, scope and importance of toxicology, Principles of toxicology. Toxicants - Classification, routes of entry, transport, storage, metabolism and excretion. Categories of toxic effects - synergistic, antagonistic and additive effects. Acute and chronic toxic effects. Dose-effect and dose response relationships, LOAEL and NOAEL.	25%	15
2	Unit 2: Toxicity of environmental pollutants Environmental fate and transport of toxicants, Risk assessment and management,	25%	15

	Major classes of Environmental Pollutants and their Ecotoxic Potential: Inorganic, (heavy metals, radioactive isotopes), Persistent Organic Pollutants – pesticides, insecticides, Organics, Organometallics, Gases, Nano-materials, Radioactive substances, fluorides and carbon monoxide. Mode of action of toxicants, mechanism of toxicants - Biochemical and molecular effects. Global Effects – Acid rain, etc.		
3	Unit 3: Analytical methods for toxicity testing Principles of toxicity testing, Measurements of LC50 and LD50 values. Monitoring approaches - indicator populations and indicator species. Model ecosystems - microcosms and mesocosms; Bioassays – in vitro and in vivo; Biosensors – enzyme based and DNA based, immunosensors; whole-cell based biosensors and bio-markers.– Bioindicators.	25%	15
4	Unit 4: Environmental risk and Occupational Health Environmental and occupational safety - Definitions, concept and scope, occupational exposure, Types of occupational hazards and diseases- Pneumoconiosis's, bagassosis, byssinosis, asbestosis, anthracosis, siderosis, farmer's lungs. Measures for protection of health of workers; prevention of occupational diseases. Legislative perspective in ecological risk assessment, human health risk assessment. OSHA and its responsibilities.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

1. Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2 nd Ed. Taylor & Francis, London.

2. Hayes, A. W. (2008), Principles and Methods of Toxicology, 5th Edition, Boca Raton, FL, Taylor and Francis.
3. Cockerham L.G., Shane B.S. (1993), Basic Environmental Toxicology. USA, CRC Press.
4. Levy B.S., Wegman D.H. (1995), Occupational Health recognizing and preventing work related disease. Boston, MA: Little Brown & Co.
5. Cockerham, Lerris, G., and Barbara, S. Shane, “Basic Environmental Toxicology”, CRC Press/Lewis Publishers, Boca Raton, FL, 1994.

Semester 2

- a. **Course Name: Environmental Pollution and Control Techniques**

b. Course Code: 11211161

c. Prerequisite: Should be familiar with the basics of Familiar with types of Environmental pollution.

d. Rationale: Will be able to enhance the skills of Environmental Pollution Control Techniques.

e. Course Learning Objective:

CLOBJ 1	Acquire knowledge on types and the science of environmental pollution.
CLOBJ 2	Gathering idea on human health and its effect of pollution
CLOBJ 3	Understand the link of cause and effect of pollution
CLOBJ 4	To gain knowledge on pollutant handling
CLOBJ 5	To remediate and mitigate the effect of pollution through technology.

f. Course Learning Outcomes:

CLO 1	Enlist the types and the science of environmental pollution
CLO 2	Describe the effect of pollution on human health
CLO 3	Recognize the link of cause and effect of pollution
CLO 4	Examine the handling pollutant as a human being
CLO 5	Design the pollution mitigation/abatement strategies

g. Teaching & Examination Scheme:

Teaching Scheme	Evaluation Scheme
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L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Air Pollution: Definition, Sources, Effects of Air Pollution on Human Health and materials, Effects of Indoor Air Pollutants, Air Quality Standard, Sampling of Pollutant- Particulate matter, Gases, Vapour. Measurements of Pollutants-dust particles, measurement of smoke density, Stack Monitoring, Bio monitoring, Prevention and Control of Air Pollution (Venturi Scrubber, Wet Scrubber, Electrostatic Precipitator and Cyclone precipitator)	25%	15
2	Soil and Radiation Pollution: Sources of pollutants (Pesticides, Sewage, Organic and Inorganic Contamination), Effects and Control Measures Basic types of Radiation, Sources, Effects of Ionizing radiation, Control of Radioactive Pollution, Radiation Protection, Radioactive waste Disposal Methods.	25%	15
3	Noise and Thermal Pollution: Definition, Sources, Measurement of sound, Effect of Noise on Human Health, Noise Pollution Abatement and Control. Definition sources, Effect of thermal pollution on man and aquatic ecosystem and control methods.	25%	15
4	Unit 4:Nuclear and Vehicular Pollution Definition, Sources, Effects of Nuclear Pollution on man and aquatic ecosystem and	25%	15

	control methods. Introduction of Vehicular Pollution, Major Pollutants of Automobile Emission, Impact of Automobile Pollutants. Indian Scenario, Air Quality w.r.t SO ₂ , SPM, NO _x , Types of Fuels used for vehicles, Automobile Pollution Abatement.		
	Total	100%	60

i. Text Book and Reference Book:

1. Environmental Engineering – Devis Cornwell 3rd edition (1998). Mc Graw Hill.
2. Environmental Engineering – Gerald Kiely (1998) Mc Graw Hill.
3. Environmental Engineering – A global Prospective (2000) edit by Gary Vanload & Duffy. Oxford Pub.
4. Encyclopedia of Environmental pollution and Control – R.K.Trivedi.
5. An Introduction to air Pollution – R.K.Trivedi and P.K.God (1998) Technology Pub.
6. Environmental Pollution control Engineering – C.S.Rao (1995) – Wiley Eastern ltd.
7. Nature and properties of Soil- N.C.Brady (1997) Mc. Millan pub.
8. Environmental Chemistry – A.K.De (1995), Widy Eastern.
9. Chemistry for Environmental Engineering- Sawyer, Mac Carty, Partein (1994) Mc. Graw Hill .
10. Introduction to Environmental engineering and Sciences – Gilbert N. Masters (1998) Printice hall of India Pvt. Ltd New Delhi.
11. Air pollution Control Engineering – Noel De Nevers – Second edition – McGraw Hill international edition.

a) **Course Name: Solid Waste Management**

b) **Course Code: 11211163**

c) **Prerequisite:** Should be familiar with basic knowledge of waste types and disposal methods.

d) **Rationale:** Acquire knowledge about the various

e) Course Learning Objective:

CLOBJ 1	Define and explain the various types of solid waste, including municipal solid waste, hazardous waste, and industrial waste.
CLOBJ 2	Analyze the processes and factors contributing to the generation of solid waste, including consumption patterns, urbanization, and industrial activities.
CLOBJ 3	Investigate methods and technologies for the efficient collection, transportation, and logistics involved in managing solid waste from its source to treatment facilities.
CLOBJ 4	Evaluate strategies for waste reduction at the source and the promotion of recycling programs, including the benefits and challenges associated with recycling initiatives.
CLOBJ 5	Assess the environmental and public health impacts of improper solid waste management, including air and water pollution, soil contamination, and the spread of diseases.

f. Course Learning Outcomes:

CLO 1	Describe the characteristic of wastes and the systems, and processes of waste management
CLO 2	To explore and evaluate the techniques to generate resources from wastes
CLO 3	Identify the case specific issues related to pollution potentials of solid wastes
CLO 4	Design solid waste management practices through a cradle-to-grave approach
CLO 5	Apply waste management principles

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme		
L	T	P	C	Internal Evaluation	ESE	Total

				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit-1: Introduction to Solid Waste Handling and Management Classification of solid waste- source based and type based, Waste characteristics and quantitative estimation of municipal solid waste, Waste generation and composition, Factors affecting solid waste management, Material flow Methodology.	33%	20
2	Unit 2: Processing of Urban waste Methods of collection, storage, transportation, Material separation, Processing on site and off site for source reduction, product recovery and recycling, Methods of disposal- Dumping, Sanitary Landfill, Incineration, Pyrolysis, Composting, Ocean Dumping, Leachate Management for MSW landfills.	34%	20
3	Unit 3: Applied Uses of Solid Waste Biogas production, Composting and Vermi composting, International cooperation in municipal solid waste management, Integrated Waste management, Solid waste Management Rules, 2016.	33%	20
	Total	100%	60

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Text Book and Reference Book:

- 1) "Waste to Wealth: The Circular Economy Advantage" by Peter Lacy and Jakob Rutqvist
- 2) "Waste Management and Sustainable Consumption: Reflections on Consumer Waste" by Susan Parham
- 3) "Waste Management Practices: Municipal, Hazardous, and Industrial" by John Pichtel
- 4) "Introduction to Environmental Engineering and Science" by Gilbert M. Masters and Wendell P. Ela
- 5) "Solid Waste Management: Principles and Practice" by William D. Robinson and P. Aarne Vesilind

- a. **Course Name: Disaster Management**
- b. **Course Code: 11211164**
- c. **Prerequisite:** Should be familiar with basic of Disaster Management Strategies
- d. **Rationale:** Acquire knowledge about the Disaster Risk Assessment and Analysis
- e. **Course Learning Objective:**

CLOBJ 1	Develop a deep understanding of the theories, concepts, and frameworks in disaster management, including the identification, classification, and analysis of various types of disasters.
CLOBJ 2	Acquire skills to assess and analyze disaster risks by employing suitable methodologies, evaluating vulnerabilities, and understanding the interplay between hazards and communities.
CLOBJ 3	Develop strategies and plans for disaster preparedness and response, including emergency management techniques, effective communication, and coordination among stakeholders during crises.
CLOBJ 4	Gain insights into the phases of post-disaster recovery and reconstruction, emphasizing community-based rehabilitation efforts and resilience-building measures.
CLOBJ 5	Evaluate governance structures, legal frameworks, and policy implications in disaster management, critically analyzing their effectiveness and proposing potential improvements.

f. Course Learning Outcomes:

CLO 1	Recognize various types of disasters, their characteristics, and classifications within the context of disaster management.
CLO 2	Demonstrate an understanding of different methodologies and tools used in disaster risk assessment, including hazard analysis and vulnerability assessment.
CLO 3	Analyse and interpret international frameworks, policies, and legal structures related to disaster management and their implications.
CLO 4	Design and implement post-disaster recovery and rehabilitation plans, focusing on sustainable reconstruction and community resilience-building efforts.
CLO 5	Develop and execute disaster preparedness plans, along with effective response strategies, considering the involvement and coordination of multiple stakeholders.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Disaster – Etymology, Definition, Classification of disaster, Prevention and Mitigation – Floods, Tropical Cyclones, Droughts, Earthquakes, Extreme weather events – Heat wave, Cold wave, fog, snow storms, avalanches, Hailstorm, thunderstorm and dust storms, Extreme temperature, Tropical cyclone and tidal wave, Floods, heavy rain, Droughts (hydrological, meteorological and agricultural etc.) Incidence of epidemics or diseases. • Urban and rural water shortage • Crop plantation failure or harvest failure • Malnutrition or under nutrition and hunger • Landslides, saline water intrusion and mudflows. (Rail, Road, Air Accidents. Mine Disasters)	25%	15
2	Unit 2: Institutional Framework - Organisation and Structure of Disaster Management, Disaster	25%	15

	Management Act, 2005, National Disaster Management Authority (NDMA), National Executive Committee (NEC), State Disaster Management Authority (SDMA), State Executive Committee (SEC), Others (DDMA, NIDM, NDRF, SDRF, NCDC, NFSC.		
3	Unit 3: Policy and Guidelines – Introduction, National Policy on Disaster Management (NPDM), National Plan on Disaster Management, National Action Plan on Climate Change, Disasters – Global Scenario - World’s Deadliest disaster, India’s Deadliest disaster, Mock Drill.	25%	15
4	Unit 4 : Preparedness and Recovery, Reconstruction and Rehabilitation, Capacity Development, Financial Arrangements, International Cooperation, Important Contacts for Disaster response.	25%	15
	Total	100%	60

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Text Book and Reference Book:

- 1) "Introduction to International Disaster Management" by Damon P. Coppola
- 2) "Disaster Management: Continuity, Resilience, and Recovery" by Geoff Wilson, David A. McEntire.
- 3) "Principles of Emergency Management and Emergency Operations Centers (EOC)" by Michael J. Fagel.
- 4) "Disaster Risk Reduction: Cases from Urban Africa" edited by Mark Pelling, Cassidy Johnson.
- 5) "Disasters by Design: A Reassessment of Natural Hazards in the United States" by Dennis Mileti

Semester 2

- a) **Course Name: Environmental Biotechnology**
- b) **Course Code: 11211169**
- c) **Prerequisite:** Should be familiar with basic of Environmental Biotechniques
- d) **Rationale:** Acquire knowledge about the various techniques used for the environmental management
- e) **Course Learning Objective:**

CLOBJ 1	Gain a deep understanding of the fundamental principles, theories, and concepts underlying environmental biotechnology, including the interaction between microorganisms and the environment.
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CLOBJ 2	Integrate interdisciplinary knowledge from fields such as microbiology, molecular biology, biochemistry, and engineering to devise holistic solutions for environmental challenges.
CLOBJ 3	Develop analytical skills to assess and evaluate environmental problems, applying biotechnological tools and methods to analyze, monitor, and mitigate environmental challenges.
CLOBJ 4	Apply knowledge of microbial ecology, genetics, and metabolism to design and implement biotechnological solutions for environmental issues such as pollution, waste management, and resource recovery.
CLOBJ 5	Develop research skills, critical thinking, and the ability to analyze and synthesize scientific literature to contribute to the advancement of environmental biotechnology through innovative ideas and methodologies.

f. Course Learning Outcomes:

CLO 1	Demonstrate a comprehensive understanding of the principles, concepts, and theories in environmental biotechnology.
CLO 2	Explain the role of microorganisms in environmental processes and their interactions within ecosystems.
CLO 3	Understand the methods and technologies involved in the treatment and management of various types of pollutants in the environment
CLO 4	Explain the application of genomics and metagenomics in studying environmental microbiomes and biodiversity
CLO 5	Evaluate and apply various bioremediation techniques for the removal or mitigation of environmental pollutants.

g) Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme		
L	T	P	C	Internal Evaluation	ESE	Total

				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h) Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Introduction to Environmental Biotechnology Overview of environmental biotechnology, Historical perspective and development, Importance and applications in various sectors, Microbial diversity and its role in the environment, Microbial ecology and interactions	25%	15
2	Unit 2: Bioremediation and Industrial Applications of Environmental Biotechnology Principles of bioremediation, Types of bioremediation: phytoremediation, microbial remediation, etc., Case studies and applications, Biotechnological processes in industries (food, pharmaceutical, etc.), Environmental sustainability in industrial practices	25%	15
3	Unit 3: Emerging Trends in Environmental Biotechnology Nanotechnology in environmental applications, Synthetic biology for environmental solutions, Circular economy and its relationship with biotechnology	25%	15
4	Unit 4: Environmental Genomics and Metagenomics Basics of genomics and	25%	15

	metagenomics, Applications in studying environmental microbiomes, Computational tools and techniques in environmental genomics		
	Total	100%	60

i) Text Book and Reference Book:

- 1) "Environmental Biotechnology: Principles and Applications" by Bruce Rittmann and Perry McCarty
- 2) "Principles of Environmental Biotechnology" by Ramesh C. Ray.
- 3) "Introduction to Environmental Biotechnology" by A. K. Mishra.
- 4) "Environmental Biotechnology: Basic Concepts and Applications" by Indu Shekhar Thakur and D. N. K. Gupta.

a) **Course Name: Water & Waste Water Treatment**

b) **Course Code: 11211165**

c) **Prerequisite:** background in chemistry, biology, mathematics, and Environmental Science fundamentals.

d) **Rationale:** Understand different sources of water pollution and their corresponding qualities, linking these to the basic objectives of wastewater treatment and the need for water quality standards for wastewater effluent disposal.

e) **Course Learning Objective:**

CLOBJ 1	Understand the fundamental processes involved in water and wastewater treatment, including physical, chemical, and biological treatment methods.
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CLOBJ 2	Develop the ability to analyze water quality issues, identify pollutants, and propose effective treatment solutions using scientific and engineering principles.
CLOBJ 3	Gain familiarity with environmental regulations and standards governing water quality, treatment, and discharge, ensuring compliance in treatment practices.
CLOBJ 4	Develop analytical skills to assess environmental problems, interpret data, and propose effective scientific solutions.
CLOBJ 5	Acquire proficiency in using and evaluating technologies and equipment employed in water and wastewater treatment processes.

f) Course Learning Outcomes:

CLO 1	Demonstrate a comprehensive understanding of the principles and processes involved in water and wastewater treatment.
CLO 2	Interpret and apply environmental regulations and standards in designing and implementing water treatment processes to ensure compliance.
CLO 3	Apply scientific and engineering principles to identify, analyze, and solve water quality and treatment issues effectively.
CLO 4	Evaluate, select, and justify the use of appropriate technologies and equipment for water and wastewater treatment scenarios.
CLO 5	Design and propose sustainable solutions that optimize resources, minimize waste, and improve overall efficiency in water treatment processes.

g) Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h) Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Fundamentals of Water Management Introduction to water resources- Properties of water, Hydrological cycle; Major sources of water pollution; Water quality parameters and standards- physical, chemical and biological parameters; Microbial indicators of water quality, Sampling and Analytical techniques for water quality assessment	25%	15
2	Water treatment technologies Physical Water Treatment Processes- Screening, sedimentation, and filtration, Coagulation and flocculation Chemical Water Treatment Processes- Disinfection methods (chlorination, ozonation, UV treatment) Ion exchange and chemical precipitation Biological Water Treatment Processes- Activated sludge process, Trickling filters and rotating biological contactors, Membrane bioreactors Tertiary Treatment- Nutrient removal (nitrogen and phosphorus), Advanced filtration techniques	25%	15
3	Waste Water Treatment Introduction to Waste Water Management- Sources and characteristics of wastewater, Public health and environmental impact, Conventional Waste Water Treatment- Primary, secondary, and tertiary treatment; Treatment plants- STP and ETP Physical, chemical treatment processes; Primary and Secondary Treatment	25%	15
	Advanced Water Treatment Technologies Membrane filtration technologies: Reverse Osmosis, Nano filtration, Ultrafiltration, Microfiltration; Green and Sustainable	25	15

	Technologies- Solar-driven water treatment processes, Green chemistry in water treatment; Biological Treatment Processes-moving bed biofilm reactor (MBBR), Sequencing Batch Reactors		
	Total	100%	60

i) Text Book and Reference Book:

- 1) "Principles of Water Treatment" by Kerry J. Howe, David W. Hand, and John C. Crittenden
- 2) "Water and Wastewater Technology" by Mark J. Hammer, Sr., Mark J. Hammer, Jr., and Paul N. Cheremisinoff
- 3) "Water Supply and Pollution Control" by Warren Viessman Jr., Mark J. Hammer, Elizabeth M. Perez, and Paul A. Chadik
- 4) "Environmental Engineering: Water, Wastewater, Soil and Groundwater Treatment and Remediation" by Nelson L. Nemerow, Franklin J. Agardy, and Joseph A. Salvato

Semester 3

(1)

a) Course Name: Remote Sensing and GIS

b) Course Code: 11211211

c) Prerequisite: Students will develop skills for Satellite Observation, object positioning and stratigraphic analysis.

d) Rationale: combined ability to gather, analyze, and interpret spatial data for a wide range of applications.

e) Course Learning Objective:

CLOBJ 1	Understand and apply techniques such as overlay analysis, buffering, and spatial querying
CLOBJ 2	Acquire skills in interpreting and analyzing remote sensing imagery.

CLOBJ 3	Identify and classify land cover types, recognizing patterns and changes over time.
CLOBJ 4	Evaluate the impact of various factors, such as seasonality or environmental conditions, on image interpretation.

f) Course Learning Outcomes:

CLO 1	analysis and interpretation of spatial data using GIS tools, including performing overlay analysis, spatial querying, and other relevant techniques.
CLO 2	To study the correlation between environmental factors and its effects on the remote sensing images
CLO 3	To demonstrate a comprehensive understanding of the fundamental principles and technologies of remote sensing and GIS.
CLO 4	Practical exercises and projects involving real-world spatial analysis scenarios.

g) Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h) Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit 1: Global Positioning System (GPS) and Geographic Information System (GIS): Definition and Characteristics of GPS. Functions and Segments of GPS. Determining GPS Position. Accuracy of GPS. Sources of GPS Errors. Application of GPS. Definition and Historical background of GIS. GIS as a system. Components of GIS: hardware, software, data, people, and method.	25%	15
2	Unit 2: Geographic Information System (GIS): Differences between Global Positioning Systems (GPS), Remote Sensing (RS) and Geographic Information System (GIS). Types of GIS Data: Raster data and Vector data. Differences between Raster data and Vector data. Representation of GIS Data Differences between Raster data and Vector data. Limitations and Advantages of GIS. Applications of GIS.	25%	15
3	Unit 3: Remote Sensing (RS): Definition and Process of Remote Sensing: Energy Source, Atmosphere, Interaction with the Target, Recording of Energy by the Sensor, Transmission, Reception, and Processing, Interpretation and Analysis. Advantages of Satellite Observation. Types of sensors: Passive sensors and Active sensors. Limitations and Advantages of sensors. Satellite Orbit Determination. Types of orbits: geostationary orbits, near-polar orbits. Swath.	25%	15

4	Unit 4: Remote Sensing (RS) Multispectral scanning through Remote Sensing: Across track scanning, Along-track scanning. Types of sensors: Multispectral Scanner, Thematic Mapper, High 3 Resolution Visible, Linear Image Self Scanning I, II, III and IV, Panchromatic camera, Wide Field Sensor. Types of Resolution: Spatial Resolution, Temporal Resolution, Spectral Resolution, Radiometric Resolution. Applications of Remote Sensing: Urban & Regional Planning, Agriculture, Disaster management, Forestry, Coast Resource Mapping, Oceans & Coastal Monitoring, Land use & Landcover Mapping, Geology, Hydrology, Sea Ice, Oil Spill.	25%	15
	Total	100%	60

i) Text Book and Reference Book:

- 1) Dr. Sailesh Samanta (2023). A textbook of Remote Sensing, GIS and GNSS, Notion press.

(2)

a. Course Name: Environmental Policies and Legislations

b. Course Code: 11211212

c. Prerequisite: Foundational understanding of environmental science, legal frameworks, and policy development, along with knowledge of basic ecology, environmental issues, and government structures.

d. Rationale: Ensures a deep understanding of environmental laws, policies, and regulations, fostering expertise in sustainable practices and compliance.

e. Course Learning Objective:

CLOBJ 1	Develop a comprehensive understanding of environmental policies and regulations at local, national, and international levels.
CLOBJ 2	Acquire skills to assess and ensure regulatory compliance, emphasizing responsible environmental practices for individuals, organizations, and industries.
CLOBJ 3	Develop the ability to analyze and critically assess environmental policies, and contribute to the development of effective and sustainable environmental policies.
CLOBJ 4	Understand and evaluate the role of international agreements and governance structures in shaping and influencing environmental policies and regulations.
CLOBJ 5	Gain insight into international environmental agreements, fostering an understanding of global perspectives and cooperative efforts in addressing environmental challenges.

f. Course Learning Outcomes:

CLO 1	Advocate for environmentally sustainable policies through effective communication, demonstrating the ability to convey complex regulatory concepts to diverse audiences.
CLO 2	Implement effective strategies for regulatory compliance, ensuring individuals, organizations, and industries adhere to environmental standards and contribute to sustainability.
CLO 3	Apply ethical considerations in decision-making related to environmental policies, recognizing and addressing issues of fairness, justice, and inclusivity.

CLO 4	Demonstrate a high level of regulatory competence by understanding and applying environmental policies and regulations at local, national, and international levels.
CLO 5	Critically evaluate the effectiveness of existing environmental policies, considering their impact on ecological sustainability, human health, and social equity, and propose evidence-based recommendations for improvement.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit :1 Environmental Laws Scheme of labeling of environmentally friendly products (ecomark). Public liability Insurance Act. Environmental policy resolution, legislation, public policy strategies in pollution control. Wild life protection Act 1972, Forest conservation act, 1980. Indian forest act 1927. Air (prevention & control of pollution) Act 1981, Motor vehicle act, 1988, The environment (protection) Act,	25%	15

	1986, The water (prevention & control of pollution) Act, 1974, Manufacturing Rules, 1989, Factories Act,		
2	Unit 2: Environmental Policies International conventions: Stockholm Conference UNCHE; United Nations Environmental Planning (UNEP) 1972; International Union for Conservation of Nature & Natural Resources (IUCN); World Wide Fund for Nature (WWF); Bruntland Commission (WCEB); Montreal Protocol; Rio Conference 1992; Convention on International Trade in Endangered Species (CITES)	25%	15
3	Unit 3: Environmental Impact Assessment Environmental impact assessment- definition, nature, scope, objectives, benefits. EIA concept and origin, Types of EIA and EIA notification 1994, Stages of EIA, EIA methodologies -Checklist, Matrices and Networks, Cost Benefit Analysis Environment Impact Evaluations	25%	15
4	Unit 4: Environmental economics Economics of natural (renewable/non-renewable) resources- theoretical models of renewable and non-renewable resources, methods for valuing environmental costs and benefits, Pollution taxes, tradable permits (CO ₂ , SO ₂ , and other pollutants), economic incentives for environmental protection.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

- 1) Nicholas A. Ashford and Charles C. Caldart, "Environmental Law, Policy, and Economics: Reclaiming the Environmental Agenda". 2008. The MIT press.

- 2) Michael E. Kraft and Sheldon Kamieniecki. 2016. "Environmental Policy and Politics" Routledge.
- 3) Divan S. and Rosencranz A. (2005) Environmental Law and Policy in India, 2nd ed., Oxford, New Delhi
- 4) Kamala S. and Singh U.K. (eds.) (2008) Towards Legal Literacy: An Introduction to Law in India, Oxford, New Delhi.
- 5) Leelakrishnan P. (2006) Environmental Law Case Book, 2nd ed, Lexis Nexis, India.
- 6) Sands P. (2002) Principles of International Environmental Law, 2nd ed, Cambridge.

a) Course Name: Research Methodology, Scientific Writing and Statistical Techniques

b) Course Code: 11211213

c) Prerequisite: Should be familiar with the basics of report and article writing.

d) Rationale: Will be able to develop the skill of writing the research & review paper.

e) Course Learning Objective:

CLOBJ 1	Acquire techniques for scientific writing and research methodology.
CLOBJ 2	Having idea on new using methods, explain and take position on the results.
CLOBJ 3	Understand methods appropriate for research aims and objectives.
CLOBJ 4	To gain knowledge on qualitative and quantitative data analysis and presentation.

f) Course Learning Outcomes:

CLO 1	Identify the methods appropriate to choose research aims and objectives.
CLO 2	Develop skills in qualitative and quantitative data analysis and presentation.
CLO 3	Demonstrate the techniques for scientific writing and research methodology to prepare the writing of a scientific report.
CLO 4	Perform investigation using methods, explain and take position on the results as well as summarize related work.

g) Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h) Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1: Basic of research methodology: Importance of research. Meaning and criteria of good research. Quality of research: General qualities, specific qualities, and unbiased attitude. Types of research: Descriptive and analytical research, Applied and fundamental research, Qualitative &	25%	15

	quantitative research, Conceptual and empirical research. Formulation of research problem.		
2	Unit 2: Research design and Data collection techniques: Experimental design of research. Sampling technique: Random sampling; stratify and cluster sampling. Non-random sampling. Types of data: Primary data and secondary data. Limitations of secondary data. Data collection techniques; Direct personal investigation, Indirect oral investigation, Use of local reports, Questionnaire method.	25%	15
3	Unit 3: Scientific deliveries, Thesis, and paper writing: Introduction. Origin of scientific writing: Early history. Scientific paper writing: Definition, character, and organization of scientific paper. Pilot study: Advantages and disadvantages of pilot study. General structure of thesis: Acknowledgement, Title, Abstract, Introduction, Material and methods, Result and discussion, Conclusion. IMARD story.	25%	15
4	Unit 4: Statistical Methods and Data analysis: Definition and scope, organizing a statistical survey and presentation of statistically analyzed information. Basic statistical methods: Measures of central tendency, dispersion and standard error; Probability distributions: binomial, poisson and normal distribution. Statistical significance: Hypothesis testing, types of error, level of significance, Student's t test, F test and Chi square goodness of fit. Simple linear regression and correlation analysis. Applications of non-parametric statistics in biological research.	25%	15
	Total	100%	60

i) Text Book and Reference Book:

1. M. L. Singh (1998). Understanding Research Methodology, J. M. Singh
2. C. R. Kothari (1990). Research Methodology, Vishwa Prakashan, India.
3. Robert E. Slavin (1994). Research Methodology in Education: A practical guide, prentice Hall.

a. Course Name: Environmental Management System and Audit

b. Course Code: 11211214

c. Prerequisite: Should be familiar with the facts of environmental auditing.

d. Rationale: Will develop the skills of environmental auditing and occupational health and hazard.

e. Course Learning Objective:

CLOBJ 1	Analyze the key components and elements of EMS, including policy development, planning, implementation, monitoring, and continual improvement.
CLOBJ 2	Evaluate the impact of legal requirements on organizational environmental performance.

CLOBJ 3	Develop strategies for managing and mitigating environmental risks.
CLOBJ 4	Develop strategies for effective stakeholder engagement in environmental management.

f. Course Learning Outcomes:

CLO 1	Acquire a comprehensive understanding of the principles, concepts, and theories related to Environmental Management Systems (EMS) and environmental auditing.
CLO 2	Understand the importance of environmental laws and regulations with legal requirements
CLO 3	Demonstrate a thorough knowledge of local and international environmental laws, regulations, and standards relevant to EMS and auditing.
CLO 4	Develop and implement effective EMS strategies within organizations, considering all stages of the EMS life cycle

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit:1 Implementation of Environmental Management System: EMS definition and components of EMS. Ideal EIA system, inventory (Physical, Chemical, Biological, Cultural, Socioeconomic) Forecasting. Approving bodies (National, International), Clauses of certification, basic schedules, and byelaws. Different standards at Local/State/National and International levels including WHO and UN. Principles of management, levels of management, functions of management & significance of management. Identification of environmental aspects and impacts. Legal and other requirements	25%	15
2	Unit 2:Environmental Audit: Auditing - internal, external, components. Pollution control boards, State level, National level, High court proceeding, penalties, and implementation. Basics of Environmental Audit and its need. Types of Environmental Audits. Environmental Appraisal and Environmental Accounting Environmental Audit Procedure	25%	15
3	Unit 3: Occupational health and Industrial Safety: Types of occupational hazards and their health effects. Classification of occupational diseases based on agents and origins. Industrial accidents-causal factors and prevention measures, (OSHAS). Measures for protection of health of workers; prevention of occupational diseases. Industrial safety: Principles of Industrial Safety. Environmental regulations. Accidents, analysis of accidents, Emergency preparedness	25%	15

4	Unit 4:Industrial Management: Quality concepts and techniques used in industry. Elementary statistics and probability. Process control, Process capability and Quality Control tools. Functions and roles of all levels of management, organization design, and planning and control of manufacturing operations. Plant layout. Site selection and efficient arrangement of work areas to achieve lower manufacturing cost.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

- 1) Barthwal R.R. (2002): Environmental Impact Assessment, New Age International (P)Ltd . Pub New Delhi.
- 2) Agrawal S.K.(2002) Pollution Management- (Vol-3),A.P.H publishing.
- 3) Gabriele Crognale P.C(1999). Environmental management strategies (The 21st century perspective) Printice Hall PTR.
- 4) Prabhakar V.K. (2001) Environmental Management. Anmol Publication pvt ltd.
- 5) Environmental Pollution - Management and Control for sustainable Development – R.K.Khitoliya, S.Chand and company, New Delhi
- 6) Kuhre W.L. (2000) ISO 14031 Environmental performance evaluation EPE,Prentice Hall, PT. Upper Saddle River N.J.
- 7) Rajshekhar, C.V.(1992), Critical Issues in Environmental Management. (Global Environmenta Seris). Discovery Publication, Delhi.

a) Course Name: Environmental economics and Blue Economy

b) Course Code: 11211216

c) Prerequisite: Should be familiar with the facts of environmental auditing.

d) Rationale: Will develop the skills of environmental auditing and occupational health and hazard.

e) Course Learning Objective:

CLOBJ 1	To design and evaluate environmental policies, considering economic efficiency, equity, and environmental effectiveness.
CLOBJ 2	To design and evaluate environmental policies, considering economic efficiency, equity, and environmental effectiveness.
CLOBJ 3	Explore the economic aspects of innovation and entrepreneurship in the blue economy, with a focus on emerging technologies such as marine biotechnology and renewable energy.
CLOBJ 4	Develop the ability to assess the economic viability and market potential of innovative solutions for sustainable ocean resource utilization.

f) . Course Learning Outcomes:

CLO 1	Demonstrate the ability to apply advanced economic principles and valuation techniques to analyze and assess the economic impact of environmental policies, projects, and resource use.
CLO 2	Expertise in the economic dimensions of sustainable marine and coastal resource management, including fisheries, aquaculture, and coastal zone planning.
CLO 3	To analyze and foster innovations in the blue economy, applying economic principles to assess the economic viability of new technologies and entrepreneurial ventures in marine and coastal contexts.
CLO 4	To design, implement, and critically evaluate environmental policies, considering economic efficiency, distributional impacts, and environmental effectiveness.

f) Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	0	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

g) Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit 1: Introduction to Environmental Economics: Introduction to environmental economics, Importance of Environmental Valuation-Assigning Monetary Value – Problems of Monetization – Market failure, and property rights, open access resources, collective action.	25%	15
2	Unit 2: Environmental Economics: Environmental damages / benefit, social cost, benefit analyses, valuation methods. Controlling environment with economics: Environmental Standards, subsidies, taxes, marketable permits, trading systems.	25%	15
3	Unit 3: Blue Economy: Introduction to Blue Economy concept. Importance to sustainably manage the marine resources. Identify ways in which entrepreneurs can create innovative business opportunities. Economic benefits of the Blue Economy. Relationship between the Blue Economy and sustainable development.	25%	15
4	Unit 4: Ecological & Economics Strategies: Two – way linkages between Ecological and Economic systems: Environment – Development handoffs. Eco – Industrial development, Eco – labeling. Theories of externality and public goods: Pigou and Coase; property rights and transaction costs, market failures and corrective actions. Pollution: optimal level, definition, types of pollution.	25%	15

	Total	100%	60
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h) Text Book and Reference Book:

- 1) Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental and Economic Impacts by Marc J Epstein, John Elkington, and Herman B Leonard (2008)
- 2) Environmental Economics & Policy“ 6th Edition – by Tom Tietenberg and Lynne Lewis (2009)
- 3) Natural Resource and Environmental Economics “ 3rd Edition “ by Roger Perman, Michael Common, James Mcgilvray, and Yue Ma (2003)
- 4) Environmental & Natural Resource Economics “ 8th Edition – by Tom Tietenberg and Lynne Lewis (2008)
- 5) Economics and the Environment “ 6th Edition- by Eban S. Goodstein (2010)

ANNEXURE-IV

SEMESTER-I

(1)

- a. **Course Name: Environmental Monitoring and Qualitative Analysis**
- b. **Course Code: 11211120**
- c. **Prerequisite:** Foundational understanding of basic chemistry, laboratory safety, analytical chemistry concepts, environmental science principles, and effective data analysis skills.
- d. **Rationale:** hands-on experience in analyzing environmental samples and understanding the qualitative aspects of pollutant assessment, fostering practical skills essential for environmental science and related fields.
- e. **Course Learning Objective:**

CLOBJ 1	Employ qualitative analysis techniques, including field measurements and laboratory methods, to assess and identify environmental pollutants in diverse samples.
CLOBJ 2	Understand the principles of environmental monitoring, including the selection of appropriate sampling methods, data collection, and interpretation, contributing to a comprehensive understanding of environmental quality assessment.
CLOBJ 3	Relate qualitative findings to potential environmental impacts, connecting laboratory results with broader environmental science concepts and understanding the significance of pollutant detection.
CLOBJ 4	Apply instrumental analysis skills, such as the use of spectrophotometry and chromatography, to characterize and quantify qualitative aspects of environmental samples.

- f. **Course Learning Outcomes:**

CLO 1	Demonstrate practical competence in employing qualitative analysis techniques and instrumentation for the assessment of environmental samples.
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CLO 2	Apply instrumental analysis skills, including spectrophotometry and chromatography, to characterize and quantify qualitative aspects of environmental pollutants.
CLO 3	Implement environmental monitoring practices, including the selection of appropriate sampling methods, data collection, and interpretation, contributing to a comprehensive understanding of environmental quality assessment.
CLO 4	Interpret environmental data derived from qualitative analyses to draw conclusions about the presence, concentrations, and potential sources of pollutants in diverse environmental matrices.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	6	4	-	-	40	-	60	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

Exp. No.	Name of the Experiment
1	Gas chromatographic techniques
2	Titrimetric methods
3	Colorimetric methods
4	AA Spectrophotometric analysis
5	HPLC techniques
6	Ion exchange chromatography

Exp. No.	Name of the Experiment
7	Electrophoresis methods
8	PCR technique

h. Text Book and Reference Book:

1. Kim Y.J. and Platt U. (Eds.) (2008) Advanced Environmental Monitoring, XXII, 420 p. Springer.
2. Laboratory Analytical Techniques Series (LATS), published by CPCB.
3. Roa M. (2008) Environmental Science Activities Kit, Jossey-Bas.
4. Wagner T.P. and Robert S. (2009) Environmental Science: Active Learning Laboratories and Applied Problem Sets, 2nd Edition, Wiley

- a. **Course Name: Biodiversity Ecological Studies and Toxicology**
- b. **Course Code: 11211121**
- c. **Prerequisite:** Familiarity with the basic principles of toxicology, including dose-response relationships, exposure assessment, and risk assessment is essential.
- d. **Rationale:** hands-on experience on conservation and preservation, ecosystem functioning, Human and environmental health, risk assessment and management, occupational safety fostering practical skills essential for education and awareness.
- e. **Course Learning Objective:**

CLOBJ 1	Demonstrate the ability to identify common plant and animal species within a given ecosystem using taxonomic keys and field guides.
CLOBJ 2	Investigate and understand the ecological roles and interactions of different species within an ecosystem, including their contributions to nutrient cycling, pollination, and predation.
CLOBJ 3	Apply toxicological principles to assess the environmental impact of pollutants. They will understand the importance of monitoring and regulatory frameworks for ensuring environmental safety.
CLOBJ 4	Apply techniques for the detection and quantification of toxic substances in environmental samples or biological tissues using analytical methods such as chromatography or spectrometry.

f. Course Learning Outcomes:

CLO 1	Evaluate and propose conservation strategies based on the biodiversity and ecological health of the studied area.
CLO 2	Investigate and understand the ecological roles and interactions of different species within an ecosystem, including their contributions to nutrient cycling, pollination, and predation.

CLO 3	Apply toxicological principles to assess the environmental impact of pollutants. Understand the importance of monitoring and regulatory frameworks for ensuring environmental safety.
CLO 4	Analyze and interpret toxicological data, critically evaluating the implications for human health and the environment. Develop informed conclusions and recommendations.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	6	4	-	-	40	-	60	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

Exp. No.	Name of the Experiment
1	Monitoring Flora and fauna and other Environmental Components.
2	Isolation and Enumeration of microorganisms from soil
3	Study of anatomical changes in plants to detect the effect of pollution.
4	Estimation of chlorophyll content
5	Estimation of Protein content
6	Toxic effect of chemicals on germination of seeds.

Exp. No.	Name of the Experiment
7	Toxic effect of chemicals on root and shoot length of plants.

h. Text Book and Reference Book:

1. Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2 nd Ed. Taylor & Francis, London."Signals and Systems" by Simon Haykin and Barry Van Veen.
2. Hayes, A. W. (2008), Principles and Methods of Toxicology, 5th Edition, Boca Raton, FL, Taylor and Francis
3. Environmental Toxicology set of 3 volumes- Peter Gomes
4. Toxicology: Principles and Methods-Second Revised Edition - M A Subramanian

ANNEXURE-IV

(1)

a. **Course Name: Lab -2 Solid Waste Management Lab**

b. **Course Code: 11211168**

c. **Prerequisite:** The prerequisite ensures that students entering the Solid Waste Management Laboratory have a common understanding of the key concepts and principles, creating a more meaningful and enriching learning experience during the laboratory sessions.

d. **Rationale:** A solid foundation in environmental science is essential for students to comprehend the complex issues related to solid waste management.

e. **Course Learning Objective:**

CLOBJ 1	Define and explain the various types of solid waste, including municipal solid waste, hazardous waste, and industrial waste.
CLOBJ 2	Investigate methods and technologies for the efficient collection, transportation, and logistics involved in managing solid waste from its source to treatment facilities.
CLOBJ 3	Assess the environmental and public health impacts of improper solid waste management, including air and water pollution, soil contamination, and the spread of diseases.
CLOBJ 4	Analyze the processes and factors contributing to the generation of solid waste, including consumption patterns, urbanization, and industrial activities.

f. **Course Learning Outcomes:**

CLO 1	Describe the characteristic of wastes and the systems, and processes of waste management
CLO 2	Identify the case specific issues related to pollution potentials of solid wastes
CLO 3	Design solid waste management practices through a cradle-to-grave approach
CLO 4	To explore and evaluate the techniques to generate resources from wastes

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	6	4	-	-	40	-	60	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

Exp. No.	Name of the Experiment
1	Sampling methods of soil and solid waste
2	Solid waste characteristics
3	Analysis of moisture content from soil sample
4	Analysis of organic content from soil sample
5	Analysis of organic matter from soil sample
6	Analysis of Sodium and Potassium from soil sample
7	Analysis of Nitrogen content from soil sample
8	Analysis of Phosphorus from soil sample
9	Preparation of compost from soil sample
10	Biological analysis of municipal solid waste

h. Text Book and Reference Book:

6. "Solid Waste Management: Principles and Practice" by William D. Robinson and P. Aarne Vesilind

7. "Waste Management Practices: Municipal, Hazardous, and Industrial" by John Pichtel
8. "Waste Management and Sustainable Consumption: Reflections on Consumer Waste" by Susan Parham

ANNEXURE-IV

a. Course Name: Lab-1 Environmental Biotechnology

b. Course Code: 11211170

c. Prerequisite: The students should have basic knowledge of environment sciences and biotechnology.

d. Rationale: The course will cover a range of topics including microbial ecology, wastewater treatment, bioremediation, and molecular biology techniques relevant to environmental monitoring and assessment.

e. Course Learning Objective:

CLOBJ 1	Illustrate the role of microorganisms in environmental processes and ecosystems.
CLOBJ 2	Utilize various laboratory techniques for monitoring and assessing environmental parameters.
CLOBJ 3	Apply molecular biology and remediation techniques to analyze environmental samples.
CLOBJ 4	Design experiments related to the treatment of wastewater using biotechnological approaches.

f. Course Learning Outcomes:

CLO 1	Isolate and characterize environmental microorganisms using appropriate techniques.
CLO 2	Interpret and analyze molecular data, drawing conclusions relevant to environmental biotechnology.
CLO 3	Understand and apply different bioremediation strategies for environmental cleanup.
CLO 4	Perform molecular biology techniques for the analysis of environmental samples

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	6	4	-	-	40	-	60	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

Exp. No.	Name of the Experiment
1	Introduction to Environmental Biotechnology
2	Microbial Ecology and Biodiversity in Environmental Systems
3	Isolation and Characterization of Environmental Microorganisms
4	Techniques for Monitoring Environmental Parameters
5	Molecular Biology Applications in Environmental Biotechnology
6	Bioremediation Strategies
7	Wastewater Treatment Processes
8	Analytical Techniques in Environmental Biotechnology

h. Text Book and Reference Book:

1. "Introduction to Environmental Biotechnology" by A. K. Choudhury
2. "Principles of Environmental Science and Engineering" by P. Venugopala Rao, S.

Subramanian

3. "Bioremediation: Principles and Applications" by Ronald L. Crawford

ANNEXURE-IV

Semester -3

a) Course Name: Remote Sensing and GIS

b) Course Code: 11211217

c) Prerequisite: Students will develop skills for Satellite Observation, object positioning and stratigraphic analysis.

d) Rationale: combined ability to gather, analyze, and interpret spatial data for a wide range of applications.

e) Course Learning Objective:

CLOBJ 1	Understand and apply techniques such as overlay analysis, buffering, and spatial querying
CLOBJ 2	Acquire skills in interpreting and analyzing remote sensing imagery.
CLOBJ 3	Identify and classify land cover types, recognizing patterns and changes over time.
CLOBJ 4	Evaluate the impact of various factors, such as seasonality or environmental conditions, on image interpretation.

e. Course Learning Outcomes:

CLO 1	Practical exercises and projects involving real-world spatial analysis scenarios.
CLO 2	Students will analyze and interpret remote sensing imagery, identify land cover changes, and perform advanced spatial analyses..
CLO 3	Practical exercises and projects involving real-world spatial analysis scenarios.
CLO 4	Group projects where students design and implement a comprehensive GIS solution for a specific application.

f. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	6	4	-	-	20	-	60	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

g. Mapping of Experiment List with Course Learning Outcomes:

Exp. No.	Name of the Experiment
1	practical 1-1 GPS: Handheld GPS Receiver
2	Practical 2 GPS: GPS Data Collection
3	Practical 3 GPS: Ground Truth Data Collection
4	Practical 4 Remote Sensing (RS): Visual Interpretation of Satellite Imagery
5	Practical 5 Remote Sensing (RS): Interpretation of Land use and Land cover Map
6	Practical 6 Geographic Information System (GIS): Introduction to GIS Software and Application
7	Practical 7 Geographic Information System (GIS): Geospatial Database Generation and Organization
8	Practical 8 Geographic Information System (GIS): Spatial Data Analysis with GIS
9	Practical 9 Geographic Information System (GIS): Vector Data Analysis
10	Practical 10 Geographic Information System (GIS): Raster Data Analysis
11	Practical 11 Geographic Information System (GIS): Map Composition

Exp. No.	Name of the Experiment
12	Practical 12 Geographic Information System (GIS): Technology trends in GIS
13	Practical 13 Geographic Information System (GIS): Geo-referencing and Projection
14	Practical 14: Demo on ArcGIS
15	Practical 15 Geographic Information System (GIS): LULC Case Studies in Environmental Areas

h. Text Book and Reference Book:

- a. Paul C. Sutton (2013). Remote Sensing and GIS for Ecologists - Using Open Source Software, Data Science, Inc.

ANNEXURE-IV

Semester -3

(2)

a) **Course Name:** Scientific Writing and Statistical Analysis Lab

b) **Course Code:** 11211218

c) **Prerequisite:** Should be familiar with the basics of report and article writing.

d) **Rationale:** Will be able to develop the skill of writing the research & review paper.

e) **Course Learning Objective:**

CLOBJ 1	Identify and prepare literature review properly.
CLOBJ 2	Apply theoretical knowledge to proper deliverables such as PPT.
CLOBJ 3	Understanding the different types of techniques for Statistical Analysis using computers.
CLOBJ 4	Acquire knowledge on database management and computer statistics.

e. **Course Learning Outcomes:**

CLO 1	Deliver the idea and can present the research results in front of an audience or scientific team.
CLO 2	Demonstrate the techniques for scientific writing and Statistical Analysis to prepare the writing of a scientific report.
CLO 3	Acquire knowledge on the importance of Scientific journals, impact factor and citation index.
CLO 4	Understanding the different types of techniques for Statistical Analysis using computers.

f. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	6	4	-	-	40	-	60	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

Exp. No.	Name of the Experiment
1	Scientific presentations and Practices: Scientific Deliveries and Communications: Writing Research proposal, Paper, Thesis, Report and Citations
2	Scientific presentations and Practices: Presenting scientific research: Power point presentations, Posters etc.
3	Scientific presentations and Practices: Publication processes, Review Processes and Significance of scientific communications
4	Scientific presentations and Practices: Fundraising in the field of environment and conservation biology
5	Scientific presentations and Practices: Preparation and delivery of scientific presentation and paper, Public talk, Technical report. Presentation in different form with the help of computer.
6	Scientific presentations and Practices: Presentation of data in tabular/ graphic form
7	Scientific presentations and Practices: Research proposal writing.
8	Scientific presentations and Practices: Important Scientific journals, impact factor and citation index.
9	Statistics and Computing: Basic computing: MS Office ®, Internet
10	Statistics and Computing: Data base management
11	Statistics and Computing: Use of computers in statistical analysis

g. Text Book and Reference Book:

1. M. L. Singh (1998). Understanding Research Methodology, J. M. Singh.
2. C. R. Kothari (1990). Research Methodology, Vishwa Prakashan, India.
3. Robert E. Slavin (1994). Research Methodology in Education: A practical guide, prentice Hall.

ANNEXURE-IV

Semester-IV

a. **Course Name: Dissertation**

b. **Course Code: 11211261**

c. **Prerequisite:** The prerequisites for the Dissertation in Environmental Science are designed to ensure that students embarking on independent research projects possess a solid academic foundation and the necessary skills to conduct meaningful and ethical research.

d. **Rationale:** Completion of core and advanced courses provides students with a broad understanding of the interdisciplinary nature of environmental science, while the inclusion of research methodology and literature review skills ensures their ability to design and execute a rigorous research project.

e. **Course Learning Objective:**

CLOBJ 1	Develop a clear and concise research question that addresses a specific environmental issue or gap in current knowledge
CLOBJ 2	Conduct a thorough literature review to identify and synthesize existing research related to the chosen environmental topic, demonstrating an understanding of the current state of knowledge.
CLOBJ 3	Develop a robust research methodology, including appropriate data collection techniques, experimental design (if applicable), and statistical analysis methods.
CLOBJ 4	Demonstrate an understanding of ethical considerations in environmental research, ensuring the responsible and transparent conduct of research, and adherence to ethical standards.

f. **Course Learning Outcomes:**

CLO 1	Develop a well-defined and feasible research question or hypothesis.
CLO 2	Conduct a thorough and critical literature review to identify gaps, relevant theories, and methodologies in the chosen research area.

CLO 3	Design a comprehensive research plan, including methodologies and data collection strategies.
CLO 4	Analyze collected data using relevant statistical or qualitative techniques, demonstrating a nuanced understanding of the research findings.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	22	12	-	100	-	-	500	600

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

- a. **Course Name: Seminar**
- b. **Course Code: 11211262**
- c. **Prerequisite:** solid academic foundation and the necessary skills to present and explain a particular topic according to the perceived information and understanding regarding the subject.
- d. **Rationale:** Successful completion of the course will prepare students for future academic and professional endeavors that require effective oral communication and research presentation skills.
- e. **Course Learning Objective:**

CLOBJ 1	Demonstrate the ability to conduct comprehensive literature reviews on specific environmental topics, synthesizing information from diverse sources.
CLOBJ 2	Evaluate and critically analyze scientific articles, research papers, and relevant environmental data to form evidence-based arguments.
CLOBJ 3	Demonstrate proficiency in utilizing visual aids, multimedia tools, and other presentation techniques to enhance clarity and engagement during seminars.
CLOBJ 4	Build confidence in public speaking and the ability to articulate environmental science concepts with clarity and coherence.

f. Course Learning Outcomes:

CLO 1	Perform a comprehensive literature review to identify relevant studies, theories, and methodologies related to the chosen environmental science topic.
CLO 2	Apply critical thinking skills to evaluate and analyze scientific literature, identifying gaps, controversies, and emerging trends in the field.
CLO 3	Develop and utilize visual aids, such as slides, charts, and graphs, to enhance the clarity and impact of the presentation.
CLO 4	Conduct independent research on a specific environmental science topic, utilizing a variety of scholarly sources and research methods.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	-	-	2	-	100	-	-	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination