

(Abstract)

M.Sc. Environmental Science Programme in the Department of Environmental Studies, Mangattuparamba Campus - Revised Scheme and Syllabus - Approved- Implemented w.e.f. 2023 admission--Orders issued

ACADEMIC C SECTION

ACAD C/ACAD C1/24145/2023

Dated: 23.11.2023

- Read:-1. U. O. No. ACAD C/ACAD C3/22373/2019 dtd.12.09.2023
2. Circular No. dated ACAD C/ACAD C3/22373/2019 dated 12/09/2023
3. Email dated 16.11.2023 from the Head, Department of Environmental Studies, Mangattuparamba Campus.
4. Minutes of the meeting of the Department Council held on 14.09.2023

ORDER

1. The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System in the University Teaching Departments/Schools were implemented w.e.f. 2023 admissions vide paper read(1) above.
2. As per paper read (2) above, Heads of all Teaching Departments were requested to submit the revised Syllabus in accordance with the approved Regulations along with a copy of the Department Council Minutes
3. As per paper read (3) above, the Head, Department of Environmental Studies, Mangattuparamba Campus submitted the Scheme & Syllabus of M.Sc. Environmental Science Programme to be implemented in the University Teaching Department w. e. f. 2023 admissions.
4. Department Council vide the paper read (4) above approved the aforementioned Scheme & Syllabus of M.Sc. Environmental Science Programme to be implemented in the Dept. of Environmental Studies of the University w. e. f. 2023 admission.
5. The Vice Chancellor after considering the matter in detail, and in exercise of the powers of the Academic Council conferred under section 11(1), Chapter III of Kannur University Act 1996, approved the **Scheme & Syllabus of M.Sc. Environmental Science Programme and accorded sanction to implement the same in the Department of Environmental Studies, Mangattuparamba Campus of the University w.e.f. 2023 admissions, subject to report to the Academic Council.**
6. The Scheme & Syllabus of M.Sc. Environmental Science Programme, under Choice Based Credit Semester System implemented in the Department of Environmental Studies, Mangattuparamba Campus w. e. f. 2023 admission, is appended and uploaded in the University Web Site.(www.kannuruniversity.ac.in)
7. Orders are issued accordingly.

Sd/-

Narayanadas K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: 1. The Head, Department of Environmental Studies, Mangattuparamba Campus.
2. Convener, Curriculum Committee.

Copy To: 1. The Examination branch (through PA to CE)

2. PS to VC/ PA to PVC/PA to R
3. DR/AR1/AR II (Acad), EXCI, EP IV
4. Web Manager (for uploading in the website)
5. Computer Programmer
- 6.SF/DF/FC

Forwarded / By Order


SECTION OFFICER







KANNUR UNIVERSITY

M.Sc. ENVIRONMENTAL SCIENCE

SCHEME & SYLLABUS

(Under Choice Based Credit & Semester System)

2023 admission onwards

DEPARTMENT OF ENVIRONMENTAL STUDIES

Kannur University

Mangattuparamba Campus,

KANNUR UNIVERSITY

KANNUR UNIVERSITY

DEPARTMENT OF ENVIRONMENTAL STUDIES

VISION

Offer education to shape the future environmental scientists and to provide skills, conduct interdisciplinary research and create new knowledge for the protection of environment and sustainability.

MISSION

- *Contribute towards sustainable utilization of natural resources and reduce pollution of water, air and soil.*
- *Create new knowledge by conducting interdisciplinary research.*
- *Educate the students on environmental science and skills for life-long learning.*

PROGRAMME OUTCOMES

- PO 1 :** **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
- PO 2 :** **Problem Solving:** Identify, formulate, conduct investigations, and find solutions to problems based on in-depth knowledge of relevant domains.
- PO 3 :** **Communication:** Speak, read, write and listen clearly in person and through electronic media in English/language of the discipline, and make meaning of the world by connecting people, ideas, books, media and technology.
- PO 4 :** **Responsible Citizenship:** Demonstrate empathetic social concern, and the ability to act with an informed awareness of issues.
- PO 5 :** **Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
- PO 6 :** **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio- technological changes.
- PO 7 :** **Environmental Sustainability and Global Perspective:** Develop an understanding of global standards to foster legal environment. Learn and practice

to critically analyze the legal issues from local, national and international concerns.

PROGRAMME SPECIFIC OUTCOME

- PSO 1 : Demonstrate ability to adapt to a rapidly changing environment and apply new skills.
- PSO 2 : Demonstrate the spirit of compassion, kinship and commitment for National Harmony
- PSO 3 : Apply the concept of ICT modules in the learning process
- PSO 4 : Inculcate the environmental and human values in students
- PSO 5 : Evaluate and strengthen the environmental protection measures through technological innovations and activities
- PSO 6 : Design and set up consultancy projects in disaster management, Environmental Impact Assessment (EIA), Remote Sensing (RS), Geographical Information System (GIS), Forest and Wildlife Management, and Environmental Audit.
- PSO 7 : Apply the skill to use advanced instrumentation facilities and propose new technology to solve environmental issues and problems.

PO - PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
PSO1	✓	✓	✓	✓	✓	✓	✓
PSO2	✓	✓	✓	✓	✓	✓	✓
PSO3	✓	✓	✓	✓	✓	✓	✓
PSO4	✓	✓	✓	✓	✓	✓	✓
PSO5	✓	✓	✓	✓	✓	✓	✓
PSO6	✓	✓	✓	✓	✓	✓	✓
PSO7	✓	✓	✓	✓	✓	✓	✓

LEGEND	
C	Credit
E	External Component (Marks)
ESA	End Semester Evaluation
CE	Continuous Evaluation
P	Practical Hours
T	Total
Tt	Tutorial
DSC	Discipline Specific Core
DSE	Discipline Specific Elective
MDC	Multi-Disciplinary Elective
VAC	Value Addition Course
SEC	Skill Enhancement Course
AEC	Ability Enhancement Course

SCHEME

FIRST SEMESTER								
Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits
		L	T/S	P	ESE	CE		
Discipline Specific Core Courses (DSC)								
MSEVS01DSC01	Fundamentals of Ecology and Environment	4	1	-	60	40	100	4
MSEVS01DSC02	Environmental Pollution	4	1	-	60	40	100	4
MSEVS01DSC03	Environmental Chemistry	4	1	-	60	40	100	4
MSEVS01DSC04	Practical in Environmental Biology	-	-	8	60	40	100	4
Discipline Specific Elective Courses (DSE)								
MSEVS01DSE01 Or MSEVS01DSE02	Biodiversity conservation	3	1	-	60	40	100	3
	Green Technology							
Field Visit (FV)								
MSEVS01DSC05	Field Work	-	-	4	60	40	100	2
Total		31			360	240	600	21

SECOND SEMESTER								
Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits
		L	T/S	P	ESE	CE		
Discipline Specific Core Courses (DSC)								
MSEVS02DSC06	Environmental Engineering	4	1	-	60	40	100	4
MSEVS02DSC07	Atmospheric Science and Climate Change	4	1	-	60	40	100	4
MSEVS02DSC08	Environmental Toxicology, occupational health and safety	4	1	-	60	40	100	4
MSEVS02DSC09	Practical in Environmental Chemistry	-	-	8	60	40	100	4
Discipline Specific Elective Courses (DSE)								
MSEVS02DSE03 OR MSEVS02DSE04	Hydrology and Water Management	3	1	-	60	40	100	3
	Energy & Environment							
Multidisciplinary Elective (MDC) (Offered for other departments)								
MSEVS02MDC01	Industrial Process	2	1	-	60	40	100	2
MSEVS02MDC02	Industrial Pollution and Waste Management							

Ability Enhancement Course (AEC) (Offered for other departments)								
MSEVS02AEC01	Solid Waste Management	2	1	-	60	40	100	2
MSEVS02AEC02	Water Management							
Ability Enhancement Course (AEC) (To be obtained from other departments)								
--		2	1	-	60	40	100	2
Skill Enhancement Course (SEC) (Offered for other departments)								
MSEVS02SEC01	Disaster Risk Reduction and Response	2	1	-	60	40	100	2
MSEVS02SEC02	Climate Resilience							
Skill Enhancement Course (SEC) (To be obtained from other departments)								
---		2	1	-	60	40	100	2
Total		42			420	280	700	23
Value Added Course (VAC)								
MSEVS02VAC01	Water Quality and Management *	1	1	-	60	40	100	2

THIRD SEMESTER								
Course Code	Title of Paper	Contact Hours/Week			Marks			Credits
		L	T/S	P	ESE	CE	Total	
Discipline Specific Core Courses (DSC)								
MSEVS03DSC10	Environmental Management	3	1	-	60	40	100	3
MSEVS03DSC11	Research Methodology and Statistics	3	1	-	60	40	100	3
MSEVS03DSC12	Practical in Environmental Geology	-	-	8	60	40	100	4
Discipline Specific Elective Courses (DSE)								
MSEVS03DSE05 Or MSEVS03DSE06	Natural Resource Management and their Conservation Application of Remote sensing and GIS	3	1	-	60	40	100	3
MSEVS03DSE07 Or	Environmental Microbiology and	3	1	-	60	40	100	3

MSEVS03DSE08	Biotechnology							
	Nano Technology and Environmental Applications							
Multidisciplinary Elective (MDC) (Offered for other departments)								
MSEVS03MDC03	Wetlands	2	1	-	60	40	100	2
MSEVS03MDC04	Mangroves							
MSEVS03MDC05	Fundamentals of Environmental Science	4	1	-	60	40	100	4
Multidisciplinary Elective (MDC) (To be obtained from other departments)								
---		4	1	-	60	40	100	4
	Total	37			360	240	600	20

FOURTH SEMESTER								
Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits
		L	T/S	P	ESE	CE		
Discipline Specific Core Courses (DSC)								
MSEVS04DSC13	Disaster management	4	1	-	60	40	100	4
Discipline Specific Elective Courses (DSE)								
MSEVS04DSE09 OR MSEVS04DSE10 OR MSEVS04DSE11	Environmental Geology	3	1	-	60	40	100	3
	Sustainable Development							
	Environmental Audit							
Project (P)								
MSEVS04DSC14	Project Work	-	-	24	60	40	100	12
Total		33			180	120	300	19
Grand Total		143			1320	880	2200	83

For all course ESA of theory, practical, field work, project evaluation will be conducted as internal evaluation by the department faculty members / Faculty members from other Departments of the Kannur University.

FIRST SEMESTER

DISTRIBUTION OF COURSES AND CREDITS

Semester	1		2	3	4	5	6	7	8	Total Credits
	Discipline Specific Courses		Discipline Specific Elective DSE	Interdisciplinary Elective/ Generic Elective Multidisciplinary Elective /Open Elective	Ability Enhancement AEC	Skill Enhancement Course (SEC)	Value Addition Course/ MOOC Courses (VAC)	Internship/ Field Visit/Minor Project/Institutional-Industrial Visit	Dissertation/Major Projects	
Discipline Specific Core DSC										
1	DSC -1(4C) DSC -2(4C) DSC -3(4C) DSC -4(4C)	DSE - 1(3C) OR DSE- 2(3C)	-	-	-	-	-	FV- 2C	-	21 Credits
	16 Credits	3 Credits						2 Credits		

SCHEME

FIRST SEMESTER									
Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits	
		L	T/S	P	ESE	CE			
Discipline Specific Core Courses (DSC)									
MSEVS01DSC01	Fundamentals of Ecology and Environment	4	1	-	60	40	100	4	
MSEVS01DSC02	Environmental Pollution	4	1	-	60	40	100	4	
MSEVS01DSC03	Environmental Chemistry	4	1	-	60	40	100	4	
MSEVS01DSC04	Practical in Environmental Biology	-	-	8	60	40	100	4	
Discipline Specific Elective Courses (DSE)									
MSEVS01DSE01 Or MSEVS01DSE02	Biodiversity conservation Green Technology	3	1	-	60	40	100	3	
Field Visit (FV)									
MSEVS01DSC05	Field Work	-	-	4	60	40	100	2	
	Total	31			360	240	600	21	

FIRST SEMESTER M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	MSEVS01DSC01 – FUNDAMENTALS OF ECOLOGY AND ENVIRONMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To know about various ecosystems and its functioning. ● To understand the dependency between biological and non-biological components. ● To study the interaction between species. ● To explore the role of ecological communities and its interaction. ● To create awareness and importance of biological diversity.

Modules	Content	Module Outcome
<p>Module I: Fundamentals of Ecology and Environment (20 hours)</p>	<p>1.1 Fundamentals of Ecology Ecology and Interrelationship of ecology with other disciplines.</p> <p>1.2 Fundamentals of Environmental Sciences Definition, Scope and Importance of Environmental Science, Multidisciplinary nature of the environmental Science; Need of Environmental awareness. Introduction to global environmental problems.</p> <p>1.3 Components of Environment The atmosphere or the air: Layers of Atmosphere, Composition of air; importance of atmosphere. The hydrosphere or water: Importance of water, distribution of fresh water at global, national and state level. Hydrological cycle. The Lithosphere or the rock and the soil: Elementary composition of rocks in the earth crust. Types of rocks; Role of soil in shaping the biosphere. The Biosphere or the living component of the environment</p>	<p>The students will be able to:</p> <ul style="list-style-type: none"> ● Recall the fundamentals of the environment. ● Identify the components of the environment (e.g., Air, Water, and Soil).
<p>Module II: Environmental Factors and Ecological adaptations (20 hours)</p>	<p>2.1 Environmental Factors Climatic Factors: Light, Temperature of Air (atmospheric temperature), Rainfall (precipitation), Humidity of air, Atmosphere (gasses and wind), fire. Topographic Factors: height of mountains, direction of mountains and valleys, steepness of slope and exposure of slope Edaphic factors: Soil-soil formation, soil profile, soil erosion, soil conservation Biotic factors: Intraspecific interactions; Interspecific interactions: Neutralism, Commensalism, Mutualism, Proto-cooperation, Parasitism, Predation.</p> <p>2.2 Ecological adaptations Plants – hydrophytes, mesophytes, xerophytes, and</p>	<ul style="list-style-type: none"> ● Analyze the interaction of various environmental factors. ● Identify and analyze the adaptations of plants and animals which will help to protect them.

	halophytes Animals – aquatic conditions-hydrocoles; amphibious conditions or sec. hydrocoles Terrestrial – mesocoles and xerocoles	
Module III: Ecosystem and its type (20 hours)	<p>3.1 Definition</p> <p>3.2 Components of ecosystem Abiotic components: Light, Temperature, Pressure, Water, Wind, Soil Biotic components: Energy flow in an ecosystem: Primary production, Secondary production; Food chain: Grazing food chain, Detritus food chain; Ecological pyramids: Pyramid of number, Pyramid of biomass, Pyramid of energy; Food web; Ecological indicators.</p> <p>3.3 Biogeochemical cycles Gaseous cycles: Oxygen cycle, Carbon cycle and Nitrogen cycle. Sedimentary cycles: Phosphorus cycle and Sulphur cycle.</p> <p>3.4 Types of Ecosystems Terrestrial Ecosystems – Forest, Grassland, Tundra and Desert ecosystem. Aquatic Ecosystems – Freshwater (Lakes, ponds, rivers, streams and wetlands) and Marine (Oceans and estuaries).</p>	<ul style="list-style-type: none"> ● Identify and analyze the interrelationship between abiotic and biotic factors. ● Recognize the relevance of material cycling within ecosystems. ● Distinguish and evaluate various ecosystems.
Module IV: Population Ecology and Community Ecology & Applied Ecology (20 hours)	<p>4.1. Population characteristics – Population growth and its dynamics; Natality, Mortality, Growth patterns; Age distribution, Malthus theory; Community structure, Species diversity, Ecological dominance, Ecotone, Edge effect, Ecological equivalent, Succession and Climax.</p> <p>4.2. Vegetation Analysis – Quadrat, Transect and Point quadrat method of samplings - Determination of quadrat size and quadrat number (Wiegerts' and Hendricks Methods).</p> <p>4.3. Species diversity measures – Species richness – Species heterogeneity (Simpson' Indices, Shannon – Wiener Indices) - Girth class and Height class measurement.</p> <p>4.4. Museology – Plants and Animals – Collection and Preservation. Major Herbaria and Museums.</p> <p>4.5. Taxonomy and Biosystematics</p> <p>4.6. Biomass and Productivity estimation techniques</p>	<ul style="list-style-type: none"> ● Analyze and evaluate the levels of organizations of organisms. ● Evaluate the sampling techniques for vegetation analysis.
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Eugene P. Odum, Fundamentals of Ecology, (Natraj Publishers, Dehradun.),2005 2. P. S. Verma, V. K. Agarwal, Principles of Ecology, (S. Chand and Co. New Delhi),2008 3. P. D. Sharma, Environmental Biology, (Rastogi Publications, Meerut) 		

4. P. D. Sharma, Ecology and Environment, (Rastogi Publications, Meerut)
5. P. K. G. Nair, Principles of Environmental Biology, (Himalaya Publishing House, New Delhi)
6. S.V.S. Rana, Essentials of Ecology and environmental science, PHI learning,2010
7. Shashi & Chawla, Textbook of environment and ecology, TataMcGraw-Hill,2011
8. Madhab, C. Dash, Fundamentals of ecology, Tata McGraw-Hill, 2009
9. S.A. Nasim, Elements of ecology, Axis Books,2011
10. M. P. Arora, Environmental Biology, (Himalaya Publishing House, New Delhi)
11. Enger Smith, Smith, W. M. C. Brown, Environmental Science, (Company Publishing)
12. K. E. F. Watt, Principles of Soil Science, (McGraw Hill Book Company, New Delhi)
13. Introduction to Environmental Studies, Turk & Turk
14. Robert Leo Smith, Ecology and Field Biology, (Harper Collins college publication)

Course Outcomes	CO1: Identify various ecosystem's structure, function and characteristics CO2: Relate the characterization of community and its dominance as well as co-existing with other community CO3: Describe the importance of protection and conservation of biodiversity CO4: Able to differentiate various habitats and its salient features
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	-
CO2	✓	✓	-	✓	✓	-	-
CO3	✓	✓	-	✓	✓	-	-
CO4	✓	✓	-	✓	✓	-	-

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Describe the components of environment.
2. Differentiate various environmental factors.
3. Write an essay on sedimentary cycles.
4. What are the types of ecosystems? Explain with their peculiarities.
5. Elaborate measures for determining species diversity.

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	MSEVS01DSC02 - ENVIRONMENTAL POLLUTION
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To gain knowledge on atmosphere and its composition ● To understand the type and sources of air pollution ● To study the air quality monitoring methods ● To acquire knowledge on air pollution control measures ● To know various policies and laws intended for air pollution prevention and control.

Modules	Content	Module Outcome
<p>Module I: Environmental Pollution – Air Pollution – Sources, effects and control measures. (25 hours)</p>	<p>1.1 Introduction to Environment Environmental factors - Segments of Environment – Man - Environment relationship, anthropogenic effects on the natural environment, Environmental degradation.</p> <p>1.2 Environmental Pollution Definition, causes of environmental pollution – population, urbanization, industrialization, resource consumption, deforestation, agriculture and transportation.</p> <p>1.3 Air Pollution Definition, Air pollutants and their sources Types of air pollutants – primary and secondary air pollutants–Gaseous, solid and bio pollutants. Movements and reactions of pollutants in the atmosphere - Reactions of pollutants in the air to form smog and PAN - Acid rain, ozone depletion, greenhouse effect and global warming. Factors affecting air pollutants and their mode of actions: climate, temperature, humidity and wind currents. Impacts of air pollution on: Human being, Plants, Materials, buildings and climate. Control measures of Air pollution.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Identify the environmental factors and its segments. ● Apply and identify the various sources of air pollution and understand how they contribute to the deterioration of air quality ● Identify the sources, types, effects, and control measures of air pollution, and to explain the effects of air pollution on human health, the environment, and the economy. ● Describe the sources, effects, and control measures of air pollution, and an understanding of the individual and collective actions that can be taken to reduce air pollution and protect the environment. ● Evaluate the control measures of air pollution, at individual, community, and governmental levels.
<p>Module II: Water pollution - Sources, effects</p>	<p>2.1 Definition and significance 2.2 Types of water pollution - Point and nonpoint source of water pollution-</p>	<ul style="list-style-type: none"> ● Identify and evaluate the various sources of water pollution.

<p>and control measures (15 hours)</p>	<p>surface and groundwater pollution. 2.3 Sources of water pollution - Domestic, Industrial, Agricultural and Natural sources 2.4 Impact of water pollution - on human beings, animals, plants and environment. 2.5 Control measures of water pollution.</p>	<ul style="list-style-type: none"> Analyze the complex interactions between different pollutants and their impact on water quality Evaluate the different control measures for water pollution, including treatment technologies, pollution prevention strategies, and government regulations.
<p>Module III: Soil / Land pollution - Sources, effects and control measures, Noise pollution (20 hours)</p>	<p>3.1 Sources of soil pollution Natural sources - Natural calamities. Anthropogenic sources - Agricultural practices, Industrial and Municipal discharges - Municipal solid waste dumping - Landfill leachates - Plastics - Radioactive leakage - Mining activities and electronic wastes. 3.2 Impact of soil / land pollution– Soil fertility - Soil microorganisms - Effects on plants and animals. Control measures. 3.3 Noise Pollution Definition and concept of Noise pollution. Sources of noise pollution - Indoor and outdoor noise pollution, Natural and Anthropogenic sources. Impact of noise pollution - Impacts on plants and animals.</p>	<ul style="list-style-type: none"> Identify the sustainable agricultural practices in crop rotation and integrated pest management Evaluate the proper disposal of hazardous waste and other pollutants Evaluate the regulations and guidelines for industrial activities Create a model to restore the contaminated sites through remediation and reclamation techniques Apply and understand the noise-reducing technologies in transportation and other industries level Create public awareness on the harmful effects of noise pollution.
<p>Module IV: Radioactive Pollution, Thermal and Marine Pollution (20 hours)</p>	<p>4.1 Radioactive pollution Definition and scope of the study. Types and sources of Radioactivity Natural and manmade radioactivity Radioactive pollution episodes Precautions and control measures. 4.2 Thermal pollution. Impacts of thermal pollution -aquatic fauna and flora. Control measures of Thermal pollution. 4.3 Marine pollution Definition Sources of Marine pollution -Natural and Anthropogenic sources Control measures Pollution status of coastal and ocean waters.</p>	<ul style="list-style-type: none"> Identify the radioactive contamination of air, water, and soil, affecting the natural environment and its control measures Apply and implement the proper safety measures and disposal methods, and a healthier environment for future generations. Construct a model for proper disposal of waste

	Oil pollution - Sources - effects and control measures.
References	<p>Reference:</p> <ol style="list-style-type: none"> 1. B.K Sharma – Environmental Chemistry – Goel publication. 2. A.K. De - Environmental Chemistry 3. Khopkar, Shripad Moreshwar, Environmental Pollution, New Age International (P) Ltd., Delhi,2004 4. Marquita K. Understanding Environmental Pollution, Cambridge University Press,1997 5. R.K. Pollution, Cambridge Pollution, Cambridge Delhi,2014 6. Tanmoy Rudra & Pollution, Cambridge, Marine Pollution Control and Pollution, Cambridge prakashan,2017 7. Pollution, Cambridge of Environmental Chemistry & Pollution Pollution, Cambridge Delhi,2018 8. Palekar, Aradhana, Air Aradhana, Air Delhi ,2018 9. Priya Ranjan Trivedi, Water Pollution and Environmental Analysis New Delhi,2018 10. Krishnamurthy, Aishwarya, Water Pollution and Its Control, Mittal, New Delhi,2016 11. Tyagi and Mehra - Environmental Chemistry 12. P.R. Trivedi & Raj Gurdeo - Environmental Water and Soil Analysis, Akashdeep Pub. House, New Delhi. 13. V. K. Ahluwalia, Environmental Chemistry, Mahe books, India 14. S.P. Misra and S.N. Pandey, Essential Environmental Studies, ANE Books Pvt. Ltd. 15. S.A. Abbasi, 1998. Environmental Pollution and Its Control. Cogent International, Pondicherry.
Course Outcomes	<p>CO1: Identify various atmospheric layer and its importance</p> <p>CO2: Apply and analyze the details about source, types and impacts of air, water and soil pollution</p> <p>CO3: Identify the sampling and analysis of the air, water and soil pollutants in the environment</p> <p>CO4: Evaluate the various air, water soil pollution control measures</p> <p>CO5: Apply and analyze the various policies related to air, water and soil pollution prevention and control</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	-	-	✓	-	✓
CO2	✓	-	-	-	✓	-	✓
CO3	✓	-	-	-	✓	-	✓
CO4	✓	-	-	-	✓	-	✓
CO5	✓	-	-	-	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Write the major impacts of anthropogenic activities on the natural environment?
2. What are the causes and effects of agricultural pollution?
3. Explain the environmental costs of industrialization?
4. Discuss various segments of environment.
5. Enumerate the various standard procedures for the estimation of water pollution parameters.

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	MSEVS01DSC03 - ENVIRONMENTAL CHEMISTRY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To study the basics of environmental chemistry, chemical reactions involved in water and electro kinetic properties. • To understand the meaning of environmental chemistry • To define atmospheric pollution, list reasons for global warming, greenhouse effect and acid rain • To describe causes of all pollution

Modules	Content	Module Outcome
<p>Module I: Fundamentals of Chemistry (15 hours)</p>	<p>1.1. Concepts and scope of environmental chemistry 1.2. Principles of Biogeochemical cycle: N, C, P, S & Water 1.3. Anthropogenic activities on biogeochemical cycle 1.4. Stoichiometry & its applications 1.5. Chemical Kinetics- Control of reactions, First, second and zero order reactions 1.6. Catalysis 1.7. Chemical Equilibria 1.8. Solubility Products 1.9. Unsaturated and Saturated Hydrocarbons 1.10. Radio nuclides & environment</p>	<p>The student will be able to</p> <ul style="list-style-type: none"> • Identify the basics of Environmental chemistry • Gain the knowledge of chemical and biochemical cycles & their principles • Recall the basics of stoichiometry & chemical kinetics • Discuss the basic concept of radio nuclide and its issues associated with the environment.
<p>Module II: Transformation of Refractory Organic compounds in the Environment (10 hours)</p>	<p>2.1. Soap & Synthetic detergent (Surfactant) - cationic, anionic and non- ionic detergents, Modified detergents 2.2. Pesticides and Fertilizers -Classification, Degradation and Analysis of pesticides, - Pollution due to pesticides, DDT, Endosulfan and its molecules, Types of synthetic fertilizers & its environmental effects. 2.3 Polychlorinated Biphenyls (PCB) 2.4 Synthetic polymers - Classification, properties and applications - Special reference to PVC, Thermoplastics & thermosetting plastics - Advantages & disadvantages of synthetic polymers 2.5. Biodegradable & non-bio degradable polymers 2.6. Petroleum products- Types of fuels, Paraffin</p>	<ul style="list-style-type: none"> • Analyze in detail about soaps and detergents. • Identify the pollution caused by cleaning products.

<p>Module III: Chemistry of Environmental components (30 hours)</p>	<p>3.1. Chemistry of Atmosphere History and evolution of the earth's atmosphere. Structure and composition of atmosphere. Chemical composition of atmosphere - Classification of elements in the atmosphere - Water, CO₂, NO_x, SO_x, O₂, Ozone, Chemical speciation, Particles, ions, and radicals in the atmosphere. Chemical processes for the formation of Inorganic and Organic Particulate matter, Thermochemical and photochemical reactions in the atmosphere. Temperature inversions, Atmospheric lapse rate, Adiabatic lapse rate, wet and dry adiabatic lapse rate. Photochemical smog, Origin and occurrence - Oxidizing and Reducing smog - Ecological effects. Oxygen and Ozone chemistry - Ozone layer - Chemistry of ozone layer - Ozone depletion Mitigation of ozone depletion. Eco friendly coolants. Chemistry of atmospheric pollutants. Acid rain and its ecological effects.</p> <p>3.2. Chemistry of Lithosphere Structure and composition of lithosphere. Chemical properties of important rocks and minerals. Chemical characteristics of soil, Organic and inorganic components of soil, Soil horizon. Formation of soil, Soil forming processes, Weathering and pedogenesis. Soil pollution, Fate of chemicals in soil. Soil erosion</p> <p>3.3. Chemistry of Hydrosphere Hydrological cycles. Composition and structure of pure water, Physico chemical properties of water and aqueous solution. Solubility of solids, liquids, and gasses in water. Chemical reaction and equilibrium in water, Carbonate equilibrium, Metal ion equilibrium, Redox equilibrium. Natural organic components in water.</p>	<ul style="list-style-type: none"> ● Discuss the basic structure & composition of atmosphere & lithosphere ● Analyze the different types of air & soil pollutants, sources & its effects. ● Explain the fate of pollutants in the atmosphere & lithosphere. ● Analyze the various reactions taking place in the atmosphere & lithosphere ● Estimate the harmful effects caused by air and soil pollution ● Describe the hydrological cycle ● Identify the basic knowledge of water and its properties ● Draw the reactions related to water
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<p>Module IV: Analytical Techniques (20 hours)</p>	<p>4.1. Gravimetry Principles and applications of gravimetric methods with examples</p> <p>4.2. Volumetric methods Standardization of Reagents. Acidimetry, Alkalimetry, Dichrometry, Iodometry, Iodimetry, Complexometry, Colorimetry, and Cerimetry.</p> <p>4.3. Instrumental methods pH meter - glass and reference electrodes - Ion selective electrodes Conductometry - Electrical conductivity measurement Potentiometry Nephelometry - Turbidimetry - Sulphide determination Spectrophotometry - Beer-Lambert's law - Deviation from Beer - Lambert's law - U.V visible Spectrophotometer - Mass spectrophotometers) Flame photometry - Determination of Metals (Na, K) Atomic absorption spectrophotometry - application Atomic emission spectrophotometry Dosimetry - Geiger Muller counter - Scintillation counter. Electrophoresis - Gel Electrophoresis - Immunoelectrophoresis (ELISA, blotting technique, RFLP)</p>	<ul style="list-style-type: none"> ● Explain the basic principles of analytical equipments ● Describe the gravimetric, spectroscopic analysis. ● Comprehend the various sampling techniques ● Identify the applications of gravimetric techniques ● Illustrate the applications of electrophoresis & blotting
<p>References</p>	<ol style="list-style-type: none"> 1. Stanely E. Manahan, Environmental Chemistry, Willard grant press, Boston, Massachusetts, 10th Ed., 2017 2. B.K Sharma, Environmental Chemistry, Goel publication. 3. A.K. De, Environmental Chemistry, New Age International Publishers, New Delhi. 4. R.A Bailey, Chemistry of the Environment, Academic press, New York, 1993. 5. J. Tolgyessy, Chemistry and Biology of Water, Air, Soil, Elsevier, Amsterdam, 1993 6. E.K. Gaur, Textbook of Environmental Chemistry, Sonali publications, New Delhi, 2019 7. S.M. Khopkar, Basic Concepts of Analytical Chemistry, New Age International Publishers, 2023 8. H. Kaur, Pragati Prakashan, Environmental Chemistry, Meerut, 2011 9. Vanloon, Wary, Environmental Chemistry, Oxford University, New York, 2015 	

	<p>10. Vogel - Analytical Chemistry</p> <p>11. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4th ed., Saunders college Publishing, Fort Worth, 1992.</p> <p>12. Standard Methods for The Examination of Water and Wastewater, APHA, 21stEd, Washington DC</p> <p>13. Lain. Marr and Malcolm S Cresser, Environmental Chemical Analysis, International textbook company (pub), New York, 1983.</p> <p>14. V.K. Ahluwalia, Environmental Chemistry, Ahe books, India</p> <p>15. S.M. Khopkar, Basic Concepts of Analytical Chemistry, Wiley Eastern Ltd., New Delhi.</p> <p>16. Daniel C. Harris, Quantitative Chemical Analysis, 4th Ed., W.H. Free man and Company, New York, 1995.</p>
Course Outcomes	<p>CO1: Interpret the chemical reactions in water, air and soil environment.</p> <p>CO2: Apply chemistry principles in analyzing pollution of water, air and soil environment.</p> <p>CO3: Analyze the fate of chemicals in the environment and suggest relevant interventions.</p> <p>CO4: Execute the knowledge on qualitative and quantitative techniques</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	-	✓	✓	-	✓
CO2	✓	-	-	✓	✓	-	✓
CO3	✓	-	-	✓	✓	-	✓
CO4	✓	-	-	✓	✓	-	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Laboratory visit</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. How do the properties of water changes by the addition of solute?
2. How the phosphate content in detergents threatens the environment?
3. Briefly explain the mechanism of formation of acid rain
4. Discuss the fate of pesticides in the environment
5. Describe the process and principle of electrophoresis and its applications

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	MSEVS01DSC04 - PRACTICAL IN ENVIRONMENTAL BIOLOGY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To make the student acquire practical skills in the determination of various ecological and microbiological parameters. • To develop skill in the field of Vegetation analysis.

Modules	Content	Module Outcome
Module 1 (20 hours)	<p><u>Ecology</u></p> <p>1.1. Identification, Preservation & Abundance of Phytoplankton</p> <p>1.2. Quantitative and Qualitative analysis of Phytoplankton & Zooplanktons:</p> <p>a) Lackey's Drop Method b) Hemocytometer Method</p> <p>1.3. Primary Productivity-Light and Dark bottle method</p> <p>1.4. Study of Phytoplankton</p> <p>1.5. Study of Zooplankton</p> <p>1.6. Determination of water transparency by Secchi disc</p> <p>1.7. Determination of pH and temperature of water</p>	<p>The student will be able to</p> <ul style="list-style-type: none"> • Gain knowledge for analyzing the effects of ecological factors • To have a practical knowledge of the abiotic-biotic and biotic-biotic interaction
Module 2 (20 hours)	<p><u>Vegetation Studies</u></p> <p>2.1. Determination of minimum size of the quadrat for vegetation study</p> <p>2.2. Study of vegetation density by quadrat method</p> <p>2.3. Study of vegetation frequency by quadrat method</p> <p>2.4. Estimation of biomass</p>	<ul style="list-style-type: none"> • Calculation of quadrat for vegetation studies
Module 3 (30 hours)	<p><u>Environmental Microbiology</u></p> <p>3.1. General Laboratory Safety</p> <p>3.2. Laboratory equipment and its familiarization</p> <p>a) Microscopy b) Compound Microscope c) Hemocytometer d) Autoclave e) Laminar Air Flow (LAF) f) Hot Air Oven g) Incubator h) Water Bath i) Filter Sterilization</p> <p>3.3. Sterilization Techniques</p> <p>3.4. Aseptic Techniques for Transfer a Culture</p> <p>3.5. Bacterial Morphology</p> <p>3.6. Culture Media</p> <p>a) Medium for Microorganism Culture</p>	<ul style="list-style-type: none"> • Gain knowledge in basic microbiological equipment. • Gain insight into the basics of microbiology from practical aspects. • Gain skill for analyzing microbes

	<p>b) Preparation of Nutrient Broth c) Preparation of Nutrient Agar Plate d) Preparation of Agar Slants for the Preservation of Microorganisms e) Preparation of Potato Dextrose Agar (PDA)</p> <p>3.7. Preparation of bacterial smear a) Preparation of Bacterial Smear from Nutrient Broth b) Preparation of Bacterial Smear from Nutrient Agar</p> <p>3.8. Inoculation & Culture techniques: a) Spread plate b) Pour plate c) Drop inoculation d) Streaking on plate e) Serial dilution method of estimation.</p>	
<p>Module 4 (10 hours)</p>	<p>4.1. Staining Techniques and microscopic observation a) Simple Staining of Bacteria b) Gram Staining of Bacteria c) Endospore Staining d) Negative Staining</p> <p>4.2. Cultivation and enumeration of bacteriophages (Coliphages) from raw sewage. (Demonstration only)</p> <p>4.3. Assessment of water quality by Total Coli, Fecal coliform</p> <p>4.4. Most Probable Number (MPN) technique for Coliform analysis</p> <p>4.5. Sampling, isolation and enumeration of microorganisms in soil samples a) THB Load of the Soil Sample by Pour Plate Method b) THB Load of the Soil Sample by Pour Plate Method</p> <p>4.6. Detection of bacterial motility- Hanging drop method</p> <p>4.7. Biochemical test for characterization of bacteria a) Catalase test b) Oxidation Fermentation Test</p> <p>4.8. Isolation of Fungi</p>	<ul style="list-style-type: none"> • Gain insight into the staining techniques. • Gain basic knowledge in sampling, isolation of bacteria
<p>Course Outcomes</p>	<p>CO1: Outfitted with hands-on knowledge in the qualitative analysis of Ecological and microbiological parameters. CO 2: Outfitted with hands-on knowledge in the quantitative analysis of Ecological and microbiological parameters. CO3: Able to conduct vegetation analysis for forest management CO4 : Skill development for ICT</p>	
<p>References</p>	<p>1. American Public Health Association (APHA), American Water Works Association, (AWWA) and Water Environment Federation (WEF) (2017). Standard Methods for the Examination of Water and Wastewater, 23rd edition, ISBN: 978-0-87553-287-5; Part 1000: P. 541. 2. UNEP. 2002. Global environment Outlook. Earth Scan Publications Ltd., London</p>	

3. P. Cot greave and I. Forseth, 2002. Introductory Ecology. Blackwell Science 4. B. Freedman, 1995. Environmental Ecology. Academic Press 5. E.P. Odum, 1993. Fundamentals of Ecology. 6. E.P. Odum, and Gary W. Barrett. 1971. Fundamentals of ecology. Vol. 3. Philadelphia: Saunders. 7. R.L. Smith, 1990. Ecology and Field Biology. Harper Collins Publ. 8. R.L. Smith and T.M. smith.1998. Elements of Ecology. Addison Wesley Longman Inc.

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	✓
CO2	✓	✓	-	✓	✓	-	✓
CO3	✓	✓	✓	✓	✓	-	✓
CO4	✓	✓	✓	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching Interactive Instruction: Active co-operative learning, Library work and Group discussion, Hands on training Field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Practical Examination 	30
<ul style="list-style-type: none"> • Lab record 	5
<ul style="list-style-type: none"> • Internal viva 	5

Sample Questions to test Outcomes

1. Identify given microorganisms.
2. Determine the minimum size of quadrat using the given data.
3. Write down the principle and procedure for the determination of transparency using Secchi disc.

DISCIPLINE SPECIFIC ELECTIVE COURSE

Course Code & Title	MSEVS01DSE01 - BIODIVERSITY CONSERVATION
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To gain knowledge of fundamental concepts within conservation and biodiversity • To understand the main threats to biological diversity and the ability to evaluate the effects of human influences such as habitat fragmentation, climate changes and invasive species on biodiversity • To understand the relationships and conflicts between social development and conservation of ecosystems; as well as moral and ethical issues • To analyze information generated from scientific investigations and use findings to address conservation and biodiversity issues.

Modules	Content	Module Outcome
Module I: Biodiversity and its Conservation (20 hours)	<p>1.1. Introduction Definition, Types of biodiversity such as genetic, species and ecosystem biodiversity; Biodiversity at Global, National and local levels; The mega-diversity countries of the world; Biogeographical classification of India. Importance and value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values</p> <p>1.2. Measurement of Biodiversity Species richness, species diversity, Simpson Index, Shannon Wiener Index, Alpha, Beta and Gamma Diversity</p> <p>1.3. Threats to Biodiversity Habitat loss and degradation, poaching of wildlife, introduction of exotic species, genetic pollution, climate change, man wildlife conflict; Endangered and endemic species of India; extinction of species, key stone species</p> <p>1.4. Hotspots of Biodiversity</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> • Identify the basics of biodiversity - global, national and local levels • Know the values of biodiversity and its threats • Measure biodiversity and to track disturbances in an ecosystem. • Identify the threats of biodiversity and its causes and impacts • Identify the hotspots of biodiversity
Module II: Biodiversity conservation (20 hours)	<p>2.1. In Situ Conservation Protected areas-National parks, Wildlife sanctuaries, Biosphere reserves – Definition. Concept and short description and importance of major national parks – Jim Corbet, Keibul Lamjao, Kazi Ranga, Kanha, Sariska, Gir, Bandipur, etc. – Major national parks in Kerala. Concept and short description and importance of major wildlife sanctuaries – Bhitarkanika, Sathya Mangalam, Brahmagiri, Kolleru,</p>	<ul style="list-style-type: none"> • Measures of conservation of biodiversity • Differentiate the in situ & ex situ conservation and their importance. • Assess & analyze the different wildlife conservation projects. • Recognize and

	<p>Borail, etc. – Major wildlife sanctuaries in Kerala.</p> <p>Concept and short description and importance of major reserves - Nilgiri Biosphere Reserve, Agasthyamalai Biosphere Reserve, Sundarbans, Andaman and Nicobar, Gulf of Mannar.</p> <p>2.2. Ex Situ Conservation Botanical gardens, zoos, aquaria, National Bureau of Plant Genetic Resources (NBPGR), National Bureau of Animal Genetic Resources (NBAGR), Documenting traditional knowledge.</p> <p>2.3. Wildlife Conservation Projects - Project Tiger, Project Elephant, etc.</p> <p>2.4. Sacred groves with special reference to Kerala</p>	<p>document traditional knowledges</p> <ul style="list-style-type: none"> Analyze the values of sacred groves in conservation of biodiversity.
<p>Module III: Global strategy for conservation (20 hours)</p>	<p>3.1. Important International Conferences for Conservation - CBD, Earth Summit, Stockholm conference, Nairobi Conference, Montreal Protocol, London, Rio Declaration 1992, Berlin Mandate, Geneva Convention, Kyoto Protocol 1996, Johannesburg Conference, UNFCCC etc.</p> <p>3.2. NGOs for Biodiversity Conservation (International and National)</p> <p>3.3. International Efforts for Environmental Protection</p>	<ul style="list-style-type: none"> Know the international conferences for biodiversity conservation. Recognize the NGOs and their roles in conservation of biodiversity Apply & analyze different international efforts for conservation of biodiversity.
<p>Module IV: People's movement for environmental conservation in India and Environmental legislations in India (20 hours)</p>	<p>4.1. People's Movement for Environmental Conservation - Bishnoi Movement, Chipko Movement, Narmada Bachao Andolan, Appiko movement, Silent Valley Movement, Baliapal Movement.</p> <p>4.2. Environmental Legislations – Definition, Need & Purpose of Environmental Legislations – Legal provisions in Indian Constitution – Laws related to water, air & Forests and wildlife – General environmental laws.</p>	<ul style="list-style-type: none"> Recognize the different peoples' movements for environmental conservation Aware of the need and purpose of environmental legislations in India.
<p>References</p>	<p>Reference Books:</p> <ol style="list-style-type: none"> S. S. Purohit, Q. J. Shammi and A. K. Agarwal, A Text Book of Environmental Sciences, Student Edition (Agrobios), Jodhpur. D. K. Asthana and Meera Asthana, A Text Book of Environmental 	

	<p>Studies, S. Chand & Co., New Delhi.</p> <p>3. Andal, Fatik Baran, Biodiversity, Asian Books, New Delhi, 2009</p> <p>4. M. Lakshmi Narasaiah, Biodiversity and environment, Discovery Pub. House. New Delhi, 2004</p> <p>5. P.D. Sharma, Ecology and Environment, Rastogi Pub., New Delhi.</p> <p>6. S.C. Santara, Environmental Science, New Central Book Agency (P) Ltd., Kolkata.</p> <p>7. J. L. Chapman and M.J. Reiss, Ecology: Principles and Applications, Cambridge University Press, U.K.</p> <p>8. Prabodh, Maiti, K, Biodiversity, PHI Learning, New Delhi, 2011</p> <p>9. T. N. Khoshoo, Environmental Concerns and Strategies, Ashish Publishing House, New Delhi.</p> <p>10. E.P. Odum, Fundamentals of Ecology, W.B. Saunders Co., Philadelphia.</p> <p>11. Handbook of Environmental Laws, Acts, Rules, Guidelines, Compliances and Standards, Vol. I and II, BS Publications, Hyderabad.</p> <p>12. R. G. Chaturvedy and M.M. Chaturvedy, Law on Protection of Environment and Prevention of Pollution (Central and States), The Law Book Co. (Pvt.) Ltd., Allahabad.</p> <p>13. R. K. Trivedy and P.K. Goel, Practical Methods in Ecology and Environmental Science, Enviro Media, Karad.</p> <p>14. P.S. Verma and V.K. Agarwal, Environmental Biology, S. Chand & Co., New Delhi.</p>
Course Outcomes	<p>CO1: Identify interactions among ecological and sociocultural variables in the context of conservation issues.</p> <p>CO2: Able to outline different concepts of biodiversity and discuss spatial and temporal aspects of biodiversity</p> <p>CO3: Able to outline the biodiversity and ecosystem services concepts and their relevance for management of natural resources and a sustainable development</p> <p>CO4: Interpret the different global impacts and its effect on ecosystems.</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	-
CO2	✓	✓	-	✓	✓	-	-
CO3	✓	✓	-	✓	✓	-	-
CO4	✓	✓	-	✓	✓	-	-

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. What are the major issues of biodiversity?
2. Discuss about the distribution of biodiversity in India
3. Briefly explain the factors influencing biodiversity?
4. What are the traditional systems of knowledge and practices? How does a community adopt it, explain?
5. Why does conserving global biodiversity matter? Explain.
6. Discuss the legislation for conservation and management in India?

DISCIPLINE SPECIFIC ELECTIVE COURSE

Course Code & Title	MSEVS01DSE02 - GREEN TECHNOLOGY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To familiarize the green chemistry • To learn about the control and remedial measures of greenhouse effect • To know about the various analytical green methods • To understand the toxic effect of various pollutants • The understand the biological methods of determining the water pollution • To know the soil and thermal pollution

Modules	Content	Module Outcome
Module I: Soaps and detergents (20 hours)	<p>1.1. Soaps, detergents and detergent builders-preparation.</p> <p>1.2. Difference between soap and detergents.</p> <p>1.3. Cleansing action of soaps and detergents.</p> <p>1.4. Soaps and detergents as pollutants.</p> <p>1.5. Shampoo and toilet soap preparation</p>	<p>The student will be able to</p> <ul style="list-style-type: none"> • Differentiate soaps and detergents. • Identify the pollution caused by cleaning products.
Module II: Food poisoning (20 hours)	<p>2.1. Food poisoning-food poisoning caused by chemicals, poisonous plants and microorganisms.</p> <p>2.2. Food hygiene in the prevention of food poisoning</p>	<ul style="list-style-type: none"> • Recognize the chemicals causing food poisoning. • Know about the microorganisms and poisonous plants that cause food poisoning.
Module III: Green Chemistry (20 hours)	<p>3.1. Green Chemistry-Principles of Green Chemistry</p> <p>3.2. Design of Green Synthesis, microwave assisted green synthesis, prevention of waste and byproducts.</p> <p>3.3. Atom Economy.</p> <p>3.4. Prevention of chemical accidents.</p> <p>3.5. Diels Alder reaction</p>	<ul style="list-style-type: none"> • Recall the basics of green chemistry • Know about the details of green synthesis. • Recognize the preventive measures for chemical accidents.
Module IV: Water Analysis and Solid wastes management (20 hours)	<p>4.1. Water Analysis-Water quality monitoring-sampling-analysis of water</p> <p>4.2.Physico-chemical and biological parameters of water - Eutrophication.</p> <p>4.3. Water quality standards-WHO, BIS.</p> <p>4.4. Solid wastes management-Solid wastes- Types, disposal methods-sanitary land filling, incineration, recycling, composting-composting methods-indoor and Bangalore method, Windrows method. Vermicomposting</p>	<ul style="list-style-type: none"> • Apply & analyze water quality • Apply & analyze solid waste management.

References	Reference Books: <ol style="list-style-type: none"> 1. V.K. Ahluwalia, Green Chemistry 2. V.K. Ahluwalia and Kidwai, New Trends in Green Chemistry 3. S.P. Misra and S.N. Pandey, 2009, Essential Environmental Studies, Ane Books Kidwai. 4. S.C. Bhatia, Environmental Chemistry, CBS publications 5. A.K. De, Environmental Chemistry. 6. E. Bharucha, Text Book of Environmental Chemistry, Oxford & IBH 7. V.K. Ahluwalia and Sunita Malhotra, Environmental Science, ANE Books Pvt. Ltd
Course Outcomes	CO1: Gain knowledge in principles of green chemistry CO2: Analyze the toxic effect of various pollutants CO3: Identify the biological effects of various chemical compounds CO4: Knowledge about water analysis and waste management

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	✓
CO2	✓	✓	-	✓	✓	-	✓
CO3	✓	✓	-	✓	✓	-	✓
CO4	✓	✓	-	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. Differentiate between soap and detergents.
2. Briefly explain food poisoning and its causative agents.
3. Discuss on green chemistry and its principles.
4. What are the preventive measures of chemical accidents?
5. Describe about water quality standards
6. Elaborate the disposal methods of solid waste.

FIELD VISIT

Course Code & Title	MSEVS01DSC05 - FIELD WORK	
		Course outcome
	<ul style="list-style-type: none"> • Students are required to go for field study in research institutions, wildlife sanctuaries, different ecosystems, polluted areas or ecotourism sites situated within and outside Kerala. • Field visits to terrestrial/aquatic environments-Study of ecological adaptations • Study of vegetation of local area/college campus-Fauna of local area/campus • The students are required to submit a report on field visit. 	The student will be able to CO1: Identify various ecosystem's structure, function and characteristics CO2: Gain knowledge on various legal provisions on environment CO3: Vigilant in issues related to environment CO4: Application of knowledge to the societal level

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	✓
CO2	✓	✓	-	✓	✓	-	✓
CO3	✓	✓	-	✓	✓	-	✓
CO4	✓	✓	-	✓	✓	-	✓

Teaching Learning Strategies	Field work and field visits, industrial training and visits
Mode of Transaction	Onsite visit and demonstration, Interaction with experts

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation (Report)	40

**SECOND SEMESTER
DISTRIBUTION OF COURSES AND CREDITS**

Semester	1	2	3	4	5	6	7	8	Total Credits
	Discipline Specific Courses		Interdisciplinary Elective/ Generic Elective Multidisciplinary Elective /Open Elective	Ability Enhancement AEC	Skill Enhancement Course (SEC)	Value Addition Course/ MOOC Courses (VAC)	Internship/ Field Visit/ Minor Project/ Institutional- Industrial Visit	Dissertation/ Major Projects	
Discipline Specific Core DSC	Discipline Specific Elective DSE								
2	DSC -5(4C) DSC -6(4C) DSC -7(4C) DSC -8(4C)	DSE - 3(3C) OR DSE- 4(3C)	MDC-1(2C) MDC-1(2C)	AEC - 1(2C) AEC - 1(2C)	SEC-1(2C) SEC-1(2C)	VAC-1(2C)	-	-	23 Credits
	16 Credits	3 Credits	2 Credits*	2 Credits	2 Credits	2 Credits**			

*MDC Offered for other departments. **VAC credit is not included here.

SCHEME

SECOND SEMESTER									
Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits	
		L	T/S	P	ESE	CE			
Discipline Specific Core Courses (DSC)									
MSEVS02DSC06	Environmental Engineering	4	1	-	60	40	100	4	
MSEVS02DSC07	Atmospheric Science and Climate Change	4	1	-	60	40	100	4	
MSEVS02DSC08	Environmental Toxicology, occupational health and safety	4	1	-	60	40	100	4	
MSEVS02DSC09	Practical in Environmental Chemistry	-	-	8	60	40	100	4	
Discipline Specific Elective Courses (DSE)									
MSEVS02DSE03 OR MSEVS02DSE04	Hydrology and Water Management Energy & Environment	3	1	-	60	40	100	3	
Multidisciplinary Elective (MDC) (Offered for other departments)									
MSEVS02MDC01 MSEVS02MDC02	Industrial Process Industrial Pollution and Waste Management	2	1	-	60	40	100	2	
Ability Enhancement Course (AEC) (Offered for other departments)									
MSEVS02AEC01 MSEVS02AEC02	Solid Waste Management Water Management	2	1	-	60	40	100	2	
Ability Enhancement Course (AEC) (To be obtained from other departments)									
--		2	1	-	60	40	100	2	
Skill Enhancement Course (SEC) (Offered for other departments)									
MSEVS02SEC01 MSEVS02SEC02	Disaster Risk Reduction and Response Climate Resilience	2	1	-	60	40	100	2	
Skill Enhancement Course (SEC) (To be obtained from other departments)									
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Total		42	420	280	700	23		
Value Added Course (VAC)								
MSEVS02VAC01	Water Quality and Management *	1	1	-	60	40	100	2

SECOND SEMESTER M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME
Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS02DSC06 - ENVIRONMENTAL ENGINEERING
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To study the standard operating procedure for water and wastewater treatment ● To study the design features of water treatment ● To know the biological treatment of wastewater ● To understand the sludge disposal and treatment ● To know about designing features of air pollution control devices

Modules	Content	Module Outcome
Module I: Introduction to Environmental Engineering (15 hours)	<p>1.1 Water Quality Parameters Physical, Chemical and Biological Parameters.</p> <p>1.2 Water Sampling Types, Selection of Sampling Point, Equipment Used, Sample Preservation and Maintenance.</p> <p>1.3 Water Quality Standards Importance of Water Quality Standards, WHO & BIS Standards, Industrial and Drinking Water Sampling.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Gain basic idea about environmental engineering ● Recall the basics of water quality parameters, various sampling methods and water quality standards.
Module II: Water Treatment Process (15 hours)	<p>2.1 Sources and Characteristics of Wastewater Point and nonpoint sources of wastewater - characteristics of industrial effluents</p> <p>2.2 Water Treatment Process Coagulation & Flocculation, Jar Test Softening – Boiling Method, Clark’s Method, Soda Ash Method, Lime Soda Method, Zeolite Method & Ion Exchange Process Filtration - Slow, Rapid and Pressure Filter Disinfection, Chlorination, Ozonation and UV Application.</p>	<ul style="list-style-type: none"> ● Identify the sources and characteristics of wastewater. ● Gain knowledge on the basic water treatment processes.

<p>Module III: Wastewater Treatment (25 hours)</p>	<p>3.1 Municipal Sewage and Industrial Treatment - Basic Treatment Process and Flow Sheet Water Flow Rates and Their Assessment.</p> <p>3.2. Unit Operations & Unit Processes</p> <p>3.3. Pre-Treatment and Primary Treatment - Bar Rocks, Grit Chambers, Comminutors, Equalization and Sedimentation, Design Concept.</p> <p>3.4. Secondary Treatment, Biological Unit Process, Nature and Kinetics of Biological Growth, Aerobic Process, Activated Sludge Process and Its Modification, Oxidation Ponds, Attached Growth System, Trickling Filters, Rotating Biological Conductors, High-Rate Anaerobic Reactor - CSTR, Up flow Anaerobic Filters – UAFS, UASB, Expanded, Fluidized Bed Reactors.</p> <p>3.1. Tertiary/Advanced Treatment System, Filtration, Absorption, Nitrogen and Phosphorous Removal, Biological Nutrient Removal (BNR) Systems.</p> <p>3.2. Sewage Disposal Methods.</p> <p>3.3. Concept of Common Effluent Treatment Plants (CETP)</p> <p>3.4. Wastewater recycling and zero liquid discharge.</p>	<ul style="list-style-type: none"> ● Distinguish & differentiate various methods in municipal sewage and industrial wastewater treatment. ● Differentiate unit operations and unit processes. ● Gain knowledge on various aerobic and anaerobic water treatment methods. ● Identify various sewage disposal methods along with their pros and cons. ● Describe the Common Effluent Treatment Plants (CETP) and zero liquid discharge.
<p>Module IV: Air Quality Standards, Air Pollution Control, and Solid Waste Management (25 hours)</p>	<p>4.1 Air Quality Monitoring Methods of Monitoring Air Pollutants Standards of Air Pollutants - Air Quality Standards. Air Sampling Analysis of NO_x, SO_x, CO and Particulate Matter</p> <p>4.2 Air Pollution Control Control of Particulate Matter - Gravitational Settling Chamber, Centrifugal Collector, Electrostatic, Fabric and Wet Collector, Scrubber. Control of Gaseous Contaminants - Adsorption, Absorption, Combustion, Automobile Emission Control.</p> <p>4.3 Solid Waste Management Municipal Solid Waste: Types, Sources, Characteristic, Waste Collection and Transport, Techniques/Processing of Solid Waste Recovery, Reclamation, Recycle and Reuse of Resources, Disposal</p>	<ul style="list-style-type: none"> ● Know the basics of air quality monitoring methods. ● Gain knowledge on air sampling and air quality standards. ● Know about analysis of various air pollutants. ● Differentiate control measures for particulate pollutants and gaseous pollutants. ● Gain knowledge on basics of

	<p>Methods, Incineration, Pyrolysis, Composting, Vermicomposting, Sanitary Landfills and Anaerobic Digestion.</p> <p>Industrial and Hazardous Waste Management– Listed Hazardous Waste, Hazardous Waste Rules.</p> <p>E-Waste Management</p> <p>Biomedical Waste Management – Classification, Categories of Biomedical Waste (Biomedical Wastes Rule, 1998), Segregation, Treatment Methods</p> <p>Plastic Waste Management – Classification, Reduce, Reuse, Recycle and Recovery, Plastic Waste Management Rules, 2016.</p>	<p>solid waste management.</p> <ul style="list-style-type: none"> ● Know about various disposal methods of solid wastes. ● Recognize the classification of hazardous wastes. ● Know the basic knowledge on legislations related to the management and handling of hazardous wastes.
References	<ol style="list-style-type: none"> 1. H.S. Peavy, D.R. Rwe, G. Tchobanoglous, Environmental Engineering, McGraw-Hill Book Company, New York. 2. Metcalf & Eddy Inc, Waste Water Engineering, Disposal and reuse, 2nd Ed., Tata McGraw-Hill 3. Sawyer & McCarty, Chemistry for Environmental Engineering, McGraw-Hill 4. K. Wark, C.F. Warner, Air Pollution- Its origin and Control, Harper & Row, New York, USA 5. S.A. Abbasi, Environmental Pollution and its control, cogent international, Pondicherry. 6. Fair Geyer & Okum, Water supply & Waste Water Engineering 7. Earnest W. Steel, Water supply & Sewage. 8. S.K. Garg (2007) Sewage Disposal and Air Pollution Engineering, 20th ed, Vol. II, New Delhi, Khanna Publisher. 9. S.K. Garg (2007) Water Supply Engineering, 18th ed., Vol. I, New Delhi, Khanna Publisher. 10. B.K Sharma – Environmental chemistry –Goel publication. 11. Tyagi and Mehra - Environmental Chemistry 12. P.R. Trivedi & Raj Gurdeo - Environmental water and soil Analysis Akashdeep Pub. House, New Delhi. 13. V.K. Ahluwalia, Environmental Chemistry Ahe books, India 14. S.P. Misra and S.N. Pandey – Essential Environmental studies – Ane books Pvt. Ltd. 15. P.L. Soni - Physical Chemistry and Analytical Chemistry 	
Course Outcomes	<p>CO1: To check the adequacy of water treatment process</p> <p>CO2: Able to distinguish aerobic and anaerobic water treatment technology.</p> <p>CO3: Estimate and monitor particulate and gaseous atmospheric pollutants Using control devices.</p> <p>CO4: To organize an appropriate management method for solid wastes.</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	-	✓	✓	-	✓
CO2	✓	-	-	✓	✓	-	✓
CO3	✓	-	-	✓	✓	-	✓
CO4	✓	-	-	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> ● Test papers 	16
<ul style="list-style-type: none"> ● Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> ● Assignment 	8

Sample Questions to test Outcomes

1. Briefly explain water quality parameters.
2. Discuss on the importance of water quality standards.
3. Describe water softening methods used in water treatment.
4. Differentiate between unit operations and unit processes with suitable examples.
5. Write an essay on suspended growth systems in biological waste water treatment.
6. What are the methods for monitoring air pollutants?

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS02DSC07 - ATMOSPHERIC SCIENCE & CLIMATE CHANGE
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To understand the concept of nuclear energy and its interactions ● To explain at a basic level the most important processes of the Earth system ● To understand environmental issues such as global climate change, and natural hazards, and also to make contributions to public debate and decision-making on how to address these issues and hazard ● To describe and explain the processes of Earth's physical systems weather and climate, water, ecosystems, geologic and hydrological processes and landform development.

Modules	Content	Module Outcome
Module I: Fundamentals of Meteorology	<p>1.1. Fundamentals of Meteorology – Thermal structure of the atmosphere and its composition, Radiation Balance and Laws, Wind Belts, Monsoon, Climate.</p> <p>1.2. Atmospheric Thermodynamics – Hydrostatic equilibrium and Hydrostatic equation, variation of pressure with height, geopotential, Tropical convection.</p> <p>1.3. Atmospheric Electricity – Cloud Physics. Observation Techniques of the Atmospheric Properties.</p> <p>1.4. Fundamental Equations – Pressure, gravity, centripetal and Coriolis forces, continuity equation in Cartesian and isobaric coordinates, Scale analysis, inertial flow, geostrophic and gradient winds, thermal wind, vorticity.</p> <p>1.5. Atmospheric Turbulence – baroclinic instability, Atmospheric Waves.</p>	<p>The student will be able to</p> <ul style="list-style-type: none"> ● Know about the fundamentals of meteorology ● Identify the basics of thermodynamics of atmosphere ● Recognize the observation techniques of atmospheric properties. ● Familiarize with fundamental equations related to meteorology. ● Gain knowledge on atmospheric turbulence
Module II: Tropical Meteorology, General Circulation and Climate Modelling	<p>2.1. Tropical Meteorology – Trade wind inversion, ITCZ, monsoon trough tropical cyclones, their structure and development theory, monsoon depressions.</p> <p>2.2. Climate Variability and Forcings – Madden-Julian oscillation (MJO), ENSO, QBO (quasi-biennial oscillation) and sunspot cycles.</p> <p>2.3. Primitive equations of Numerical Weather Prediction.</p>	<ul style="list-style-type: none"> ● Gain knowledge on tropical meteorology. ● Know climate variability and forcings. ● Illustrate primitive equations of numerical weather predictions. ● Recognize general circulations and climate

	<p>2.4. General Circulation and Climate Modelling – Synoptic weather forecasting, prediction of weather elements such as rain, maximum and minimum temperature and fog. Data Assimilation.</p> <p>2.5. Weather & Climate - Definition & scope, classification, Climate of India, oceanic & continent influence (air-sea interaction), El Nino & La Nina effects.</p> <p>2.6. Climate of India - Indian monsoon, (Onset of monsoon), Rain bearing systems, Break in change in the ecosystems.</p>	<p>modelling.</p> <ul style="list-style-type: none"> ● Interpret influence of oceanic and atmospheric circulations in the climate of an area. ● Gain knowledge on climate of India.
<p>Module III: Climate Forcing & Human Induced Climate Variability (15 Hours)</p>	<p>3.1. Natural Climate Forcing - climate change with Indian perspective Intergovernmental panel on climate change, United Nations Framework Convention on Climate Change (UNFCCC).</p> <p>3.2. Human Induced Climate Variability - Changing patterns of land use, Changes in urban climate, El Nino and La Nina effects.</p> <p>3.3. Anthropogenic Sources of greenhouse gasses, Enhanced greenhouse effect - Aerosols and other pollutants.</p> <p>3.4. Greenhouse Gases Emission from Various Sectors - energy, industries, transport, shipping, aviation, built environment, agriculture, domestics and forestry, Waste sector.</p> <p>3.5. Global Radiative Forcing.</p>	<ul style="list-style-type: none"> ● Describe climate change in Indian perspective ● Correlate UNFCCC on climate change ● Differentiate Changing patterns of land use and climate variability ● Distinguish El Nino and La Nina effects ● Determine anthropogenic sources of greenhouse gases and their enhanced effects ● Evaluate emission of greenhouse gases from various sectors ● Recognize the facts about global radiative forcing.
<p>Module IV: Climate Change Impacts & Mitigation Policies (25 Hours)</p>	<p>4.1. Climate change-causes, effects. Regional scenario of climate change.</p> <p>4.2. Climate Change Impacts on agriculture, coastal system, food supply and demand, biodiversity.</p> <p>4.3. Land Degradation - desertification, precipitation, polar ice melting and sea level rise.</p> <p>4.4. Climate Change on Health – overview, food, biological and seasonal cycle, economy. Direct effect - health injuries, thermal stress, infectious, malnutrition, mental stress, drugs.</p> <p>4.5. Climate Change Mitigation Policies - World Summit 1972, Brundtland commission report - sustainable development - Rio conference 1992, Agenda 21, Montreal</p>	<ul style="list-style-type: none"> ● Evaluate causes and effects of climate change ● Justify impacts of climate change on ecosystems ● Enumerate climate change on health ● Interpret mitigation policies on climate change ● Interpret mitigation potential of climatic change ● Demonstrate bio energy options for energy sector ● Interpret facts about international emission

	<p>protocol, Conference of Parties, Kyoto protocol, UNFCCC, IPCC, Paris Agreement,</p> <p>4.6. Mitigation Potentials-Energy sector - Transport sector -Industrial sector-Agricultural sector.</p> <p>4.7. Bio-energy Options - hybrid fuel system, good cultivation habits, tree cover enhancement and policy regulation.</p> <p>4.8. International Emission Trading - carbon credit, carbon budget, green labeling, Coastal regulation zone notification 1991, Carbon Neutrality: Concept and Case studies.</p> <p>4.9. National Action Plan on climate change and state action plan on climate change, International collective action on climate change.</p>	<p>trading</p> <ul style="list-style-type: none"> • Cite action plan on climate change.
<p>References</p>	<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Albert Miller, Jack C Thompson, Richard E Peterson and Donald R Haragan; Elements of Meteorology; Charles E Merrill publishing Co. Columbus. 2. Frederick K Lutgens and Edward J Tarbuck; The atmosphere; prentice Hall publications, New Jersey 3. Lutgens and Tarbuck; The Atmosphere, Prentice Hall publication, New jersey. 4. Climate Change 2007: The Physical Science Basis, Intergovernmental Panel on Climate Change Report (http://www.ipcc.ch) 5. Barry, Roger G.; Atmosphere, weather and climate; Routledge; London, New York; 2003 6. M.H. Syed; Earth atmosphere; Sushi Publications; Gurgaon; 2009 7. K.R. Jayachandran, Atmosphere; Rajat Publications; Delhi; 2013 8. H. Edward, Newell; Beyond the Atmosphere; Dover Publications; Mineola, N.Y; 2010 9. Change in climate, environment and economic development; SSDN Publishers; Delhi; 2012 10. K. Siddhartha; Atmosphere, weather and climate; Klsalaya Publications; Delhi; 2014 11. Bimal, Dhawan; Introduction climatology; Random Publications; Delhi; 2014 12. Manhendra, Pandey; Global warming and climate change; Dominant publishers & distributors; Delhi; 2014 13. Gupta, Rajeev; Global warming and climate change; Sonali Publications; New Delhi; 2012 14. Dubois, Etienne; Introduction to global warming and climate change; Apple academics; Delhi; 2010 15. Cowie, Jonathan; Climate change; Cambridge University Press for IPCC; Cambridge; 2005 	

Course Outcomes	<p>CO1: Compute and interpret Climatogram analysis for weather predictions.</p> <p>CO2: Identify and compute the causes and consequences of greenhouse gas emission</p> <p>CO3: Interpret and model general atmospheric circulations that influences climate of an area.</p> <p>CO4: Interpret and check the potential of mitigation policies on climatic change</p>
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	✓	✓	-	✓
CO2	✓	-	✓	✓	✓	-	✓
CO3	✓	-	✓	✓	✓	-	✓
CO4	✓	-	✓	✓	✓	-	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. Discuss about thermodynamics of atmosphere
2. Differentiate gradient winds and thermal winds
3. Discuss Indian monsoon. 'The summer monsoon has been called India's true finance minister', explain this statement.
4. 'A world with many climates' Explain? What are the factors influencing the climate of a region?
5. Discuss the impacts of climate change on ecosystems

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS02DSC08 - ENVIRONMENTAL TOXICOLOGY, OCCUPATIONAL HEALTH AND SAFETY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To understand the concept of toxicology ● To know various types of toxin and toxicants ● To understand the toxic action of toxicants on the human system ● To assess the risk associated with the exposure to contaminants ● To acquire knowledge on natural and manmade contaminants exposure and its outcomes

Modules	Content	Module Outcome
Module I: Basics of Toxicology (20 hours)	<p>1.1. Definition of toxicology, Branches of toxicology, scope and importance of toxicology, Principles of toxicology</p> <p>1.2. Environmental toxicology</p> <p>1.3. Toxicants and their classification.</p> <p>1.4. Categories of toxic effects. Factors influencing toxicity. Toxic effects due to a combination of chemicals.</p> <p>1.5. Dose effect and dose response relationships.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Identify the basic knowledge of toxicology. ● Evaluate and categorize the level of toxicants, their effects and factors influencing toxicity. ● Apply and identify the potential sources of exposure and severity of harmful effects. ● Identify and manage the risks associated with exposure to toxic substances in our daily lives.
Module II: Toxic Chemicals in the Environment (20 hours)	<p>2.1. Toxic chemicals in the environment Inorganic and organic toxicants - entry into the environment, cycles and residence time.</p> <p>2.2. Xenobiotics Translocation of xenobiotics. Toxicity of pesticides - organochlorine, organophosphates and carbamates - insecticides, heavy metals, radioactive substances, fluorides, chemicals, fertilizers.</p>	<ul style="list-style-type: none"> ● Apply and understand the entry of inorganic and organic toxicants into the environment. ● Remember and attain the mechanisms of toxicity of xenobiotics. ● Identify and mitigate the potential risks, promote the responsible use and disposal of chemicals, and work towards a healthier and more sustainable future.
Module III: Toxicity (20 hours)	<p>3.1. Metabolism of toxic substances by plants and animals.</p> <p>3.2. Mode of action of toxicants - Biotransformation, Bioaccumulation, Bio-concentration & Biomagnification. Toxicity test - In vitro and In vivo toxicity test</p>	<ul style="list-style-type: none"> ● Recall the metabolism of toxic substance by plants and animals ● Evaluate the mechanisms of mode of action of toxicants. ● Apply and examine the role of regulation and policy in managing exposure to toxic substances, and ecosystem influence.

	<p>3.2 Exposure Pathways to Toxicants. LC50, LD50</p> <p>3.3 Pollution by industries - types and characteristics, dispersion and circulation, Mechanism of pollutants, degradable and non-degradable toxic substances.</p> <p>3.5 Heavy Metal Toxicity, Fate and Transport of Heavy metals in the Environment.</p> <p>3.6 Ecosystem influence on the fate and transport of toxicants.</p>	
<p>Module IV: Occupational Health Hazards & Ecological Risk Assessment (20 hours)</p>	<p>4.1. Occupational Health Hazards- physical, chemical, biological and physiological hazards.</p> <p>4.2. Control of toxic materials and protection measures. Toxicity of air, water and soil.</p> <p>4.3. Health and hygiene - epidemiology, epidemiological diseases (air & water) due to pollution problems with special reference to Kerala and India.</p> <p>4.4. Ecological risk assessment.</p> <p>4.5. Sanitary engineering- sewage systems, sewage treatment and disposal, Sanitary regulation.</p>	<ul style="list-style-type: none"> ● Examine the potential health hazards. ● Apply knowledge of health and hygiene, epidemiology, epidemiological diseases based on the air and water pollution. ● Identify the role of environmental regulation and policy in managing occupational health hazards and ecological risks. ● Analyze and apply a wide range of industries and sectors in the context of occupational health hazards and ecological risk assessment.

References	Reference Books: <ol style="list-style-type: none"> 1. Kamleshwar Pandey, Fundamentals of Toxicology, New central book agency, New Delhi, 2005 2. P.D. Sharma, Environmental Biology and Toxicology, 1997-98. 3. P.K. Gupta and agency, New, Modern Toxicology 4. G.C. Butler, Principles of Ecotoxicology 5. Duffus, H. John, Environmental Toxicology 6. J.P. Shukla and Pandey, Elements of Toxicology, Radha publishers, New Delhi. 7. G.M. Rand and S.R. Petrocelli, Fundamental of Aquatic Toxicology, Hemisphere Publishing Corporation, Washington. 8. L.G. Cockerham and B.S. Shane, Basic Environmental Toxicology, CRC Press, Boca Raton, USA. 9. M. Kalia & Sood. Food preservation and processing, Kalyani Pub. Ludhiana, New Delhi. 10. B.C. Hobbs & D. Roberts, Food poisoning and Food Hygiene 6th Edition. Edward Arnold Pub. London, 1993. 11. Kamleshwar Pandey, J.P. Shukla, Trivedi (ed) 2009, Fundamentals of Toxicology, New Central Book Agency (p) Ltd
Course Outcomes	<p>CO1: Illustrate the route of entry and mobilization of toxins and toxicants in human and environmental systems .</p> <p>CO2: Map depositions and responses of toxins in human systems.</p> <p>CO3: Identify the risk of exposure of contaminants.</p> <p>CO4: Execute and judge the role of regulations and policies in managing exposure to toxic substances, and ecosystem influence.</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	-	✓	-	-	✓
CO2	✓	-	-	✓	-	-	✓
CO3	✓	-	-	✓	✓	-	✓
CO4	✓	-	-	✓	✓	-	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits, industrial training and visit</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. What are the principles of toxicology?
2. Explain the importance of environmental toxicology.
3. Illustrate the ingestion type of exposure with suitable examples.
4. Comment on historical perspective of toxicity studies.
5. Briefly explain the importance of metabolism in toxicity.
6. Describe details about the construction of dose response curve with neat diagram.

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS02DSC09 - PRACTICAL IN ENVIRONMENTAL CHEMISTRY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To make the student acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis. ● To acquaint the students with the determination of molecular weight of a polymer by viscometry.

Modules	Content	Course Outcome
Module I: Determination of various Physico-chemical properties of Water 25 hrs.	1.1. Determination of pH 1.2. Determination of conductivity 1.3. Determination of D.O 1.4. Determination of total solids (Gravimetry) 1.5. Determination of total dissolved solids (Gravimetry) 1.6. Determination of total suspended solids (Gravimetry) 1.7. Determination of chlorides 1.8. Estimation of iron (Colorimetry) 1.9. Estimation of Hardness, Calcium and Magnesium 1.10. Chemical oxygen demand 1.11. Biological oxygen demand	CO1: Know the basic principles of the analysis of water, air, soil quality parameters
Module II: Determination of various Physico-chemical properties of Water	2.1. Estimation of fluoride 2.2. Estimation of phosphate 2.3. Estimation of Nitrate & Nitrite 2.4. Estimation of Sodium & Potassium (Flame photometry) 2.5. Estimation of pesticides using TLC / paper chromatography 2.6. Estimation Acidity and Alkalinity.	CO2: Skill for analysis of Physico-chemical parameters of soil
Module III: Determination of various Physico-chemical properties of Soil Analysis	3.1. Determination of soil pH 3.2. Determination of soil moisture content 3.3. Estimation of soil chloride 3.4. Determination of TOC 3.5. Determination of Ca ²⁺ & Mg ²⁺ 3.6. Determination Food Adulterant 3.7. Organic Carbon, Soil Texture	CO3: Assess Physico-chemical parameters of soil
Module IV: Air Quality & Noise Quality Analysis	4.1. Air Quality Analysis (Demonstration only) a) Particulate matter b) NO _x	CO4: Skill in various pollution monitoring techniques

	c) SO _x d) Pollen grains. 4.2. Noise Quality Analysis (Demonstration only)
References	Reference Books: 1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001. 2. B.S. Furniss, A. J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, LBS Singapore 1994. 3. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denny Vogel's, Text Book of Quantitative Analysis Chemical Analysis, ELBS 5 th Edn. Longman, Singapore publishers, Singapore, 1996. 4. I.M. Kolthoff, E.B. Sandell et al. Quantitative chemical analysis, McMillan, Madras 1980.

CO - PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	✓	✓	-	✓
CO2	✓	-	✓	✓	✓	-	✓
CO3	✓	-	✓	✓	✓	-	✓
CO4	✓	-	✓	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching Interactive Instruction: Active co-operative learning, Library work and Group discussion, Hands on training Field visit and National Laboratory visits
Mode of Transaction	Face to face: Lecture method & Demonstration method

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Practical Examination	30
• Lab record	5
• Internal viva	5

Sample Questions to test Outcomes

1. Write down the principle and procedure for determination of phosphate.
2. Estimate calcium and magnesium hardness of the given sample.
3. Write the principle and procedure for the determination of soil TOC.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS02DSE03 - HYDROLOGY AND WATER MANAGEMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To study occurrence movement and distribution of water that is a prime resource for development of a civilization ● To know diverse methods of collecting the hydrological information, which is essential, to understand surface and ground water hydrology ● To know the basic principles and movement of groundwater and surface water and properties of groundwater and surface water flow ● To promote the awareness of the life-long learning and to introduce them professional ethics and codes of professional practice in water management

Modules	Content	Module Outcome
Module I: Hydrology (20 hours)	<p>1.1. Definition & History of hydrology,</p> <p>1.2. Branches of Hydrology – Chemical hydrology, Eco hydrology, Hydrogeology, hydro informatics, hydrometeorology, isotope hydrology, surface hydrology.</p> <p>1.3. Hydrologic Cycle – Different processes of hydrologic cycle – precipitation, Canopy interception, snow melt, remelt, subsurface flow, infiltration, evaporation, transpiration, sublimation, advection, condensation.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Identify the basic knowledge about hydrology ● Analyze the various processes associated with the hydrological cycle.
Module II: Surface and ground water hydrology (25 hours)	<p>2.1. Surface Water Hydrology – rainfall and surface runoff relationship, runoff, runoff characteristics, open channel flow.</p> <p>2.2. Statistical Analysis in Hydrology – Probable maximum precipitation – hydrograph, flow duration curve – Flood frequency analysis and estimation – Water balance.</p> <p>2.3. Ground Water Hydrology – Ground water table, stream – aquifer interactions, base flow recession, porosity and permeability, hydraulic head and fluid potential, Darcy's Law and hydro conductivity, Heterogeneity and anisotropy, storage properties of aquifers, Equations of groundwater flow, well hydraulics, solute transport.</p>	<ul style="list-style-type: none"> ● Identify the features of surface water hydrology ● Gain the knowledge about various aspects of ground water hydrology and the same can be applied for getting job related to hydrology
Module III: Hydrologic measurements	<p>3.1. Quantifying Surface Water Flow – Stage – discharge measurement.</p> <p>3.2. Quantifying Groundwater Flow - Groundwater pressure (Piezometer), groundwater</p>	<ul style="list-style-type: none"> ● Develop skills for the measurements of hydrological parameters

(20 hours)	<p>depth (aquifer test), conductivity, infiltration (infiltrometer), soil moisture (soil moisture meter, gravimetric method, capacitance probe, Time domain reflectometer, Tensiometer). Geophysical investigation – resistivity and seismic method – application of remote sensing.</p> <p>3.3. Quantifying Hydrologic Exchange at The Land-Atmospheric Boundary - Precipitation:</p> <ol style="list-style-type: none"> Precipitation characteristics Cloud properties, rain rate estimation, hail and snow detection (radar) Rain and snowfall (Rain gauge) Humidity (Sling psychrometer, thermo-hydrograph) Evaporation (Evaporation pan) Transpiration 	<ul style="list-style-type: none"> Apply techniques for groundwater study and measurement.
Module IV: Water management practices (15 hours)	<ol style="list-style-type: none"> Watershed management Wetland conservation Rainfall pits and rain water harvesting Contour bunding Drip irrigation Channel irrigation <p>4.7. Agricultural Water Use, Irrigation water management, Precision farming</p>	<ul style="list-style-type: none"> Experience various water management practices
References	<p>Reference Books:</p> <ol style="list-style-type: none"> Madan Mohan Das & Mimi Das Saikia, Hydrology, PHI learning private Limited, New Delhi, 2018 V.T. Chone, Handbook of Applied Hydrology, Mc Grace Hill publication, New Delhi. T.G.K. Charlu, and D.K. Datta, Groundwater Development in India, Rural Electric Corporation, New Delhi, 1982. Jayaram Reddy, A Text Book of Hydrology, Lakshmi publishers, New Delhi. H.M. Raganath, Hydrology, Wiley, 1985 Linsey, Kohei's Panthus; Applied Hydrology, Mc Grace Hills Publication, New Delhi. K. Subramanya, Hydrology for Engineers, Tata Mc Grace Hills Publications, New Delhi, 1984. IS 4986 (2002) Measurement of Rainfall. IS 5973 (1998) Pan Evaporimeter. R.S. Varshney; Engineering Hydrology, New Chand & Bros. Publications Roorkee. D.K. Todd, Green Water Hydrology; John Wiley's & Sons Publications, New York. K.S. Validia, Environmental Geology, Tata Mc Grace Hills Publishing Co. Ltd. New Delhi. Barry and Choslay, Atmosphere, Weather and Climate, The English Language Book Society. 	

	14.
Course Outcomes	<p>CO1: Apply science and engineering fundamentals to solve current problems, mitigate and prevent problems in the area of water management.</p> <p>CO2: Ability to measure, analyzes, interpret hydrological data and forecast their variability.</p> <p>CO3: The application of advanced optimization techniques in the field of water resources.</p> <p>CO4: Develop skills in the water quality management</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	✓	✓	-	✓
CO2	✓	-	✓	✓	✓	-	✓
CO3	✓	-	✓	✓	✓	-	✓
CO4	✓	-	✓	✓	✓	-	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. What are the branches of hydrology?
2. Explain hydrological cycle using suitable diagram.
3. Briefly explain statistical analysis in hydrology.
4. Differentiate drip irrigation and channel irrigation.
5. Elaborate methods of water management practices.
6. What are methods for quantifying rain and snowfall?

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS02DSE04: ENERGY AND ENVIRONMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To know the various sources of energy source and distribution ● Energy, environment and society Nature ● Energy, ecology and the environment ● Politics of energy policy and our energy future ● Environmental implications of energy use

Modules	Content	Module Outcome
Module I: Basics of Energy and Environment (15 hours)	<p>1.1. Energy Demand and Energy resources Defining energy; forms and importance; fossil fuels, advent of nuclear energy, global energy resources; renewable and non-renewable resources</p> <p>1.2. Distribution and availability; future technologies for capturing and integrating these resources into our energy infrastructure;</p> <p>1.3. Energy use scenarios in rural and urban setups; energy conservation. Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sectors; energy subsidies and environmental costs.</p> <p>1.4. Energy Resources: Renewable and Non-Renewable Energy Sources, Alternative Energy Sources, Growing energy needs</p>	The student will be able to: <ul style="list-style-type: none"> ● Demonstrate various forms of energy resources and their importance ● Distinguish global energy resources and enumerate future technologies for capturing and integrating these resources ● Illustrate demand and conservation of energy resources ● Evaluate global energy demand and use in historical and current perspectives ● Differentiate Renewable and Non-Renewable Energy Sources for growing energy needs. ● Determine alternative energy sources energy needs
Module II (25 hours) Renewable energy	<p>2.1. Sun as source of energy: solar radiation and its spectral characteristics.</p> <p>2.2. Fossil fuels: classification, composition, Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net-calorific value.</p> <p>2.3. Hydro-power: Principles of generation of hydro-power</p> <p>2.4. Geothermal Energy & Ocean Energy: Types of wells, methods of harnessing the energy, potential in India. Principles utilization, setting of OTEC plants, thermodynamic cycles.</p>	<ul style="list-style-type: none"> ● Demonstrate sun as source of energy ● Differentiate Composition, Physico-chemical characteristics and energy content of different fossil fuels ● Identify the principles of generation of hydropower ● Assess harnessing and utilization of geothermal and oceanic energy. ● Evaluate potential and

	<p>2.5. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.</p> <p>2.6. Wind power-Expand- Basics of wind energy conversion, Wind turbine technologies and components, Onshore and offshore wind farms, Avian and wildlife interactions</p> <p>2.7. Solar energy (solar collectors, photo-voltaic modules, solar ponds). Principles of solar radiation and applications: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sunshine, solar radiation data. Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion</p> <p>2.8. Nuclear energy - fission and fusion, nuclear fuels, nuclear reactor – principles and types.</p> <p>2.9. Bioenergy: methods to produce energy from biomass.</p>	<p>conservation of tidal and wave energy and their economics.</p> <ul style="list-style-type: none"> ● Analyze the principles of generation and applications of wind, solar and nuclear energy forms
<p>Module III: (15 hours)</p>	<p>3.1. Energy, environment and society Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and, urban heat island effect; nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution, and use.</p>	<ul style="list-style-type: none"> ● Assess scope and analysis of local and global impacts of energy use on environment ● Critique social inequalities related to energy production, distribution, and use.
<p>Module IV: (25 hours)</p>	<p>4.1. Energy, ecology and the environment Energy production as a driver of environmental change; energy production, transformation and utilization associated with environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change.</p> <p>4.2. Environmental implications of energy use; energy use pattern in India and the world, emissions of CO₂ in developed and developing countries including India, Radiative forcing and global warming.</p>	<ul style="list-style-type: none"> ● Diagnose energy production as a driver of environmental changes ● Memorize events that impact the environment during production, transformation and utilization of energy. ● Create an outline on environmental implications of energy use. ● Characterize politics of energy policy and our

	<p>Impacts of large-scale exploitation of solar, wind, hydro and nuclear energy sources.</p> <p>4.3. Politics of energy policy and our energy future</p> <p>Political choices in energy policy globally and in the Indian context; domestic and international energy policy; energy diplomacy and bilateral ties of India with her neighbors. Current and future energy use patterns in the world and in India; alternative sources as green energy (bio fuels, wind energy, solar energy, geothermal energy; ocean energy; nuclear energy); need for energy efficiency; energy conservation and sustainability.</p>	energy future.
References	<ol style="list-style-type: none"> 1. Biomass Energy Systems (1997). Tata Energy Research Institute (TERI), New Delhi 2. T.P. Eastop and D.R. Croft, Energy Efficiency for Engineers and Technologists, Longman and Harrow (2006). 3. W. C. Turner, and S. Doty, Energy Management Hand book, Fairmont Press 7th Edition 2009 4. W. R. Murphy, Energy Management, Elsevier 2007 5. C. B. Smith, Energy Management Principles, Pergamum 2007 6. C. S. Rao Environment pollution control Engineering, New Age International reprint 2015, 2nd edition 7. G.D. Rai, Non-conventional Energy Sources, Khanna Publishers, 2003 8. J. Twidell and T. Weir, Renewable Energy Resources, Taylor& Francis, 2006. 9. B. Joseph, Environmental Studies, Tata McGraw-Hill (2006). 10. K.M. Mittal, Non-conventional Energy Systems-Principles, Progress and Prospects, Wheeler Publications, 1997 11. Looking back to think ahead: Green India 2047. (1998). Tata Energy Research Institute (TERI), New Delhi 12. M. McKinney and R.M. Schoch, 1998. Environmental Sciences: System and Solutions. Johnes and Bartlett publishers, Massachusetts 13. G.T. Miller, Environmental Science- Working with Earth, Thomson (2006). 14. TERI Energy Data Directory & Year Book (TEDDY). (1997). Tata Energy Research Institute (TERI), New Delhi 15. R.T. Wright, Environmental Science-Towards a sustainable Future, Prentice Hall (2008) 	
Course Outcomes	<p>CO1: Analyze and apply various methods of energy storage, energy management & economic analysis.</p> <p>CO2: Analyze the principles of generation and applications of wind, solar and nuclear energy forms</p> <p>CO3:Analyze and interpret energy policy and energy future</p> <p>CO4: Analyze the awareness about the environment and energy.</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	✓
CO2	✓	✓	-	✓	✓	-	✓
CO3	✓	✓	-	✓	✓	-	✓
CO4	✓	✓	-	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> ● Test papers 	16
<ul style="list-style-type: none"> ● Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> ● Assignment 	8

Sample Questions to test Outcomes

1. Identify the various forms of energy resources and explain their importance.
2. Differentiate Renewable and Non-Renewable Energy Sources
3. Discuss the global energy demand and use in historical and current perspectives
4. Differentiate Composition, Physico-chemical characteristics and energy content of different fossil fuels.
5. Discuss local and global impacts of energy use on environment.
6. Discuss the impacts of environment during production, transformation and utilization of energy.

Multidisciplinary Elective (MDC)

Course Code & Title	MSEVS02MDC01 - INDUSTRIAL PROCESS
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To know about the various industrial processes ● To acquire knowledge on raw materials using in various industries. ● To understand the environmental issues associated with the extraction of raw materials.

Modules	Contents	Course Outcome
Module I Agro based industries (15 Hours)	Diary, Sugar, Textiles, Leather, Rubber, Pulp and Paper Mills, Food Processing Industry, and Distillery; different types and nature of raw materials, manufacturing processes of Agro-based industries, significance, and environmental issues.	CO1: Identify and evaluate the manufacturing processes of agro based industries.
Module II Non-Agro based industries 15 Hours	Synthetic fiber and Dyes, Plastics, and Detergent, Fertilizers, Oil refineries and Mineral acids, Cement, Pharmaceutical, and Electroplating (Iron, Steel, Copper, Aluminum, Lead and Zinc industry); manufacturing process, raw materials, and environmental issues.	<p>CO2: Analyze and describe the manufacturing processes of non-agro based industries, their raw material extraction.</p> <p>CO3: Evaluate the environmental issues related to raw material extraction</p> <p>CO4: To understand the issues of industrial process associated with the environment</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	✓	✓
CO2	✓	✓	-	✓	✓	✓	✓
CO3	✓	✓	-	✓	✓	✓	✓
CO4	✓	✓	-	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Write a note on Agro based industries.
2. Briefly explain the manufacturing processes of electroplating industry.
3. What is the nature of raw materials used in agro based industries?
4. Write an essay on the environmental issues due to the extraction of raw materials for non-agro based industries.

Multidisciplinary Elective (MDC)

Course Code & Title	MSEVS02MDC02 - Industrial Pollution and Waste Management
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To acquire knowledge on industrial specific pollutants ● To gain knowledge on industrial waste management ● To know about various control measures followed in industries ● To understand the nature and characteristics of industrial emissions. ● To impart knowledge on sources and characteristics of various industrial wastes and strategies for its prevention and control

Modules	Contents	Module Outcome
Module I Industrial Pollution (12 Hours)	Industrial wastes and their sources: Various industrial processes (Agro and Non-agro based industries). Sources and types of solid, liquid, gaseous wastes, Noise & radiation emissions, characteristics of waste, effects of waste on receiving water system.	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Assess and study to understand wastes originating from various Industries. ● Evaluate the effects of wastes in various Ecosystems.
Module II Control measures (18 Hours)	<p>Industrial waste water treatment Control and removal of specific pollutants in industrial wastewaters, e.g., oil and grease, biodegradable organics, chemicals such as cyanide, fluoride, toxic organics, heavy metals, Radioactivity, etc. Wastewater reuse and recycling.</p> <p>b. Solid waste generation and disposal management c. Control of gaseous emissions d. Hazardous wastes: Generation, control and management e. Noise & radiation: Generation, control and management f. Recent trends in industrial waste management, Case studies of various industries, e.g., dairy, fertilizer, distillery, sugar, paper, iron and steel, thermal power plants, etc.</p>	<ul style="list-style-type: none"> ● Apply and gain knowledge of control measures that can be adopted in various industries to minimize waste generation. ● Analyze the recent trends in industrial waste management

Course Outcomes	<p>CO1: Characterize and differentiate industrial emissions</p> <p>CO2: Evaluate control measures adopted to minimize industrial pollution</p> <p>CO3: Identify recent trends in industrial waste management.</p> <p>CO4: Identify and interpret the industrial waste management techniques</p>
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	✓	✓
CO2	✓	✓	-	✓	✓	✓	✓
CO3	✓	✓	-	✓	✓	✓	✓
CO4	✓	✓	-	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. What are the effects of waste on receiving water system?
2. Write an essay on recent trends in industrial waste management.
3. Write a note on wastewater reuse and recycling.
4. Briefly explain removal of specific pollutants in industrial wastewaters.

Skill Enhancement Course (SEC)

Course Code & Title	MSEVS02SEC01: DISASTER RISK REDUCTION (DRR) AND RESPONSE
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To provide basic conceptual understanding of disasters. • To understand approaches of Disaster Risk Reduction (DRR). • To build skills to respond to disaster. • To understand various tools used in Disaster Management. • To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

Modules	Contents	Module Outcome
Module I Basic Concept of DRR (12 Hours)	<p>1.1. Concepts of Disaster Risk – Disaster, Risk, Hazard, Vulnerability and Capacity. Interaction between Concepts of Disaster Risk.</p> <p>1.2. Disaster Risk Reduction (DRR) – Definition, Concept of DRR,</p> <p>1.3. Disaster Risk Reduction Management (DRRM) – Components: Pre-event (Prevention, Mitigation, Adaptation and Preparedness) and Post-event (Response and Recovery).</p> <p>1.4. Tools of Disaster management – Forecasting and warning systems of disasters, Measurement of responses of disasters, Community reaction to disaster, Emergency Management Information Systems (EIMS)</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> • Understand the basic concept of Disaster Risk Reduction • Identify the components of Disaster Risk Reduction Management.
Module II Disaster Risk Management and Resilience (18 Hours)	<p>2.1. Community Based Disaster Risk Management (CBDRM) - Community Preparedness and Survival Kit.</p> <p>2.2. Resilience - Definition of Resilience, Resilience in Society and the Physical Environment, Capacities for Disaster Mitigation and Reconstruction.</p> <p>2.3. Managing Disasters - Reinstating and Supplying Temporary Services and Shelter; Temporary Housing; Stakeholders for Managing Disasters and Disaster Risk Reduction; Impact of Disasters to Social and Physical Infrastructure Facilities and Restoring Major Social and Physical Infrastructure.</p> <p>2.4. Sendai Framework and Sustainable Development Goals 2030 (SDGs) to the Process of Disaster Management.</p> <p>2.5. Role of research organizations in DRR.</p>	<ul style="list-style-type: none"> • Understand the basic idea of CBDRM. • Recognize the role of research in disaster management.

Course Outcomes	CO1: Identify the approaches of Disaster Risk Reduction (DRR). CO2: Skill development in disaster management tools CO3: Identify the role of research organizations in DRR. CO4: Familiarize the idea of Community Based Disaster Risk Management.
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> ● Test papers 	16
<ul style="list-style-type: none"> ● Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> ● Assignment 	8

Sample Questions to test Outcomes

1. Write a note on Disaster Risk Reduction (DRR).
2. What are the tools of disaster management?
3. Write a note on Community Based Disaster Risk Management.
4. What is the Role of research organizations in DRR?

Skill Enhancement Course (SEC)

Course Code & Title	MSEVS02SEC02: CLIMATE RESILIENCE
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To understand the concept of climate change and climate resilience. ● To explain the impacts of climate change. ● To understand human induced climate variability and climate change adaptations. ● To describe and explain the holistic approach to climate resilience.

Modules	Contents	Course Outcome
Module I Introduction (10 Hours)	<p>1.1. Global Warming and Climate Change – Definition, Basics of Climate Change – Causes and Effects, Carbon Emission and Carbon Reservoirs.</p> <p>1.2. Impacts of Climate Change – Short Term and Long-Term Impacts.</p> <p>1.3. Climate Forcing – Natural and Anthropogenic Forcing.</p> <p>1.4. Human Induced Climate Variability - Changing Patterns of Land Use, Changes in Urban Climate, El Nino and La Nina Effects.</p>	<p>CO1:Evaluate causes and effects of climate change</p> <p>CO2:Enumerate human induced climate variability.</p>
Module II Climate Risk and Adaptation (20 Hours)	<p>2.1. Climate Change Adaptation – Drivers of Vulnerability, Response Capacity Building, Adaptation and Sustainable Development, Mitigation.</p> <p>2.2. Climate Change Mitigation Policies – World Summit 1972, Brundtland Commission Report - Sustainable Development - Rio Conference 1992, Agenda 21, Montreal Protocol, Conference of Parties, Kyoto Protocol.</p> <p>2.3. International Emission Trading – Carbon Credit, Carbon Budget and Green Labeling</p> <p>2.3. Climate Risk – Climate Risk Management (CRM).</p> <p>2.4. Resilience Capacity – Absorptive capacity, Adaptive Capacity and Transformative Capacity.</p> <p>2.5. Holistic Approach to Climate resilience – Importance of Holistic Approach, challenges to a multi-sectoral approach.</p>	<p>CO3:Understand and apply the climate change adaptations and mitigation policies</p> <p>CO4: Evaluate the holistic approach of climate resilience.</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> ● Test papers 	16
<ul style="list-style-type: none"> ● Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> ● Assignment 	8

Sample Questions to test Outcomes

1. Briefly explain about the impacts of climate change.
2. What is global warming?
3. Write an essay on holistic approach of climate resilience.
4. Explain about climate change mitigation policies.

Ability Enhancement Course (AEC)

Course Code & Title	MSEVS02AEC01: SOLID WASTE MANAGEMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To understand the concept of solid waste management. ● To explain the disposal methods of solid wastes. ● To understand the concept of industrial and hazardous waste management. ● To describe and explain the legislations for the management of hazardous wastes.

Modules	Contents	Course Outcome
Module I Municipal Solid Waste (12 Hours)	1.1. Types, Sources and Characteristics. 1.2. Waste Collection and Transport. 1.3. Techniques/Processing of Solid Waste Recovery and Reclamation. 1.4. Recycle and Reuse of Resources 1.5. Disposal Methods - Incineration, Pyrolysis, Composting, Vermi-composting, Sanitary Landfills and Anaerobic Digestion.	CO1: Gain knowledge on basics of solid waste management.
Module II Hazardous Waste (18 Hours)	2.1. Industrial and Hazardous Waste Management – Listed Hazardous Waste, Hazardous Waste Rules. 2.2. E-Waste Management – Classification and categories of E-waste, E-waste (Management And Handling) Rules, 2011, E-waste Recycling Process. 2.3. Biomedical Waste Management – Classification, Categories of Biomedical Waste (Biomedical Wastes Rule, 1998), Segregation, Treatment Methods. 2.4. Plastic Waste Management – Classification, Reduce, Reuse, Recycle and Recovery, Plastic Waste Management Rules, 2016.	CO2: Recognize the classification of hazardous wastes. CO3: Know the basic knowledge on legislations related to the management and handling of hazardous wastes. CO4: Organize an appropriate management method for solid wastes.

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	✓
CO2	✓	✓	-	✓	✓	-	✓
CO3	✓	✓	-	✓	✓	-	✓
CO4	✓	✓	-	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. What are the disposal methods for solid wastes?
2. What are listed hazardous wastes?
3. Differentiate incineration and Pyrolysis.
4. Briefly explain about E-waste management.

Ability Enhancement Course (AEC)

Course Code & Title	MSEVS02AEC02: WATER MANAGEMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● Introduce the concepts of water quality management and monitoring ● To understand the physical, chemical and biological characteristics of water and their significance ● To appreciate the importance of water quality monitoring and development of monitoring strategy ● Recognize the role of water quality guidelines and legislation in water quality management

Modules	Contents	Course Outcome
Module I Introduction (15 Hours)	1.1. Water Quality - Definition, Monitoring – Importance. 1.2. Water Quality Sampling – Selection of sampling stations, Sampling frequency, Representative sampling, Types of samples and preservation of samples, Transportation and storage of samples, Safety during field work. 1.3. Physical, Chemical and Biological Parameters of Water. 1.4. Water Quality Standards - BIS, WHO & USEPA	CO1: Identify the water quality characteristics & water quality networks CO2: Evaluate and estimate the water quality sampling program.
Module II Water Pollution (15 Hours)	2.1. Point and Nonpoint Sources of Pollution 2.2. Types of Pollutants – Municipal Wastewater Discharge, Agriculture Related Water Impurities and Industrial Related Water Impurities. 2.3. Standards and Criteria for Drinking Water/Irrigation Water/Water in Industry. 2.4. Impact of Water Pollutants on Environment - Self-Purification of Waste in Streams, Zones of Purification, Eutrophication, Disposal Standards, Impairment of Natural Water Bodies.	CO3: Identify the pollutants and contaminants of water. CO4: Apply the knowledge on the impact of water pollutants on the environment.

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	✓	✓
CO2	✓	✓	-	✓	✓	✓	✓
CO3	✓	✓	-	✓	✓	✓	✓
CO4	✓	✓	-	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. Write an essay on water quality characteristics.
2. Differentiate types of water pollutants.
3. Differentiate point and non-point sources of water pollution.
4. Elaborate water quality sampling.

Value Added Course (VAC)

Course Code & Title	MSEVS02VAC01 -WATER QUALITY AND MANAGEMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● Introduce the concepts of water quality management and monitoring ● To understand the physical, chemical and biological characteristics of water and their significance ● To learn ways to improve water quality through treatment and management of chemically and biologically polluted waters. ● To appreciate the importance of water quality monitoring and development of monitoring strategy ● Recognize the role of water quality guidelines and legislation in water quality management ● Provide a practical understanding of the significance of water quality management to society and the role of water practitioners in the management process

Modules	Contents	Module Outcome
Module I Introduction (20 Hours)	<p>1.1. Water quality and health linkage - impurities (pollutants and contaminants) in water, their significance and estimation techniques; water borne diseases; standards of potable water.</p> <p>1.2. Impact of water pollutants on environment - self-purification of waste in streams; zones of purification; eutrophication; disposal standards, Impairment of natural water bodies</p> <p>1.3. Water Quality Characteristics - Physical, chemical and biological water quality parameters.</p> <p>1.4. Contaminants of Emerging Concern, Antibiotic Resistance</p>	<p>The student will be able to</p> <ul style="list-style-type: none"> ● Identify the pollutants and contaminants of water technique and water borne diseases ● Apply the knowledge on the impact of water pollutants on the environment. ● Evaluate the water quality characteristics studies.
Module II Significance of the Characteristics of Water (20 Hours)	<p>2.1. Water quality in rivers</p> <p>2.2. Water quality in lakes and reservoirs</p> <p>2.3. Water quality in groundwater aquifers</p> <p>2.4. Water quality in aquaculture.</p>	<ul style="list-style-type: none"> ● Evaluate and estimate the water quality in rivers, lakes and reservoirs, groundwater aquifers and aquaculture.
Module III Movement of Contaminants in the	<p>3.5. Point and Nonpoint Sources of Pollution</p> <p>3.6. Types of pollutants</p> <p>a) Municipal wastewater discharge</p> <p>b) Agriculture related water impurities</p> <p>c) Industrial related water impurities.</p>	<ul style="list-style-type: none"> ● Gain knowledge on point and nonpoint sources of pollution. ● Apply and assess the types of pollutants.

Environment (20 Hours)	<p>3.7. Standards and criteria for drinking water/irrigation water/water in industry.</p> <p>3.8. Institutional and legal framework regarding Water Quality Pollution control in India.</p>	<ul style="list-style-type: none"> • Check the drinking water, irrigation water, industry water in standards level and water quality pollution control in India.
Module IV Introduction to Water Quality Monitoring Techniques (20 hours)	<p>4.1. Design of water quality monitoring networks</p> <p>4.2. Water quality sampling program: Selection of sampling stations: Sampling frequency, Representative sampling, Types of samples and preservation of samples, Field quality assurance requirements, Transportation and storage of samples, Safety during field work.</p> <p>4.3. Modeling of water quality in natural systems.</p>	<ul style="list-style-type: none"> • Identify the water quality networks • Evaluate and estimate the water quality sampling program. • Apply and make the modeling of water quality in natural system
References	<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Isobel W. Heathcote, (1998). Integrated watershed management: Principle and practice. John Wiley & Sons, Inc. Steven C. Chapra (2008). 2. Surface water quality modeling. Waveland Pr Inc. ISBN-13:978-1577666059. 3. J. Bartram and R. Balance (1996). Water Quality Monitoring: A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. E & FN Spon on behalf of UNESCO, WHO & UNEP. ISBN 0-419-22320-7. 4. APHA/AWWA/WEF (1999). Standard methods for the examination of water and wastewater, 20th Edition. American Public Health Association, American Water Works Association and Water Environment Federation (APHA/AWWA/WEF) Publication. Washington D.C, USA. ISBN-13:978- 0875532356. 5. Gilbert M. Masters and Wendell P. Ela (2017) Introduction to Environment Engineering and Science. 3rd ed. Pearson, 6. S.K. Garg (2007) Sewage Disposal and Air Pollution Engineering, 20th ed, Vol. II, New Delhi, Khanna Publisher. 7. S.K. Garg (2007) Water Supply Engineering, 18th ed., Vol. I, New Delhi, Khanna Publisher. 8. A. G. Howard (2002). Water quality surveillance: A practical guide. WEDC, Loughborough. ISBN 184380 0039. 9. ARGOSS (2001). Guidelines for Assessing the Risk to Groundwater from On-site Sanitation. British Geological Survey Commissioned Report, CR/01/142. National Environmental Research Council, London. 10. Summerfelt, C. Robert (n.d). Water quality considerations for aquaculture. Aquaculture Network Information Centre (http://aquanics.org). 11. Joan Rose: Water is Life but Water Quality is Health http://www.iwa-network.org/news/water-islife-but-water-quality-is-health/ 12. Victor Mallet (2018) River of Life and River of Death 	

Course Outcomes	<p>CO1: Identify the key concepts of water quality, water quality and health, impairment of natural water bodies..</p> <p>CO2: Comprehend components of wastewater treatment and schemes based on input water quality and desired water quality.</p> <p>CO3: Determine the integrated perspective on water resource and water quality management</p> <p>CO4: Skill in water quality parameter analysis</p>
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	✓	✓
CO2	✓	✓	-	✓	✓	✓	✓
CO3	✓	✓	-	✓	✓	✓	✓
CO4	✓	✓	-	✓	✓	✓	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. What is the relation between water quality and health?
2. Write an essay on water quality characteristics.
3. Differentiate types of water pollutants.
4. Discuss on the legal framework regarding water pollution control in India.
5. Differentiate point and non-point sources of water pollution.
6. Elaborate water quality sampling.

THIRD SEMESTER
DISTRIBUTION OF COURSES AND CREDITS

Semester	Discipline Specific Courses		Interdisciplinary Elective/ Generic Elective Multidisciplinary Elective /Open Elective	Ability Enhancement AEC	Skill Enhancement Course (SEC)	Value Addition Course/ MOOC Courses (VAC)	Internship/ Field Visit/Minor Project/Institutional- Industrial Visit	Dissertation/Major Projects	Total Credits
	1 Discipline Specific Core DSC	2 Discipline Specific Elective DSE							
3	DSC -9(3C) DSC -10(3C) DSC- 11(4C)	DSE - 5(3C) OR DSE- 6(3C) DSE - 7(3C) OR DSE- 8(3C)	MDC-3(2C)** OR MDC-4(2C)** MDC-5 -1 (4C)**	-	-	-	-	-	20 Credits
	10 Credits	6 Credits	4 Credits [#]						

**MDC Offered for other departments. #Students should earn 4 credits from other departments.

THIRD SEMESTER

Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits
		L	T/S	P	ESE	CE		
Discipline Specific Core Courses (DSC)								
MSEVS03DSC10	Environmental Management	3	1	-	60	40	100	3
MSEVS03DSC11	Research Methodology and Statistics	3	1	-	60	40	100	3
MSEVS03DSC12	Practical in Environmental Geology	-	-	8	60	40	100	4
Discipline Specific Elective Courses (DSE)								
MSEVS03DSE05 Or MSEVS03DSE06	Natural Resource Management and their Conservation Application of Remote sensing and GIS	3	1	-	60	40	100	3
MSEVS03DSE07 Or MSEVS03DSE08	Environmental Microbiology and Biotechnology Nano Technology and Environmental Applications	3	1	-	60	40	100	3
Multidisciplinary Elective (MDC) (Offered for other departments)								
MSEVS03MDC03 MSEVS03MDC04	Wetlands Mangroves	2	1	-	60	40	100	2
MSEVS03MDC05	Fundamentals of Environmental Science	4	1	-	60	40	100	4
Multidisciplinary Elective (MDC) (To be obtained from other departments)								
---		4	1	-	60	40	100	4
	Total	37			360	240	600	20

THIRD SEMESTER M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS03DSC10 - ENVIRONMENTAL MANAGEMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • o understand the need for EIA • acquire knowledge on various components of environmental impact assessment • explore various environmental assessment methodologies • comprehend the impact of any developmental activities and its mitigation measures • study about disaster management and policy

Modules	Content	Module Outcome
Module I: EIA Process (25 hours)	<p>1.1. Introduction: Definition, aim, principles and concept, scope. Origin and development of EIA. Relationship of EIA to sustainable development EIA in project planning and implementation.</p> <p>1.2. Methods and steps a) Ad Hoc Method, b) Overlay Method, c) Checklist Method, d) Network Method e) Matrix Method f) Ecosystem Modeling</p> <p>1.3. Methods for preparing EIA a) Socio-economic aspects, b) Making inventories, c) Sampling and data process d) Baseline study</p> <p>1.4. Impact prediction a) Positive and negative impact, b) Primary and secondary impact, c) Impact on Physical Social and biotic environment</p> <p>1.5. Evaluation of proposed action a) Risk assessment and risk management, b) Mitigation Measures, c) Comparison of alternatives, EIS and EMP, d) Review and decision-making e) Practices and guidelines in India</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> • Evaluate and implement the EIA method and steps • Evaluate the significance of Potential environmental impacts, and methods for preparing EIA. • Identify the impact prediction and evaluation of proposed action of environmental risk assessment and management • Apply and ensure potential environmental impacts, and decision-making process and inclusive of all relevant stakeholders.

<p>Module II: EIA for Different Environmental Programmes (15 hours)</p>	<p>2.1. EIA for Different Environmental Programmes. i) Industries, ii) Urban development iii) land use iv) Energy projects a) Hydel, b) Thermal, c) Nuclear, d) Oil gas e) solar f) wind v) Resource management a) Agriculture, b) Irrigation c) Water, d) Biodiversity, e) Coastal Zone vi) EIA case studies</p>	<ul style="list-style-type: none"> • Identify different environmental impacts from the environmental programme. • Evaluate the significance of potential environmental impacts and conduct various environmental programmes • Attaining the potential mitigation measures and implement to reduce • Ensure that potential environmental impacts are identified, evaluated, and addressed, and that the decision-making process is transparent and inclusive of all relevant stakeholders.
<p>Module III: Environmental Planning and Management (20 hours)</p>	<p>3.1. Principles of EPM - concepts and scope of environmental Planning, Ecological aspects of EPM, Steps in Environmental Planning, Identification and formulation of strategies of EPM 3.2. Environmental Analysis and EPM - Physical planning in relation to environment and land use classification 3.3.EPM for a) Town and urban lands, b) Rural and agriculture land c) Wastelands d) Lands reclaimed e) Wetlands f) Mining areas g) Industrial areas h) Transportation and urban planning</p>	<ul style="list-style-type: none"> • Identify the key environmental issues facing our planet, such as climate change, pollution, biodiversity loss, and resource depletion. • Assess the different approaches to planning and managing environmental resources, including policy development, stakeholder engagement, and risk assessment. • Recall the environmental laws and regulations at the local, national, and international levels • Develop sustainable solutions to environmental problems, taking into account social, economic, and environmental factors.

<p>Module IV: EPM for Environmental Hazards & Environmental Auditing (20 hours)</p>	<p>4.1. EPM for Environmental Hazards i) Types of Environmental Hazards - Flood, draught, landslides, earthquakes, cyclones etc. ii) Significance and characteristics of hazards in Environmental Planning and development iii) Opportunity and regional planning for hazard management 4.2. Environmental Auditing i) Cost benefit Analysis ii) Scope and types of Environmental audit iii) Audit Process – Pre, post audit process iv) International organization for standardization (ISO) v) ISO standards and certification</p>	<ul style="list-style-type: none"> • Conduct a risk assessment to identify potential hazards and evaluate the risks associated with them. • Develop strategies to mitigate the risks and reduce the impact of environmental hazards • Develop emergency response plans that outline procedures for responding to environmental hazards, such as evacuation plans, emergency communication protocols, and disaster relief strategies. • Identify potential environmental impacts of development projects and identify mitigation measures to minimize those impacts. • Gain knowledge to environmental auditing scope and its types
<p>References</p>	<ol style="list-style-type: none"> 1. World commission on Environment and Development; “Our common future”. Oxford University Press publications. 2. Leela Krishnan, Law and Environment. 3. M.S. Adiseshiah, (1987) Economics of Environment. 4. P.A. Victor, (1972) The Economics of Pollution, Mathau, London Publication. 5. Rogene A. Buchholz (1993) Principles of Environmental management, Prentice Hall publications. 6. Indian Institute of Ecology and Environment, New Delhi. <ol style="list-style-type: none"> a. Occasional monographs – 11,22,41,42,51,70,77,87 b. Environment International – 42,51,71,72,75,76,84,85,86. 7. Roscheraz, Environment law and policy in India. 8. Lohithakshan (2002), ParisthithiNiyamangal, Kerala State Institute of Languages (Malayalam). 	
<p>Course Outcomes</p>	<p>CO1: Realize the role EIA in decision making CO2: Identify various impacts of any proposed projects CO3: Analyze the procedures for environmental clearance CO4: To conduct an environmental audit and interpret its outcome</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, Demonstration, E- learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Tutorials Presentation by individual student/ Group representative. Field visits and institutional visit
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Explain the various steps in preparing of EIA report.
2. List out different EIA methods and explain Ad hoc methods in detail.
3. Explain the different characteristics that the impact evaluation methods.
4. What is EMP? What are measures employed for mitigation of adverse environment?
5. Comment on the EPM for wastelands. How it is relevant to the modern India?
6. Briefly explain about the socio-economic aspects of EIA.

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS03DSC11 – RESEARCH METHODOLOGY AND STATISTICS
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • discuss and verify the different types of sampling design • classify and explain the various methods of central tendency and dispersion in research • summarize the advantages and disadvantages of use of computer modeling in research • impart knowledge to develop data analytics skills and meaningful interpretation to the data sets so as to solve the research problem. • design and encompass all the relevant research basics such as data acquisition, literature review, and statistical analysis.

Modules	Content	Module Outcome
Module I Fundamentals of Statistics (15 hours)	<p>1.1. Fundamentals of Statistics (Basic concept) – Collection of Data- Classification and Tabulation- Diagrammatic Representation; Line diagrams, Bar diagrams, Histograms, Pie diagrams, Pictographs</p> <p>1.2. Attributes and Variables; Types of variables</p> <p>1.3. Scales of Measurements; Ordinal, Nominal, interval, ratio</p> <p>1.4. Standard Error</p> <p>1.5. Moments</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> • Identify and describe basic statistical concepts and terminology, • Apply the knowledge on basics of statistics concept, collection and classification of data and diagrammatic representation • Identify the attributes and variables types • Apply the scale of measurements and be aware of standard errors and moments.
Module II Statistical Measures (20 hours)	<p>2.1. Statistical Measures Measures of Central Tendency: Arithmetic Mean, Median, Mode, Geometric Mean, and Harmonic Mean</p> <p>Measures of Dispersion: Range, Mean Deviation, Quartile Deviation, Variance and Standard Deviation</p> <p>Measures of Asymmetry: Skewness and Kurtosis</p> <p>Measures of Relationship: Correlation and Regression</p> <p>Parametric Tests; z- test, t- test, Chi square test, F- test</p>	<ul style="list-style-type: none"> • Evaluate and help to calculate and interpret measures of central tendency, such as mean, median, and mode. • Construct and interpret graphical representations of data, such as histograms, box plots, and scatter plots. • Gain the knowledge about measures of dispersion, asymmetry such as skewness

	<p>2.2. Probability - Probability distributions, Monte Carlo Analysis</p> <p>2.3. Sampling</p> <p>2.4. Distributions - Normal, Log-normal, Binomial, Poisson, t, Chi square and F-Distribution Moments</p> <p>2.5. Analysis of variance - One way ANOVA, Two-way ANOVA.</p> <p>2.6. Significance and Confidence limits</p>	<p>and kurtosis, and measures of relationship and parametric tests.</p> <ul style="list-style-type: none"> Gain knowledge probability distributions, Monte Carlo Analysis & the analysis of variance, significance and confidence limits.
<p>Module III Environmental Modeling (20 hours)</p>	<p>3.1 Approaches to development of environmental models: Linear, Simple and Multiple Regression Models, Validation and forecasting.</p> <p>3.2. Types of Environmental Models; Fate and transport models, emissions and activities models, exposure models, and impact models. Point Source Stream Pollution Model, Air Quality Model, Thermal Plume and Dispersion models.</p> <p>3.2. Models of Population growth and Interactions: Lotka- Volterra models, Leslie's matrix Model.</p> <p>3.3. Applications of Computer in Environmental Science and Management; Data Analysis using packages (SPSS), R programming Editing, Data Tabulation, Descriptive statistics – Correlation – Regression – Factor analysis – Cluster analysis – PCA, Graph Plotting.</p>	<ul style="list-style-type: none"> Gain knowledge on approaches of regression models, validation and forecasting. Apply and understand the environmental models Evaluate the models of population growth and interactions. Analyze and understand the applications of computers in environmental science and management. Apply & use the statistical software, such as R and SPSS, to perform data analysis and visualization. Analyze and implement the descriptive statistics like correlation and regression, factor and cluster analysis, PCA.
<p>Module IV Research Methodology (25 hours)</p>	<p>4.1. Research Aptitude Research: Meaning, Types, and Characteristics Positivism and Post positivistic Approach to Research</p> <p>4.2. Methods of Research: Experimental, Descriptive, Historical, Qualitative and Quantitative Methods; Steps of Research.</p> <p>4.3. Research Ethics Publication ethics: definition, introduction and importance Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Publication misconduct: definition, concept,</p>	<ul style="list-style-type: none"> Recall the knowledge on research aptitude, types, characteristics. Identify the methods of research and steps of research. Evaluate and understand the research ethics. Analyze and attain the knowledge based on conflicts of interest, violation of publication

	<p>problems that lead to unethical behavior and vice versa, types</p> <p>Violation of publication ethics, authorship and contributor ship</p> <p>Identification of publication misconduct, complaints and appeals</p> <p>Predatory publishers and journals</p> <p>4.4. Application of ICT in Research: Data Analysis tools, presentation software, database management packages (DBMS), Tools through internet, Modern research tools</p>	<p>ethics and identification complaints and appeals.</p> <ul style="list-style-type: none"> • Apply ICT in research and modern research tools.
References	<p>Reference Books:</p> <ol style="list-style-type: none"> 1. R.R. Vittal, Business Mathematics and Statistics, (1986) Margham Publications. 2. S.P. Gupta, Statistical Methods, (1996) Sultan Chand & Sons Publications, New Delhi. 3. R. Haynes, Environmental Science Methods, (1982) Chapman & Hall, London. 4. I.A. Khan and A. Kanum, Fundamentals of Biostatistics, (1994) Ukaaz Publication, Hyderabad. 5. C.R. Kothari, Quantitative Techniques, (1996) Vikas Publishing Housing Pvt Ltd, Hyderabad. 6. J. Miller, Statistics for Advanced Level, (1989) Cambridge University Press. 7. G.W. Snedcor and W.G. Cochran Statistical Methods, (1982) Academic Press. 8. G.I. Bliss, Statistics in Biology, (1970). McGraw Hill Book Company, Vol. I and II. New Delhi. 9. A.C. Wardlaw, Practical Statistics for Experimental Biologists, (1985), Wiley Chichester. 10. B.A.V. Sharma, D. Ravindra Prasad, and P. Satyanarayana, Research Methods in Social Sciences, (1989), Sterling Publishers Pvt. Ltd. 11. C.R. Kothari, Research Methodology – Methods and Techniques, (1989), Wiley Eastern, New Delhi. 12. V. Venkatasubramanian, Introduction to Research Methodology in Agricultural and Biological Sciences, (1999), New Century Book House (P) Ltd., Chennai. 	
Course Outcomes	<p>CO1: Develop the ability to apply the methods while working on a research project</p> <p>CO2: Able to design and develop hypothesis for a research project</p> <p>CO3: Able to interpret graphical representations of data, such as histograms, box plots, and scatter plots.</p> <p>CO4: Implement various ICT techniques in research.</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	-	✓	-	✓
CO2	✓	-	✓	-	✓	-	✓
CO3	✓	-	✓	-	✓	-	✓
CO4	✓	-	✓	-	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Define Biostatistics.
2. Explain methods of collecting primary data with examples.
3. Briefly discuss continuous and discrete data
4. Briefly illustrate types of graphical representation of data.
5. Explain in detail the note on Poisson distribution conditions with examples.

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS03DSC12 - PRACTICAL IN ENVIRONMENTAL GEOLOGY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To develop analytical skill in the respective areas ● To study the basic principles of Remote sensing and GIS and to apply for practical studies ● Understand the Geological features by practical methods ● To conduct digital image processing ● Apply GIS and Remote sensing techniques for Environmental analysis

Modules	Content	Module Outcome
Module 1	<p>1.1. Determination of mechanical properties of soil – Soil texture, Moisture, bulk density, porosity, permeability, infiltration, liquid limit, plastic limit and plasticity index</p> <p>1.2. Texture analysis of soil – Sieve method and settling analysis</p> <p>1.3. Rock identification (Hand specimen only) – Texture and structure – Granite, Gneiss, Schist, Slate, Marble, Sand Stone, Grit, Conglomerate, limestone, Kankar Limestone, Shale, Orthoquartzite and laterite.</p>	<ul style="list-style-type: none"> ● Evaluate and learn the determination of mechanical properties of soil. ● Identify & analyze the texture analysis of soil and rock identification ● Evaluate and apply the knowledge of texture soil and their different types of rock identification
Module 2	<p>2.1. Study of water bearing characteristics of the above rocks.</p> <p>2.2. Sedimentology - Exercise - Size classification of sediments, sediment and rock fragments.</p> <p>2.3. Study of minerals - Hand Specimens</p> <p>2.4. Structural geology - Interpretations of topographical and geological maps.</p>	<ul style="list-style-type: none"> ● Analyze the water bearing characteristics of the rocks. ● Evaluate the characteristics of the sediments and rock fragments ● Attain the interpretations of topographical and geological maps
Module 3	<p>3.1. Introduction to GIS software-Familiarization of GIS software (ArcGIS/ QGIS)</p> <p>3.2. Geo-referencing, Shape file creation, Digitization techniques, Spatial Analysis, DEM, Slope, Aspects, Geo-processing, raster interpolation.</p> <p>3.3. Delineation of Watershed - Generation of drainage density and drainage frequency maps.</p> <p>3.4. Topology checker - layout preparation, Introduction to Google earth Interface.</p>	<ul style="list-style-type: none"> ● Analyze and apply the GIS software and their exercises ● Analyze and learn the Georeferencing, digitization techniques, spatial analysis and raster interpretation. ● Attain the watershed delineation and drainage frequency maps

		<ul style="list-style-type: none"> Apply the knowledge of the topology checker, and geological maps Google earth Interface.
Module 4	<p>4.1. Climatogram Analysis – Measurement of Rainfall and Graphical representation of rainfall data – Estimation of relative humidity using dry and wet bulb thermometer - Estimation of Sunshine duration and intensity – Atmospheric Temperature - Wind Velocity and Direction</p> <p>4.2. Hydro-geological Analysis – Measurement of Evaporation – Infiltration – Velocity of Water Current</p> <p>4.3. Wind Rose Analysis – Interpretation of results</p>	<ul style="list-style-type: none"> Attain the Climatogram analysis Identify the knowledge of sunshine duration and intensity and wind direction and velocity Analyze the hydro-geological analysis. Gain the knowledge on wind rose analysis
References:	<ol style="list-style-type: none"> 1. Debashis Chakraborty, Rabi N. Sahoo (2007). Fundamentals of Geographic Information System-Viva Books, New Delhi. 2. Miroslav Radojevic, Vladimir Bashkin (1999). Practical Environmental Analysis, The Royal society of chemistry, Cambridge, UK. 3. W. D. Nesse, (2012). Introduction to mineralogy (No. 549 NES). 4. Perkins, Dexter, Mineralogy, In the Beginning 17.17 (1998): 38. Prentice Hall, p484. 5. M. L. Thomas, W. K. Ralph & W. C. Jonathan, (2000). Remote sensing and image interpretation. John Wiley and sons, New York. 6. William Lowrie, Andreas Fichtner (2020). Fundamentals of Geophysics, 3rd Edition, Cambridge University Press, UK. 	
Course Outcome	<p>CO1: The students will study the basic principles of Remote sensing and GIS and to apply for practical studies in Environmental analysis.</p> <p>CO2: The students can understand the Geological features by practical methods</p> <p>CO3: Able to conduct digital image processing</p> <p>CO4: Develop skill to Apply GIS and Remote sensing techniques to solve the Environmental issues</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	-	✓	✓	✓
CO2	✓	-	✓	-	✓	✓	✓
CO3	✓	-	✓	-	✓	✓	✓
CO4	✓	-	✓	-	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching Interactive Instruction: Active co-operative learning, Library work and Group discussion, Hands on training Field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Practical test	30
• Lab record	5
• Internal viva	5

Sample Questions to test Outcomes

1. Find out the texture of the given soil using trilinear diagram.
2. Georeference the given map and mark important watersheds.
3. Write down the procedure for the estimation of relative humidity.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS03DSE05 - NATURAL RESOURCE MANAGEMENT AND THEIR CONSERVATION
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To understand the importance of natural resources ● To know the role of water, soil conservation and management ● To learn moral and ethical values of biodiversity ● To create awareness on sustainable utilization of resources ● To gain knowledge on various hurdles of resource management

Modules	Content	Module Outcome
Module 1 : Fundamentals of Natural resources (25 hours)	<p>1.1. Introduction to Natural Resources: Definition, Concept, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Ecological, social and economic dimension of resource management.</p> <p>1.2. Land / Soil resources – Land as a resource, land degradation, conservation measures. Soils of India, Soil or land degradation, Causes of soil and land degradation, waste lands, desertification.</p> <p>1.3. Water resources – sources of water, hydrological cycle, Use and exploitation of surface and groundwater, conflict over water, water conservation strategies,</p> <p>1.4. Forest resources – Importance of Forest - Ecological and Economic significance - Classification of Forest resources - Use and over exploitation, deforestation, Timber extraction, afforestation, basic causes of deforestation, management of forest resources.</p> <p>1.5. Plants and animal resources – over exploitation, species extinction, control measures.</p> <p>1.6. Energy resources - Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.</p> <p>1.7. Food resources - World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, World food supply, food security, Sustainable agriculture.</p> <p>1.8. Fish and other marine resources -</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Gain knowledge on natural resources and its types. ● Assess and learn the soil resources degradation and its causes of soil and land degradation, waste lands and desertification. ● Evaluate and explain the sources of water resources and its types. ● Gain the knowledge on the importance of forest resources & economic significance. ● Analyze the classification of forest resources, and their management. ● Recall and approach the over exploitation, species extinction, control measures of the plants and animal resources. ● Identify the knowledge based on energy resources and its types, and use of alternative energy ● Assess and approach the food resources problems and its effects and causes. ● Evaluate the fish and marine resources on the production, status and unsustainable harvesting, issues and challenges of

	Production, status, dependence on fish resource, unsustainable harvesting, issues and challenges of resource supply.	resource supply
Module II Natural Resource Management (20 hours)	<p>2.1. Resource Management Paradigms: Resource management the evolution and history of resource management paradigms.</p> <p>2.2. Resource conflicts: Resource extraction, access and control system.</p> <p>2.3. Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies. Poverty and implications in Resource Management in developing countries–Poverty in developing countries, causes and link with resources scarcity and poverty.</p>	<ul style="list-style-type: none"> • Apply and assess the resource management and its historical resource management paradigms • Recall to gain the knowledge on resource conflicts like extraction, access and its control system. • Evaluate and approach the various types of resource management, and learn the integrated resource management strategies in poverty developing countries.
Module III: Mineral resources (15 hours)	<p>3.1. Classification of Minerals, Minerals of India. Uses of economic importance of minerals. 3.2. Management of Mineral resources, Mineral wealth of our planet, non-renewable nature of mineral deposits, the inexhaustible nature of mineral elements, use and exploitation of mineral resources, environmental effects of extracting and using mineral resources. Remedial measures.</p>	<ul style="list-style-type: none"> • Analyze the classification of minerals and its types in India. • Gain the knowledge on management of minerals, use of minerals, use and exploitation, environmental effects and remedial measures.
Module IV: Natural Resources Governance and Policy (25 hours)	<p>4.1. Introduction: Legal and political environments in resource management. Global and local governance, challenges of good governance. Natural Resource Governance in a rapidly changing world.</p> <p>4.2. Overview of legal policy instruments in Natural Resource Management: National Forest Policy of 1988, National Environment Policy of 2004, National Conservation Policy, National Action Plan on Climate Change of 2008, ICZM-Indian Coastal zone management, Biological Diversity Act of 2002 and Rule 2004, Forest Rights Act of 2006. Green Tribunal Act, 2009. The precautionary principle and common responsibilities.</p> <p>4.3. International and National efforts: CITES and other international treaties and conventions, roles of international</p>	<ul style="list-style-type: none"> • Gain the knowledge of legal and political environments in resource management. • Recall the global and local governance, challenges of good governance. • Assess and understand the legal policy instruments in NRM. • Assess the legal Policies for natural resource management.

	organizations and NGOS with special reference to UN and specialized agencies, institutional regulatory bodies and authorities: direct intervention by the state, green business and green ethics.
References	<ol style="list-style-type: none"> 1. Anil Tyagi, Environmental Science, Danika Publishing Company, New Delhi, 2007. 2. E.J.W. Barrington, Environmental Biology, Resource and Environmental Science Series, Edward Arnold (pub) Ltd. London. 3. S.S. Purohit, Q. Shammi, and A.K Agarwal, A Text Book of Environmental Science, Student Edition Publishers, Jodhpur, 2004. 4. Heal Geoffrey, 2000, Nature and the Marketplace: Capturing the Value of Ecosystem Services. Island Press. 5. Kareiva Peter, and Michelle Marview, 2010, Conservation Science: Balancing the Needs of People and Nature. Roberts and Company. 6. Daily Gretchen, 1997, Nature's Services: Societal Dependence on Natural Ecosystems. Island Press. 7. P.M. Vitousek, Global Change and Natural Resource Management, 1994, Beyond global warming: Ecology and global change. Ecology 75, 1861 - 1876.
Course Outcomes	<p>CO1: Assess the value of natural resources</p> <p>CO2: Differentiate the pros and cons of non-renewable energy utilization</p> <p>CO3: Identify environmental implications of resource extraction</p> <p>CO4: Develop an awareness on natural resources conservation practices</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	-
CO2	✓	✓	-	✓	✓	-	-
CO3	✓	✓	-	✓	✓	-	-
CO4	✓	✓	-	✓	✓	-	-

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Explain about the classification of natural resources.
2. Discuss on the approaches in resource management.
3. Comment on the legal policy instruments in natural resource management.
4. Elaborate the international and national efforts in natural resource management.
5. Briefly explain the National Action Plan on Climate Change of 2008.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS03DSE06 - APPLICATION OF REMOTE SENSING AND GIS
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● study the basic principles of Remote sensing and GIS ● differentiate various types and characters of sensors ● understand the concept of active, passive and microwave remote sensing ● know the importance of digital image processing ● know about various applications of GIS and Remote sensing

Modules	Content	Module Outcome
Module I: Fundamentals of Remote Sensing	<p>1.1. Remote sensing: Introduction, Remote sensing system; components and principles; platforms, sensors, medium, target, interactions and their characteristics including various resolutions, concept of DN value, radiance, reflectance, emission</p> <p>1.2. Electromagnetic spectrum: energy interaction with atmosphere and earth surface, atmospheric windows, spectral properties of various objects on the earth's surface and the concept of spectral signature, active and passive remote sensing</p> <p>1.3. Space borne earth observation: various orbits and their characteristics, operations, image acquisition and various data products Indian remote sensing programme & Other satellites and sensors like Landsat, SPOT, etc.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Identify the principles of remote sensing and its application to environmental management, natural resource management, and land-use planning ● Gain the knowledge of the active and passive remote sensing principles and its concepts ● Describe the various orbit and their characteristics, operations and image acquisition
Module II: Application of remote sensing & Digital Image Processing	<p>2.1. Application of remote sensing in Environment; ground water exploration, mining of mineral resources, Landslides, Avalanches, subsidence and earthquake mitigation, waste land mappings, Wetland conservation.</p> <p>2.2. Image Formats, Image restoration, Image Enhancements; Image interpretation, Digital image classification.</p>	<ul style="list-style-type: none"> ● Identify the application of remote sensing in the environment. ● Evaluate and gain knowledge on the image formats and restoration, enhancement, image classification and digital image

		classification.
Module III: Fundamentals of Geographical Information System	<p>3.1. Geographical Information System (GIS): GIS Data and Spatial Models, Topology and Spatial Operations, Projections, Scale and Coordinate Systems, Mapping, GIS Analysis, Cartography.</p> <p>3.2. Basics of GIS application development, concepts, components and organizations of GIS representing & modeling spatial features and processes; vector and raster structures, relationship between features; topology; raster data compressions and storage formats</p> <p>3.3. Non-spatial/attribute Database Management Systems (DBMS), significance of DBMS, principles, data types, models – RDBMS, data storage, query and retrieval</p> <p>3.4. Basic GIS functions: data inputting methods & various data sources, data management, data manipulation and geographic analysis and output presentation</p>	<ul style="list-style-type: none"> ● Explain the fundamentals and application of GIS in the environment. ● Attain the concepts and components of GIS and discuss the spatial and non-spatial data. ● Apply and evaluate the knowledge on the basic GIS functions. ● Recognize the GIS data input methods, data sources and management and their analysis output
Module IV: Application of GIS in Environment	<p>4.1. Geographic analysis and modeling; Exploration, query, vector spatial analysis & Geo processing; extraction, proximity, overlay Network analysis – route, trace, closest facility, allocation, Raster based spatial modeling and analysis – density, distance, map algebra – arithmetic & weighted overlay; multi-criteria decision making</p> <p>4.2. Surface modeling and analysis: DEM creation – input sources, interpolation; slope, aspect, volume, profile, hill shade, viewshed, visibility, contouring</p> <p>4.3. Applications of learning (Management, Forestry, Agriculture, Water resource management, Watershed management, Coastal zone management.</p>	<ul style="list-style-type: none"> ● Analyze the geographic analysis and GIS modeling in the environment. ● Recognize the surface modeling and analysis ● Develop and gain knowledge on the GIS modeling and analysis. ● Apply and learn the and their applications
References	<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Arther Beiser, Applied physics, Schaum's outline series, Mc Grace Hills Book Co. New York. 2. Albert Miller, Jack C Thompson, Richard E Peterson and Donald R Haragan, Elements of Meteorology, Charles E Merrill publishing Co. Columbus. 3. Frederick K Lutgens and Edward J Tarbuck, The Atmosphere, Prentice Hall publications, New Jersey 4. Floyd F Sabins, Remote sensing – Principles and Interpretation, W.H 	

	<p>freeman and Co. San Francisco.</p> <p>5. Erwin Schande, Springer – Verlag; Remote sensing for environmental sciences, Berlin Heidelberg, New York.</p> <p>6. E.C. Barrett and L.F. Curtis, Introduction to Environmental Remote Sensing, Chapman and Hall, London.</p> <p>7. Lutgens and Tarbuck, The Atmosphere, Prentice Hall publication, New jersey.</p> <p>8. Barry and Charley, Atmosphere, Weather and Climate, The English Language Book Society, 1976.</p> <p>9. A.A. Rama Sastry, Weather and Weather forecasting, Publication division, Ministry of Information and Broadcasting, Ministry of India, 1984.</p> <p>10. A.V. Strahler and A.H. Strahler, Environmental Geo-Science, Wiley International, 1973.</p> <p>11. G.W. Tyrell, Principles of petrology, Methven publication, 1959</p>
Course Outcomes	<p>CO1: Identify the characteristics of GIS and Remote sensing</p> <p>CO2: Analyze the Toposheet and digital maps usage</p> <p>CO3: Know about the importance of image processing and enhancement of GIS and Remote sensing</p> <p>CO4: Implement GIS and RS applications on various domains of environmental studies</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	-	✓	✓	✓
CO2	✓	-	✓	-	✓	✓	✓
CO3	✓	-	✓	-	✓	✓	✓
CO4	✓	-	✓	-	✓	✓	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, Demonstration, E- learning (Video).</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Tutorials</p> <p>Presentation by individual student/ Group representative.</p> <p>Lab visits and institutional visit.</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Define remote sensing.
2. Describe the effect of atmosphere on remote sensing process.
3. Illustrate EMR spectrum and its application in remote sensing.
4. Appraise the characteristics of a soil and vegetation that determine its reflectance properties.
5. Explain in detail about types of multispectral scanners used in remote sensing methods.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS03DSE07 -ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To understand the history and basics of microbiology ● To learn about microbial diversity in environmental matrix ● To study the importance of microbes in the field of environmental microbiology ● To understand the biodegradation and its importance ● To know about recent advances in bioremediation technique

Modules	Content	Module Outcome
Module I: Scope and history of Environmental Microbiology (20 hours)	<p>1.1. Scope and history of Environmental Microbiology – characteristics, classification, identification and morphology of microorganism. 1.2. Microbial world – Bacteria, Archaea, Fungai, Algae, Virus, Protozoa.</p> <p>1.3. Identification of microorganisms – Direct microscopic examination, cultural characteristics, biochemical and physiological properties.</p> <p>1.4. Application: Antibiotic sensitivity testing, serological methods, Phage typing, protein analysis, comparison of nucleotide sequences.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Identify the basics of environmental microbiology. ● Know characteristics, classification, identification and morphology of microorganism ● Handle microscopes and helps to identify microorganisms. ● Interpret the biochemical and physiological properties of microorganisms. ● Know the application of microbiology in the environmental science field.
Module II: Genetic engineering (15 hours)	<p>2.1. Genetic engineering - Principles and scope of Genetic engineering. Application of genetic engineering, benefits and hazards- the ethical and social implications of genetic engineering.</p> <p>2.2. Tissue culture- Techniques and its applications</p>	<ul style="list-style-type: none"> ● Identify the scope and principles of genetic engineering. ● Aware of applications, benefits and hazards of genetic engineering. ● Recognize tissue culture techniques and its applications.
Module III: Environmental Microbiology (20 hours)	<p>3.1. Microbiology and segments of Environment. Microbial diversity in soil, biogeochemical role of soil microorganisms. Biodegradation of herbicides and pesticides. The aquatic microorganisms.</p> <p>3.2. The role and importance of microbial ecosystems, biogeochemical transformation.</p>	<ul style="list-style-type: none"> ● Know the diversity and biogeochemical role of soil and aquatic microorganisms ● Analyze the Biodegradation of herbicides and pesticides in the environment.

<p>Module IV: Environmental Biotechnology & Emerging trends in Environment Biotechnology (25 hours)</p>	<p>4.1. Environmental Biotechnology – Principles and scope, Role of biotechnology in Environmental Protection. 4.2. Biotechnology in industrial pollution control – Paper industries, Textile Industries, Petrochemical Industries, Leather Industries and Mining Industries 4.3. Emerging trends in Environment Biotechnology- Bioremediation and Biosensors. Principles of Bioremediation, Techniques used in Bioremediation, Advantages and Disadvantages of Bioremediation. Principles and applications of Biosensors. Concept of Bioremediation in waste water management. Waste water treatment Practices, solid waste management.</p>	<ul style="list-style-type: none"> • Describe the Principles and scope, Role of biotechnology in Environmental Protection. • Know the application of biotechnology in various industrial sectors. • Explore emerging trends in environmental biotechnology.
<p>References</p>	<ol style="list-style-type: none"> 1. Prescott, Harley and Klein, Microbiology, 7th edition. 2. Kanika Sharma, Manual of Microbiology - Tools and Techniques, Second edition, 2010 3. Michael J Pelzar, JR. E. C. S Chan and Noel. R. Krieg, Microbiology, 8th edition. 4. R. Soper, Biological Science, Cambridge University, 3rd Edition. 5. Elsar, Jansson and Tervors, Modern soil Microbiology, 2nd Edition. 6. S.C Bhatia, Handbook of Environment Biotechnology vol 1, Atlantic publication 7. S.K Agarwal, Advances Environmental Biotechnology 8. Gareth M. Evans and Indith C. Furlong, Environment Biotechnology, theory and application. 9. R.C. Sobti and Suparna S Pachauri, Essentials of Biotechnology. 10. Hanspeter, Methods in Biotechnology 11. S. Kanika, Manual of Microbiology, Ane, New Delhi, 2008 12. Sustainable biotechnology, DPH, New Delhi, 2010 13. Indu S., Thakur, Environmental Biotechnology, I.K. International, New Delhi, 2006 14. Environmental biotechnology and application, DPH, New Delhi, 2013 15. K.P. Ulhas, Muskan, Kalyani, Essentials of Biotechnology, I.K. International, New Delhi, 2009 16. S. Hari, Environmental Microbiology, Crescent, New Delhi, 2017 17. H. Alan, Varnam, Environmental Microbiology, Manson Publishing Ltd, Washington, 2000 	
<p>Course Outcomes</p>	<p>CO1: Familiarize the microbiological standards for water CO2: Compare microbial diversity among the environmental compartments CO3: Acquire knowledge on microbe's aid in containment's degradation CO4: Explore various updated methods of bio-remediation technique</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	-	-	✓	-	✓
CO2	✓	-	-	-	✓	-	✓
CO3	✓	-	-	-	✓	-	✓
CO4	✓	-	-	-	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Laboratory visit.
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. Discuss the history and scope of environmental microbiology
2. What are the physical factors influencing the growth of aquatic microorganisms?
3. Discuss the role of bacteria in maintaining ecosystem health.
4. Comment on distribution of microorganisms in the aquatic environment?
5. Give a detailed account on ecological importance of micro-organisms
6. Explain the role of aquatic microorganisms in biogeochemical cycles?

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS03DSE08 - NANOTECHNOLOGY AND ENVIRONMENTAL APPLICATIONS
Course Objectives	This course on Nanotechnology and Environmental applications covers the basic principles of nanotechnology which includes different types of nanomaterials, its fabrication and synthesis, size dependent properties, characterization, and environmental applications of these nano materials.

Modules	Content	Module Outcome
Module I: Introduction to Nano (25 hours)	<p>1.1. Historical introduction–Bulk Vs Nano size, Concept of Nano and its evolution, Scientific Revolution - Feynman’s Vision and its explanation.</p> <p>1.2. Size-dependence of properties– Surface area to volume ratio and Quantum size effects.</p> <p>1.3. Classifications–Zero Dimensional, One Dimensional, Two Dimensional and Three-Dimensional Nanomaterials, Metal nanoparticles, semiconductor quantum dots</p> <p>1.4. Nano porous materials – mesoporous and micro porous materials.</p> <p>1.5. Magnetic nanoparticles –Nano magnetism.</p> <p>1.6. Carbon Nanostructures–fullerene, carbon nanotubes and graphene nanostructures.</p>	The student will be able to: <ul style="list-style-type: none"> • Identify the basics of nanotechnology • Describe the latest development in the area of Nanotechnology. • Know in detail about the classification of nanoparticles. • Recognize carbon nanostructures.
Module II: Nanomaterials – Properties and Synthesis (20 hours)	<p>2.1. Nanomaterials and Properties Metal Nanoparticles - Surface plasmon resonance, Semiconductor nanoparticles optical and electronic properties. Nano porous materials – mesoporosity and micro porosity, Magic numbers, Mesoporous materials - silica and titania and their applications. Self-assembled nanostructures.</p> <p>2.2. Nanomaterials Synthesis - General: Top-down process – Lithography and High-energy balling. Bottom-up approach -Wet chemical routes, solution phase and vapor phase synthesis, sol-gel synthesis. Synthetic methods for metal and semiconductor nanoparticles. Template-based synthesis of mesoporous</p>	<ul style="list-style-type: none"> • Identify the properties of nanoparticles. • Know about nano porous materials and their applications. • Gain idea about the synthesis methods of nanomaterials • Recognize semiconductor nanoparticles, their synthesis and importance.

	metal oxides. Synthesis of carbon nanotubes, fullerenes and graphene.	
Module III: Nanomaterials Characterization (15 hours)	3.1. Tools for Characterization of Nanomaterials - UV-Visible spectroscopy, X-Ray Diffraction (XRD) Techniques, Electron microscopy – Scanning Electron and Transmission Electron Microscopy (SEM and TEM), Atomic Force Microscopy (AFM) techniques, BET surface area measurements.	<ul style="list-style-type: none"> Identify the basics of characterization. Gain knowledge on various tools used for the characterization of nanomaterials.
Module IV: Environmental Applications of Nanomaterials (20 hours)	4.1. Nanomaterials for water treatment- Photocatalysis, Degradation of textile industry wastes such as dyes, Removal of waste from water using semiconductor nanomaterials, 4.2. Air purification 4.3. Nanomaterials for antimicrobial coatings 4.4. Medical Implants and Paints 4.5. Superhydrophilicity, Self-cleaning applications 4.6. Dye sensitized solar cells and electrochromic device applications.	<ul style="list-style-type: none"> Analyze the environmental applications of nanomaterials Gain knowledge about photo catalysis and degradation of industrial wastes using semiconductor nanomaterials. Describe about dye sensitized solar cells and their applications.
References	<ol style="list-style-type: none"> C. P. Poole Jr. & F. J. Ownes. <i>Introduction to Nanotechnology</i>. Wiley India (2007), New Delhi. T. Pradeep. <i>Nano: The Essentials</i>. Tata McGraw Hill (2007), New Delhi. K. J. Klabunde (Ed.) <i>Nanoscale Materials in Chemistry</i>, John Wiley & Sons (2001). Hari Singh Nalwa (Ed.), <i>Nanostructured materials and nanotechnology</i>, Academic Press, New York (2002). D. Vollath. <i>Nanomaterials</i>, Wiley-VCH (2008). K.K. Chattopadhyay & A.N. Banerjee, <i>Introduction to Nanoscience and Technology</i>, PHI Learning Pvt. Ltd. (2009). G. A. Ozin, A. C. Arsenault, L. Cademartiri, <i>Nano chemistry: A Chemical Approach to Nanomaterials</i>, Royal Society of Chemistry (2009) London. P. Atkins & J. De Paula, <i>Atkins's Physical Chemistry</i>, 8th Edition, W.H. Freeman & Co., 2006. Skoog and West, <i>Principles of Instrumental Analysis</i>. 	
Course Outcomes	CO1: Familiarize with advanced topics of nanotechnology and promote research-oriented mentality to solve environmental issues and problems such as water and air pollution using nanomaterials. CO2: The course contents will give ideas about the latest development in the area of Nanotechnology. CO3: This course prepares the student to acquire knowledge, skills and expertise on nanotechnology along with the integrated knowledge of all relevant disciplines. CO4: Apply the knowledge for Environmental and energy issues.	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	✓	✓	✓	-	✓
CO2	✓	-	✓	✓	✓	-	✓
CO3	✓	-	✓	✓	✓	-	✓
CO4	✓	-	✓	✓	✓	-	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Explain the concept and evolution of nano.
2. Describe the classification of nanomaterials.
3. Briefly explain carbon nanostructures.
4. Explain the properties of nanomaterials.
5. Differentiate Top-down and Bottom-up approach in the synthesis of nanomaterials.
6. Write an essay on the environmental applications of nanomaterials.

Multidisciplinary Elective (MDC)

Course Code & Title	MSEVS03MDC03:WETLANDS
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To know about the various wetlands ● To study the structural and functional elements of wetlands ● To manage the wetland ecosystems

Modules	Content	Module Outcome
Module I : Introduction to Wetlands (15 hours)	1.1. Wetlands - Definition, History, Classification 1.2. Biological Adaptations to the Wetland Environment 1.3. Biodiversity and economic importance of wetlands of Kerala 1.4. Wetland Hydrology 1.5. Human Impacts and Management of Wetlands	The student will be able to: <ul style="list-style-type: none"> ● Identify the adaptations in the wetland environment. ● Illustrate hydrology of wetlands. ● Predict impacts on wetlands.
Module II (15 hours)	2.1. Ramsar Convention and Ramsar sites 2.2. Ramsar Sites in Kerala 2.3. Wetlands of Kannur 2.4. Wetland laws 2.5. Wetland restoration and wise use 2.6. Wetlands and Climate change	<ul style="list-style-type: none"> ● Idea about Ramsar Convention and Ramsar sites. ● Identify and explain about the legislations related to wetlands. ● Predict the changes in wetland ecosystems due to climate change.
References	<ol style="list-style-type: none"> 1. W.J. Mitsch and J.G. Gosselink. (2007). Wetlands, 4th edition. Van Nostrand Reinhold, New York, New York and John Wiley & Sons, Inc., Hoboken, New Jersey. 2. M. Brinson, (1993) A Hydrogeomorphic Classification of Wetlands 3. Dugan, Patrick (editor) (1993) Wetlands in Danger, World Conservation Atlas Series. 4. L.H. Fraser and P.A. Keddy (eds.). 2005. The World's Largest Wetlands: Ecology and Conservation. Cambridge University Press, Cambridge, UK. 488 p. 5. A. A. Ghabo, (2007) Wetlands Characterization; Use by Local Communities and Role in Supporting Biodiversity in the Semiarid Ijara District, Kenya. 6. P.A. Keddy, 2010. Wetland Ecology: Principles and Conservation (2nd edition). Cambridge University Press, Cambridge, UK. 497 pp. 7. E. Maltby and T. Barker (eds) (2009) The Wetlands Handbook. Wiley-Blackwell, Oxford. 1058 pp. 8. W.J. Mitsch, J.G. Gosselink, C.J. Anderson, and L. Zhang. (2009) Wetland Ecosystems, John Wiley & Sons, Inc., Hoboken, 295 pp. 9. N. Romanowski, 2013, Living Waters, CSIRO Publishing, Melbourne, ISBN 9780643107564 	

Course Outcomes	CO1: Identify the importance and conservation of wetlands CO2: Familiarization in structural and functional aspects of wetlands CO3: Apply and analyze the management of wetlands ecosystems CO4: Identify and explain about the legislations related to wetlands.
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	✓	-
CO2	✓	✓	-	✓	✓	✓	-
CO3	✓	✓	-	✓	✓	✓	-
CO4	✓	✓	-	✓	✓	✓	-

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. What is a wetland and how is it classified?
2. Explain the adaptations in the wetland environment.
3. Briefly explain Ramsar convention and Ramsar sites.

Multidisciplinary Elective (MDC)

Course Code & Title	MSEVS03MDC04: MANGROVES
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To know about the various mangroves ● To study the structural and functional elements of mangroves ● To manage the mangrove ecosystems

Modules	Content	Module Outcome
Module I: Introduction to Mangroves (15 hours)	3.1. Mangroves - Definition. True mangroves and Mangrove associates 3.2. Mangrove biome - characteristics 3.3. Distribution of mangroves 3.4. Mangrove adaptations 3.5. Significance of mangroves - Ecosystem Service Value of mangroves 3.6. Species diversity and uses of True mangroves of Kerala 3.7. Conservation of mangroves	<ul style="list-style-type: none"> ● Identify the mangroves and their characteristics. ● Identify and analyze the adaptations in the mangrove ecosystem. ● Identify true mangroves of mangrove ecosystems in Kerala.
Module II: Mangroves in India (15 hours)	4.1. Types of Mangroves in India - Red, black and white mangroves 4.2. Mangroves Forests in India 4.3. Importance of Mangroves Forests in India 4.4. Threats to Mangroves Forests in India 4.5. Conservation of Mangroves Forests in India	<ul style="list-style-type: none"> ● Identify types of mangroves in India. ● Describe the importance, threat and conservation of mangroves.
References	<ol style="list-style-type: none"> 1. Saenger, Peter (2002). Mangrove Ecology, Silviculture, and Conservation. Kluwer Academic Publishers, Dordrecht. ISBN 1-4020-0686-1. 2. Thanikaimoni, Ganapathi (1986). Mangrove Palynology, UNDP/UNESCO and the French Institute of Pondicherry, ISSN 0073-8336 (E). 3. Tomlinson, B. Philip (1986). The Botany of Mangroves. Cambridge University Press, Cambridge, ISBN 0-521-25567-8. 4. H. J. Teas, (1983). Biology and Ecology of Mangroves. W. Junk Publishers, The Hague. ISBN 90-6193-948-8. 5. J.C. Plaziat (2001). History and biogeography of the mangrove ecosystem, based on a critical reassessment of the paleontological record. Wetlands Ecology and Management 9 (3): 161-179. 	
Course Outcomes	CO1: Identify the importance and conservation of mangroves CO2: Familiarization in structural and functional aspects of mangroves CO3: Apply and analyze the management of mangroves ecosystems CO4: Identify the different types of mangroves in India	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	-
CO2	✓	✓	✓	✓	✓	✓	-
CO3	✓	✓	✓	✓	✓	✓	-
CO4	✓	✓	✓	✓	✓	✓	-

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. What is a mangrove and how is it classified?
2. Differentiate true mangroves and mangrove associates.
3. What is the significance of mangroves?

Multi Disciplinary Elective (MDC)

Course Code & Title	MSEVS03MDC05 - FUNDAMENTALS OF ENVIRONMENTAL SCIENCE
Programme	Open to other P.G courses
Course Objectives	<ul style="list-style-type: none"> ● To understand the basics of environment and its role ● To assess the concept of ecology ● To know the interaction of matter, energy and material cycling ● To impart knowledge on the principles for balancing social, economic and environmental dimensions of human development ● To learn about environmental management

Modules	Content	Module Outcome
Module I: (25 hours)	<p>1.1. Ecosystems:</p> <p>Concept of an ecosystem.</p> <p>Structure and function of an ecosystem.</p> <p>Producers, consumers and decomposers.</p> <p>Energy flows in the ecosystem.</p> <p>Ecological succession.</p> <p>Food chains, food webs and ecological pyramids.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Identify the basic facts of environmental science. ● Gain knowledge on basics on natural resources. ● Differentiate renewable and nonrenewable resources. ● Know different natural resources. ● Aware of conservation and sustainable utilization of natural resources.
Module II: (15 hours)	<p>2.1. Basics of Environmental Science - Definition, scope and importance. Need of Environmental awareness – Methods for Environmental awareness.</p> <p>2.2. Natural Resources: Renewable and non-renewable resources: Problems and prospects with natural resources.</p> <p>Forest resources: Use and over-exploitation.</p> <p>Water resources: Use and over-utilization of surface and ground water</p>	<ul style="list-style-type: none"> ● Gain knowledge on basics of ecosystems and their structure and function. ● Identify & analyze the types, features, structure and function of major ecosystems.

	<p>Mineral resources: Use and exploitation</p> <p>Food resources: World food problems</p> <p>Energy resources: renewable and non-renewable energy sources, use of alternate energy sources.</p> <p>Land resources: land degradation, soil erosion and desertification.</p> <p>Role of an individual in conservation of natural resources.</p>	
<p>Module III: (20 hours)</p>	<p>Module III: (20 hours)</p> <p>3.1. Environmental Pollution Definition - Cause, effects and control measures of:</p> <ol style="list-style-type: none"> Air pollution Water pollution Soil pollution Marine pollution Noise pollution Thermal pollution Nuclear hazards <p>3.2. Solid waste Management: Causes, effects and control measures of solid wastes.</p> <p>3.3. Role of an individual in prevention of pollution.</p>	<ul style="list-style-type: none"> • Gain knowledge on environmental pollution • Identify and describe the causes, effects and control measures of various environmental pollution. • Know the basics of solid and E- wastes and its causes, effects and management. • Analyze the role of individuals in prevention and control of pollution. • Identify the basics of disaster management.

<p>Module IV: (20 hours)</p>	<p>4.1. Social Issues and the Environment From Unsustainable to Sustainable development</p> <p>4.2. Resettlement and rehabilitation of people</p> <p>4.4. Environmental ethics - Issues and possible solutions.</p> <p>4.5. Climate change, global warming, acid rain, ozone layer depletion.</p> <p>4.6. Environment Protection Act</p> <p>4.7. Public awareness.</p>	<ul style="list-style-type: none"> • Gain knowledge on social issues and environment • Know water conservation, rain water harvesting, watershed management • Identify the basics resettlement and rehabilitation of people • Aware of environmental ethics; issues and possible solutions. • Analyze the basics of climate change, global warming acid rain ozone layer depletion and different nuclear accidents. • Gain knowledge on acts and policies related to environmental protection.
<p>References</p>	<ol style="list-style-type: none"> 1. K.C. Agarwal, 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner. 2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India. 3. R.S. Clark, Marine Pollution, Clarendon Press Oxford (TB) 4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p 5. A.K. De, Environmental Chemistry, Wiley Eastern Ltd. 6. Down to Earth, Centre for Science and Environment (R) 7. H.P. Gleick, 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p 8. R.E. Hawkins, Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R) 9. V.H. Heywood & R.T. Waston, 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p. 10. H. Jadhav & V. M. Bhosale, 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p. 11. M.L. McKinney & R.M. School, 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p. 12. A.K. Mhaskar, Matter Hazardous, Techno-Science Publication (TB) 13. T.G. Miller Jr., Environmental Science, Wadsworth Publishing Co. (TB) 	

	14. E.P. Odum, 1971. Fundamentals of Ecology. W.B. Saunders Co. USA
Course Outcomes	<p>CO1: Identify the importance of Environment, various ecosystem's structure, function and characteristics</p> <p>CO2: Identify the characterization of community and its dominance as well as co-existing with other community</p> <p>CO3: Realize the importance of protection and conservation of biodiversity</p> <p>CO4: Act on various Environmental Issues and try to restore the precious Environment.</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	-
CO2	✓	✓	-	✓	✓	-	-
CO3	✓	✓	-	✓	✓	-	-
CO4	✓	✓	-	✓	✓	-	-

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. What are natural resources?
2. Differentiate renewable and non-renewable resources.
3. Comment on the structure and function of an ecosystem.
4. What are the causes and effects of water pollution?
5. What are the methods for water conservation?
6. Elaborate environmental legislations in India.

DISTRIBUTION OF COURSES AND CREDITS

	1	2	3	4	5	6	7	8	
	Discipline Specific Courses		Interdisciplinary Elective/ Generic Elective Multidisciplinary Elective /Open Elective	Ability Enhancement AEC	Skill Enhancement Course (SEC)	Value Addition Course/ MOOC Courses (VAC)	Internship/ Field Visit/Minor Project/Insti- tutional- Industrial Visit	Dissertation/ Major Projects	Total Credits
Semester	Discipline Specific Core DSC	Discipline Specific Elective DSE							
4	DSC -13(4C)	DSE - 9(3C) OR DSE- 10(3C) OR DSE- 11(3C)	-	-	-	-	-	DSC -14(2C)	19 Credits
	4 Credits	3 Credits						12Credits	

SCHEME

FOURTH SEMESTER								
Course Code	Title of Paper	Contact Hours/Week			Marks		Total	Credits
		L	T/S	P	ESE	CE		
Discipline Specific Core Courses (DSC)								
MSEVS04DSC13	Disaster management	4	1	-	60	40	100	4
Discipline Specific Elective Courses (DSE)								
MSEVS04DSE09 OR MSEVS04DSE10 OR MSEVS04DSE11	Environmental Geology	3	1	-	60	40	100	3
	Sustainable							
	Development							
	Environmental Audit							
Project (P)								
MSEVS04DSC14	Project Work	-	-	24	60	40	100	12
Total		33			180	120	300	19
Grand Total		143			1320	880	2200	83

Discipline Specific Core Courses (DSC)

Course Code & Title	MSEVS04DSC013- DISASTER MANAGEMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To provide basic conceptual understanding of disasters. • To understand approaches of Disaster Management • To build skills to respond to disaster • To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Modules	Content	Module Outcome
Module I Natural & Artificial hazards (15 hours)	1.1 Types and Classification of Disasters 1.1. Types and Classification of Disasters - Definition a. Natural Disasters: Meteorological disasters, Geological disasters, biological disasters b. Anthropogenic Disasters: Chemical, Industrial and Nuclear related Disasters, Accident-related Disasters	The student will be able to: <ul style="list-style-type: none"> • Identify the types and classification of disasters.
Module II Disaster Management (20 hours)	2.1. Disaster Management Introduction to key concepts, terminologies and their complexities (Hazard, vulnerability, Exposure, Risk, Crisis, emergencies, Vulnerability, Disasters, Resilience) 2.2. Disaster management Spectrum – components, Scope of DM and Disaster Management Cycle 2.3. Professional activities – Mitigation, preparedness, response, recovery, programme planning and management.	<ul style="list-style-type: none"> • Discuss various processes associated with the disaster management • Experience the professional activities involved in disaster management.
Module III Tools of Disaster management	3.1. Tools of Disaster management Forecasting and warning systems of disasters 3.2. Phases of disaster management	<ul style="list-style-type: none"> • Familiarize the warning systems used in disaster management.

(25 hours)	Pre disaster phase, Actual disaster phase, Post disaster phase Disaster Assistance, Technological assistance Relief camps; Camp layout, Food requirement, Water needs, Sanitation, Security	<ul style="list-style-type: none"> Identify the different phases of disaster management.
Module IV Organizations related to disaster management. (20 hours)	<p>4.1. International organizations, bodies and Finance – International Association of Emergency Managers, Red cross/Red crescent, United Nations, World Bank - International Strategies and functions - Role of the United Nations in Disaster management.</p> <p>4.2. National Organizations – National Disaster Management of India, Emergency management and research institute (EMRI), National remote sensing institute (NIRS).</p> <p>4.3. National Disaster management – Hierarchy and Institutionalizations, National Disaster Decision support system, Technological applications, Role of research organizations.</p>	<ul style="list-style-type: none"> Know about various national and international organizations associated with disaster management. Recognize the role of research in disaster management.
References	<p>Reference Books:</p> <ol style="list-style-type: none"> Anil Tyagi, Environmental Science, Danika publishing company, New Delhi, 2007. E.J.W. Barrington, Environmental Biology. Resource and Environmental Science series, Edward Arnold (pub) Ltd. London. S.S. Purohit, Q. Shammi, A.K. Agarwal, A Text Book of Environmental Science, student edition publishers, Jodhpur, 2004. R.K. Khitoliya and K. Venkatachalam, 1997, Urban settlements and Natural hazards. Proceedings of seminar on Natural hazards in the Urban habitat. November, New Delhi. Rajesh Arora, Natural Calamities and Disaster Management, Sonali Publications, 2012 Kumar Amit, Disaster Management, Sonali Publications, New Delhi, 2009 	
Course Outcomes	<p>CO1: Differentiate the types of disasters, causes and their impact on environment and society</p> <p>CO2: The hazard and vulnerability profile of Indian Continent.</p> <p>CO3: Disaster damage assessment and management</p> <p>CO4: Familiarize the warning systems used in disaster management.</p>	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion Presentation by individual student/ Group representative Institution visits.
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. Differentiate natural and anthropogenic disasters.
2. What are the professional activities involved in disaster management?
3. Explain about the forecasting and warning systems used in disaster management.
4. Elaborate the phases of disaster management.
5. Comment on the role of research organizations in disaster management.
6. Briefly describe about national organizations associated with disaster management.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS04DSE09 ENVIRONMENTAL GEOLOGY
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> ● To introduce the concept of formation, evolution, structure and composition of Earth. ● Understanding different types of weathering. ● Understand the weathering and erosion process of different geological agents and the associated landforms. ● Identify different rocks, rock forming minerals and soil forming minerals. ● To understand the physical and chemical properties of minerals.

Modules	Contents	Module Outcome
Module I Introduction (20 Hours)	<p>1.1 Introduction to Geology - Environmental Geology - Definition and scope</p> <p>1.2 Geological Agents - Exogenous, and endogenous geological agents.</p> <p>1.3 Current views on the origin of earth.</p> <p>1.4 Internal structure of Earth - crust, mantle and core - composition, continental drift, plate tectonics.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> ● Known the basic knowledge about environmental geology and its scope ● Gain knowledge in theories regarding the origin of Earth ● Analyze the internal structure of Earth
Module II Concept of Rocks and Soil Formation (20 Hours)	<p>2.1 Classification of Rocks – Igneous, Sedimentary and Metamorphic Rocks - Concept of rock cycle.</p> <p>2.2 Weathering - Weathering reactions, erosion, transportation and deposition of sediments.</p> <p>2.3 Soil Formation - Soil forming minerals and process of soil formation (Pedogenesis), Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls, Factors of soil formation, soil profile, Classification of types of soil (Reference to India and Kerala), Structure of soil.</p>	<ul style="list-style-type: none"> ● Classify different types of rocks. ● Describe the soil formation process weathering and types of soils in India and Kerala
Module III Geological Agents (20 Hours)	<p>3.1. Wind - Development of characteristic features by wind (arid cycle) erosion and deposition – pedestal rock-mushroom topography-Inselberg – Ventifacts – locus – sand dunes.</p> <p>3.2. River - Erosion, Transportation and deposition of river (fluvial) cycle in different stages – Development of typical landforms by river erosion and deposition. V-shaped valley. Waterfall, alluvial fans, natural levees, meander.</p>	<ul style="list-style-type: none"> ● Identify the basic concepts of geological agents ● Classify the geochemical elements ● Analyze the paleoclimate

	<p>ox-bow lakes, flood plains, peneplain and deltas. Types of rivers. Development of river.</p> <p>3.3. Glaciers – Definition – types – development of typical landforms by glacial erosion and deposition – cirque, U-shaped valley – hanging valley, monadnocks, moraines, drumlin. Eskers and Varves, Characteristic features of glaciated regions.</p> <p>3.4. Geochemical classification of elements Abundance of elements in bulk earth, crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements.</p> <p>3.5. Paleoclimate</p>	
<p>Module IV Crystals and Minerals (20 Hours)</p>	<p>4.1. Physical properties of minerals – color, streak, opalescence, asterism, transparency, luster, luminescence, specific gravity, magnetic properties, electrical properties, pyro and piezo electricity.</p> <p>4.2. Chemical properties of minerals – Isomorphism, solid solution, polymorphism, allotropy, pseudomorphism, radioactivity; silicate structures.</p> <p>4.3. Composition and diagnostic properties of minerals - Quartz, feldspar, talc, gypsum, galena, beryl, corundum</p>	<ul style="list-style-type: none"> ● Identify the crystals and minerals ● Characterize the chemical and physical properties of minerals. ● Identify and diagnose the different minerals based on their properties
<p>References</p>	<p>Reference Books:</p> <ol style="list-style-type: none"> 1. N. Chenna Kesaulu, Textbook of Engineering, Geology, 1993 JNTU College of Engineering, Macmillan India limited. 2. G. N. Ghosh, Atmospheric Science and Environment, ISBN 81-7764-043-7-(C) 2000, Allied publishers Ltd. 3. P. K. Mukergee, A textbook of Geology, 1986. 4. S. K. Parbingsingh, Engineering & General Geology, Katariah& sons, Gurunank Market, New Delhi. 5. D.L. Holmes, Holmes Principles of Physical Geology (1978). 6. A.N. Strahler, Physical Geology (1981). 7. E.S. R. kobinsion, Basic Physical Geology (1982). 8. Rutleys, A Text Book of Mineralogy 9. H.H. Reed, Elements of Mineralogy 10. C.S. Hurlburt and C. Klein, Manual of Optical Mineralogy 11. M.H. Baitey, Mineralogy for Students 12. E.S. Dana and W.E. Ford. A textbook of Mineralogy 13. Deer, Howie, and Zussman, An Introduction to Rock Forming Minerals 14. Manson and Berry, Elements of Mineralogy 15. Billings, Structural Geology, Tata Mc Grace Hill publication Co., New Delhi. 16. Holmes A, Principles of physical geology, Ronald, New York, 1965. 17. L.G. Berry& Brian Mason, Mineralogy, Freeman publication, 1959. 	

Course Outcomes	CO1: Gain knowledge on environmental geology CO2: Know about weathering and soil formation. CO3: Acquire knowledge on geological agents. CO4: Explore properties of minerals.
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CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	-	-	-	✓	-	-
CO2	✓	-	-	-	✓	-	-
CO3	✓	-	-	-	✓	-	-
CO4	✓	-	-	-	✓	-	-

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative Field work and field visits
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. Explain the classification of rocks.
2. What are geological agents and how are they classified?
3. Explain the action of river as a geological agent.
4. Elaborate the concept of paleoclimate.
5. Briefly explain the physical properties of minerals.
6. Comment on the chemical properties of minerals.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS04DSE10 - SUSTAINABLE DEVELOPMENT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • To understand the status of environment • To assess the concept of sustainability on various sectors • To know actions taken against the climate change in the world and national level • To impart knowledge on the principles for balancing social, economic and environmental dimensions of development and the associated international and national frameworks • To learn about environmental management

Modules	Content	Course Outcome
<p>Module I: Challenges of sustainable development and global Environmental issues (25 hours)</p>	<p>1.1 Status of Global and Indian Environment - Environmental, Social and Economical issues.</p> <p>1.2. Concept of sustainability - Need for sustainability- Nine ways to achieve sustainability- population, resources, development and environment. Factors governing sustainable development - Linkages among sustainable development - Environment and poverty - Determinants of sustainable development.</p> <p>1.3. Case studies on sustainable development - Population, income and urbanization - Health care - Food, fisheries and agriculture - Materials and energy flows.</p>	<p>The students will be able to:</p> <ul style="list-style-type: none"> • Gain ideas on the need for sustainability. • Identify the concept of sustainability. • Interpret sustainable development.
<p>Module II: Sustainable Development Indicators and Goals (15 hours)</p>	<p>2.1. Sustainable Development Indicators - Need for indicators - Statistical procedures - Aggregating indicators - Use of principal component analysis - Three environmental quality indices.</p> <p>2.2. Sustainable Development Goals - SDG initiatives in India, Global initiatives, Progress, SDG report 2021.</p>	<ul style="list-style-type: none"> • Identify the sustainable development indicators. • Analyze sustainable development goals. • Gain knowledge about global initiatives as well as initiatives in India for SDGs.
<p>Module III: Environmental Assessment, Management and Social Dimensions</p>	<p>3.1. Environmental Impact Assessment -National environmental policy act of 1969 -Project categories based on environmental impacts - Impact identification methods - Environmental impact assessment process.</p>	<ul style="list-style-type: none"> • Recall the basics of environmental impact assessment. • Identify the environment management. • Describe the social

(20 hours)	3.2. Revisiting complex issues – Sector policies concerning the environment – Institutional framework for environmental management – Achievements in environmental management – People’s perception of the environment – Participatory development – NGOs – Gender and development – Indigenous peoples – Social exclusion and analysis.	dimensions of environmental management.
Module IV: Sustainable Development through Environmental Law (20 hours)	4.1. History of environmental law, environmental legislation in India, Central and state boards for the prevention and control of environmental pollution, powers and functions of pollution control boards, penalties and procedure, duties and responsibilities of citizens for environment protection 4.2. International cooperative movements. Global Environment monitoring systems (GEMS). Antarctica convention, Stockholm summit, UNCED and its four conventions- climate change biodiversity, desertification, tropical forest, Ramsar convention.	<ul style="list-style-type: none"> • Recall the environmental legislations and how it helps in sustainable development. • Describe international movements and conventions for achieving sustainable development.
References	Reference Books:	
	<ol style="list-style-type: none"> 1. J. Sayer and B. Campbell, The Science of Sustainable Development: Local Livelihoods and the Global Environment (Biological Conservation, Restoration & Sustainability), Cambridge University Press, London, 2003. 2. J. Kirkby, P. O’ Keefe and Timberlake, Sustainable Development, Earth scan Publication, London, 1993. 3. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, An introduction to sustainable development, Glen Educational Foundation, 2008. 4. Jennifer A. Elliott, An introduction to sustainable development. London: Routledge: Taylor and Francis group, 2001. 5. N. Low, Global ethics and environment. London: Routledge. 1999. 6. Douglas Muschett, Principles of Sustainable Development, St. Lucie Press, 19 7. The 17 Goals, https://sdgs.un.org/goals 	
Course Outcomes	CO1: Attaining the national and global environmental, economic and social issues. CO2: the principles of different sustainable development frameworks CO3: Applying the sustainable development principles during the planning of developmental activities CO4: Environmental legislation in Sustainable development	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	-	✓	✓	-	-
CO2	✓	✓	-	✓	✓	-	-
CO3	✓	✓	-	✓	✓	-	-
CO4	✓	✓	-	✓	✓	-	-

Teaching Learning Strategies	Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video) Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method & Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
<ul style="list-style-type: none"> • Test papers 	16
<ul style="list-style-type: none"> • Tutorial with Seminar presentations/Discussions/Debate, etc. 	16
<ul style="list-style-type: none"> • Assignment 	8

Sample Questions to test Outcomes

1. What is sustainable development and why it is need of the hour?
2. Explain the indicators of sustainable development.
3. Comment on Sustainable Development Goals.
4. Explain SDG initiatives in India.
5. Discuss on international cooperatives movements for achieving sustainable development.
6. Explain about UNCED and its four conventions.

Discipline Specific Elective Courses (DSE)

Course Code & Title	MSEVS04DSE11 ENVIRONMENTAL AUDIT
Course Objectives	<p>The Course aims</p> <ul style="list-style-type: none"> • Introduce the concept of environmental audit. • Practical knowledge on conducting an environmental audit. • To recognize various environmental legislations, statutes and their amendments. • Learn about the legal frameworks for conducting an environmental audit. • An introduction to EMS and its standards.

Modules	Contents	Module Outcome
Module I Industrial Pollution and its effects (15 Hours)	<p>1.1. Climate – Weather and Air Pollution.</p> <p>1.2. Classification of water and water bodies – Water Quality Parameters – Water Pollution – Sources – Classification, Nature and Toxicology of water pollutants.</p> <p>1.3. Soil parameters – Soil pollution and impacts – Soil conservation.</p>	<p>The student will be able to:</p> <ul style="list-style-type: none"> • Identify the sources, types, and effects of industrial pollution on the environment, human health, and the economy. • Identify and classify water and water quality. • Observe the soil parameters, and impacts of soil pollution and conservation. • Identify the regulations aimed at preventing and controlling industrial pollution and their effectiveness.
Module II Environmental Law & Policy (25 Hours)	<p>Highlights of the Acts, Institutional arrangements for: (1) The Water (Prevention & Control of Pollution) Act, 1974 amended in 1988; (2) The Air (Prevention and Control of Pollution) Act, 1981 amended in 1987; (3) The Water (Prevention and Control of Pollution) Cess Act, 1977 amended in 1991; (4) The Environment (Protection) Act, 1986; (5) The Public Liability Insurance Act, 1991; (6) Hazardous Waste (Management & Handling) Rules, 1989 amended in 2008</p>	<ul style="list-style-type: none"> • Describe the legal frameworks that regulate environmental issues. • Analyze and interpret key environmental statutes, such as the Water and Air (Prevention & Control of Pollution) Act, Environmental protection

	& 2016 – Indian Policy Statement for abatement of Pollution, 1992.	Act, Public Liability Act and Hazardous Waste Rules etc.
Module III Environmental Auditing (25 Hours)	<p>3.1. Environmental Auditing Definition, Objectives, Scope, Coverage – Policy development: Defining boundaries, Goals, Policy compliance. Organization and staffing of Audit team – Resources.</p> <p>3.2. Approaches to Audit (a) Pre-visit Activity (b) On-site Activities (c) post-Audit activities</p> <p>3.3. Audit Principles – Benefits to Industry, Audit procedure, merits and demerits.</p> <p>3.4. Environmental Audit Types – Environmental Compliance Audit, Environmental Management Audit and Functional Environment Audit. Water Audit, Social Audit and Energy Audit, Carbon Footprint, Water Footprint.</p> <p>3.5. Environmental Auditing Principles and Steps - Environmental auditing activities, Methods of EA, Benefits of EA.</p> <p>3.6. Audit Report and Environmental Statement (ES) – Importance of Audit Report, Reporting Environmental Audit Findings, Fundamentals, Coverage, Confidentiality, Opportunity for dialogue.</p> <p>3.7. Environmental Statement and Public Information – Definition and scope, Protocols, Preparation of Flow diagrams, Material Balance, Preparation of EIS.</p>	<ul style="list-style-type: none"> • Gain the knowledge on environmental auditing. • Observe the audit procedure, principles and types. • Describe the legal frameworks that regulate environmental audit report and environmental statement. • Analyze the importance of audit reports and statements. • Identify the scope and protocols and preparation of EIS.
Module IV Environmental Management Accounting, Environmental Management System and Standards (15 Hours)	<p>4.1. Environmental Management Accounting (EMA) Definition, EMA standards in India, Need and Role of Accountants in Environmental Management, Information included in EMA, Limitations.</p> <p>4.2. Environmental Management System and Standards–Concept, Elements, Benefits of EMS; Certification body Assessments of EMS, Green consumerism and Green Business, EMS Standards - ISO 14000 series.</p>	<ul style="list-style-type: none"> • Recall the environmental management accounting, need and role of accountants in EMA. • Identify the elements and benefits of EMS. • Recall Environment Management Systems and Standards.
References	Reference Books: 1. K.R. Gupta, Environmental Legislation in India	

	<ol style="list-style-type: none"> 2. B. Krishnamoorthy, (2009). Environment Management -Text and Practices, New Delhi: Prentice Hall India. www.prenticehall.india.org third edition. 3. M. Karpagam and G. Jaikumar, (2010), Green Management – Theory and Applications, Ane Books Pvt. Ltd. New Delhi. 4. L.W. Canter (2002). Environmental Impact Analysis, McGraw Hill Book Co., New York, International Chamber of Commerce (1986) ICC Guide to Effective Environmental Auditing, ICC, New York. 5. A.D. Little (1990) Principles for conducting Environmental Health, and Safety Audits, Centre for Environmental Assurance. 6. Ministry of Environment & Forests (1992) Policy Statement for Abatement of Pollution, Govt. of India, New Delhi. 7. C. V. Jayamani and R. Vasanth Gopal (2012), Environmental Management, New Century Publications, New Delhi. 8. V. Kulkarni and T.V. Ramchandra (2006) – Environmental Management, Capital Publishing Company. New Delhi. 9. https://parivesh.nic.in/ 10. https://www.cpcb.nic.in/ 11. https://www.free-ebooks.net/environmental-studies-academic.
Course Outcomes	<p>CO1: Identify and analyse the various phases of Environmental Audit</p> <p>CO2: To recognize Management System and Standards</p> <p>CO3: Learn and identify the industrial pollution</p> <p>CO4: Explain the highlights in the regulatory aspects of Environmental law and policy.</p>

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓

Teaching Learning Strategies	<p>Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning (Video)</p> <p>Interactive Instruction: Active co-operative learning, Seminars, Group Assignments, Library work and Group discussion, Presentation by individual student/ Group representative</p> <p>Field work and field visits, Industrial training and visits</p>
Mode of Transaction	<p>Face to face: Lecture method & Demonstration method</p> <p>Learner centered technique: Computer assisted learning & Individual project teaching</p>

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Test papers	16
• Tutorial with Seminar presentations/Discussions/Debate, etc.	16
• Assignment	8

Sample Questions to test Outcomes

1. Explain air pollution and water pollution.
2. Describe the legal framework that regulates environmental issues.
3. What is environmental auditing? What are the objectives and scope of environmental auditing?
4. Differentiate the types of environmental audit.
5. Briefly explain environmental auditing principles and steps.
6. Comment on Environment Management System and standards.

PROJECT

Course Code & Title	MSEVS04DSC14 – PROJECT WORK
Course Objectives	The Course aims to: - develop Research aptitude in the field of Environmental Sciences - develop skill to prepare research reports

Modules	Activity	Module outcome
	The students have to complete a research project during IV Semester in collaboration with any of the authorized research institutions located within or outside the state.	The student will be able to: <ul style="list-style-type: none"> • Demonstrate skills required for carrying out research • Analyze the data obtained • Write dissertation • Present the research findings
Course Outcome	CO 1: Develop research aptitude CO 2: Analytical skill development CO 3: Writing, listening and presentation skill through electronic media in English. CO 4: Networking skill	

CO -PSO MAPPING

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓

Teaching Learning Strategies	Own learning, practical learning Interactive Instruction: Active co-operative learning, Library work and Group meeting and discussion, Presentation by individual student Field visits
Mode of Transaction	Demonstration method Learner centered technique: Computer assisted learning & Individual project teaching

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	60
Continuous Evaluation	40
• Internal presentation	30
• Internal viva	5
• Project Report	5