

SYLLABUS
FOR
POST GRADUATION (PG) PROGRAMME IN
ENVIRONMENTAL SCIENCE

(Year-2025)

as per

NEP-2020



DEPARTMENT OF ENVIRONMENTAL SCIENCE
SCHOOL OF EARTH AND ENVIRONMENTAL SCIENCE
UNIVERSITY OF KASHMIR, HAZRATBAL, SRINAGAR-190006,
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Vision

To strive for excellence in teaching, research, consultancy and policy formulation for environmental protection and management

Mission

To educate and train students as next-generation thinkers, decision makers and problem solvers in the field of Environmental Science

Preface

The Postgraduate (PG) syllabus in Environmental Science has been designed in accordance with the National Education Policy 2020 (NEP-2020), adopted by the University of Kashmir for implementation at the PG level from the academic session 2025 onwards. The syllabus was formulated by the Board of Postgraduate Studies (BOPGS), constituted under university statutes in its meeting held on 23-06-2025. This curriculum is developed on the national curriculum framework and is aligned with the National Missions as well as the Sustainable Development Goals (SDGs).

Curriculum Framework: The programme offers a flexible multi-level entry and exit system. Students enrolled in the full master's programme can exit after completing the two semesters (1st and 2nd) with a Post Graduate Diploma in Environmental Science.

Students from 4-year undergraduate programmes may enter directly into the 3rd semester and upon completing the 3rd and 4th semesters, will be awarded a 1-year master's degree. Those from 3-year undergraduate programmes can enrol from the 1st semester and earn a 2-year master's degree upon completion of all four semesters.

One-Year P.G. Diploma in Environmental Science:

A student who opts for an exit after completion of 2nd semester will be awarded P.G. Diploma in Environmental Science. To qualify, the student must secure a minimum of 20 credits and maximum of 24 credits per semester with an overall requirement of 40 to 48 credits for one-year P.G. Diploma having minimum of 50% from core courses as prescribed under the University statutes. The programme will be based on Course Work (CW) in both the semesters.

One or Two-years P.G. Programme in Environmental Science:

For the two-year (four-semester) Master's Degree Programme, students are required to complete all four semesters. Each semester carries a credit load of 20–24 credits, making the total requirement for the degree 80–96 credits, with at least 50% of these credits earned from core courses. The curriculum for the first two semesters will consist entirely of coursework. In the third and fourth semesters, depending on the facilities and resources available in the department, students will be offered the following options:

- Course Work (CW) in the all the semesters (CW+CW)
- Research Work (RW) in the fourth Semester in addition to course work in earlier semester/s (CW+R)
- Research (R) in the third and fourth semesters in addition to course work in earlier semesters (R+R), subject to the availability of the resources

For the one-year (two-semester) Master's Programme, students admitted through the lateral entry route after completing a four-year (eight-semester) Bachelor's Degree with Honours or Honours with Research are required to complete the third and fourth semesters in the department. Each semester shall carry 20–24 credits, making the overall credit requirement for the degree 40–48

credits, with at least 50% of these credits earned from core courses. Within this one-year Master's programme, the department will offer the students with the following options:

- Course Work (CW) in third and fourth semesters (CW+CW)
- Course Work (CW) in third semester and Research (R) work in the fourth Semester (CW+R)
- Research (R) in the third and fourth semesters (R+R), subject to the availability of the resources

Course Framework:

Core Courses (CC): The core courses shall follow the following pattern as per the programmes offered:

- **CW+CW:** Each semester will include three core courses of 4 credits each, amounting to 12 courses across all semesters, with a total of 48 credits.
- **CW+R:** In the first, second, third and fourth semesters, students will undertake three core courses of 4 credits each, while the fourth semester will consist of a Research core course carrying 20 credits, making a total of 56 credits.
- **R+R:** First and second semesters will include three core courses of 4 credits each, followed by a Research core course of 40 credits spread across the third and fourth semesters, giving a total of 64 credits.

Discipline Centric Electives Courses (DCEC): The programme includes twelve (12) Discipline-Centric Elective Courses (DCEC), four in the 1st semester, three in the 2nd semester, and five in the 3rd semester. In total, the department offers 38 credits, distributed as 12 credits each in the 1st and 2nd semesters, and 14 credits in the 3rd semester. Students are required to choose a minimum of 8 credits per semester from these electives.

Abbreviations:

CC: Core Course

DCEC: Discipline Centric Elective Course

OEC: Open Elective Course

EEC: Employability and Entrepreneurship Skills Course

SEC: Skill Enhancement Course

P: Project

DI: Dissertation

Programme Learning Outcomes (PLOs)

After completing the PG Programme in Environmental Science, the students will acquire the following learning outcomes:

- **PLO1:** Accomplish holistic growth with strong environmental awareness and ethical values and foster intellectual curiosity, scientific temper and service commitment.
- **PLO2:** Able to effectively contribute in strengthening science-policy-society interface.
- **PLO3:** Develop an understanding and appreciation of interdisciplinary nature, interconnectedness and importance of environmental systems.
- **PLO4:** Develop a broader and comprehensive understanding of environmental pollution scenario.
- **PLO5:** Develop strong analytical skills to utilise scientific methods/techniques and innovations for environmental monitoring, assessment and management.
- **PLO6:** Gain in-depth understanding of environmental policy, regulations, interventions, initiatives and institutions involved in environmental protection.
- **PLO7:** Attain broader understanding and wider perspective on relationship and dynamics between natural resources, biodiversity, microbial diversity and ecosystem services.
- **PLO8:** Professional competence and skill to pursue productive careers in multidisciplinary settings in the field of Environmental Science.

Examination scheme and marks distribution of various courses of Environmental Science programme

Breakup of semester end and Internal marks in each course	4 Credit Courses		2 Credit Courses	
	External (72 Marks)	Internal (28 Marks)	External (36 Marks)	Internal (14 Marks)
	Questions x Marks	Questions x Marks	Questions x Marks	Questions x Marks
Section A (08 short answer type questions (in about 10-20 words))	8x2=16 Marks	As per University policy	8x1=8 Marks	As per University policy
Section B (04 Medium answer type questions with alternatives (in about 200-250 words))	4x6=24 Marks		4x3=12 Marks	
Section C (2 out of 4 long answer type questions (in about 400-500 words))	2x16=32 Marks		2x8=16 Marks	

words) questions to be attempted				
Total Marks in each Course	4 x 25 = 100 Marks		2 x 25 = 50 Marks	

Course Structure of PG Environmental Science under NEP 2020 to be implemented from 2025

SEMESTER-I

Master's Degree in Environmental Science

Semester	Course Code	Course Title	Course Type	Hours per week			Total
				L	T	P	Credits
SEM-I	MEVSCEE125	Essentials of Environmental Science	CC	4	0	0	04
	MEVSCAE125	Advances in Environmental Pollution and Management		4	0	0	04
	MEVSLLC125	Laboratory Course-I		0	0	8	04
	MEVSDET125	Environmental Toxicology	DCEC	3	1	0	04
	MEVSDCC125	Climate Change		3	1	0	04
	MEVSDGE125	Green Environment and Ecotourism		1	1	0	02
	MEVSDME125	Mountain Ecology		1	1	0	02
SEM-II	MEVSCEI225	Environmental Impact Assessment and Auditing	CC	4	0	0	04
	MEVSCEE225	Environmental Engineering		4	0	0	04
	MEVSLLC225	Laboratory course-II		0	0	8	04
	MEVSDRM225	Research Methodology	DCEC	3	1	0	04
	MEVSDM225	Environmental Microbiology and Biotechnology		3	1	0	04
	MEVSDPE225	Environmental planning, Remote Sensing and GIS		3	1	0	04
SEM-III	MEVSCNR325	Natural Resource and Management	CC	4	0	0	04
	MEVSCEP325	Environmental Protection and Sustainability		4	0	0	04
	MEVSLLP325	Laboratory course-III		0	0	8	04
	MEVSDET325	Ecological Tour	DCEC			4	02
	MEVSDRE325	Water Science		3	1	0	04
	MEVSDSS325	Soil Science		3	1	0	04
	MEVSMAS325	Meteorology and Aerosol Science		1	1	0	02
SEM-IV (CW+CW)	MEVSCRE425	Restoration Ecology	CC	4	0	0	04
	MEVSCM425	Environmental Modelling and Geospatial Science		4	0	0	04
	MEVSCWS425	Write shop and outreach activity		0	0	4	02
	MEVSCEE425	Environmental Education	DCEC	1	1	0	02
	MEVSDS425	Energy Studies		3	1	0	04
	MEVSDNH425	Natural Hazards and Disaster Management		3	1	0	04
	MEVSDOG425	Oceanography		1	1	0	02
	MEVSDT425	Ecological Tour/Industrial visit		0	0	4	02
SEM-IV (CW+R)	MEVSCPW425	Project Work	CC	0	0	36	20
SEM-III&IV (R+R)	MEVSCPW325	Project Work	CC	0	0	36	40

Semester-I

Course Title: Essentials of Environmental Science
Course Code: MEVSCEE125
Max. Marks: 100 (External:72; Internal:28)

Course Type: Core
Credits: 04, Hours:60

Course learning outcomes:

MEVSCEE125.1: To have a comprehensive understanding of environmental components

MEVSCEE125.2: To familiarize students with interconnectedness of biome, biodiversity and natural resources

MEVSCEE125.3: To gain an understanding of various analytical techniques for environmental analysis

MEVSCEE125.4: To have a broader understanding of chemical composition of environmental components

Unit I: Fundamentals of Environmental Science

Scope and multidisciplinary nature of environmental science; Components of the environment: atmosphere, hydrosphere, lithosphere, biosphere and cryosphere; Ecosystems: structure and function; Earth surface processes

Unit II: Biodiversity and Natural Resources

Major terrestrial and aquatic biomes; Biodiversity decline: drivers and trends; Biodiversity conservation; Zoogeographical realms; Types and distribution of natural resources: forest, water, mineral, land, and energy resources

Unit III: Analytical Chemistry

Stoichiometry; Thermodynamics and kinetics in environmental systems; Spectroscopy (ICP-MS, Raman, FTIR); Chromatography (HPLC and GC)

Unit IV: Environmental Chemistry

Evolution of Earth's atmosphere; Chemical and photochemical reactions in the atmosphere; Properties of water; Chemical reactions in water: Redox potential and carbonate system; Soil composition: inorganic and organic components; Chemical reactions in soil

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCEE125.1	3	3	3	2	2	2	3	3	2.62
MEVSCEE125.2	3	2	3	2	2	2	3	2	2.38
MEVSCEE125.3	3	2	2	2	3	2	2	3	2.38
MEVSCEE125.4	3	2	2	2	3	2	2	2	2.25
Avg. PLO	3	2.25	2.50	2	2.50	2	2.50	2.25	2.41

Suggested readings:

1. Sharma, B. K. (2011). *Environmental Chemistry*. Goel Publishing House.
2. De, A. K. (2010). *Environmental Chemistry* (7th ed.). New Age International.
3. Manahan, S. E. (2017). *Environmental Chemistry* (10th ed.). CRC Press.
4. Mishra, P. C. (2007). *Environmental Pollution and Control*. APH Publishing.
5. Drever, J. I. (1997). *The Geochemistry of Natural Waters: Surface and Groundwater Environments* (3rd ed.). Prentice Hall.
6. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2002). *Chemistry for environmental engineering and science* (5th ed.). McGraw-Hill.
7. Botkin, D. B., & Keller, E. A. (2014). *Environmental science: Earth as a living planet* (9th ed.). Wiley.
8. De, A. K. (2010). *Environmental Chemistry* (7th ed.). New Age International.
9. Enger, E. D., & Smith, B. F. (2015). *Environmental Science: A study of interrelationships* (14th ed.). McGraw-Hill.
10. Miller, G. T., & Spoolman, S. E. (2015). *Environmental Science* (15th ed.). Cengage Learning.
11. Rajvaidya, N., & Markandey, D. K. (2005). *Environmental analysis and instrumentation*. Narosa Publishing House.
12. Ghosal, S., & Avasthi, A. S. (2nd ed.). (Year). *Fundamentals of bioanalytical techniques and instrumentation* (2nd ed., 504 pp.). Publisher. PHI. Learning.

Master's Degree in Environmental Science
Semester-I

Course Title: Advances in Environmental Pollution and Management **Course Type: Core**
Course Code: MEVSCAE125 **Credits: 04, Hours:60**
Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSCAE125.1: *Students will be able to analyse air pollution dynamics and advanced pollution management strategies*

MEVSCAE125.2: *Students will be able to comprehend drivers of water pollution dynamics and advanced water pollution control strategies*

MEVSCAE125.3: *Students will be able to understand advancement in soil and waste management*

MEVSCAE125.4: *Students will be able to critically evaluate sources, behaviour, fate and risks of emerging contaminants*

Unit I: Air and Noise Pollution

Classification of air pollutants; Chemistry of air pollutants (GHGs, PM, SO_x, NO_x, BVOCs), Air pollution monitoring techniques and standards; Environmental and health impacts; Noise: source and impacts; Advances in noise measurement and instrumentation; Advances in air control and pollutant detection techniques: molecular detection and biosensor technology; RS, Drone and AI in air pollution monitoring and management

Unit II: Water Pollution

Sources and classification of water pollutants; Eutrophication; Water quality standards and monitoring; Environmental and health impacts; Advanced water pollution control strategies: physical (screening, flow equalisation, sedimentation, floatation and aeration), chemical (coagulation, adsorption, ion-exchange, electrokinetic process, chemical precipitation, oxidation and neutralisation, surface and depth filtration, membrane technology and reverse osmosis) and biological (phytobial and microbial remediation); Nanotechnology in water pollution management

Unit III: Soil and Solid Waste Pollution

Soil degradation and pollution; Pesticides, heavy metals and industrial effluents; Soil erosion; Sustainable soil management, Solid waste management (municipal, hazardous, biomedical, e-waste); Advanced techniques in soil remediation; Emerging advanced technologies in soil and waste management; Role of robotics, AI and IoT

Unit IV: Emerging Pollutants

Emerging contaminants and their type (pharmaceuticals, antibiotic resistant genes, personal care products, per- and polyfluoroalkyl substances (PFAS), dioxins, nanomaterials, microplastics, POPs and PAH); Impacts of emerging contaminants on environment and public health; Advanced technology for detection of emerging contaminants; Radiation hazard: sources, pathways and effects; Radiation protection and safety

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCAE125.1	3	2	3	3	3	2	2	3	2.62
MEVSCAE125.2	3	2	2	3	3	2	2	3	2.50
MEVSCAE125.3	3	2	2	3	2	2	3	2	2.37
MEVSCAE125.4	3	3	2	3	2	3	2	2	2.62
Avg. PLO	3	2.75	2.25	3	2.50	2.25	2.25	2.50	2.52

Suggested readings:

1. Jacobson, M. Z. (2024). *Air pollution and global warming: History, science, and solutions* (3rd ed.). Cambridge University Press.
2. Seinfeld, J. H., & Pandis, S. N. (2016). *Atmospheric chemistry and physics: From air pollution to climate change* (3rd ed.). John Wiley & Sons.
3. Food and Agriculture Organization of the United Nations. (2018). *Soil pollution: A hidden reality*. <https://www.fao.org/documents/card/en/c/19183EN/>
4. Chandrappa, R., & Das, D. B. (2024). *Solid waste management: Principles and practice* (2nd ed.). Springer Nature.
5. Ahuja, S. (Ed.). (2018). *Advances in water purification techniques: Meeting the needs of developed and developing countries*. Elsevier.
6. Tonelli, F. M. P., Roy, A., Ozturk, M., & Murthy, H. A. (Eds.). (2024). *Nanotechnology-based sensors for detection of environmental pollution*. Elsevier.
7. Karapanagioti, H. K., & Kalavrouziotis, I. K. (Eds.). (2019). *Microplastics in water and wastewater*. IWA Publishing.
8. Kümmerer, K. (2008). *Pharmaceuticals in the environment: Sources, fate, effects and risks* (3rd ed.). Springer-Verlag.
9. Spellman, F. R. (2020). *The science of water: Concepts and applications* (4th ed.). CRC Press.
10. Sarma, H., Dominguez, D. C., & Lee, W. Y. (Eds.). (2022). *Emerging contaminants in the environment: Challenges and sustainable practices*. Elsevier.
11. Ghosh, S., Habibi-Yangjeh, A., Sharma, S., & Nadda, A. K. (Eds.). (2021). *Nanomaterials for water treatment and remediation*. CRC Press.
12. Murphy, E., & King, E. A. (2022). *Environmental noise pollution: Noise mapping, public health, and policy* (2nd ed.). Elsevier.
13. Nathanson, J. A. (2007). *Basic environmental technology: Water supply, waste management, and pollution control* (5th ed.). Pearson Prentice Hall.
14. Metcalf & Eddy, Inc., Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2013). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Education.
15. Ahmed, T., & Hashmi, M. Z. (Eds.). (2022). *Hazardous environmental micro-pollutants, health impacts and allied treatment technologies*. Springer Nature.
16. Nathanson, J. A., & Schneider, R. A. (2015). *Basic environmental technology: Water supply, waste management and pollution control* (6th ed.). Boston, MA: Pearson.
17. Metcalf & Eddy, A. E. C. O. M. (2014). *Wastewater engineering treatment and resource recovery*. McGraw-Hill Education.
18. Sarma, H. (Ed.), Dominguez, D. C. (Ed.), & Lee, W.-Y. (Ed.). (2022). *Emerging contaminants in the environment: Challenges and sustainable practices* (1st ed.). Elsevier.

**Master's Degree in Environmental Science
Semester-I**

Course Title: Laboratory Course-I

Course Type: Core

Course Code: MEVSLLC125

Credits: 04, Hours:120

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSLLC125.1: Students will gain specific practical skills in measurement of water and soil parameters

MEVSLLC125.2: Students will develop the ability to utilize the standard protocols and techniques for environmental analysis

MEVSLLC125.3: Students will be able to handle and analyze the field data for environmental monitoring

MEVSLLC125.4: Students will be able to handle and operate the basic and advanced instrumentation facilities

1. Preparation, calibration and standardization of chemical reagents for experiments
2. Determination of latitude, longitude and altitude of a place
3. Collection and identification of major rock types
4. Estimation of rate of flow of water and determination of silt load of a stream / river
5. Estimation of total dissolved and suspended solids in water
6. Determination of the soil texture in different terrestrial habitats
7. Determination of pH and conductivity of soil and water samples
8. Determination of free carbon dioxide and alkalinity of water samples
9. Determination of chloride in water and soil samples
10. Estimation of total hardness, calcium and magnesium in water samples
11. Estimation of calcium and magnesium in soil samples
12. Estimation of sodium and potassium in water and soil samples
13. Experimental verification of Beer-Lambert's law
14. Estimation of dissolved oxygen in different waters
15. Estimation of BOD as indicator of organic pollution in different water samples
16. Estimation of COD for water quality assessment in different water samples
17. Estimation of organic carbon and organic matter in different soils samples
18. Study of dose-response relationships of important toxicants/pollutants
19. Study of ambient noise levels and indices in different zones
20. Operational demonstration of GC-MS for environmental samples
21. Operational demonstration of HPLC for environmental samples
22. Operational demonstration of FTIR for environmental samples
23. Ecological foot print of an individual/house/building/Institute
24. Collection and identification of the fish fauna
25. Visit to a high-altitude ecosystem to study ecological characteristics

CLO	PLO								Avg.
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	
MEVSLLC125.1	3	2	3	3	3	2	1	2	2.38
MEVSLLC125.2	3	2	2	2	3	2	1	3	2.25
MEVSLLC125.3	3	3	2	2	3	2	2	2	2.38
MEVSLLC125.4	3	2	2	1	3	1	1	3	2
Avg. PLO	3	2.25	2.25	2	3	1.75	1.25	2.50	2.25

Suggested Readings:

1. APHA (2017). Standard Methods for the Examination of Water and Wastewater (23rd Ed.). APHA Press.
2. Jackson, M. L. (1973). Soil chemical analysis, pentice hall of India Pvt. Ltd., New Delhi, India, 498, 151-154.
3. WHO (1999). Guidelines for Community Noise. World Health Organization.

**Master's Degree in Environmental Science
Semester-I**

Course Title: Environmental Toxicology

Course Type: DCEC

Course Code: MEVSD125

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSD125.1: Students will be able to understand the fundamental principles of toxicology

MEVSD125.2: Students will have a comprehensive understanding of the toxicokinetic and toxicodynamic properties of xenobiotics

MEVSD125.3: Students will be able to comprehend the process of biomagnification and chemical safety measures

MEVSD125.4: Students will get insights on the potential impact of various toxicants on public health

Unit I: Principles of Toxicology

Scope, goals and divisions of toxicology; Factors influencing toxicity; Toxicological interactions; Routes of exposure; Dose - response relationship; Toxicity testing methods

Unit II: Biotransformation of Xenobiotics

Absorption of xenobiotics, membranous barriers, binding and storage; Excretion of xenobiotics; Biotransformation: General principles and types of biotransformation; Cytochrome P450 and Glutathione-S-transferase

Unit III: Biomagnification of Xenobiotics

Bioaccumulation, bioconcentration and biomagnification; Compartment models; Bioassay and its applications in toxicology; Antidotal procedures in toxicology; Chemical safety evaluation

Unit IV: Toxicants as Public Health Hazard

Heavy Metals; Radioactive substances; Food additives; Pesticides; Occupational diseases: Evaluation and control of occupational health hazards; Carcinogenicity, mutagenicity and teratogenicity

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSD125.1	3	2	2	2	1	1	2	2	1.88
MEVSD125.2	3	1	2	3	2	1	3	2	2.12
MEVSD125.3	3	2	2	3	3	1	3	3	2.50
MEVSD125.4	3	2	2	2	2	2	2	2	2.12
Avg. PLO	3	1.75	2	2.50	2	1.25	2.50	1.75	2.16

Suggested Readings:

1. Klaassen, C. D. (Ed.). (2018). *Casarett and Doull's toxicology: The basic science of poisons* (9th ed.). McGraw-Hill.
2. Newman, M. C. (2019). *Fundamentals of ecotoxicology: The science of pollution* (5th ed.). CRC Press.
3. Richards, I. S., & Bourgeois, M. M. (2013). *Principles and practice of toxicology in public health* (2nd ed.). Jones & Bartlett Learning.
4. Stine, K. E., & Brown, T. M. (2006). *Principles of toxicology* (2nd ed.). CRC Press.
5. Boroujerdi, M. (2023). *Handbook of pharmacokinetics and toxicokinetics* (2nd ed.). CRC Press.
6. Omkar. (2017). *Concepts of toxicology* (3rd ed.). Vishal Publishing Co.
7. Landis, W. G., & Yu, M.-H. (2017). *Introduction to environmental toxicology: Impacts of chemicals upon ecological systems* (5th ed.). CRC Press.
8. Schruemann, G & Markert, B. (1997). *Ecotoxicology: Ecological Fundamentals, Chemical exposure and Biological Effects* (Ed). Wiley and Spektrum.
9. Walker, Hopkin, Sibly & Peakall (2006). *Principles of Ecotoxicology*. CRC Press.

Master's Degree in Environmental Science Semester-I

Course Title: Climate Change
Course Code: MEVSDCC125
Max. Marks: 100 (External:72; Internal:28)

Course Type: DCEC
Credits: 04, Hours:60

Course learning outcomes:

MEVSDCC125.1: Students will get insights on fundamentals and complexities of climatology

MEVSDCC125.2: Students will gain an in-depth understanding of the impact of climate change

MEVSDCC125.3: Students will acquire knowledge about different climate mitigation and adaptation strategies

MEVSDCC125.4: Students will be able to analyse the role of various international agreements and frameworks for combating climate change

Unit I: Climatology

Fundamentals of climatology; Classification of climate: Koppen, Thornthwaite; Monsoon and climatic zones of India; Western disturbances and climate of J & K; Paleo-climatology, climate change and climate modelling

Unit II: Climate Change Impacts

Extreme weather events; Climate change impacts: biodiversity, cryosphere, forest and marine ecosystems, agriculture and food security, water resources and public health; Climate-induced migration; Economic losses and social inequalities

Unit III: Mitigation and Adaptation Strategies

Concept of climate vulnerability and risk; Mitigation strategies for different sectors; Adaptation strategies for different sectors; National Action Plan on Climate Change (NAPCC); Nationally Determined Contributions (NDCs); Climate justice and equity

Unit IV: International Agreements

United Nations Framework Convention on Climate Change (UNFCCC); International initiatives: Kyoto Protocol and Paris Agreement; IPCC and emission scenarios; Clean Development Mechanism (CDM); Grassroot activism and climate movements

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDCC125.1	3	2	3	2	1	2	1	2	2.00
MEVSDCC125.2	3	3	3	3	3	3	2	2	2.75
MEVSDCC125.3	3	3	2	2	2	3	2	2	2.37
MEVSDCC125.4	3	2	2	3	2	3	2	2	2.37
Avg. PLO	3	2.50	2.50	2.50	2	2.50	1.75	2	2.37

Suggested readings:

1. IPCC. (2021). *Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://doi.org/10.1017/9781009157896>
2. Ghil, M., & Lucarini, V. (2020). The physics of climate variability and climate change. *Reviews of Modern Physics*, 92(3), Article 035002. <https://doi.org/10.1103/RevModPhys.92.035002>
3. Shukla, P. R., & Sharma, S. K. (Eds.). (2003). *Climate change and India: Vulnerability assessment and adaptation*. Universities Press.
4. Mahdi, S. S. (Ed.). (2018). *Climate change and agriculture in India: Impact and adaptation*. Springer Cham. <https://doi.org/10.1007/978-3-319-90086-5>
5. Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., van Vuuren, D. P., Carter, T. R., Emori, S., Kainuma, M., Kram, T., Meehl, G. A., Mitchell, J. F. B., Nakicenovic, N., Riahi, K., Smith, S. J., Stouffer, R. J., Thomson, A. M., Weyant, J. P., & Zurek, M. B. (2010). The next generation of scenarios for climate change research and assessment. *Nature*, 463(7282), 747–756. <https://doi.org/10.1038/nature08823>

6. IPCC Working Group II. (2022). *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
7. Lal, D. S. (2011). *Climatology*. Sharda Pustak Bhawan.
8. Shideler, J. C., & Hetzel, J. (2021). *Introduction to climate change management: Transitioning to a low-carbon economy* (1st ed.). Springer-Nature Switzerland AG
9. Hulme, M. (2022). *Climate change*. Routledge, Taylor & Francis Group.

**Master's Degree in Environmental Science
Semester-I**

Course Title: Green Environment and Ecotourism

Course Type: DCEC

Course Code: MEVSDGE125

Credits: 02, Hours:30

Max. Marks: 50 (External:36; Internal:14)

Course learning outcomes:

MEVSDGE125.1: To have a better understanding of principles of green and sustainable technology

MEVSDGE125.2: To understand the interconnectedness between tourism and environment

Unit 1: Green Environment

Concept of green buildings and cities; Green building technologies and certifications (LEED, GRIHA); Green consumerism and eco-labelling; Concept of green chemistry; Role of panchayats, municipalities, and NGOs in promoting green environment

Unit II: Ecotourism

Ecotourism: concept, significance and strategies; Tourism in national parks, sanctuaries, wetlands and other landscapes; Criteria for selecting ecotourism sites; Tourism carrying capacity; Ecotourism potential in J&K

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDGE125.1	3	2	2	2	3	3	3	3	2.20
MEVSDGE125.2	3	3	3	2	2	3	3	3	2.20
Avg. PLO	3	2.50	2.50	2	2.50	3	3	3	2.20

Suggested readings:

1. Kubba, S. (2016). *Handbook of green building design and construction: LEED, BREEAM, and Green Globes* (2nd ed.). Butterworth-Heinemann.
2. Savla, H. (2021). *Green building: Principles & practices*. Independently published.
3. Malya, R. S., & Duhan, P. (Eds.). (2019). *Green consumerism: Perspectives, sustainability, and behavior*. Apple Academic Press.
4. Tiwari, V. K., Kumar, A., Rajkhowa, S., Tripathi, G., & Singh, A. K. (2022). *Green chemistry: Introduction, application and scope*. Springer.
5. Ceballos-Lascurain, H. (1996). *Tourism, ecotourism, and protected areas*. IUCN.
6. Gale, T., & Hill, J. (Eds.). (2016). *Ecotourism and environmental sustainability: Principles and practice*. Routledge.
7. Frost, W., & Hall, C. M. (Eds.). (2009). *Tourism and national parks: International perspectives on development, histories and change*. Routledge.
8. Mowforth, M., & Munt, I. (2016). *Tourism and sustainability: Development, globalisation and new tourism in the Third World* (4th ed.). Routledge.
9. Coccossis, H., & Mexa, A. (Eds.). (2004). *The challenge of tourism carrying capacity assessment: Theory and practice*. Ashgate Publishing.
10. Sharma, R., & Rao, P. (Eds.). (2019). *Environmental impacts of tourism in developing nations*. IGI Global.
11. United Nations World Tourism Organization. (2010). *Tourism and biodiversity: Achieving common goals towards sustainability*. UNWTO.
12. Woolley, T., Kimmins, S., Harrison, P., & Harrison, R. (2002). *Green building handbook: Volume 1*. Spon Press.
13. Ceballos-Lascurain, H. (1996). *Tourism, ecotourism, and protected areas*. IUCN.
14. Gautham, R. K. (2009). *Green homes: Efficient, healthy and smart*. BS Publications.

Master’s Degree in Environmental Science

Semester-I

Course Title: Mountain Ecology

Course Type: DCEC

Course Code: MEVSDME125

Credits: 02, Hours:30

Max. Marks: 50 (External:36; Internal:14)

Course learning outcomes:

MEVSDME125.1: *Students will be able to understand human environmental interactions and assess mountain vulnerability and sustainability to climate change*

MEVSDME125.2: *Students will be able to gain knowledge on distribution and management of physical and biological resources of Kashmir Himalaya*

Unit I: Mountain Ecology

Global distribution and classification of mountains; Ecological zonation: montane, subalpine, alpine, nival; Mountain ecosystem services; Impacts of climate change on mountain ecosystems; Drivers of change to mountain sustainability

Unit II: Himalayan Resources

Overview of Himalayan mountain system; Kashmir himalayan resources: glacial, water, forests, agricultural, biodiversity, energy (hydropower) and mineral

CLO	PLO								Avg.
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	
MEVSDME125.1	3	3	3	3	2	2	3	3	2.75
MEVSDME125.2	3	3	3	2	2	2	3	3	2.10
Avg. PLO	3	3	3	2.50	2	2	3	3	2.41

Suggested Readings:

1. Ives, J. D., & Messerli, B. (1989). *The Himalayan dilemma: Reconciling development and conservation*. Routledge.
2. Singh, S. P. (2006). *Ecology of the Indian Himalaya*. Gyanodaya Prakashan.
3. Price, M. F. (1995). *Mountain research in Europe: An overview of MAB research from the Pyrenees to Siberia*. UNESCO.
4. International Centre for Integrated Mountain Development. (n.d.). *Reports on ecosystem services, climate change adaptation, and sustainability in the Hindu Kush Himalaya*. <https://www.icimod.org>
5. Körner, C. (2003). *Alpine plant life: Functional plant ecology of high mountain ecosystems* (2nd ed.). Springer.
6. Dar, G. H., Khuroo, A. A., & Khan, M. A. (2013). *Biodiversity of the Himalaya: Jammu and Kashmir State*. Scientific Publishers.
7. Ahmad, M. (2012). *Resource geography of Jammu and Kashmir*. Dilpreet Publishing House.
8. Wani, M. H., & Khursheed, R. (2014). *Agriculture in Jammu & Kashmir: Performance and challenges*. Dilpreet Publishing.
9. Kumar, M., & Rizvi, S. H. (2021). *Water resources of J&K Himalaya: Issues and strategies*. Himalayan Publishing House.
10. Department of Ecology, Environment, and Remote Sensing, Jammu & Kashmir. (n.d.). *J&K State Action Plan on Climate Change (SAPCC)*. <https://jkdears.com>

SEMESTER-II

**Master's Degree in Environmental Science
Semester-II**

Course Title: Environmental Impact Assessment and Auditing

Course Type: Core

Course Code: MEVSCEI225

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSCEI225.1: To gain a basic understanding of the core concepts, processes and legal framework of EIA

MEVSCEI225.2: To develop capacity to apply different methods for identification, prediction, evaluation and mitigation of environmental impacts of development projects

MEVSCEI225.3: To gain an in-depth understanding of EIA and SEA processes through case studies

MEVSCEI225.4: To learn environmental management systems through environmental auditing and risk management

Unit I: Fundamentals of EIA

Environment impact assessment: Concept and objectives; EIA process; Impact evaluation and prediction; Issues and challenges; EIA notification 2006 and amendments; Environment Protection Act, 1986

Unit II: EIA Methodologies

EIA Methods; Baseline data collection; Physical impact assessment; Biological impact assessment; Social impact assessment; Cost benefit analysis

Unit III: Strategic Environmental Assessment

SEA: Concept and process; Case studies of EIA (Hydro power and town area development); Case studies of SEA (hydropower and industrial estate); Environmental Performance Indicators (EPIs) and benchmarking

Unit IV: Environmental Auditing and Risk Management

Principles and guidelines of environmental auditing; Preparation of environmental audit report; Environment management system ISO 14000 series; Life Cycle Assessment (LCA); Risk assessment and management

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCEI225.1	3	2	3	2	3	3	2	3	2.62
MEVSCEI225.2	3	3	2	2	3	3	2	3	2.62
MEVSCEI225.3	3	3	2	2	3	3	2	3	2.62
MEVSCEI225.4	3	3	3	2	3	3	2	3	2.50
Avg. PLO	3	3	2.50	2	3	3	2	3	2.59

Suggested readings:

1. Canter, L. W., & Wood, C. (1996). Environmental impact assessment (Vol. 2). New York: McGraw-Hill.
2. Rau, J. G., & Wooten, D. C. (1980). *Environmental impact analysis handbook*. McGraw-Hill.
3. Anjaneyulu, Y., & Manickam, V. (2011). *Environmental impact assessment methodologies* (2nd ed.). BS Publications.
4. Ministry of Environment, Forest and Climate Change. (2006). *EIA Notification 2006 (with amendments)*. Government of India. http://moef.gov.in/wp-content/uploads/2018/03/EIA_notification_2006.pdf
5. World Bank. (1991). *Environmental assessment sourcebook*. World Bank. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/337051468739290923/environmental-assessment-sourcebook>

6. Petts, J. (Ed.). (1999). *Handbook of environmental impact assessment: Vol. 1. Process, methods and potential*. Blackwell Science.
7. Glasson, J., Therivel, R., & Chadwick, A. (2019). *Introduction to environmental impact assessment* (5th ed.). Routledge.
8. Sadler, B. (1996). *Environmental assessment in a changing world: Evaluating practice to improve performance*. Canadian Environmental Assessment Agency.
9. United Nations Environment Programme. (2002). *EIA training resource manual* (2nd ed.). UNEP. <https://www.unep.org/resources/report/environmental-impact-assessment-training-resource-manual-second-edition>
10. World Bank. (2018). *Environmental and social framework (ESF)*. World Bank. <https://www.worldbank.org/en/projects-operations/environmental-and-social-framework>
11. Quality Council of India-National Accreditation Board for Education and Training. (n.d.). *Guidelines for EIA consultants*. QCI-NABET. <https://nabet.qci.org.in/>

**Master’s Degree in Environmental Science
Semester-II**

Course Title: Environmental Engineering

Course Type: Core

Course Code: MEVSCEE225

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSCEE225.1: To get acquainted with basic principles and approaches of sanitation and environmental and green engineering

MEVSCEE225.2: To gain knowledge of public water supply systems, distribution, purification and treatment methods

MEVSCEE225.3: To comprehend the design and functioning of wastewater drainage systems along with treatment methods and technologies

MEVSCEE225.4: Gain insights into control measures and technologies for managing air, noise, and soil pollution.

Unit I: Fundamentals of Environmental Engineering

Scope of environmental engineering; Ecological sanitation; Eco-restoration; Green engineering and sustainable practices; Ecosystem based designs; Mass transfer and transformation

Unit II: Water Resource Engineering

Overview of public water supply systems; Water distribution systems; Water purification methods for public supply: Screening; Coagulation; Flocculation; Sedimentation; Filtration; Disinfection methods; Advanced treatment processes

Unit III: Waste Water Engineering

Sewage and storm water drainage; Treatment methods and technologies: primary, secondary and tertiary (advanced), trickling filter, activated sludge, Rotating Biological Contractors (RBCs), Fluidized Bed Reactor (FBR), Sequencing Batch Reactor (SBR), Membrane Bioreactor (MBR), Disinfection theory: methods and means

Unit IV: Air and Soil Engineering

Concept of ventilation; Air conditioning; Green technologies for air pollution control; Noise control engineering; Soil remediation techniques; Design and operation of sanitary landfills; Recycling and waste-to-energy technologies.

CLO \ PLO	PLO								Avg.
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	
MEVSCEE225.1	3	3	3	3	3	3	2	3	2.87
MEVSCEE225.2	3	3	2	2	3	3	3	3	2.75
MEVSCEE225.3	3	2	3	3	3	3	3	3	2.87
MEVSCEE225.4	3	2	2	3	3	3	2	3	2.62
Avg. PLO	3	2.50	2.50	2.75	3	3	2.50	3	2.78

Suggested Readings:

- Nathanson, J. A. (2007). *Basic environmental technology: Water supply, waste management, and pollution control* (5th ed.). Pearson Prentice Hall.
- Metcalf & Eddy, Inc., Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2013). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Education.
- Rao, P. V. (2008). *Textbook of environmental engineering*. PHI Learning.

4. Valsaraj, K. T. (2009). *Elements of environmental engineering: Thermodynamics and kinetics* (3rd ed.). CRC Press.
5. Helmer, R., & Hespanhol, I. (Eds.). (1997). *Water pollution control: A guide to the use of water quality management principles*. E & FN Spon.
6. Bitton, G. (2010). *Wastewater microbiology* (4th ed.). Wiley-Blackwell.
7. Williams, P. T. (2013). *Waste treatment and disposal* (2nd ed.). Wiley.
8. Gomes, K. (2010). *Wastewater management*. Oxford Book Company.
9. Karia, G. L., & Christian, R. A. (2013). *Wastewater treatment: Concepts and design approach* (2nd ed.). PHI Learning.
10. Hammer, M. J., & Hammer, M. J., Jr. (2012). *Water and wastewater technology* (7th ed.). Pearson.
11. Riffat, R., & Husnain, T. (2022). *Fundamentals of wastewater treatment and engineering*. CRC Press.

Master's Degree in Environmental Science
Semester-II

Course Title: Laboratory course-II
Course Code: MEVSLLC225
Max. Marks: 100 (External:72; Internal:28)

Course Type: Core
Credits: 04, Hours:120

Course learning outcomes:

- MEVSLLC225.1:** *To develop hands-on training for conducting Environmental Impact Assessment (EIA), socio-economic surveys, public perception studies and statistical analysis*
- MEVSLLC225.2:** *To acquire practical skills for conducting microbial culturing techniques*
- MEVSLLC225.3:** *To develop skill on application of GIS, remote sensing and GPS tools for mapping land use and drainage*
- MEVSLLC225.4:** *To build understanding of protected and biodiversity rich areas through field work and reporting*

1. EIA – Leopold Matrix method and case studies
2. Methodology for socio-economic studies-survey, interview and focal discussions
3. Assessment of Environmental literacy in society regarding environmental issues
4. Computation of standard deviation, standard error and coefficient of variation
5. Computation of correlation and regression
6. One way classification of ANOVA
7. Data collection techniques (GPS and field surveys)
8. Land use / land cover classification from satellite data
9. Delineation of drainage of a given area from satellite data
10. Delineation of point, line and polygon themes
11. Waste auditing of any institution/ organization
12. Working and design of sewage treatment plants
13. Jar test for dosage and turbidity measurement
14. Disinfection agents and dose determination
15. Detection and enumeration of coliform bacteria in water samples
16. Biochemical tests for different enzymes
17. Preparation of bacterial smears and gram staining
18. Estimation of bacterial population in different water samples by culture technique
19. Estimation of fungal population in different habitats through culture techniques
20. Collection and identification of common aquatic macrophytes
21. Phytosociological analysis of plant community in the field
22. Measurement of Forest biomass through allometry
23. Quantification of forest standing stock of litter and carbon analysis
24. Visit to a National Park/ wild life sanctuary/natural forest (data collection and report preparation)
25. Field trip to an Industrial area /Hydropower project (data collection and report preparation)

Suggested readings:

1. Shaw, & Peter, J. A. S. (2009). Introductory multivariate statistics for the environmental science. John Wiley & Sons.
2. Mariappan, P. (2013). Biostatistics. Pearson Education India.
3. Dengler, J. (2016). Phytosociology. International Encyclopedia of Geography: People, the Earth, Environment and Technology: People, the Earth, Environment and Technology, 1-6.
4. Collins, C. H., & Lyne, P. M. (1984). Microbiological methods. Butterworth & Co. (Publishers) Ltd, 88 Kingsway, London WC2B 6AB.
5. Wilks, Daniel S. Statistical methods in the atmospheric sciences. Vol. 100. Academic press, 2011.
6. Bergeron, B. P. (2003). Bioinformatics computing. Prentice Hall Professional.
7. Prakash, A. (2021). Remote sensing and geographical information system. Academic Aspirations.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSLLC225.1	3	3	2	2	3	2	2	3	2.50
MEVSLLC225.2	3	1	2	2	3	1	3	2	2.12
MEVSLLC225.3	3	2	3	3	3	2	2	3	2.62
MEVSLLC225.4	3	3	3	3	3	2	3	2	2.75
Avg. PLO	3	2.25	2.50	2.50	3	1.75	2.50	2.50	2.50

**Master's Degree in Environmental Science
Semester-II**

Course Title: Research Methodology

Course Type: DCEC

Course Code: MEVSDRM225

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSDRM225.1: *To provide a fundamental knowledge for formulation of research hypothesis*

MEVSDRM225.2: *Ability to draw inferences and meaningful conclusion from research datasets*

MEVSDRM225.3: *Cultivation of research ethics and fair use of modern tools for conducting research*

MEVSDRM225.4: *Ability to communicate and disseminate research findings to various stakeholders*

Unit I: Research Foundations

Meaning and nature of research, Types of research: exploratory, experimental and descriptive; Types of research data: primary, secondary, qualitative, quantitative and mixed; Formulation of research problem and hypotheses; Review of literature; Research design; Case studies

Unit II: Data Analysis

Data collection; Development of scales/questionnaire/schedules/tests; Sampling: types, methods and errors; Measurement scales- nominal, ordinal, Likert scale; Data distribution; Measure of central tendency; Measurement of dispersion; Correlation and regression; Analysis of variance

Unit III: Research Ethics

Research ethics; Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP); Publication misconduct; Predatory publishers and journals. Use of plagiarism softwares like Urkund, Turnitin and other

CLO	PLO								Avg.
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	
MEVSDRM225.1	3	3	1	2	2	2	2	2	2.12
MEVSDRM225.2	3	3	3	2	3	2	2	2	2.50
MEVSDRM225.3	3	3	1	1	3	2	1	2	2
MEVSDRM225.4	3	3	2	3	3	3	2	3	2.75
Avg. PLO	3	3	1.75	2	2.75	2.25	1.75	2.25	2.34

open-source software tools; AI and ethics

Unit IV: Scientific writing

Research report: Writing, structure and components of thesis; Manuscript writing, Project grant writing; Policy paper document; Science, technology and innovation in India; funding agencies/research schemes

Suggested Readings:

1. Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.
2. Henderson, P. A., & Southwood, T. R. E. (2016). *Ecological methods* (4th ed.). Wiley-Blackwell.
3. Ford, E. D. (2000). *Scientific method for ecological research*. Cambridge University Press.
4. Booth, W. C., Colomb, G. G., & Williams, J. M. (2008). *The craft of research* (3rd ed.). University of Chicago Press.

- Bell, J., & Waters, S. (2018). *Doing your research project: A guide for first-time researchers* (7th ed.). Open University Press.
- Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K., & Schlüter, M. (Eds.). (2021). *Handbook of research methods for social-ecological systems*. Routledge.
- Hilborn, R., & Mangel, M. (1997). *The ecological detective: Confronting models with data*. Princeton University Press.
- Flick, U. (2023). *Introducing research methodology: A beginner's guide to doing a research project* (3rd ed.). Sage Publications India.

Master's Degree in Environmental Science

Semester-II

Course Title: Environmental Microbiology and Biotechnology

Course Type: DCEC

Course Code: MEVSDM225

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSDM225.1: To understand and analyse microbial interactions and their role in nutrient cycling

MEVSDM225.2: To gain knowledge about the causes and impacts of air, water and soil borne diseases

MEVSDM225.3: To gain an in-depth understanding of various biotechnological interventions for environmental management

MEVSDM225.4: To understand the applications of genomic tools for pollution control and resource management

Unit I: Microbes and Environment

Microorganisms in environment; Factors effecting microbial growth, growth curve; Microbial interactions; Role of microbes in carbon, nitrogen, phosphorus and sulphur cycles

Unit II: Microorganisms and Human Health

Human health and environment: Air borne microbial diseases: (SARS, COVID, Influenza, Tuberculosis); Water borne microbial diseases: (Hepatitis, Cholera, Typhoid, Giardiasis); Soilborne disease: (Tetanus, Botulism)

Unit III: Applied Environmental Biotechnology

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDM225.1	3	2	3	2	3	2	3	2	2.50
MEVSDM225.2	3	2	3	2	2	2	3	2	2.12
MEVSDM225.3	3	2	2	2	3	3	2	3	2.50
MEVSDM225.4	3	2	2	2	3	2	3	3	2.50
Avg. PLO	3	2	2.5	2	2.75	2.12	2.75	2.50	2.41

Biodegradation and bioremediation; Bio-composting and biogas production; Biofuels and biomining; Biosensors in environmental biomonitoring; Ecofriendly approach of biofertilizers

Unit IV: Environmental Genomics & Applications

Biotechnology in pollution control; Environmental genomics: A key concept of e-DNA; Metagenomics: environmental applications; Genetically modified organisms and biosafety: an account; Bioprospecting: use of microbial enzymes

Suggested Readings:

- Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2001). *Microbiology* (5th ed.). McGraw-Hill Education.
- Rittmann, B. E., & McCarty, P. L. (2020). *Environmental Biotechnology: Principles and Applications* (2nd ed.). McGraw-Hill Education.

3. Martin, C. C. (Ed.). (2007). *Environmental Genomics*. Humana Press.
4. Selendy, J. M. H. (Ed.). (2011). *Water and Sanitation-related Diseases and the Environment: Challenges, Interventions, and Solutions* (1st ed.). Wiley-Blackwell.
5. Konur, O. (Ed.). (2018). *Bioenergy and Biofuels* (1st ed.). CRC Press.
6. Buckley, R. G. (2016). *Environmental Microbiology*. CBS Publishers & Distributors.
7. Gupta, R. K., & Singh, S. S. (2016). *Environmental Biotechnology: A New Approach*. Astral International.
8. Tyagi, I., Kumar, V., & Karri, R. R. (Eds.). (2024). *Environmental Metagenomics, Water Quality, and Suggested Remediation Measures of Polluted Waters: A combined approach* (1st ed.). Elsevier. Mohapatra, P. K. (2013). *Textbook of Environmental Biotechnology* (1st ed.). I. K. International Publishing House Pvt. Ltd.

**Master’s Degree in Environmental Science
Semester-II**

Course Title: Environmental planning, Remote Sensing and GIS
Course Code: MEVSDEP225
Max. Marks: 100 (External:72; Internal:28)

Course Type: DCEC
Credits: 04, Hours:60

Course learning outcomes:

- MEVSDEP225.1:** *To understand the core principles of environmental planning guided by ethical, aesthetic, and scientific considerations*
- MEVSDEP225.2:** *To develop an understanding of remote sensing tools and techniques*
- MEVSDEP225.3:** *To analyse spatial and non-spatial data with GIS tools*
- MEVSDEP225.4:** *To apply remote sensing and GIS to tackle real-world environmental issues*

Unit I: Environmental Planning

Environmental planning – importance and objectives; Land use planning and zoning; Urban and rural development and environmental planning; Smart city concept; carbon neutrality; Role of ethics, aesthetics and science in environmental planning

Unit II: Remote Sensing

Remote sensing: concept and history; Electromagnetic spectrum: EMR sources-active & passive, radiation laws; Resolution: spatial, spectral, radiometric and temporal; Remote sensing satellites: LANDSAT & IRS satellite series; Image processing and interpretation; Aerial photographs

CLO \ PLO	PLO								Avg.
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	
MEVSDEP225.1	3	2	2	2	3	3	3	3	2.62
MEVSDEP225.2	3	2	3	2	3	2	2	3	2.50
MEVSDEP225.3	3	2	3	2	3	2	2	3	2.50
MEVSDEP225.4	3	2	3	2	3	2	3	3	2.62
Avg. PLO	3	2	2.75	2	3	2.25	2.5	3	2.56

Unit III:

Geographic Information System (GIS)

GIS: history and development; Functional requirements: Hardware configuration, software modules; Geographic data: Spatial and non-spatial data types; Geospatial data models: raster and vector; Global Positioning System (GPS)

Unit IV: Applications of Remote Sensing and GIS

Environmental impact assessment; Biodiversity conservation; Watershed management; Land-use planning; Disaster management; Urban and rural planning; Natural resource mapping

Suggested readings:

1. Clark, J. J. (2020). *Uneven innovation: The work of smart cities* (Illustrated ed.). Columbia University Press.
2. Benninger, C. C. (2001). Principles of intelligent urbanism. *Ekistics*, 69(412), 39–65.
3. Kunstler, J. H. (2019). *The geography of nowhere: The rise and decline of America's man-made landscape* (A. Kessel, Narr.) [Audiobook]. Tantor Media.
4. Jensen, J. R. (2006). *Remote sensing of the environment: An earth resource perspective* (2nd ed.). Pearson Education.
5. Weng, Q. (2016). *Remote sensing for sustainability* (1st ed.). CRC Press.
6. Bolstad, P. V. (2016). *GIS fundamentals: A first text on geographic information systems* (6th ed.). XanEdu Publishing.
7. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). *Geographic information science and systems* (4th ed.). Wiley.
8. Mohan, B., Munoth, S., and Sharma, J. (Eds.). (2021). *Smart buildings and cities with remote sensing and GIS*. Routledge.

SEMESTER-III

**Master's Degree in Environmental Science
Semester-III**

Course Title: Natural Resource and Management

Course Type: Core

Course Code: MEVSCNR325

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSCNR325.1: *Students will be able to analyse the patterns of natural resource distribution and depletion*

MEVSCNR325.2: *Students will gain an understanding of sustainable land use planning and water resource management*

MEVSCNR325.3: *Students will be able to understand the energy resource dynamics and management*

MEVSCNR325.4: *Students will learn about the distribution and management of forest and mineral resources*

Unit I: Natural Resource Management

Introduction to natural resource base: Concept and factors influencing resource availability, distribution and uses; Interrelationships among different types of natural resources; Resource depletion; causes and consequences; Ecological, social and economic dimension of resource management

Unit II: Land and Water Resources Management

Land suitability and sustainable land management; Land restoration and reclamation; Integrated Soil Management (ISM); Watershed management; Water harvesting techniques; Sustainable irrigation practices; Integrated Water Resource Management (IWRM)

Unit III: Energy Resource Management

Global and national energy demand-supply scenario; Components of energy management, goal and strategies for sustainable management; Energy management and its present scenario in India; Energy policy of India; Emerging energy alternatives; Energy mix and energy nexus

Unit IV: Forest and Mineral Resource Management

Forests, types, global distribution, issues and threats; Sustainable forest management; CAMPA, REDD+; Forest conservation in India; recent initiatives and programs; Forest Rights Act, 2006; Classification of mineral resources; Mineral resources in India with special reference to J&K; Mineral Resource Management (MRM); National mineral policy of India; Sand mining in J&K

Suggested readings:

1. Chiras, D. D. (2013). *Environmental science: Creating a sustainable future* (9th ed.). Jones & Bartlett Learning.
2. Brady, N. C., & Weil, R. R. (2016). *The nature and properties of soils* (15th ed.). Pearson Education.

3. Dwivedi, R. S. (2001). *Natural resources: Conservation and management*. CBS Publishers & Distributors.
4. Sharma, P. D. (2011). *Ecology and environment* (10th ed.). Rastogi Publications.
5. Joshi, P. K., Pal, S., & Gulati, A. (2013). *Sustainable agricultural and natural resource management*. Academic Foundation.

**Master’s Degree in Environmental Science
Semester-III**

Course Title: Environmental Protection and Sustainability
Course Code: MEVSCEP325
Max. Marks: 100 (External:72; Internal:28)

Course Type: Core
Credits: 04, Hours:60

Course learning outcomes:

- MEVSCEP325.1:** Gain knowledge about legal and regulatory framework for environmental protection
MEVSCEP325.2: Understand the ongoing efforts and initiatives for the protection of environment
MEVSCEP325.3: Develop critical thinking for shaping strategies for implementation of sustainable alternatives
MEVSCEP325.4: Imbibe sustainability as a practice in life, society, academics and industry

Unit I: Legal and Regulatory Framework

Evolution and principles of environmental protection: UNEP principle 10; Principles (Polluter pays, Precautionary, no fault; Waste management hierarchy, conservation), Public trust doctrine; Evolution of environmental laws and policy in India; Provisions of Indian constitution (Article 21, 48A, 51A and 253); National Environmental Policy-2006

Unit II: Environmental Initiatives

International efforts for environment protection: UNEP, major environmental milestones, Ramsar convention-1971, Stockholm-1972, CITES-1973, Basal convention-1989, ESPO convention-1991; Indian initiatives: Three waves of environmentalism in India, Comprehensive Environmental Pollution Index (CEPI), Lighting a billion lives, National Electric Mobility Mission Plan (NEMMP), Swatch Bharat Mission (SBM), National Clean Air Programme (NCAP), Single use plastic ban

Unit III: Sustainable Practices

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCNR325.1	3	2	2	2	2	2	3	2	2.25
MEVSCNR325.2	3	2	3	3	3	2	3	2	2.62
MEVSCNR325.3	3	2	3	3	2	3	3	2	2.62
MEVSCNR325.4	3	2	3	3	2	2	3	2	2.50
Avg. PLO	3	2	2.75	2.75	2.25	2.25	3	2	2.50

Engineering for sustainability; Renewable energy use; Responsible consumption; Sustainable living spaces; Sustainable mobility; Sustainable diets; Sustainable waste practices; Traditional environment friendly practices; Sustainable business practices from environmental economic perspective: Hydroponics, plant based packaging, eco-design, resource efficiency

Unit IV: Environmental Sustainability

Sustainable development; Principles of sustainable development; Sustainable Development Goals (SDGs): Structure and framework; Good practice principles for sustainable infrastructure; Sustainable consumption and production policy; Environmental Performance Index (EPI); Environmental Sustainability Index (ESI); Environmental Impact Index (EII); Circular economy

Suggested readings:

1. Leelakrishnan, P. (2021). *Environmental law in India* (6th ed.). LexisNexis.
2. Singh, A., Tyagi, A. C., & Saha, D. (Eds.). (2019). *Water governance: Challenges and prospects*. Springer Nature Singapore.
3. Kolliopoulos, A., Rieu-Clarke, A., Tanzi, A., McIntyre, O., & Kinna, R. (Eds.). (2015). *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its contribution to international water cooperation*. Brill Nijhoff.
4. Rosencranz, A., Divan, S., & Noble, M. L. (2022). *Environmental law and policy in India: Cases and materials* (3rd ed.). Oxford University Press.
5. Prabhakar, V. K. (2001). *Environmental protection and law*. Anmol Publications.

Master's Degree in Environmental Science

Semester-III

Course Title: Laboratory course-III

Course Code: MEVSLLP325

Max. Marks: 100 (External:72; Internal:28)

Course Type: Core

Credits: 04, Hours:60

Course learning outcomes:

MEVSLLP325.1: *To enable advanced understanding of the standard protocols used for the analysis of water, soil and air*

MEVSLLP325.2: *To acquire practical understanding of criteria and emerging pollutants in different environmental components*

MEVSLLP325.3: *Detailed understanding of the biomonitoring of the aquatic systems using multiple ecological indices*

MEVSLLP325.4: *Application of data for assessment of ecosystem quality*

1. Field visit to IMD for meteorological instrumentation and weather data recording
2. Estimation of nitrogen (NH₃, NO₂ and NO₃) in different water samples
3. Estimation of ortho and total phosphorus in different water samples
4. Estimation of available and total phosphorus in different soil samples
5. Estimation of total nitrogen content in different soil samples
6. Estimation of dissolved silica and sulphate in different water bodies
7. Determination of SO_x, NO_x and Particulate Matter (PM) in ambient air
8. Determination of air quality status based on pollutant concentrations and AQI standards
9. Determination of primary productivity aquatic and terrestrial habitats
10. Detection and quantification of microplastics in soil and water
11. Extraction and analysis of pesticide residues from environmental matrices

CLO	PLO								Avg.
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	
MEVSCEP325.1	3	2	2	3	2	3	3	2	2.5
MEVSCEP325.2	3	2	3	3	2	3	2	3	2.62
MEVSCEP325.3	3	3	2	2	3	3	2	3	2.62
MEVSCEP325.4	3	3	3	2	3	2	2	3	2.62
Avg. PLO	3	2.5	2.5	2.5	2.5	2.75	2.25	2.75	2.59

12. Estimation of protein content in biological samples
13. Estimation of carbohydrate content in biological samples
14. Determination of rate of soil erosion in different ecosystems
15. Estimation of dust accumulated on plant parts and its effect on morphology and anatomy
16. Qualitative and quantitative estimation of phytoplankton community in different aquatic habitats and their application in biomonitoring using multiple ecological indices
17. Qualitative and quantitative estimation of periphyton community in different aquatic habitats and their application in biomonitoring using multiple ecological indices

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSLLP325.1	3	3	3	2	3	3	2	3	2.75
MEVSLLP325.2	3	2	3	3	3	2	3	2	2.62
MEVSLLP325.3	3	2	3	2	3	2	2	3	2.38
MEVSLLP325.4	3	3	3	2	3	2	2	2	2.50
Avg. PLO	3	2.5	3	2.25	3	2.25	2.25	2.25	2.56

18. Qualitative and quantitative estimation of zooplankton community in different aquatic habitats and their application in biomonitoring using multiple ecological indices
19. Qualitative and quantitative assessment of macroinvertebrates across various aquatic habitats and their application in biomonitoring using multiple ecological indices
20. Application of diversity indices in aquatic and terrestrial ecosystems
21. Estimation of Chlorophyll-a and FDOM (Fluorescent Dissolved Organic Matter) in different water samples using water multiparameter probe (Sonde)
22. Assessment of water quality status based on physicochemical parameters using WQI
23. Spring and stream order classification
24. Study of colonization potential of periphyton on artificial substrates
25. Morphometric and bathymetric survey of a lake or pond

Suggested Readings

1. Dengler, J. (2016). Phytosociology. International Encyclopedia of Geography: People, the Earth, Environment and Technology: People, the Earth, Environment and Technology, 1-6.
2. Collins, C. H., & Lyne, P. M. (1984). Microbiological methods. Butterworth & Co. (Publishers) Ltd, 88 Kingsway, London WC2B 6AB.
3. Wilks, Daniel S. Statistical methods in the atmospheric sciences. Vol. 100. Academic press, 2011.
4. APHA (2017). Standard Methods for the Examination of Water and Wastewater (23rd Ed.). APHA Press.
5. Jackson, M. L. (1973). Soil chemical analysis, pentice hall of India Pvt. Ltd., New Delhi, India, 498, 151-154.
6. WHO (1999). Guidelines for Community Noise. World Health Organization.

**Master's Degree in Environmental Science
Semester-III**

Course Title: Ecological Tour

Course Code: MEVSDDET325

Max. Marks: 50 (External:36; Internal:14)

Course Type: DCEC

Credits: 02, Hours:30

Course learning outcomes:

MEVSDDET325.1: *To gain field-based insights of ecosystems, biodiversity, and environmental processes through direct observation and data collection.*

MEVSDDET325.2 *To gain exposure by visiting premier institutions and laboratories for academic and research opportunities*

During the 3rd semester, students may opt for an ecological tour conducted within the country, preferably in the Indian Himalayan states. The tour, carrying 2 credits, is a part of the DCEC. Of these, 1 credit will be awarded for participation, and 1 credit for field collection, tour report, and viva voce.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDDET325.1	3	3	3	3	3	3	3	3	3
MEVSDDET325.2	3	3	2	2	3	2	3	3	2.62
Avg. PLO	3	3	2.5	2.5	3	2.5	3	3	2.81

**Master's Degree in Environmental Science
Semester-III**

Course Title: Water Science

Course Type: DCEC

Course Code: MEVSDWS325

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSDWS325.1: *Ability to comprehend importance of water distribution and drivers shaping allocation and consumption patterns*

MEVSDWS325.2: *Ability to understand hydrological processes both at watershed and catchment scales.*

MEVSDWS325.3: *Ability to understand magnitude of various water issues and challenges*

MEVSDWS325.4: *Ability to apply concepts and principles of water governance, policy frameworks, and diplomacy for sustainable water management*

Unit I: Water Resources

Importance of water in earth systems and ecosystems; Distribution of global water resources (surface water, groundwater, glaciers, wetlands); Water resources of India; Water and ecosystem services; Water resource allocation and consumption (industrial, domestic and agriculture)

Unit II: Hydrology

Hydrological processes; Surface-groundwater interactions; Watershed and catchment hydrology; Impacts of land use, vegetation and climate change on hydrological processes; Hydrograph & hyetograph concepts: assumptions and limitations; Basics of ground water hydrology; Hydrological models: types and applications

Unit III: Water Issues

Threats to water resources; Water crisis: growing demand, declining health; Water footprint, stress, scarcity and insecurity; Poverty and water; Gender conceptualization; Water inaccessibility; Overexploitation of water resources; Fragmentation of river ecosystems; Water resources management: principles, challenges and strategies

Unit IV: Water Governance and diplomacy

Water security; Integrated Water Resource Management (IWRM) approaches; Transboundary and interstate water conflicts and treaties; National and international water policy frameworks; Water diplomacy: tools and processes, legal and institutional framework; Role of data, information and knowledge in water cooperation and diplomacy for transboundary river management

Suggested readings:

1. Cech, T. V. (2018). *Principles of water resources: history, development, management, and policy*. John Wiley & Sons.
2. Davie, T. (2019). *Fundamentals of hydrology*. Routledge.
3. Brutsaert, W. (2023). *Hydrology*. Cambridge university press.
4. Clarke, R. (2013). *Water: the international crisis*. Routledge.
5. Willhite, D., & Pulwarty, R. S. (Eds.). (2017). *Drought and water crises: integrating science, management, and policy*. Crc Press.
6. Islam, S., & Susskind, L. E. (2012). *Water diplomacy: A negotiated approach to managing complex water networks*. Routledge.
7. Vij, S., Warner, J., & Barua, A. (2020). Power in water diplomacy. *Water International*, 45(4), 249-253.
8. Zareie, S., Bozorg-Haddad, O., & Loáiciga, H. A. (2021). A state-of-the-art review of water diplomacy. *Environment, Development and Sustainability*, 23(2), 2337-2357.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDWS325.1	3	2	2.5	2.5	2	2.5	2	2.5	2.38
MEVSDWS325.2	3	2	3	3	2.5	3	3	2	2.56
MEVSDWS325.3	3	3	3	3	2	3	2	2	2.63
MEVSDWS325.4	3	3	3	2	2.5	3	2.5	3	2.75
Avg. PLO	3	2.5	2.75	2.62	2.25	2.75	2.38	2.38	2.58

**Master's Degree in Environmental Science
Semester-III**

Course Title: Soil Science

Course Code: MEVSDSS325

Max. Marks: 100 (External:72; Internal:28)

Course Type: DCEC

Credits: 04, Hours:60

Course learning outcomes:

MEVSDSS325.1: *Able to understand soil as a natural resource and its relevance in pedology and edaphology*

MEVSDSS325.2: *Able to understand the basics of physical and chemical properties of soils*

MEVSDSS325.3: *Able to assess the role of soil biodiversity in maintaining soil health*

MEVSDSS325.4: *Able to apply soil conservation practices and integrated nutrient management strategies for soil management*

Unit I: Fundamentals of Soil Science

Soil genesis and weathering processes; Soil forming factors and processes; Soil profile development; Soil mineralogy: Primary and secondary minerals; Soil colloids: Clay minerals, organic colloids, ion exchange and surface charge; Soil taxonomy and classification

Unit II: Soil Properties

Soil physical properties; Soil water (retention, movement and availability); Mechanisms of gas movement (diffusion and mass flow); Soil buffering capacity (CEC, OM and pH); Nutrient dynamics (C, N, P, S)

Unit III: Soil Biology

Classification and functions of soil organisms; Soil microbial biomass; Enzyme activities in soil; Soil respiration; Soil organic matter: decomposition and stabilization; Soil-plant-microbe interaction; Soil Quality Index (SQI) and standards

Unit IV: Applied Soil Science and Management

Soil fertility evaluation methods; Fertilizer use efficiency and Integrated Nutrient Management (INM); Soil carbon sequestration and climate change mitigation; Advances in soil remediation strategies; Soil information systems

Suggested readings:

1. Brady, N. C., & Weil, R. R. (2022). *The nature and properties of soils* (15th ed.). Pearson Education.
2. Baver, L. D., Gardner, W. H., & Gardner, W. R. (1972). *Soil physics* (4th ed.). John Wiley & Sons.
3. Hanks, R. J., & Ashcroft, G. L. (1980). *Applied soil physics: Soil water and temperature applications*. Springer-Verlag.
4. Hillel, D. (1980). *Applications of soil physics*. Academic Press.
5. Indian Society of Soil Science. (2002). *Fundamentals of soil science*. Indian Society of Soil Science.
6. Oswal, M. C. (1994). *Soil physics*. Oxford & IBH Publishing.

**Master’s Degree in Environmental Science
Semester-III**

Course Title: Meteorology and Aerosol Science
Course Code: MEVSDMA325
Max. Marks: 50 (External:36; Internal:14)

Course Type: DCEC
Credits: 02, Hours:30

Course learning outcomes:

MEVSDMA325.1: *To get well versed with dynamics and complexities of the meteorology and its application in forecasting*

MEVSDMA325.2: *To get acquainted with the sources and distribution of aerosols in the atmosphere*

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDSS325.1	3	2	3	2.5	2.5	2	3	3	2.62
MEVSDSS325.2	3	2	3	2	2	2	3	2	2.5
MEVSDSS325.3	3	2	3	3	2.5	3	3	2	2.68
MEVSDSS325.4	3	2.5	2.5	3	2.5	2.5	2.5	2.5	2.62
Avg. PLO	3	2.12	2.87	2.62	2.37	2.37	2.87	2.37	2.60

Unit I:

Meteorology

Meteorological parameters: Atmospheric pressure, temperature, precipitation, humidity, Wind, Radiation and heat budget; Atmospheric stability and lapse rates; Weather analysis and forecasting techniques

Unit II: Atmospheric Aerosols

Aerosols: types, sources, transformation, geographical distribution and atmospheric effects; Chemical composition of aerosols; Carbonaceous aerosols; Aerosol monitoring and measurement

Suggested readings:

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDMA325.1:	3	2	2	2	3	2	3	2	2.37
MEVSDMA325.2	3	2	3	3	3	2	3	2	2.75
Avg. PLO	3	2	2.5	2.5	3	2	3	2	2.56

1. Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: An introductory survey* (2nd ed.). Academic Press.
2. Lutgens, F. K., & Tarbuck, E. J. (2019). *The atmosphere: An introduction to meteorology* (14th ed.). Pearson.
3. Rogers, R. R., & Yau, M. K. (1989). *A short course in cloud physics* (3rd ed.). Pergamon Press.
4. Intergovernmental Panel on Climate Change. (n.d.). *IPCC assessment reports and special reports*. <https://www.ipcc.ch/reports/>
5. World Meteorological Organization. (n.d.). *WMO guidelines and publications*. <https://public.wmo.int/en/resources/library>
6. India Meteorological Department. (n.d.). *IMD publications and reports*. <https://mausam.imd.gov.in/>

SEMESTER-IV

Master's Degree in Environmental Science Semester-IV

Course Title: Restoration Ecology

Course Code: MEVSCRE425

Max. Marks: 100 (External:72; Internal:28)

Course Type: CC

Credits: 04, Hours:60

Course learning outcomes:

MEVSCRE425.1: *Students will be able to get insights on principles and practices of Restoration ecology*

MEVSCRE425.2: *Students will be able to identify suitable and appropriate policy and planning strategies for ecological restoration*

MEVSCRE425.3 *Students will develop ecological restoration projects and select appropriate methods for monitoring and evaluating restoration outcomes*

MEVSCRE425.4: *Students will be able to critically analyse the scientific and technical components of ecological restoration research and practices*

Unit I: Principles of Restoration Ecology

Basic principles and concepts of restoration ecology; Characteristics of degraded and restored ecosystems; Ecological indicators in restoration; Theory and practice of restoring animal and plant diversity; Ecological principles of the restoration of native ecosystems

Unit II: Restoration Planning

Goals and objectives; Restoration planning and design; Adaptive management and monitoring; Ethics of restoration; Role of public-private partnership in restoration; Policy instruments in restoration ecology

Unit III: Ecotechnology and Restoration tools

Basic principles and applications of ecotechnology; Biomimicry and ecological engineering in restoration ecology; Ecological design principles; Ecological site assessment and inventory; Evaluating and monitoring restoration outcomes; Role of GIS and remote sensing in restoration ecology; Measuring progress and success of restoration programs

Unit IV: Ecosystem Restoration

Ecological restoration of forest and grassland ecosystems; Basic concepts and case studies. Reclamation of mining sites and disturbed lands; Prevention and mitigation of invasive species; Ecological restoration of aquatic systems: River corridors, wetlands and lakes, springs; Restoration of riparian and floodplain ecosystems

Suggested Readings:

- Allison, S. D., & Murphy, S. D. (Eds.). (2019). Ecosystem collapse and restoration. Oxford University Press.
- Benedetti-Cecchi, L. (2021). Marine restoration ecology. Oxford University Press.
- Benson, M. H., & Phillips, A. (Eds.). (2016). Ecosystem services and conservation in urbanizing Asia. Springer.
- Higgs, E. S., Falk, D. A., Guerrini, A., Hall, M. P., & Harris, J. G. (Eds.). (2021). The Routledge handbook of ecological and environmental restoration. Routledge.
- Moreno-Mateos, D., & Perring, M. P. (Eds.). (2019). Ecological restoration and environmental change: Renewing damaged ecosystems in a changing world Routledge.
- Palmer, M. A., Zedler, J. B., & Falk, D. A. (Eds.). (2021). Foundations of restoration ecology (2nd ed.). Island Press.

**Master’s degree in Environmental Science
Semester-IV**

Course Title: Environmental Modelling and Geospatial Science
Course Code: MEVSCM425

Course Type: CC
Credits: 04, Hours:60

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCRE425.1	3	2.5	3	3	2.5	3	2.5	3	2.81
MEVSCRE425.2	3	3	2.5	2	3	2.5	3	3	2.75
MEVSCRE425.3	3	3	2.5	2	3	3	2.5	3	2.75
MEVSCRE425.4	3	3	2	2.5	3	2	2.5	3	2.62
Avg. PLO	3	2.87	2.5	2.37	2.87	2.62	2.62	3	2.73

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

- MEVSCM425.1:** Students will be able to understand environmental models from conceptual design to real-world application
- MEVSCM425.2:** Students will be able to implement appropriate environmental models for informed environmental decision-making
- MEVSCM425.3:** Students will be able to apply image enhancement and classification techniques to produce validated spatial data products
- MEVSCM425.4:** Students will be able to design and implement advanced spatial and geostatistical analyses

Unit I: Basics of Environmental Modelling

Role and scope of models in environmental science and management; Model types: deterministic vs. stochastic; static vs. dynamic; linear vs. nonlinear; Model development steps: conceptualization, formulation, calibration, validation, and practical application; Statistical methods: regression analysis, time-series analysis, sensitivity analysis, and uncertainty quantification

Unit II: Environmental & Ecosystem Modelling

Population dynamics models (Lotka-Volterra and Leslie); Air quality models (Gaussian plume, line and area source); Water-quality models (QUAL2K, SWAT); Soil erosion and sediment transport models (RUSLE, SWAT modules); Land-use/land-cover change models (CLUE-S, DLS)

Unit III: Applied Remote Sensing & GIS

Electromagnetic radiation and surface interaction; Image processing; Image enhancement; Classification methods and validation procedures; GIS data management (spatial data input, editing, and management, database design and query languages); Geospatial spatial data models; Open-source geospatial data and processing.

Unit IV: Advanced Geospatial Analysis

Spatial analysis techniques; Geostatistical methods and interpolation techniques; Integration of remote sensing data with GIS; 3D visualization and terrain modelling; Basics of scripting and automation in GIS (e.g., Python, R).

Suggested readings:

1. Wainwright, J., & Mulligan, M. (Eds.). (2013). *Environmental modelling: Finding simplicity in complexity* (2nd ed.). Wiley.
2. Schnoor, J. L. (1996). *Environmental modeling: Fate and transport of pollutants in water, air, and soil*. Wiley-Interscience.
3. Jain, S. K., & Singh, V. P. (2019). *Engineering hydrology: An introduction to processes, analysis, and modeling* (1st ed.). McGraw Hill.
4. Parnis, J. M., & Mackay, D. (2020). *Multimedia environmental models: The fugacity approach* (3rd ed.). CRC Press.
5. Beven, K. (2012). *Environmental modelling: An uncertain future?* Routledge.
6. Jakeman, A. J., Beck, M. B., & McAleer, M. (Eds.). (1993). *Modelling change in environmental systems*. Wiley.
7. Rizzoli, A. E., & Young, W. J. (1997). Delivering environmental modelling tools to decision makers: The integrated modelling approach. *Environmental Modelling & Software*, 12(2–3), 101–108.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCEM425.1	3	3	2	2	3	2	2	3	2.50
MEVSCEM425.1	3	2	2	1	3	2	3	3	2.37
MEVSCEM425.1	3	3	2	1	3	1	1	3	2.12
MEVSCEM425.1	3	2	2	2	3	1	3	3	2.37
Avg. PLO	3	2.5	2	1.50	3	1.50	2.25	3	2.34

8. Jørgensen, S. E., & Bendricchio, G. (2001). *Fundamentals of ecological modelling* (3rd ed.). Elsevier.
9. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to remote sensing* (5th ed.). Guilford Press.
10. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote sensing and image interpretation* (7th ed.). John Wiley & Sons.
11. Bhatta, B. (2008). *Remote sensing and GIS* (2nd ed.). Oxford University Press.
12. Jensen, J. R. (2016). *Introductory digital image processing: A remote sensing perspective* (4th ed.). Pearson.
13. Bolstad, P. (2016). *GIS fundamentals: A first text on geographic information systems* (5th ed.). Eider Press.
14. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). *Geographic information science and systems* (4th ed.). Wiley.
15. Zandbergen, P. A. (2020). *Python scripting for ArcGIS Pro*. Esri Press.

16. Law, M., & Collins, A. (2023). *Getting to know ArcGIS Pro 3.2* (5th ed.). Esri Press.
17. Shin, M., Campbell, J., & Burkhart, S. (2022). *Essentials of geographic information systems* (3rd ed.). FlatWorld.
18. Zandbergen, P. A. (2019). *Python scripting for ArcGIS Pro*. Esri Press.
19. Chang, K.-T. (2019). *Introduction to geographic information systems* (9th ed.). McGraw-Hill Education.
20. Rees, W. G. (2013). *Physical principles of remote sensing* (3rd ed.). Cambridge University Press.

**Master's Degree in Environmental Science
Semester-IV**

Course Title: Write Shop
Course Code: MEVSCWS425
Max. Marks: 50 (External:36; Internal:14)

Course Type: CC
Credits: 02, Hours:60

Course learning outcomes:

MEVSCWS425.1: *Students will master skills and practices on digital content creation by researching and publishing sustainability-focused blogs/piece*

MEVSCWS425.2: *Students will strengthen journalistic writing by producing researched articles and reviews on environmental issues*

Note: This course focuses on the skills and practices needed to convey information and knowledge related to Environment in a way having broad appeal and effective messaging for non-scientific audience. The course will be assessed on completing any of the two activities: 1. Science communication, 2. Documentary making, 3. Infographic, 4. Policy Brief, 5. Internship, each evaluated for accuracy, clarity, engagement, creativity, and relevance by examiner.

Activity 1: Science Communication

Task: Students will pick any theme or topic related to environment and publish a news-style article/ blog/ letter for a newspaper/magazine/journal of repute

Activity 2: Environmental Documentary Making

Description: Students will create a documentary on pressing environmental issues

Activity 3: Infographic

Task: Design and develop a visual infographic to communicate an environmental science concept, process, phenomena, issue, problem etc.

Activity 4: Policy Brief

Task: Prepare a brief for policymakers or local administrators on any pressing environmental issue and challenges

Activity 5: Internship

Task: Students will undergo internship at a local school to assist teaching and impart environmental education for upgradation of pedagogical skills.

Suggested readings:

1. Bayer, R. (2020). *Resource Review: Project Learning Tree PreK-8 Environmental Education Activity Guide. Journal of Youth Development, 15(5), 12.*
2. Sachsman, D. B., & Valenti, J. M. (Eds.). (2020). *Routledge handbook of environmental journalism. London and New York: Routledge.*
3. Hardy, N. (2009). *A writer's green guide: how to work for the environment. Poets & Writers Magazine, 37(1), 89-93.*
4. Risdahl, A. (2006). *The everything blogging book: Publish your ideas, get feedback, and create your own worldwide network. Simon and Schuster*

**Master’s Degree in Environmental Science
Semester-IV**

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCEE425.1	3	2.5	3	2.5	3	3	2.5	2.5	2.75
MEVSCEE425.2	3	3	2.5	2	2.5	2.5	2	3	2.56
Avg. PLO	3	2.75	2.75	2.25	2.75	2.75	2.25	2.75	2.65

Course Title: Environmental Education and Humanities

Course Type: CC

Course Code: MEVSCEE425

Credits: 02, Hours:30

Max. Marks: 50 (External:36; Internal:14)

Course learning outcome:

MEVSCEE425.1: *Able to understand the philosophy and importance of environmental education*

MEVSCEE425.2: *Able to equip students to understand the critique and respond to environmental issues by analyzing their social, cultural, ethical and historical dimensions.*

Unit 1: Environmental Education

Environmental education: Goals and objectives; Evolution of environmental education: Global and Indian perspectives; Formal, non-formal and informal environmental education; Use of ICT, digital platforms and social media in Environmental Education; Community-based environmental education, NGOs, and citizen science; National and international policies/frameworks (UNESCO, UNEP, NCF, NEP 2020)

Unit II Environmental Humanity

Introduction to Environmental humanities; Classical concepts: Environmental Kuznets curve and stewardship; Contemporary concepts: corporate environmental responsibility and tipping points; Environmental ethics, values and worldviews; Classic approaches: Ecofeminism and environmental politics; Contemporary approaches: sustainability and vulnerability science

Suggested readings:

1. Robbins, P. (2007). *Encyclopedia of environment and society* (Vols. 1–5). SAGE Publications.
2. Schreurs, M., & Papadakis, E. (2003). *The A to Z of the green movement*. Scarecrow Press.
3. Mishra, S. (2016). *Environmental education: Principles and policies*. APH Publishing.
4. Ganguly, D., & Ghole, V. S. (2023). *Textbook of environmental education*. PHI Learning.
5. Beach, R., & Smith, B. E. (2023). *Youth-created media on the climate crisis: Hear our voices*. Routledge.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCEE425.1	3	3	3	3	2	3	2.5	3	2.81
MEVSCEE425.2	3	3	2.5	2.5	3	3	2.5	3	2.81
Avg. PLO	3	3	2.75	2.75	2.5	3	2.5	3	2.81

Master's Degree in Environmental Science Semester-IV

Course Title: Energy Studies

Course Code: MEVSDES425

Max. Marks: 100 (External:72; Internal:28)

Course Type: DCEC

Credits: 04, Hours:60

MEVSDES425.1: *Able to understand and explain conventional energy sources, their consumption patterns, and associated environmental and social impacts*

MEVSDES425.2: *Able to analyse global and national energy demands, security issues, economic factors, and institutional roles*

MEVSDS425.3: *Able to evaluate renewable energy technologies, emerging innovations, and pathways toward decarbonization*

MEVSDS425.4 *Able to assess the interlinkages between energy, climate change, and sustainable development policies at multiple scales*

Unit I: Conventional Energy Sources

Introduction to energy and its importance in society and development; Overview of conventional energy sources: coal, petroleum, natural gas, hydro, nuclear, and thermal power generation; Energy consumption patterns at global and national level; Environmental and social impacts of conventional energy use

Unit II: Energy Perspectives

Global and national energy demands: trends and challenges; Energy security and geopolitics of energy; Energy economics: pricing, subsidies and markets; Technological perspectives on energy efficiency and conservation; Role of policy and institutions in shaping the energy sector

Unit III: Future Energy Scenarios

Renewable energy sources: solar, wind, biomass, geothermal, tidal, hydrogen; other unconventional energy sources; Emerging technologies: smart grids, energy storage, carbon capture; Future energy mix and pathways to decarbonization; Energy forecasting models and scenario-building

Unit IV: Energy and Sustainable Development

Energy and climate change linkages; Concept of energy nexus; Sustainable energy systems: SDG7 (Affordable and Clean Energy); Low-carbon economies and green energy transitions; Community-based energy solutions and decentralized systems; Policies for sustainable energy: international agreements, national missions and local initiatives

Suggested readings

1. Armstrong, F., & Blunde, K. (2007). *Energy beyond oil*. Oxford University Press.
2. Roosa, S. A., Doty, S., & Turner, W. C. (2018). *Energy management handbook* (9th ed.). River Publishers.
3. Gonzalez, J. (Ed.). (2017). *Energy planning: Approaches and assessment* (Energy policies, politics and prices). Nova Science Publishers.
4. Kaushik, S. C., Pathi, S. G., & Reddy, V. S. (2010). *Energy conservation awareness and opportunities*. Arihant Prakashan Pvt. Ltd.
5. Petroleum Conservation Research Association. (2011). *Energy saving in industry: Real life case studies*. Petroleum Conservation Research Association.
6. Kleinpeter, M. (1995). *Energy planning and policy*. John Wiley & Sons.
7. Kumar, L. A., & Ganesan, G. (Eds.). (2022). *Energy audit and management: Concept, methodologies, procedures, and case studies*. CRC Press.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDS425 .1	3	2	2.5	3	2	2.5	2.5	2	2.43
MEVSDS425.2	3	2.5	3	2.5	2	3	3	2	2.5
MEVSDS425.3	3	2	3	2	2.5	3	2.5	2	2.5
MEVSDS425.4	3	3	3	2	2.5	2.5	2	2	2.5
Avg. PLO	3	2.37	2.87	2.37	2.25	2.75	2.50	2	2.48

Master’s Degree in Environmental Science

Semester-IV

Course Title: Natural Hazards and Disaster Management

Course Type: DCEC

Course Code: MEVSDNH425

Credits: 04, Hours:60

Max. Marks: 100 (External:72; Internal:28)

Course learning outcomes:

MEVSDNH425.1: *Able to comprehend the concept and impacts of hazard and disasters*

MEVSDNH425.2: *Able to learn hazard mapping and forecasting techniques to assess to identify multi-hazard scenarios.*

MEVSDNH425.3: Able to evaluate risk and vulnerability through geoinformatics applications and role of technology, planning, and public participation.

MEVSDNH425.4: Able to examine and understand the principles, policies, and institutional frameworks of disaster management

Unit I: Hazards

Concept of hazard, disaster, vulnerability and risk; Classification of natural hazards; Causes, distribution and impact of hazards (earthquake, volcanoes, landslides, floods, drought, cyclones, cloud bursts, heatwave, cold wave and forest fire)

Unit II: Hazard Analysis

Hazard mapping, zonation and monitoring techniques; Estimation of potential causes; Geological processes leading to natural hazards; Short-term and long-term prediction; Multi hazard assessment; Early warning system and forecasting

Unit III: Risk and Vulnerability Assessment

Concept of risk and vulnerability; Components of risk; Application of geoinformatics in hazard, risk & vulnerability assessment; Concept of mitigation; types of mitigation; Use of technologies in mitigations; Importance of planning, exercise and training in preparedness; Role of public and media in hazard preparedness

Unit IV: Disaster Management

Basic principles; Disaster management cycle; Disaster management policy; National and state bodies of disaster management; Community-Based Disaster Risk Reduction (CBDRR); Role of technology: GIS, Remote sensing in disaster management; Disaster Management Act 2005

Suggested readings:

1. Edward A Keller and Robert H Blodgett. 2008. Natural hazards. Pearson Prentice Hall, 488p.
2. Bankoff, G., Frerks, G. and Hilhorst, D. 2004. (eds.) Mapping Vulnerability: Disasters, Development, and People, Earthscan, London.
3. Birkmann, J. 2007. "Risk and vulnerability Indicators at Different Scales: Applicability, Usefulness and Policy Implications", Environmental Hazards, 7 (1): 20-31.
4. Burton, I., Kates, R.W. And White, G.F. 1968. "The Human Ecology of Extreme GeoPhysical Events", Natural Hazard Research, Working Paper#1 Karuson, K. and 3
5. MacManus, S.A. 2011. "Gauging Disaster Vulnerabilities at the Local Level: Divergence and Convergence in an all-Hazard System", Administration and Society, XXX:1-26

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDNH425.1	3	2	3	2	2.5	2	3	2.5	2.5
MEVSDNH425.2	3	2.5	3	2.5	3	2.5	3	2	2.68
MEVSDNH425.3	3	2	2	2	3	3	2	2	2.37
MEVSDNH425.4	3	3	3	2	2.5	3	2	2.5	2.37
Avg. PLO	3	2.37	2.75	2.12	2.75	2.62	2.5	2.25	2.48

6. Quarantelli, E. L. 1998 (eds) What is a Disaster? Perspectives on the Question, Routledge, London.
7. Wisner, B., Blaikie, P., Cannon, T. and Davis, I. 2004. At Risk: Natural Hazards, People's Vulnerability and Disasters, Second Edition, Routledge, London.
8. Birkmann J (2006): Measuring Vulnerability to promote disaster resilient societies: Conceptual frameworks and definitions, United Nations University Press, Pg. 9-54. Coburn, Spence & Pomonis (1991): Actions to reduce risk in Disaster Mitigation, UNDP/UNDRO Manual, Pg. 15 – 27.
9. Bryant Edwards, 2005. Natural hazard. Cambridge University press, UK. Coburn, Spence & Pomonis (1991): Mitigation Strategies, UNDP-UNDRO Manual, Pg. 29 – 34.
10. Jeannette Sutton and Kathleen Tierney (2006) Disaster Preparedness: Concepts, Guidance, and Research, Natural Hazards Center, Institute of Behavioral Science, University of Colorado, Accessible at McEntire D A (2005): Why Vulnerability Matters: Exploring the merit of an inclusive disaster reduction concept, Disaster Prevention and Management, 14 (2), Pg. 206- 222.

11. Morrow B H (1999): Identifying and Mapping Community Vulnerability, *Disasters*, 23 (1): 1-18.
12. Rautela P and RK Pande (2005): Implications of ignoring the old disaster management plans: Lessons from the Amparav tragedy of 23 September 2004 in the Nainital district of Uttarakhand (India), *Disaster Prevention and Management*, 14 (2), Pg. 388-394.
13. Weichselgartner F (2001): Disaster Mitigation: The concept of Vulnerability Revisited, *Disaster Prevention and Management*, 10 (2), Pg. 85- 94.
14. Wisner B (2004): Assessment of Capability and Vulnerability in Bankoff G, Frerks G and Hilhorst D eds. 'Mapping Vulnerability: Disasters, Development & People', Earthscan, Pg. 183- 193.
15. Wisner B et al (2005): At Risk: Natural Hazards, People's Vulnerability and Disasters, London and New York, Routledge, Pg. 319 – 376. 15. Wisner B et al (2005): At Risk: Natural Hazards, People's Vulnerability and Disasters, London and New York, Routledge, Pg. 49-87.

**Master's Degree in Environmental Science
Semester-IV**

Course Title: Oceanography

Course Code: MEVSDOG425

Max. Marks: 50 (External:36; Internal:14)

Course Type: DCEC

Credits: 02, Hours:30

Course learning outcomes:

MEVSDOG425.1: *Students will learn fundamental concepts of oceanography*

MEVSDOG425.2: Students will be able to understand marine ecosystems, resources and related environmental issues

Unit I: Introduction to Oceanography

Scope and branches of oceanography; Origin of oceans; Ocean floor features; Seawater properties: physical and chemical; Ocean circulation

Unit II: Marine Environment and Resources

Marine ecosystems; Primary productivity; Marine sediments; Marine mineral resources; Fisheries oceanography; Climate ocean interactions; Marine pollutants

Suggested readings:

1. Pereira, L., & Pardal, M. A. (2024). Introductory chapter: General overview on oceanography. *Oceanography-Relationships of the Oceans with the Continents, Their Biodiversity and the Atmosphere*.
2. Denny, M. (2008). *How the ocean works: an introduction to oceanography*. Princeton University Press.
3. Wang, Y. (Ed.). (2020). *Coastal and marine environments*. CRC Press.
4. Kennish, M. J. (2017). *Practical handbook of estuarine and marine pollution*. CRC press.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDOG425.1	3	2	3	2.5	2	2.5	2	2	2.37
MEVSDOG425.2	3	2	3	2.5	2	2.5	2	2	2.37
Avg. PLO	3	2	3	2.5	2	2.5	2	2	2.37

5. Pinet, P. R. (2019). *Invitation to oceanography* (8th ed.). Jones and Bartlett Publishers, Inc.
6. Abel, D. C., & McConnell, R. L. (2009). *Environmental oceanography: Topics and analysis* (1st ed.). Jones and Bartlett Publishers, Inc.
7. Singh, S. (2015). *Oceanography*. Generic.
8. Levinton, J. (2017). *Marine biology: Function, biodiversity, ecology* (5th ed.). OUP USA.

**Master’s Degree in Environmental Science
Semester-IV**

Course Title: Ecological Tour/Industrial Visit
Course Code: MEVSD425
Max. Marks: 50 (External:36; Internal:14)

Course Type: DCEC
Credits: 02, Hours:30

Course learning outcomes:

MEVSDet425.1: To gain field-based insights of ecosystems, biodiversity, and environmental processes through direct observation and data collection.

MEVSDet425.2 To gain exposure by visiting industries/premier institutions and laboratories for academic and research opportunities

In the 4th semester, students have the option to undertake an ecological tour or an industrial visit within the country. This tour, allotted 2 credits under the DCEC, carries one credit for participation and another for fieldwork, report preparation, and viva-voce.

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSDet425.1	3	3	3	3	3	3	3	3	3
MEVSDet425.2	3	3	2	2	3	2	3	3	2.62
Avg. PLO	3	3	2.5	2.5	3	2.5	3	3	2.81

Master's Degree in Environmental Science
Semester-IV
(CW+R)

Course Title: Project Work
Course Code: MEVSCPW425
Max. Marks: 500 (External:360; Internal:140)

Course Type: Core
Credits: 20

Course learning outcome:

MEVSCPW425.1: Pursue research which is socially relevant, locally need based, nationally important and globally significant

MEVSCPW425.2: Well trained in applying modern tools for environmental analysis and experimentation

MEVSCPW425.3: Apply critical thinking skills to analyse data and synthesize research findings

MEVSCPW425.4: Able to convey scientific information in a clear and easy-to-understand form

MEVSCPW425.5: Lead and offer solutions to environmental issues both independently and through collaboration

MEVSCPW425.6: Demonstrate intellectual flexibility to view and analyse environmental questions from multiple perspectives

MEVSCPW425.7: Provide sustainable solutions to overcome regional environmental problems

Description: A student shall undertake 6-month Project Dissertation (Short-term Research Study) related to the environment as per the following framework:

1. Orientation and Topic Finalization (3 weeks)

Selection of research area/theme

Literature review and gap identification

Setting objectives, hypothesis & synopsis

2. Methodology Development (4 weeks)

Training in relevant field/lab techniques

Designing sampling protocols or analytical frameworks

Ethical and safety clearance (if needed)

3. Data Collection & Experimentation (12 weeks)

Field sampling / surveys / lab analysis

Pilot testing for feasibility

Preliminary data processing

4. Data Analysis & Interpretation (3-weeks)

Statistical and/or GIS analysis

Comparison with existing literature

5. Report Writing & Presentation (4-weeks)

Dissertation.

Viva-voce / seminar presentation

Note: During the course of the dissertation, the student is expected to present two seminars, Synopsis seminar & progress report prior to the submission, followed by the viva-voce by an external examiner. The internal assessment (140 marks) will be based on attendance (40), seminar presentation (50) and performance (50). The external examination (360) will be based on the dissertation evaluation (290) and viva voce (70).

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCPW425.1	3	2	3	2	3	3	3	2	2.62
MEVSCPW425.2	3	3	2	2	3	2	2	3	2.5
MEVSCPW425.3	3	3	2	2	3	1	2	3	2.37

MEVSCPW425.4	3	3	2	1	3	3	3	2	2.5
MEVSCPW425.5	3	3	2	3	3	2	3	2	2.62
MEVSCPW425.6	3	3	3	1	3	2	3	1	2.37
MEVSCPW425.7	3	2	2	2	2	1	3	3	2.25
MEVSCPW425.8	3	3	2	2	2	2	3	2	2.37
Avg. PLO	3	2.75	2.25	1.87	2.75	2	2.75	2.25	2.45

Suggested Readings

1. Shaw, & Peter, J. A. S. (2009). *Introductory multivariate statistics for the environmental science*. John Wiley & Sons.
2. Mariappan, P. (2013). *Biostatistics*. Pearson Education India.
3. Dengler, J. (2016). Phytosociology. *International Encyclopedia of Geography: People, the Earth, Environment and Technology: People, the Earth, Environment and Technology*, 1-6.
4. Collins, C. H., & Lyne, P. M. (1984). *Microbiological methods*. Butterworth & Co. (Publishers) Ltd, 88 Kingsway, London WC2B 6AB.
5. Wilks, Daniel S. *Statistical methods in the atmospheric sciences*. Vol. 100. Academic press, 2011.
6. Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.
7. Henderson, P. A., & Southwood, T. R. E. (2016). *Ecological methods* (4th ed.). Wiley-Blackwell.
8. Ford, E. D. (2000). *Scientific method for ecological research*. Cambridge University Press.
9. Bell, J., & Waters, S. (2018). *Doing your research project: A guide for first-time researchers* (7th ed.). Open University Press.
10. Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K., & Schlüter, M. (Eds.). (2021). *Handbook of research methods for social-ecological systems*. Routledge.
11. Warton, D. I. (2022). *Eco-stats: Data analysis in ecology*. Springer.

Master's Degree in Environmental Science
Semester-III & IV
(R+R)

Course Title: Project Work
Course Code: MEVSCPW426
Max. Marks: 1000 (External:720; Internal:280)

Course Type: Core
Credits: 40

Course learning outcomes:

MEVSCPW425.1: *Able to identify research gaps through literature review and formulate clear research objectives and hypothesis*

MEVSCPW425.2: *Able to design appropriate methodologies and acquire training in relevant field and laboratory techniques*

MEVSCPW425.3: *Able to develop ethical and safety awareness while planning and executing research*

MEVSCPW425.4: *Able to enhance technical skills in field surveys, laboratory techniques, modern instruments and software*

MEVSCPW425.5: *Competent to apply statistical, computational, or GIS tools for data analysis and interpretation*

MEVSCPW425.6: *Competent to critically compare findings with existing literature to draw valid conclusions*

MEVSCPW425.7: *Competent prepare a well-structured dissertation and communicate scientific results effectively in written and oral formats*

MEVSCPW425.8: *Competent to propose evidence based sustainable solutions and policy recommendations*

Description: A student shall undertake 12-Month Project Dissertation related to the environment as per the following framework.

1. Orientation & Topic Finalization (6 weeks)

Selection of research area.

Literature review and gap identification.

Setting objectives, hypotheses & synopsis.

2. Methodology Development (8 weeks)

Training in relevant field/lab techniques.

Designing sampling protocols or analytical frameworks.

Ethical and safety clearance (if needed).

3. Data Collection & Experimentation (24 weeks)

Field sampling / surveys / lab analysis.

Pilot testing for feasibility.

Preliminary data processing.

4. Data Analysis & Interpretation (6-weeks)

Statistical and/or GIS analysis.

Comparison with existing literature.

5. Report Writing & Presentation (8-weeks)

Dissertation.

Viva-voce / seminar presentation.

Note: During the course of the dissertation, the student is expected to present three seminars, synopsis, methodology & progress reports prior to the submission, followed by the viva-voce by an external examiner. The internal assessment (280 marks) will be based on attendance (80), seminar presentation (100) and performance (100). The external examination (720) will be based on the dissertation evaluation (580) and viva voce (140).

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Avg.
MEVSCPW426.1	3	2	3	2	3	3	3	2	2.62
MEVSCPW426.2	3	3	2	2	3	2	2	3	2.5
MEVSCPW426.3	3	3	2	2	3	1	2	3	2.37
MEVSCPW426.4	3	3	2	1	3	3	3	2	2.5
MEVSCPW426.5	3	3	2	3	3	2	3	2	2.62
MEVSCPW426.6	3	3	3	1	3	2	3	1	2.37
MEVSCPW426.7	3	2	2	2	2	1	3	3	2.25
MEVSCPW426.8	3	3	2	2	2	2	3	2	2.37
Avg. PLO	3	2.75	2.25	1.87	2.75	2	2.75	2.25	2.45

Suggested Readings

1. Shaw, & Peter, J. A. S. (2009). *Introductory multivariate statistics for the environmental science*. John Wiley & Sons.
2. Mariappan, P. (2013). *Biostatistics*. Pearson Education India.
3. Dengler, J. (2016). Phytosociology. *International Encyclopedia of Geography: People, the Earth, Environment and Technology: People, the Earth, Environment and Technology*, 1-6.
4. Collins, C. H., & Lyne, P. M. (1984). *Microbiological methods*. Butterworth & Co. (Publishers) Ltd, 88 Kingsway, London WC2B 6AB.
5. Wilks, Daniel S. *Statistical methods in the atmospheric sciences*. Vol. 100. Academic press, 2011.
6. Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.
7. Henderson, P. A., & Southwood, T. R. E. (2016). *Ecological methods* (4th ed.). Wiley-Blackwell.
8. Ford, E. D. (2000). *Scientific method for ecological research*. Cambridge University Press.
9. Bell, J., & Waters, S. (2018). *Doing your research project: A guide for first-time researchers* (7th ed.). Open University Press.
10. Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K., & Schlüter, M. (Eds.). (2021). *Handbook of research methods for social-ecological systems*. Routledge.
11. Warton, D. I. (2022). *Eco-stats: Data analysis in ecology*. Springer.