Department of Environmental Science and Technology

Course Structure of M.Sc. (Environmental Science and Technology)

with 2 Semesters of Course work and 2 Semesters of Research

Academic Session 2025 – 2026 onwards

School of Environment and Earth Sciences

Central University of Punjab

Graduate Attributes

The graduates passing the programme will have the knowledge, attitude and skill related attributes. The students will have comprehensive knowledge and understanding of various regional, national, & global environmental issues. The students will have the ability to apply the acquired knowledge in a rational manner for environmental management. The students will also have the ability to apply critical, creative and evidence-based thinking to solve the future challenges in the field of environment. The skill-linked-learning will inculcate research and entrepreneurial skills in the learners which make them compete professionally at national/international level.

Course Structure

Semester I

Paper Code	Course Title	Course Type	Contact Hours			Credit
			L	T	P	C
MEVS.401	Ecology and Biodiversity	CC	3	0	0	3
MEVS.402	Principles of Environmental Chemistry	CC	3	0	0	3
MEVS.403	Atmospheric and Earth Science	CC	3	0	0	3
MEVS.404	Environmental Pollution – I	CC	3	0	0	3
MEVS.405	Research Methodology and Data Analysis	AEC	3	0	0	3
MEVS.406	Ecology and Biodiversity (Practical)	S	0	0	2	1
MEVS.407	Environmental Pollution – I (Practical)	S	0	0	4	2
MEVS. 594	Seminar	S	0	0	2	1
MEVS.XXX	Elective-I	E	3	0	0	3
XXX	Remedial classes	Non-credit	0	2	0	0
	Total		**18**	**2**	**8**	**22**
List of Electives						
MEVS.517	Natural Hazards and Disaster Management	E	3	0	0	3
MEVS.518	Microbial Technology for Pollution Abatement	E	3	0	0	3
MEVS.519	Environmental Law and Policy	E	3	0	0	3
MEGS.516	Geochemistry and Isotope Geology	E	3	0	0	3
MGEO.516	Climatology	E	3	0	0	3

AEC-ability enhancement course; CC- core course; S- Skill course
L-Lecture, T-Tutorial, P-Practical; C-credits

* The elective will be opted as per courses offered in the respective department and once taken during this semester, same course cannot be taken in other semesters.

****MOOC:** MOOC may be taken up 40% of the total credit (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match minimum 70% syllabus. MOOC should be taken during first and/or second semesters. **Any department offering compulsory MOOCs in lieu of IDC may offer in the first semester.**

Semester II

Paper Code	Course Title	Course type	Contact Hours			Credit
			L	T	P	C
MEVS.408	Energy and Environment	CC	3	0	0	3
MEVS.409	Environmental Pollution –II	CC	3	0	0	3
MEVS.520	Geospatial Technology	CC	3	0	0	3
MEVS.521	Environmental Assessment, Management and Auditing	AEC	3	0	0	3
MEVS.522	Environmental Pollution-II (Practical)	S	0	0	4	2
MEVS.523	Basics of Geospatial Technology (Practical)	S	0	0	2	1
MEVS. 524	Advanced Geoinformatics and Geospatial Modeling (Practical)	S	0	0	2	1
MEVS.525	Instrumental Methods of Analysis (Practical)	S	0	0	4	2
	Interdisciplinary Course**	E	2	0	0	2
	Value Based Course	VB	2	0	0	2
	Remedial classes	Non-credit		2		
	Total		**16**	**2**	**12**	**22**
IDC For students of other departments						
MEVS.506	Waste Management in Our Daily life	IDC	2	0	0	2
MEVS.507	Environmental Conservation	IDC	2	0	0	2
MEVS.508	Environmental Geology	IDC	2	0	0	2
MEVS.509	Environmental Issues and Policies in India	IDC	2	0	0	2
MEVS.510	Climate Change and Sustainability	IDC	2	0	0	2

CC- core course; S- Skill course; VB: Value based; AEC-ability enhancement course; L-Lecture, T-Tutorial, P-Practical; C-credits

SWAYAM Plus*:Additional compulsory course.

**IDC course to be opted from other departments.

****MOOC:** MOOC may be taken up 40% of the total credit (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match minimum 70% syllabus. MOOC should be taken during first and/or second semesters.

Semester III

Paper Code	Course Title	Course type	Contact Hours			Credit
			L	T	P	C
EVS.599-1	Dissertation/Internship/Project - Part I	Skill	0	0	40	**20**

Semester IV

Paper Code	Course Title	Course type	Contact Hours			Credit
			L	T	P	C
EVS.599-2	Dissertation/Internship/Project - Part II	Skill	0	0	40	**20**

Evaluation Pattern

Semester I and II					
Core, Discipline Elective, and Compulsory Foundation Courses			IDC, VAC, Entrepreneurship, Innovation and Skill Development Courses (≤2credits) or any other theory course of ≤2credits		
	Marks	Evaluation	Marks		Evaluation
Internal Assessment	25	Various methods	-		-
Mid-semester test (MST)	25	Descriptive	50		Descriptive (upto100%) Objective (upto30%)
End-semester exam (ESE)	50	Descriptive (upto100%) Objective (upto30%)	50		Descriptive (upto100%) Objective (upto30%)
Dissertation Proposal (Semester III)			**Dissertation (Semester IV)**		
	Marks	Evaluation		Marks	Evaluation
Supervisor	50	Dissertation proposaland presentation	Supervisor/ co-supervisor(s)	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
HoD and senior-Most faculty of the department	50	Dissertation Proposal and presentation	External expert	50	Report of dissertation(25), presentation (10), novelty/originality (5) and final viva-voce(10).

- Marks for internship shall be given by the supervisor/internal mentor and external mentor.

Multiple Entry & Multiple Exit

To award Post-Graduate Diploma at the end of the first year of M.Sc. in Environmental Science and Technology, the students must do one course of 4 credits out of the three options proposed by the department. The options include:

1. Skill based course of 4 credits offered by the Department on Environmental Quality Monitoring (**Annexure I**)
2. MOOCs courses with credits equivalent to four.
3. Industrial training or internship for a period of two months.

Semester I

Course Title: Ecology and Biodiversity
Paper Code: MEVS.401

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes
At the completion of the course, the student will be able to:
CLO1: Acquaint with the basic concepts and scope of ecology
CLO2: Classify and characterize different types of ecosystems
CLO3: Distinguish between population dynamics and community dynamics
CLO4: Identify values and threats of biodiversity
CLO5: Describe the strategies for biodiversity conservation

Units/Hours	Contents	Mapping with Course Learning Outcome
I 12 Hours	**Unit 1: Basics of Ecology** History and scope of ecology, origin of life, evolution and speciation, geological time scale. Ecological factors, ecosystem, concept of ecotone, edge effect, habitat and niche. Biomes- classification and characteristics, Biogeography – classification. Learning Activities: Group Discussion, student's presentation	CLO1
II 10 Hours	**Unit 2: Ecosystem Dynamics** Ecosystem structure and functions, food chains and food webs, ecological pyramid, energy flow models,methods of measuring productivity, Types and characteristics of ecosystems- terrestrial (forest, desert, grassland) and aquatic (pond, marine), wetlands, estuaries, forest types in India. Biogeochemical cycles. Variations in ecosystem functions Learning Activities: Case studies, Visit to a local pond ecosystem	CLO2
III 12 Hours	**Unit 3: Population and Community Ecology** Population ecology: characteristics, types of interactions; population growth and regulation; population dynamics; 'r' and 'k' species, meta-population, niche- types, keystone and dominant species, prey predation model, ecological adaptation Community ecology: community organization; types and interaction, ecological succession – types and mechanism, Landscape ecology, Theory of Island Biogeography, restoration ecology.	CLO3

	Learning Activities: Pros and Cons method, Case Studies	
IV 12 Hours	**Unit 4: Biodiversity and its conservation** Definition, types of biodiversity- species richness, measurement of diversity, values of biodiversity, threats to biodiversity-Global change and sustainability issues, biological invasion. Hotspots of biodiversity, Biodiversity hotspots of India, ecological footprint. Causes of species extinction, IUCN Categories of threatened species, Red data book, Endangered and Threatened flora and fauna of India. Tree Aadhaar Mission.	CLO4
	Strategies for Biodiversity conservation- in situ, ex situ; national and international initiatives for biodiversity conservation,wildlife conservation projects, Green India Mission, Conference of Parties on Convention on Biodiversity- COP15, SDG Goal 14 (Life Below Water), SDG Goal 15 (Life on Land). Learning Activities: One minute presentation, Visit to Zoo, Herbal garden	CLO5

Suggested Readings:

1. Weber, L. M. (2023). *Understanding Nature: Ecology for a New Generation.* CRC Press,Boca Raton
2. Bowman,W.D. and Hacker, S.D. (2023). Ecology, Sixth Edition. Oxford Press, United States of America.
3. Frances Dipper (2022). E*lements of Marine Ecology* (Fifth edition), Elevier, Butterworth-Heniemann, United Kingdom.
4. Ambasht, R.S. and Ambasht N.K. (2022). A Textbook of Plant Ecology, 16 Ed., CBS Publishers & Distributors. Pvt. Ltd, New Delhi.
5. William, D. B., Sally, D. H. (2020). *Ecology*, Fifth Edition, Oxford University Press, United Kingdom.
6. Fath, B. (2019). *Encylopedia of Ecology*, Vol 1-5, Elsevier Publishers, Netherlands.
7. Eugene P. Odum and Gary W. Barrett. (2018). *Fundamentals of Ecology*, 5th Edition. Cengage Learning, India Pvt. Ltd., New Delhi.
8. Sharma, P. D. (2018). *Ecology and Environment*, 13th Edition, Rastogi Publications, New Delhi
9. Lomolino, M. V., Riddle, B. R., Whittaker, R. J. and Brown, J. H. (2016). *Biogeography* (5th Ed),Sinauer Associates, United States.
10. Begon, M., Howrath, R. B., Townsend, C. R. (2014). *Essentials of Ecology*, 4th Edition. John Wiley & Sons, Inc., United States
11. Rockwood, L. L. (2015). *Introduction to Population Ecology*, Second Edition. John Wiley & Sons, Inc. and Blackwell., United States.
12. William, J. M., James, G. G. (2015). *Wetland*, Wiley-Interscience, New Jersey.
13. Richard B. Primack. (2014). *Essentials of Conservation Biology*, Sixth Edition. Sinauer Associates, Inc., United States.
14. Smith, T. M., Smith, R. L. (2014). *Elements of Ecology*, (9th Ed), Pearson. London.
15. Vandermeer, J. H., Riddle, B. R., Brown, J. H. (2013). *Population ecology: First principle* (2nd Ed), Princeton University Press, United States.
16. Day, J. W., Kemp, W. M., Alejandro, Y., Byron, C. C. (2012). *Estuarine Ecology* (2nd Ed), Wiley-Blackwell Publishers, United States.

17. Peter J. M. (2011). *Community Ecology, Second Edition*. John Wiley & Sons, Inc. and Blackwell., United States.

Suggested Websites:

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. https://www.iucn.org/
3. https://www.cbd.int/
4. http://nbaindia.org/

Mode of Transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point, google meet, zoom

Course Title: Principles of Environmental Chemistry
Paper Code: MEVS.402

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes

On completion of this course, students will be able to:
CLO1: Understand the basic concept of environment chemistry and green chemistry and their role to solve environmental pollution
CLO2: Characterize the chemical compositions and their controlling factors in water and air
CLO3: Learn about the factors/processes responsible for soil formation and soil quality
CLO4: Analyze the basic physico-chemical parameters in water, soils and air

Units/Hours	Contents	Mapping with Course Learning Outcome
I 11 Hours	**Unit 1: Basics of Chemistry** **Fundamental of environmental chemistry:** Mole Concept, Classification of elements, Oxidation-reduction reaction, Stoichiometry calculation, Acid-base indicators, Ionic Strength and Activity. **Green chemistry:** New trends in green chemistry, Basic principles, Atom economy concept and its environmental importance, Green reagents, Green solvents; Student generated Questions, Group tasks-assignments.	CLO1
II 12 Hours	**Unit 2: Air & Water Chemistry** **Atmospheric chemistry:** Composition of air, Chemical speciation, particles, ion and radicals, Formation of particulate matter, Photochemical reactions in the atmosphere **Aquatic chemistry:** Type of water quality parameters (physical, chemical, organic and microbiological parameters), Chemical composition of natural water types (freshwater and saline water); Hydrogeochemistry and water-rock interaction, Factors controlling solubility and mobility of chemical elements, Group Discussion, Think-pair-share method, Interactive demonstration	CLO2
III 12 Hours	**Unit 3: Soil Geochemistry** **Chemistry of soil:** Physio-chemical properties of soil (pH, EC, texture, cation exchange capacity, and sodicity), Inorganic and organic components of soil, micro and micro nutrients in soil, Soil organic matter, Concept of major and trace elements, heavy metals and potentially toxic elements in soil, Origin of chemical elements in soils and their behavior, Soil pedogenic processes, Chemical processes affecting the mobility of metals in soils; Group Discussion, Case Studies, One minute presentation, Think-pair-share method	CLO3

IV 10 Hours	**Unit 4: Quantitative analysis** Acid-base equilibria and titration, complexometric, precipitation and redox titrimetric. Gravimetric analysis – total solids and suspended solids; Student generated Questions, Group tasks-assignments, Think-pair-share method, Interactive demonstration.	CLO4

Suggested readings:

1. Pani, B. (2020). *Textbook of Environmental Chemistry,* 2nd Edition, New Delhi: International Ptv. ltd.
2. Kaur, H. (2018). *Environmental Chemistry,* Pragati Prakashan, Meerut.
3. Ahluwalia, V. K. (2017). *Advance Environmental Chemistry*. Teri Press Publisher.
4. Manahan, S. E. (2017). *Water chemistry: green science and technology of nature's most renewable resource,* USA: CRC Press.
5. Manahan, S. E. (2017). *Environmental Chemistry, 10th Edition*. USA: CRC Press.
6. Lancaster, M. (2016). *Green Chemistry: An Introductory Text,* UK: RSC Publishing
7. Weiner E. R. (2013). Application of Environmental Aquatic Chemistry: A practical guide. CRC Press Taylor & Francis Group.
8. Girard J. (2013). *Principles of Environmental Chemistry, 2nd Edition*. USA: James & Barlett Publishers.
9. Baird, C., Cann, M. (2012). *Environmental Chemistry,* USA: W.H. Freeman.
10. Subramanian, V. (2011). *A Textbook of Environmental Chemistry*, New Delhi: I.K International Publishing House.
11. Ahluwalia, V. K., Malhotra, S. (2009). *Environmental Science,* Ane Books Pvt. Ltd
12. Hillel, D. (2008). *Soil in the Environment: Crucible of Terrestrial Life, 1st edition.* USA: Academic Press.
13. Clark J. H. and Macquarrie, D. J. (2008). *Handbook of Green Chemistry and Technology,* UK: Wiley-Blackwell.
14. Harrison R. M. (2007). *Principles of Environmental Chemistry,* UK: RSC Publishing.
15. Connell D.W, (2005). Basic Concept of Environmental Chemistry. Publisher: CRC Press.

Suggested Websites:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. https://www.epa.gov/environmental-topics
3. https://chem.libretexts.org/Bookshelves/Environmental_Chemistry

Mode of Transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point, google meet, zoom

Course Title: Atmospheric and Earth Science

Paper Code: MEVS.403

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes:

At the completion of the course, the learner will be able to:

CLO1: Learn various earth processes

CLO2: Understand the meteorological parameters

CLO3: Learn about the climate system of the earth

CLO4: Gain an insight about the ocean circulation mechanism

Units/Hours	Contents	Mapping with Course Learning Outcome
I 11 Hours	**Unit 1: Earth processes** Structure and Composition of the Earth; Plate tectonics; Mountain Building; Mass Movements; Vulcanicity; Fluvial; Wind; Glacial processes; Group Discussion, Case Studies, One minute presentation	CLO1
II 11 Hours	**Unit 2: Meteorology** Origin and composition of Earth's atmosphere; vertical structure of atmosphere, scales of meteorology, parameters of meteorology- pressure, temperature, humidity, wind; Rotation of earth- solar radiation, surface and planetary albedo, radiation windows,Radiation Budget of Earth; Cloud Morphology and Microphysics; Atmospheric stability and Thermodynamics; Group Discussion, Student generated Questions, Group tasks-assignments,	CLO2
III 12 Hours	**Unit 3: Climatology** Weather and Climate, seasons in India, the boundary layer; Local microclimate; Atmospheric movements; General meridional circulations: Hadley cells, Ferrel and Polar cells; Circulation of water and energy in atmosphere; monsoons, cyclones and anticyclones; Climatic classification schemes; Climate change —Observed climate change over India and globe; SDG 13 – Climate change, Arctic and Polar Affairs. Case Studies, One minute presentation	CLO3
IV 11 Hours	**Unit 4: Oceanography** Sea water properties; Chemistry of seawater; Wind driven circulations in upper oceans; Waves, Tides and currents Upwelling and El Niño–Southern Oscillation; Deep Ocean Circulations; Marine Resources and Diversity; Ocean warming, Sea level rise, Ocean acidification, Decarbonization, Carbon sequestration; Group Discussion, Student generated Questions, Group tasks-assignments,	CLO4

	Case Studies	

Suggested readings:

1. Grotzinger, J. P., Jordan, T. H. (2019). *Understanding Earth*, New York: Freeman & Company.
2. Kusky, T. (2017). *The encyclopedia of Earth Science*, Viva book private limited.
3. Singh, S. (2017). *Physical Geography*, Allahabad: Prayag Pustak Bhavan.
4. Merritts, D., Menking, K., Wet, A. (2014). Kirsten, *Environmental Geology: An Earth Systems Science Approach*, New York: W. H. Freeman & company.
5. Siddhartha, K. (2014). *Oceanography: A Brief Introduction*, New Delhi: Kisalaya Publications Pvt. Limited.
6. Trujillo, A. P., Thurman, H. V. (2014). *Essentials of Oceanography*, New York: Pearson education inc.
7. Roy, R. (2013). *Introduction to General Climatology*, New Delhi: Anmol publication private limited.
8. Strahler, A.N. (2013). *An Introduction to Physical Geography*, UK: John Wiley & Sons.
9. Kale, V. S., Gupta, A. (2012). *Introduction to Geomorphology*, Bangalore: Orient Longman.
10. D. S. Lal. (2011). *Climatology*, Sharda Pustak.
11. Veena. (2009). *Understanding earth science*, Delhi: Discovery
12. Critchfield, H. J. (2008). *General Climatology*, Pearson Education India.
13. Bell, F. G. (2007). *Basic environmental and engineering geology*, London: CRC Press.
14. Frank, P., Raymond, S. (2003). *Understanding Earth*. W. H. Freeman & Co Ltd.
15. Bell, F. G. (1998). *Environmental Geology: Principles and Practice*, USA: Blackwell Science Publisher.
16. Krishnamurti, T., Misra, V., Stefanova, L. (2013). Tropical Meteorology: An Introduction. Germany: Springer New York.
17. Wallace John M. Jr., Peter V. Hobbs (2006): *Atmospheric Science: An Introductory Survey*, 2nd Edition,
18. Frederick K. Lutgens, Edward J.Tarbuck (2010): *The Atmosphere: An IntroductionTo Meteorology*, Phi (Prentice-hall New Arrivals), ISBN: 978-8120344150

Suggested Websites:

1. https://mausam.imd.gov.in/
2. https://public.wmo.int/en
3. NASA Earth Observatory: https://earthobservatory.nasa.gov/?eocn=topnav&eoci=logo

Mode of Transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, power point, e-learning, E-PG Pathshala, Google meet, Google forms, Zoom, Microsoft Teams

Course Title: Environmental Pollution-I

Paper Code: MEVS.404

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes

After completing this course, student will be able to:

CLO1: Characterize inorganic and organic pollutants in water and soil

CLO2: Develop water purification techniques for safe drinking water and wastewater treatment technologies for abatement of water pollution

CLO3: Explain the soil forming factors and processes and the causes of soil degradation

CLO4: Understanding methods for conservation and reclamation of soil

Units/Hours	Contents	Mapping with Course Learning Outcome
I 12 Hours	**Unit 1: Water Pollution and Purification Technique** **Water pollution***:* Type of water pollutants (organic, inorganic, microbiological, emerging and radioactive pollutants), Point and non-point sources of water pollution, Water quality assessment criteria, Diseases caused by water pollution, Geogenic groundwater contamination in Indian scenario (Arsenic, fluoride, uranium and salinity), Acid Mine drainage – cause and effect.SDG Goal 6: Clean water and sanitation Group discussion. **Water purification for drinking process** – Principal, process design and applications - Coagulation, flocculation, Filtration, Disinfections (Chlorination, UV, Ozonization), water softening Drinking water standards (physical, chemical & bacteriological); Field sampling, Visit to University Water Centre and Desalination plant.	CLO1, CLO2
II 11 Hours	**Unit 2: Wastewater Treatment** **Wastewater treatment:** Wastewater generation; Classification, sampling and characterization of wastewater; Sewage treatment – Primary, secondary and tertiary treatment; Process design of biological wastewater treatment process - Aerobic (activated sludge process) and anaerobic (UASB) processes; activated sludge process modifications; Group tasks-assignments, Case Studies, Visit to Sewage treatment Plant	CLO2
III 11 Hours	**Unit 3: Soil Formation and Erosion** **Soil formation:** Soil weathering and forming (pedogenic) processes,composition of soil; soil profiles, physico-chemical and biological properties of soil, soil biota and their role in nutrient cycling, Soil types in India **Soil erosion**: Types of soil erosion – water and wind erosion, and causes, Land degradation – causes and impacts, desertification and its control; Salt affected soil – Saline soils,	CLO3

	Sodic soil; Group tasks-assignments, Case Studies, One minute presentation	
IV 11 Hours	**Unit 4: Soil pollution and Management** **Soil pollution:** Sources of soil pollution – point vs. non-point source; type of soil pollutants (organic, inorganic (including heavy metals), synthetic pollutants and biological agents); Causes of soil pollution, Chemical process affecting metal mobility in soils, Soil Pollution Index (Contamination factor, Pollution load Index, Geoaccumulation Index). **Soil management:** Consequences and control measures of soil pollution, methods for soil conservation, wasteland reclamation, National Mission for Sustainable Agriculture; SDG 15: Life on land,Group tasks-assignments, Case Studies, Pros and Cons method.	CLO4

Suggested readings

1. Peirce, J., Vesilind, P. A., Weiner, R. (2020). *Environmental Pollution and Control* (4th Edition). Elsevier Publisher
2. Khopkar, S. M. (2020). *Environmental Pollution Analysis*. New Age International Pvt. Ltd.; 2nd edition.
3. Blum, W. E. H., Schad, P., Nortcliff, S. (2018). *Essentials of Soil Science: Soil formation, functions, use and classification* (World Reference Base, WRB), BorntraegerGebrueder Publisher.
4. Metcalf & Eddy. (2017). *Wastewater Engineering: Treatment, Disposal, Reuse* (4th Ed.). New Delhi: TMGHl.
5. Peavy, H. S., Donald, R. R., Tchobanoglous, G. (2017). *Environmental Engineering,* New York: McGraw-Hill Education.
6. Dorian, G. (2017). *Elements of soil conservation*. Koros Press Ltd.
7. Singh, R. (2015). *Membrane technology and engineering for water purification: application, system design, and operation,* Elsevier Publisher.
8. Irena, S. (2015). *Heavy metal contamination of soil: monitoring and remediation,* New York: Springer.
9. Soggard, E. G. (2014). *Chemistry of advanced environmental purification processes of water: Fundamental and application,* Elsevier Publisher.
10. Alfred R. Conklin Jr. (2014). Introduction to soil chemistry- Analysis and Instrumentation. John Wiley & Sons Inc.
11. Agrawal, S. K. (2013). *Water Pollution,* APH Publisher.
12. Singh, B. S., Kumar, R., Singh, M. R. (2012). *Water pollution and Environment,*Enkay Publishing house.
13. Rathore, H. S., Nollet, L. M. L. (2012). *Pesticides- Evaluation of Environmental Pollution*. CRC Press.
14. Havlin, J. L., Tisdale, S. L. (2011). *Soil fertility and fertilizers: An introduction to nutrient management,* New Delhi: PHI learning.
15. Edzwald, J. K. (2011). *Water Quality & Treatment: A Handbook on Drinking Water,* McGraw-Hill Education.
16. Stuart, A. (2010). *Soil Pollution,* Apple academics, Oakville.
17. Palmer, E. (2010). *Water pollution,* Apple Academic Press, Inc.
18. Mishra, S. K. (2009). *Assessment of Water Pollution,* APH Publishing corp.
19. Thomas, S. V. (2008). *Water Pollution issues and development,* Nova science publishers.
20. Humberto, B., Rattan, L. (2008). *Principles of Soil Conservation and Management*. Springer Netherlands

21. Mishra, S. G., Vani, D. (2009). *Soil Pollution*, APH Publishing group.
22. Mirsal, I. A. (2008). *Soil pollution: origin, monitoring & remediation,* Springer, Berlin.
23. Mishra, P.C. (2008). *Soil Pollution and Soil Organisms*. APH Publishing Corporation
24. Raven, P. H., Berg, L. R., Hassenzahl, D. M. (2008), *Environment.* 6th ed. John Wiley & Sons., USA.
25. Blanco, H., Rattan, L. (2008). *Principles of soil conservation and management.* USA: Springer
26. Botkin, D. B., Keller, E. A. (2007). *Environmental Science: Earth as a Living Planet,* 6th ed. USA: John Wiley & Sons.
27. Ujang, Z. (2006). *Municipal wastewater management in developing countries: Principles and Engineering,* Iwa Publishing.
28. De, A. K. (2000). *Environmental Chemistry,* New Delhi: New Age International (P) Ltd. Publishers.

Suggested Web Resources:

1. https://cpcb.nic.in/
2. https://www.epa.gov/environmental-topics
3. https://www.unccd.int/issues/land-and-drought

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study, e learning, Experimentation, Tutorial, Problem solving, Self-learning

Course Title: Research Methodology and Data Analysis
Paper Code: MEVS.405

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes:

On completion of this course, students will be able to:
CLO1: Differentiate and apply different research approaches in their research
CLO2: Evaluate the research journals and profiles based on standard research indexes
CLO3: Search most appropriate research references from different search engines
CLO4: Set their research hypothesis and design their experiments,
CLO5: Format their write-ups as per publication types and journal/publisher guidelines
CLO6: Evaluate plagiarism in their write up using tools like Urkund, Turnitin/Ithenticate
CLO7: Apply statistical and graphical tools in presentations and publications

Units/ Hours	**Contents**	**Course Learning Outcome**
I 11 Hours	**Unit 1: Introduction** Meaning and importance of research, Research approaches; Research ethics; types of journals, concept of citations, impact factor, *h*-Index, I-10 index etc.	CLO1 CLO2
II 12 Hours	**Unit 2: Academic Writing** Scientific writing, Review of Literature - Web-based literature search engines, concept of plagiarism/similarity search, referencing/Bibliography, hand on training on similarity search and Reference Manager soft-wares Group tasks-assignments, One minute presentation	CLO3 CLO4
III 11 Hours	**Unit 3:Descriptive Statistics** Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, pie chart etc. Group tasks-assignments, Interactive demonstrations	CLO5 CLO7
IV **11 Hours**	**Unit 4 : Measures of central tendency** Measures of central tendency- mean, mode and median; Measures of dispersion- range, standard deviation, variance, box and whisker plots; Moments, skewness and kurtosis. Group tasks-assignments, Interactive demonstrations	CLO6 CLO7

Suggested Readings:

1. Paltridge, B., Starfield, S. (2019). *Thesis And Dissertation Writing InA Second Language,* Routledge Publisher.
2. Hofmann, A. H. (2019).*Scientific Writing and Communication: Papers, Proposals, and Presentations,* Oxford Univ Pr; 4th edition, USA.
3. Kothari, C. R., Garg, G. (2019). *Research Methodology: Methods And Techniques,* New Age International Publishers; Fourth edition, India.
4. Prathapan, K. (2019). *Research Methodology for Scientific Research*, Dreamtech Press, India

5. Kothari, C. R. (2008). *Research methodology(s)*. New Age International, New Delhi.
6. Patnaik, P. (2010). *Handbook of environmental analysis*, CRC Press, UK.
7. Skoog D. A., Holler F. L. Crouch, S. R. (2007). *Principles of instrumental analysis,* Thomson Brooks/Cole Publishers, Australia.
8. Eaton, A. D., Clesceri, L. S., Rice, E. W., Greenberg, A. E. (2005). *Standard methods for examination of water and wastewater 21st Edition.* American Public Health Association, American Water Worker Association, Water Environment Federation, USA.
9. Gupta, S. (2005). *Research methodology and statistical techniques*, Deep and Deep Publications (P) Ltd. New Delhi.
10. Wiersma, G. (2004). *Environmental monitoring*, CRC Press, UK.
11. Katz, M. (1977). *Methods of air sampling and analysis, 2nd edition,* American Public Health Association, USA.
12. Shukla, S. K., Srivastava, P. R. (1992). *Methodology for environmental monitoring and assessment*, Commonwealth Publishers, New Delhi.
13. Svehla, G. (1996). *Vogel's qualitative inorganic analysis, 7th Edition,* Prentice Hall, USA.
14. Ewing, G. W. (1985), *Instrumental methods of chemical analysis, 5th edition,* McGraw Hill Publications, USA.

Suggested Websites:

1. https://www.open.edu/openlearn/money-management/understanding-different-research-perspectives/content-section-8
2. https://www.modares.ac.ir/uploads/Agr.Oth.Lib.17.pdf
3. https://research-methodology.net/

Mode of Transaction: Class room teaching, assignment, Lectures, Group discussions, presentation, quiz competition.

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Google Apps, Websites

Course Title: Ecology and Biodiversity (Practical)
Paper Code: MEVS.406

L	T	P	C
0	0	2	1

Total teaching hours: 30 h

Course Learning Outcomes:

Student will be able to:

CLO1:Apply techniques for qualitative and quantitative sampling of plant diversity

CLO2:Design scientific methods/experiments to study various ecological parameters and biodiversity in laboratory/field conditions

CLO3: Estimate the indices of biodiversity

Units/Hours	Contents	Mapping with Course Learning Outcome
I 4 Hours	1. Familiarization with various biotic and abiotic components of the pond and grassland ecosystem.	CLO1
II 12 Hours	2. Determination of minimum quadrat size for studying herbaceous vegetation in the campus 3. Estimation of density, frequency and abundance of herbaceous plant species in the campus using the quadrat method.	CLO1 and CLO2
III 4 Hours	4. Estimation of population size by using growth models 5. Assessment of interaction pattern in a prey - predator system	CLO2
IV 6 Hours	6. Evaluation of Importance value index (IVI) of species 7. Estimation of index of diversity, richness, evenness and dominance of species	CLO3
IV 4 Hours	8. Determination of turbidity in water sample using a Secchi disk	CLO3

Suggested Readings

1. Wheater, C. P., Bell, J.R. and Cook, P.A. (2020). Practical Field Ecology: A Project Guide . Wiley, United States of America
2. Rina Mumjada (2019). Practical Manual of Ecology and Environment Science. Prestige Books. New Delhi
3. Misra, R., Puri, G. S. (2018). *Indian Manual of Plant Ecology*. Scientific Publishers, India
4. Stephen, R. G. (2014). *Field and Laboratory investigations in agroecology*, Third edition, CRC Press, United States.
5. Darrell, V. (2010). *Ecology Laboratory Manual*, 1st Edition. McGraw-Hill Education, United States,
6. Magurran, A. E. (2003) *Measuring Biological Diversity*. Wiley-Blackwell, United States.

Mode of Transaction: Demonstration, Lecture, E-tutoring, Hands on training, discussion, assignments, Practical

Evaluation criteria:

Continuous Assessment **(10 Marks):** Based on attendance in practical class, practical record, involvement in practical, etc.

End Semester Exam **(40 Marks)**: Subjective Type with experimental performance (30 Marks) and viva-voce (10 Marks)
Total Marks: 50

Course Title: Environmental Pollution – I (Practical)
Paper Code: MEVS.407

L	T	P	C
0	0	4	2

Total teaching hours: 60 h

Course Learning Outcomes
On completion of this course, students will be able to:
CLO1: Learn safety measures and basic knowledge to be used while working in a chemistry lab
CLO2: Apply knowledge to estimate inorganic pollution in water, wastewater, and soil
CLO3: Evaluate organic and microbiological pollution in water and wastewater
CLO2: Apply knowledge for qualitative and quantitative analysis of water, wastewater and soil

Units/Hours	Contents	Mapping with Course Learning Outcome
I 12 Hours	1. Lab safety procedures and good laboratory practices 2. Introduction and operating procedure for different Equipment and instruments in the lab 3. Determination of total suspended solids in water by gravimetric method	CLO1
II 11 Hours	4. Determination of pH/EC/TDS of water/soil sample by ion selective electrode method. 5. Determination of acidity and alkalinity 6. Complexometric titration for determination of total hardness	CLO2
III 11 Hours	7. Argentometric titration for determination of chloride ions in water 8. Turbidimetry analysis (determination of sulfate)	CLO3
IV 11 Hours	9. Determination of dissolved oxygen in water samples by Winkler method. 10. Determination of COD in wastewater 11. Determination of BOD in waste water	CLO4

Suggested Readings

1. Gopalan, R. (2020). *A laboratory manual for environmental chemistry*, Dreamtech Press, Wiley India Pvt. Ltd, Noida.
2. American Public Health Association (APHA). (2012). *Standard method for examination of water and wastewater,* 22nd Ed. APHA, AWWA, WPCF, Washington.
3. Patnaik, P. (2010). *Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes,* London: CRC Press.
4. Gupta, P. K. (2009). *Methods in environmental analysis water, soil and air*, Jodhpur: Agrobios.
5. Yadav, M. S. (2008). *Instrumental methods of chemical analysis*, Campus Books International. Delhi.
6. Nollet, L. M. L (2007). *Handbook of water analysis,* London: CRC Press.
7. Quevauviller, P. (2006). *Analytical methods for drinking water: Advanced in sampling and analysis,* John Wiley Publisher.
8. Dunnivant F M (2004). E*nvironmental laboratory Exercises for Instrumental Analysis and Environmental Chemistry*. Wiley Publisher.
9. Yadav, M. S. (2008). *Instrumental methods of chemical analysis*, Campus Books International. Delhi.
10. Quevauviller, P. (2006). *Analytical methods for drinking water: Advanced in sampling and analysis,* John Wiley Publisher.

11. Patnaik, P. (2010). *Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes,* London: CRC Press.
12. Nollet, L. M. L (2007). *Handbook of water analysis,* London: CRC Press.
13. Gupta, P. K. (2009). *Methods in environmental analysis water, soil and air,* Jodhpur: Agrobios.

Mode of Transaction: Lecture, demonstration, experiment, E-tutoring, discussion, assignments, case study, power point.

Evaluation criteria:

Continuous Assessment **(10 Marks):** Based on attendance in practical class, practical record, involvement in practical, etc.

End Semester Exam **(40 Marks)**: Subjective Type with experimental performance (30 Marks) and viva-voce (10 Marks)
Total Marks: 50

Course Title: Seminar
Paper Code: MEVS.594

L	T	P	C
0	0	2	1

Total teaching hours: 60 h

Evaluation criteria for seminar for 50 marks

Report writing (Quality of content, language level, originality etc.) 20 marks

Presentation 15 marks

Knowledge about the topic accessed through questions/discussion 10 marks

Interaction, attentiveness and attendance during seminars	05 marks

List of Electives

Course Title: Natural Hazards and Disaster Management
Paper Code: MEVS.517

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning outcomes:

On completion of the course, the students will be able to:
CLO1: Learn about the types of disaster and their classification
CLO2:Understand the concept of hazard, vulnerability and risk assessment.
CLO3: Gain knowledge about the techniques of disaster management
CLO4: Apply the knowledge of remote sensing and GIS for effective management of disasters
CLO5: Understand the legal framework for disaster management

Units/Hours	Contents	Mapping with Course Learning Outcome
I 11 Hours	**Unit I: Introduction to Natural Hazard and Disasters** Introduction to Disaster: Concept of hazards, Catastrophe and disaster; Concept of vulnerability and risk; Types of disasters: Natural (flood, cyclone, earthquake, landslides, Tsunamis; Volcanoes, Wild fires) and man-made (Oil spills; Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011, Group assignments	CLO1 and CLO2
II 12 Hours	**Unit II: Disaster Risk Reduction and mitigation (DRRM)** Risk Assessment and Preparedness: Pre-Disaster Management activities; Hazard, Risk, vulnerability and capacity analysis (HRVCA); Hazard zonation maps: preparation and utilization; capability assessment; emergency / contingency planning and Post-disaster management activities; Development planning, planning environment, types of plans, MBO, SWOT analysis; Mitigation strategy : Relief measures, community health, casualty management Role of Government, Non-Governmental and media agencies; Reconstruction and Rehabilitation; Awareness through print and electronic media, involving youth in field observation, Case studies	CLO2 and CLO3
III 11 Hours	**Unit III: Approaches in Disaster Management** Application of Geoinformatics in Disaster Management: Role of GPS, GIS and Remote Sensing in disaster management - monitoring, tracking, risk assessment, estimation of losses and planning and modelling for disaster	CLO4

	management; Early warning systems and Decision-making models and processes; Approaches to make Disaster management plan and field based HRVCA,Case-based evaluation	
IV 11 Hours	**Unit IV: Legislations and Policies for Disaster Management** India Disaster Resource Network; Emergency Management and planning; Organization and structure for Emergency Management; Principles and Practice of Disaster Relief and Recovery; Disaster management policy; Command and coordination in disaster management; Important statutes with provisions relevant to Disaster Management; Scope of Disaster Management Law with reference to Disaster Management Bill 2005, Local Administration and disaster risk reduction; Relief and Rehabilitation; Sendai Framework for Disaster Risk Reduction, Group discussions.	CLO5

Suggested Readings

1. Kukal, S. S., Kingra, P. K. (2019). *Introduction to Environmental and Disaster Management*, Kalyani Publishers.
2. Schwab, A. K. (2017). *Hazard mitigation and preparedness: An introductory text for emergency management and planning professionals*, CRC Press.
3. López-Carresi, A., et al. (2014). *Disaster management: International lessons in risk reduction, response and recovery*, New York: Routledge.
4. Smith, K. (2013). *Environmental Hazards: Assessing Risk and Reducing Disaster*, Routledge: Taylor & Francis group.
5. Yadav, R. K., Singh, R. (2013). *Hazard Analysis and Management*. New Delhi: Oxford Book Company.
6. Vaidyanathan, S. (2011). *An Introduction to disaster managements: Natural Disasters and manmade hazards*, New Delhi: Ikon books.
7. Mullick, N. H. (2011). *Disaster Management*, Enkay Publication House, New Delhi.
8. Shaw, R., Krishnamurthy, R. R. (2009). *Disaster Management: Global Problems and Local Solutions*, Hyderabad: Universities Press.
9. Arvind, A. (2009). *Environment and disaster management*, New Delhi: Shree Publishers.
10. Jain, A. K. (2008). *A practical guide to disaster management*, Delhi: Pragun Publication.
11. Parasuraman S. (2004). *India Disasters Report: Towards a Policy Initiatives*, Oxford University Press.
12. Bohle, H. G., Downing, T. E., Watts, M. J. *Climate change and social vulnerability: the sociology and geography of food insecurity, Global Environmental Change*. No.4, pp. 37-48.
13. Goel S. L., Kumar, R. (2001). *Disaster Management*, Deep and Deep Publications
14. Collins L.R., Schneid, T. D. (2000). *Disaster Management and Preparedness*. Taylor and Francis.
15. Barbar W., Murk et. al., (1996). *Environmental Geology*, John Wiley & Sons, New York.
16. William H. D., Bruce R. M. (1986). *Geology and Engineering*, Iowa: WCB Publishers.
17. John M. W., Peter V. H., (1977). *Atmospheric Science: An Introductory Survey*, New York: Academic Press.

Suggested Websites:

1. https://mausam.imd.gov.in/
2. https://ndma.gov.in/
3. https://public.wmo.int/en/our-mandate/focus-areas/natural-hazards-and-disaster-risk-reduction

Mode of Transaction: Lecture, Demonstration, Power point, E-tutoring, discussion, assignments, case study

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Google Apps, Websites

Course Title: Microbial Technology for Pollution Abatement

Paper Code: MEVS.518

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes

Student will be able to:

CLO1: Explain role of microbes in the environment

CLO2: Analyze biosensors for environmental pollution detection and monitoring

CLO3:Apply bioremediation techniques for pollution control and management of xenobiotics

CLO4:Develop eco-friendly products from metabolic processes of microorganisms

CLO5:Discuss risks and benefits of genetically modified organisms in the environment

Units/Hours	Contents	Mapping with Course Learning Outcome
I 11 Hours	**Unit 1: Fundamentals of Environmental Microbiology** Microbial diversity in the environment, microbial ecology, aeromicrobiology, geomicrobiology, biofilm and microbial mats. Drinking water microbiome and treatment,extremophiles. Microbes and biogeochemical cycles, Role of microbes in environment protection, management of resources, bioindicators	CLO1
	Role of biosensors - types and applications in environmental pollution detection and monitoring. Learning Activities:Group Discussion, Student generated Questions, Group tasks-assignment	CLO2
II 12 Hours	**Unit 2: Microbial Bioremediation and Biofertilizers** Microbial interactions, Bioremediation – types, advantages and disadvantages, Biodeterioration, Ex-situ and in-situ bioremediation, Bioaugmentation, biostimulation. Principles of microbiology to the degradation of contaminants, Remediation of organic and metal pollutants, biofiltration, bioscrubbers Microbial metal resistance, metallophiles, biosorption, bioleaching and bio-beneficiation, Biomining Enhanced oil recovery. Biocomposting, Biofertilizer- types and benefits, Microbial biopesticides, bioprospecting. Microbial applications in sustainable development. Learning Activities: Case studies, Student generated Questions, Group tasks-assignment	CLO3
III 11 Hours	**Unit 3: Microbial Bioproducts** Development of biodegradable and eco-friendly products – biomaterials, biopolymers, bioplastics, use of microorganisms in waste treatment.	CLO4

	Fermentation Technology- types of fermentation processes; Bioreactors. Biofuel- biohydrogen, bioethanol, Microbial fuel cells. Primary and secondary metabolites- Alcohol (ethanol), acids, solvents, antibiotics, amino acids; Enzyme Technology- Production, recovery and their industrial applications. Learning Activities: Group Discussion, Student generated Questions, Group tasks-assignment	
IV 11 Hours	**Unit 4: Genetically Modified Organisms and Environment** GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC for GMO applications in food and agriculture; Environmental significance of GMOs; applications in environmental protection. Transgenic plants-Pest and Disease Resistance, Herbicide resistant plants, Bt cotton, Genetically engineered insects**,** Relevance of Biosafety, Cartagena Protocol. Learning Activities:Group tasks-assignments, Case Studies, Debate.	CLO5

Suggested Readings

1. Shah, M.P. and Vyas, B. R. M. (2023). Emerging Technologies in Applied and Environmental Microbiology, Academic Press, Elsevier, United Kingdom.
2. Yogalakshmi K. N., Garg, V.K., Labhsetwar N.K. and Singh, A. (2022). Zero Waste Biorefinery. Springer Verlag, Singapore
3. Shah, M.P. (2022). Application of Biofilms in Applied Microbiology. Elsevier Science, Netherlands.
4. Maddela, N.R., Abiodun, A.S. and Prasad, R. (2022). Ecological Interplays in Microbial Enzymology. (2022). Springer Nature, Singapore.
5. Buckley R. G. (2019). *Environmental Microbiology*, CBS, New Delhi.
6. Casida, L. E. J. R. (2019). *Industrial Microbiology*, New Age International Private Limited, New Delhi.
7. Chandra, R., Dubey, N. K., Kumar, V. (2017). *Phytoremediation of Environmental Pollutants,* CRC Press.
8. Das, S. (2014). *Microbial biodegradation and bioremediation,* Elsevier, London.
9. Peppler, H. J., D. Perlman, (2012). *Microbial Technology: Microbial processes,* Academic Press, Amsterdam.
10. Maheshwari, D. K., Dubey, R. C. (2012). *Bioremediation of pollutants,* I.K. International Publishing House, New Delhi.
11. Okafor, N. (2011). *Environmental microbiology of aquatic and waste systems,* USA: Springer.
12. Fulekar, M. H. (2010). *Bioremediation Technology: Recent Advances,* Springer, Netherlands.
13. Ronald L. C., Don, L. C. (2005). *Bioremediation: principles and applications.* Cambridge University Press, UK.
14. Kaur, J. (2007). *Organic farming for sustainability,* Ludhiana: Academic book Depot.
15. Sharma, P. D. (2005). *Environmental Microbiology,*Narosa Publishing House.

Suggested Website:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. https://nptel.ac.in/courses/102/105/102105087/
3. https://www.nap.edu/read/2131/chapter/3

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Google Apps, Websites

Course Title: Environmental Law and Policy
Paper Code: MEVS.519

L	T	P	C

3	**0**	**0**	**3**

Total teaching hours: 45 h

Course Learning outcomes:

At the completion of the course, the learner will be able to:

CLO1: To introduce various laws and policies at national and international aspects relating to environment protection, management and pollution control

CLO2: To acquaint with the institutional mechanism in environmental management

CLO3: To provide the skills needed for interpreting environmental laws and policies

Units/ Hours	**Contents**	**Mapping with Course Learning Outcome**
Unit 1 11 hours	History of environmental laws in India; Basic concepts and scope in Environmental Law: Introduction to environmental legal system, General principles in Environmental law, Constitutions, Acts, Regulations, Sources of environmental law, Common law remedies to curb pollution. Sustainable Development-Inter-generational and Inter-generational Equity; Precautionary Principle; Polluter Pays Principle; Public Trust Doctrine; Community rights Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A).	CLO1
Unit 2 12 hours	Indian environmental laws: Indian Forest Act, 1927; Forest (Conservation) Act, 1980; The Wild Life (Protection) Act, 1972; The Wild Life (Protection) Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Water (Prevention and Control of Pollution) Act, 1974 and its amendments; : Air (Prevention and Control of Pollution) Act 1981 and amendments; The Environmental (Protection) Act, 1986; Public Liability Insurance Act 1991, Motor vehicle Act 1980 (Environmental/Pollution control provisions only). Central and state boards for the prevention and control of environmental pollution National Forest Policy, 1988; National Environment Policy 2006; National Water Policy-2012; National Green Tribunal; National Action Plan on Climate Change (NAPCC); National environmental appellate authority, National Biodiversity Authority, State Biodiversity Board, Biodiversity Management Committees; National Air Quality Monitoring Programme; National Clean Air Programme; Role of supreme court on environmental protection.	CLO1; CLO2; CLO3
Unit 3 11 hours	Hazardous and other Wastes (Management and Transboundary Movement) Amendment Rules, 2016; Solid Waste Management Rules, 2016; Plastic Waste Management Rules, 2016 and upto date amendments; E-Waste Management Rules, 2016 and amendments; Biomedical waste Management 2016 and amendments; The Noise Pollution (Regulation and Control) Rules, 2000; Coastal Zone Regulation Notification 2011; The Biological Diversity Act, 2002.	CLO1; CLO3

	Environment and Public Interest Litigation; Writs and its jurisdiction for environmental protection, Judicial activism for protection of the environment, Role of NGOs and public in environmental protection.	
Unit 4 11 hours	Stockholm Declaration on Human Environment, 1972; Earth Summit – Rio Conference, 1992; Agenda 21 and Rio +20; Ramsar Convention, 1972; Convention on Biological Diversity; Cartagena and Nagoya Protocol; Convention on Biological Diversity, 1992; The Biological Diversity Act, 2002; Cartagena Protocol on Bio-Safety; Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing Benefits arising from their Utilization; Aichi Biodiversity Targets and Global Biodiversity Outlook, 2020; Strategic Action Plants for Biodiversity, 2011-2020; Nairobi Declaration, 1982; Johannesburg Convention, 2002; Basel Convention on the Control of Transboundary Movement of Hazardous Waste and Their Disposal; Kyoto Protocol and Paris Agreement 2015; Convention on Long-Range Transboundary Air Pollution; Montreal Protocol, Vienna Convention; United Nations Convention on Combating Desertification; Institutional Mechanism: UNEP, GEF; UNFCCC; IPCC.; Recent three COPs.	CLO2; CLO3

Suggested Readings:

1. Divan S. and Rosencranz A. (2023) Environmental Law and Policy in India, 3rd edition, Oxford University Press, New Delhi
2. Kohli, K. and Menon, M. (2022). Development of Environment Laws in India. Cambridge University Press.
3. Divan, S. and Rosencranz, A. (2022). Environmental Law and Policy in India: Cases and Materials. Oxford University Press, New Delhi

Suggested Websites:

1. National Green Tribunal: https://www. greentribunal.gov.in
2. MoEFF&CC: http://moef.gov.in
3. https://www.indiacode.nic.in/
4. Environmental Clearance – General, https://moef.gov.in/moef/rules-and-regulations/environment-protection/environmental-clearance-general/index.html
5. Environmental Standards - https://www.moef.gov.in/moef/rules-and-regulations/environment-protection/environmental-standards/index.html
6. https://cpcb.nic.in/index.php
7. United Nations Framework Convention on Climate Change - https://unfccc.int/

Mode of Transaction: Lecture, power point, demonstration, case study, co-operative learning, group discussion, e-learning

Course Title: Geochemistry and Isotope Geology

Course Code: MEGS.516

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes (CLO):
Upon successful completion of this course, the student will be able to

CLO1 : Appraise behaviors of elements in the formation of primary and secondary rocks
CLO2 : Formulate the basics of isotope systematics and radioactive decay.
CLO3 : Design the geochemical aspects for the assessment of elements in and on Earth.
CLO4 : Discuss the principles and applications of radiogenic isotope systems to study geological processes and date rock-forming events.
CLO5 : Adapt the principles and applications of stable isotope systematics.

Unit/ Hour	Contents	Mapping with CLO
I **11** Hours	Introduction to geochemistry and cosmochemistry.The abundance of elements in the solar system and the chemical composition and properties of Earth's layers.Atmosphere: its layers, chemical composition, and evolution of the atmosphere.Meteorites, classification, mineralogy, origin, significance, and phenomena of fall. **Learning Activities:** Assignments, Take-homeexercises, and Group discussions.	**CLO1** **CLO2**
II **10** Hours	Geochemical classification of elements.Chemical Bonds,Ionic Radii, and Crystals, Distribution coefficient; Behavior of major and trace, including rare earth elements during magmatic crystallization, Oddo-Harkins rule.Elemental mobility in surface environment, Eh-pH diagram.Concept of geochemical-biogeochemical cycling: Minor cycle and major cycle.Chemical weathering of minerals and rocks.	**CLO3**

	Learning Activities: Take-home exercise, peer learning, and plotting of Eh-pH diagram for stability of different species/complexes of elements.	
III **12** Hours	**Isotope Geology:** The law of radioactive decay; principles of mass spectrometry; Principles, methods, and applications of K-Ar method, Ar-Ar method, Rb-Sr method, Sm-Nd Method, U-Th-Pb Method: decay schemes, U-Pbisochron, U-Pb mineral dating, and application. **Learning Activities:** Hands-on exercise during class, take-home exercise, assignment, and student seminar.	**CLO4** **CLO5**
IV **12** Hours	Stable isotopes and their fractionation; ratio Mass Spectrometry; principles of oxygen, carbon, and sulphur isotope geochemistry and their application in Geology.Application of Cosmogenic radionuclides in the geosciences.Principles and application of Fission Track and Radiocarbon methods of dating. **Learning Activities:** Assignment, student seminar, and group discussion.	**CLO4** **CLO5**

Transactiona lModes: Lecture, Project Method, Seminar, Co-operative Learning, Focused Group Discussion, Team Teaching, Mobile Teaching, Collaborative Learning, E-tutoring, Problem-solving, Case Analysis, Self-learning, Case-based Study,Experimentation.

Suggested readings:

1. Gunter Faure,1998.*Principles and Applications of Geochemistry, Prentice Hall*.
2. JohnV.Walther,2010.*Essentials of Geochemistry, Jones and Bartlett Publications*.
3. Claude Allegre,2008.*Isotope Geology, Cambridge University Press*.
4. Dickin,A.P.,2005.*Radiogenic Isotope Geology*.Cambridge University Press.
5. JochenHoefs,2015.*StableIsotopeGeochemistry*, Springer International Publishing.
6. GunterFaure,1986.*Principles of Isotope Geology*,Wiley.
7. Gunter Faureand Teresa M. M,2004.*Isotopes:Principles and Applications*,Wiley.
8. Francis Albarede, 2003. *Geochemistry: An Introduction, Cambridge University Press*.
9. William M. W.,2013.*Geochemistry*,Wiley-Blackwell.
10. Mc Sween Jr., H. Y., Richardson, S. M., and Uhle, M. E.,2003.*Geochemistry:*

Pathways and Processes, Columbia University Press,
11. Mason, B., and Moore,C.B.,1991.*Introduction to Geochemistry, Wiley Eastern*.
12. Krauskopf,K.B.,1967.*Introduction to Geochemistry, McGraw-Hill*.

Web Resources:

https://www.uvm.edu›GEOL195-Geochemistryhttp://www.geo.cornell.edu/geology/classes/Geo656/656notes03.html
https://wwwrcamnl.wr.usgs.gov/isoig/isopubs/itchch2.html
https:/www.southalabama.edu/geology/haywick/GY112/ppt/112-pp8a.pdf
https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-742-marine-chemistry-fall-2006/lecture-notes/lecture_2_notes.pdf

Course Title: Climatology

Paper Code: MGEO.516

L	T	P	C
3	0	0	3

TTotal teaching hours: 45 h

Course Learning Outcomes

At the completion of the course, the student will be able to:

CLO1: comprehend the atmosphere dynamics and climatic processes

CLO2: enlist the processes that drive the general global as well as regional circulation.

CLO3: understand the mechanism of ISM

CLO4: gain knowledge on classification of climatic region

CLO5: analyse method of interpretation of weather symbols, and the contemporary climatic issues.

Unit/Hours	Content	Mapping with CLO
I 10 Hours	**Introduction to climatology** Fundamentals of climatology; Earth's Atmosphere: Evolution, Structure and Composition; Solar radiation and Terrestrial radiation; Variation, distribution and effect on atmosphere; Greenhouse effect and global heat budget; Temperature: Concept, measurement, scales, daily and annual cycles of temperature; vertical distribution; world distribution. **Learning activities::** Assignment writing	CLO1
II 11 Hours	**Atmospheric dynamics** Stability and instability in atmosphere; Cloud: Type and formation; Atmospheric moisture and precipitation: Concept and measurement of atmospheric moisture; Condensation - forms of condensation; adiabatic temperature changes; Formation and types of precipitation; global distribution of precipitation. **Learning activities:** Quiz; Students' presentation/Group discussion	CLO1 CLO2
III 12 Hours	**Wind circulation and Monsoon** Wind circulation Models of general circulation of the atmosphere: Jet stream, Air masses and fronts, characteristics, movements, frontogenesis; Tropical cyclones; mechanism and characteristics; Genesis of Indian Monsoon and the causes of its variability; Oscillations: ENSO **Learning activities:** Paper reading, case study; Movie	CLO2C LO3

IV 12 Hours	**Climatic Classification** Classification of climates: Empirical and generic; Climatic classification with special reference to Koppen or Thornthwaite (any one); Indian Meteorological Department and All India Weather Forecast. **Learning activities:** Case study, IMD report reading/ familiarisation with weather apps, Test	CLO4 CLO5
Transaction mode: Lecture, Demonstration, Problem solving, Tutorial, Seminar, Local field visit discussion. Tools used: PPT, video, animation movie, whatsapp and Expert's Video Conferencing lectures from various national & international organizations		

Suggested readings:

1. Grotzinger, J. P., Jordan, T.H. (2019). *Understanding Earth*, New York: Freeman & Company.
2. Kusky, T. (2017). *The encyclopedia of earth science*, Viva book private limited.
3. Singh, S. (2017). *Physical Geography*, Allahabad: Prayag Pustak Bhavan.
4. Strahler, A.N. (2013). *An Introduction to Physical Geography*, UK: John Wiley & Sons.
5. Roy, R. (2013). *Introduction to general climatology*, New Delhi: Anmol publication private limited.
6. D. S. Lal. (2011). *Climatology*, ShardaPustak
7. Veena (2009). *Understanding earth science*, Delhi: Discovery.
8. Critchfield, H. J. (2008). *General Climatology*, Pearson Education India.
9. Frank Press and Raymond Siever (2003). *Understanding Earth*. W.H.Freeman& Co Ltd.
10. Lal, D.S. (1998). 'Climatology', Chaitanya Publishing House, Allahabad.
11. Malhotra,Nitashsa&Sen,Shyamoli (2018) Climatology, MK Books, New Delhi
12. Singh, Savindra (2017) Climatology,Pravalika publication, Allahabad
13. Hussain,Majid (2014) climatology, Anmol publications, New Delhi

Website/web references:

1. IMD: http://www.imd.gov.in/pages/main.php
2. NASA Earth Observatory: https://earthobservatory.nasa.gov/?eocn=topnav&eoci=logo
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=17
4. https://www.youtube.com/watch?v=ooZfziqY1Hk
5. https://www.tropmet.res.in/
6. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14

Semester II

Course Title: Energy and Environment

Paper Code: MEVS.408

L	T	P	C
3	0	0	3

TTotal teaching hours: 45 h

Course Learning Outcomes

Student will be able to:

CLO1: Describe the origin and composition of fossil fuels

CLO2: Demonstrate the working principles and applications of non-conventional energy sources

CLO3: Assess waste to energy conversion technologies

CLO4: Evaluate the environmental impacts of over exploitation of renewable energy sources

CLO5: Design models for maximum energy conservation in buildings

Units/Hours	Contents	Mapping with Course Learning Outcome
I 11 Hours	**Unit 1: Conventional energy sources** Introduction to energy sources, classification of energy resources-conventional and non-conventional, renewable and non- renewable, environmental implications of energy resources, carbon footprint. Fossil fuels (Coal, petroleum, LPG and natural gas) – origin, composition and physico-chemical characteristics and energy content, sources, properties and production process; nuclear energy– fission and fusion, technologies – nuclear enrichment, nuclear reactors, Energy consumption scenario in the world and India.Learning Activities: Case-studies, Student presentation.	CLO1
II 11 Hours	**Unit 2: Non -Conventional energy sources** Prospects of renewable and non-conventional energy, introduction to solar energy, wind energy, hydel, tidal and geothermal energy,magneto-hydrodynamic power (MHD). Solar collectors, applications of solar energy: Solar water heating, solar heating and cooling of buildings, solar photo-voltaics, solar distillation, solar cookers and solar ponds. Learning Activities:Visit to nearby villages for understanding the working of solar panels/collectors.	CLO2
III 13 Hours	**Unit 3: Bioenergy** Bioenergy - Biomass as an energy source, characteristics of biomass, energy plantations, biomass conversion technologies. Types of biofuels - biodiesel, bioethanol, biogas, biohydrogen - importance, production, technologies and applications. Microbial fuel cell – principle, types and	CLO3

	challenges.LearningActivities:Group discussions on biofuels, case studies	
IV 10 Hours	**Unit 4: Energy conservation** Energy conservation – principles and approach, energy conservation in buildings, green buildings, solar passive architecture, eco-housing, GRIHA norms, electric vehicles-challenges; energy audit and management, national and international norms**,** Pradhan Mantri Ujjwala Yojana, Ujala Yojna, National Solar Mission, National Mission for Enhanced Energy Efficiency,Energy Conservation (Amendment) Bill, 2022,PM KUSUM, GOBARdhan. SDG 7: Affordable and clean energy.	CLO4
	Designing models to reduce energy consumption in home/building. Learning Activities: Group discussions, Case studies	CLO5

Suggested Readings

1. Sergio Capareda (2023). Introductions to Biomass Energy Conversions (Second Edition). CRC Press,Boca Raton
2. Kalbande, S., Bhale, V.M. and Sedani, S.R. (2022). Textbook of Green Energy Technologies, Narendra Publishing House, New Delhi.
3. John Twidell. (2021). Renewable Energy Resources (4th Edition). Routledge, Taylor & Francis, England.
4. Kanoğlu, M., Çengel, Y. A., Cimbala, J. M. (2020). Fundamentals and Applications of Renewable Energy. McGraw-Hill Education. United States.
5. Bent, S., (2017). Renewable Energy- Physics, Engineering, Environmental Impacts, Economics and Planning, Fifth Edition. Academic Press, Elsevier Inc.
6. Abbi, Y., Jain, S. (2015). *Handbook on Energy and Environment management*. The Energy Resources Institute.
7. Bhushan, C. (2014).*State of renewable energy in India: A citizen's report*. Centre for Science and Environment, New Delhi.
8. Glassley, W. E. (2014).*Geothermal energy: Renewable energy and the environment*, 2nd edition, CRC press, London
9. Sergio, C. C. (2013). *Introduction to biomass Energy Conversions*. CRC press.
10. Prasad, S., Dhanya, M. S. (2012). *Biofuels*, New Delhi: Narendra Publishing House, New Delhi.
11. Sawhney, G. S. (2012). *Non - Conventional Energy Resources*, PHI Learning Private Limited, New Delhi.
12. Ahmed, F. Z., Ramesh, C. B. (2011). *Handbook of Renewable Energy Technology*. World Scientific Publishing Company.
13. Lal, B., Sarma, P. M., (2011). *Wealth from waste*: Trends and technologies, TERI.
14. MNRE (2011). *Griha manual volume - 3: Technical manual for trainers on building and system design optimization renewable energy application*, Ministry of New and Renewable Energy.
15. Ottmar, E., Ramón P.,Youba, S., Kristin, S., Susanne, K., Timm, Z., Patrick, E., Gerrit, H., Steffen, S., Christoph, S., Patrick, M. (2011). *Renewable energy sources and climate change mitigation: Special report of the Intergovernmental Panel on Climate Change*, IPCC.
16. Zobaa, A. F., Bansal, R. (2011). *Handbook of renewable energy technology*, World Scientific Publishing Co., Singapore.

17. European Wind Energy Association. (2009). *Wind Energy- The facts: A guide to the technology, economics and future of wind power*. Routledge Publishers
18. Rathore, N. S., Panwar, N. L. (2007). *Renewable energy sources for sustainable development*, New India Publishing Agency, New Delhi.
19. Gupta, H., Roy, S. (2006). *Geothermal energy: An alternative resourcefor the 21st century*, Elsevier Science Ltd.
20. Tiwari, G. N. (2002). *Solar energy: Fundamentals, design, modeling and applications*, Narosa Publishers, New Delhi.
21. Sukhatme, S. P. (2000). *Solar Energy – Principles of Thermal Collection and Storage*. Tata McGraw Hill.

Suggested websites:

1. https://www.energy.gov/science-innovation/energy-sources
2. https://mnre.gov.in
3. https://beeindia.gov.in
4. https://www.iea.org

Mode of Transaction: Lecture, demonstration, E-tutoring, discussion, assignments, case study, powerpoint, Google meet, Google Classroom, Swayam, e-PG Pathshala,

Course Title: Environmental Pollution -II
Paper Code: MEVS.409

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning Outcomes*:*

On completion of this course, students will be able to:

CLO1: Evaluate the state of air pollution in India and its emerging health risks,

CLO2: Measure the outdoor and indoor air pollutants

CLO3: Model the plume behavior and pollutant dispersion in the atmosphere

CLO4: Evaluate and select the appropriate pollution control device for target pollutants

CLO5: Evaluate the novelty of current vehicular control technology to curb pollution

CLO6: Measure the noise level in the field

Units/ Hours	Contents	Mapping with Course Learning Outcome
I 12 Hours	**Unit 1: Air Pollution** **Air pollution –** world and Indian scenario, Sources and classification of air pollutants, Air pollutants impact on health and the environment, Criteria pollutants and NAAQS, Air Quality Index. Government initiatives to tackle air pollution: Continuous emissions monitoring system, National Clean Air Programme. Atmospheric Aerosols: composition, sources and impact on earth's radiative balance; gas to particle formation and growth: nucleation, condensation and coagulation, Size distribution; lognormal distribution, thermodynamics of aerosols; Nucleation phenomenon; Bioaerosols-types and consequences.Case study on air pollution scenario.	CLO1 CLO2
II 11 Hours	Unit 2: Air Pollution Modeling Gas and particulate pollutant sampling: passive and active measurement, Indoor and outdoor environmental monitoring; Air dispersion and Modeling: Atmospheric stability, plume behavior, and the Gaussian dispersion model; Plume rise estimation, Atmospheric and Indoor chemical modeling, Demonstration on measuring indoor air pollution.	CLO3

III 11 Hours	**Unit 3: Air Pollution Control Technologies** Particulates - filters, gravitational, centrifugal-multiple type cyclones, Scrubbers and electrostatic precipitators: Equipment and collection efficiency; Adsorbents, PSA, adsorption cycle, rotary bed/fluidized bed, Condensation - contact condensers, shell and tube condenser, flaring. **Vehicular Pollution Control:** Combustion Cycle, Fuel/air Ratio, and Catalytic Converter; selective catalytic and selective non-catalytic reduction. Visit a Nearby Industry/Power plant.	CLO4 CLO5
IV 11 Hours	**Unit 4: Noise Pollution** Definition, sources, properties of sound waves, Sound pressure, intensity, decibel, measurement and analysis of sound, Noise Indices, Sound absorption, Meteorological effects on Noise propagation, Effects and impacts on humans Noise exposure level and standards, Noise control, Preventive measures and abatement measures. Measuring noise levels at any two sites in Campus.	CLO6

Suggested Readings:

1. Tiwari, A., Williams, I. (2018). *Air Pollution: Measurements, Modelling and Mitigation,* 4th Edition, CRC Press.
2. Schnelle, K. B., Dunn, R. F., Ternes, M. E. (2017). *Air pollution control technology handbook,* Routledge Publisher.
3. Cooper, D. C. (2015). *Air pollution control*. Medtech Publisher.
4. Wayne T. D., Thad, G., Joshua S. F. (2015). *Air Quality*. CRC Press.
5. Vallero, D. A. (2014). *Fundamentals of air pollution*. 5th edition, Academic Press, USA.
6. Jacobson, M. Z. (2012). *Air pollution and global warming: History, Sciences and solutions,* Cambridge University Press.
7. Kumar, A. (2011). *Noise Pollution and its control,* New Delhi: Shree Publishers & Distributors.
8. Klein, A. (2010). *Encyclopedia of Environmental Pollution and its Control,* Apple Academic Press.
9. Wang, L. K., Pereira, N. C. (2010). *Advanced air and noise pollution control,* Humana Publisher.
10. Agrawal, S. K. (2009). *Noise Pollution,* APH Publishing Corporation.
11. Jeremy, C., Tiwary, A., Colls, J. (2009). *Air pollution: measurement, modeling and mitigation*, 3rd Edition, USA: Crc Press.
12. Rao, C. S. (2006). *Environmental pollution control engineering,* New Delhi: New Age International Publishers.
13. Cheremisinoff, N. P. (2002). *Handbook of air pollution prevention and control,* UK: Butterworth-Heinemann Publishers.
14. Kenneth Jr., W., Davis, W. T., Warner C. F. (1998). *Air pollution and its origin and control,* 3rd edition, USA: Prentice Hall.
15. Clarke A. G. (1997). *Industrial air pollution monitoring: gaseous and particulate emissions,* USA: Springer.
16. Khopkar, S. M. (2007). Environmental Pollution Monitoring and Control. India: New Age International (P) Limited.

17. Mahajan, S. P. (2009). Air Pollution Control. India: TERI Press.
18. Gelencsér, A, (2004) Carbonaceous Aerosol, Springer, The Netherlands.
19. Seinfeld, J.H., Pandis, S.N., (2006): Atmospheric Chemistry and Physics: From Air Pollution to Climate Change. Wiley interscience publication.

Suggested Websites:

1. https://www.ipcc.ch
2. https://www.epa.gov/environmental-topics
3. https://cpcb.nic.in/
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
5. https://nptel.ac.in/courses/119/106/119106008/
6. http://www.indiaenvironmentportal.org.in/content/about-us/

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Google Apps, Websites

Course Title: **Geospatial Technology**

Paper Code: MEVS.520

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning outcomes:

The student will be able to:

CLO1: Learn aboutthe fundamental concepts of remote sensing

CLO2: Understand the techniques of image processing

CLO3: Learn about the various navigational satellite systems of the world

CLO4:Apply the concept of remote sensing and GIS for solving environmental problems

CLO5: Choose appropriate geospatial technique for environmental management

Units/Hours	Contents	Mapping with Course Learning Outcome
I 12 Hours	**Fundamental Concepts of Remote Sensing** History of Remote Sensing, Remote Sensing system,Indian Remote Sensing Program, Theory of EMR: Laws of Radiation; Concept of Blackbody radiation; Electromagnetic Spectrum; Scattering, Absorption, Refraction, Path Radiance Reflection, Transmission, Absorption; Energy-Earth Interaction, Atmospheric Windows, Spectral Signatures of Surface Features; RS Satellites- Polar sun-synchronous, geo-stationary; Platforms: Types and their orbital characteristics; Sensors types: active and passive; Sensors systems: whiskbroom and push broom; Principles and geometry of scanners and CCD arrays; Satellite RS data products or series: Optical, Microwave and Hyperspectral. Video based evaluation	CLO1
II 11 Hours	**Image Processing and Interpretation** Image: Meaning and Types (Analogue and Digital); Resolution: Spatial, Spectral, Radiometric and Temporal; Basics of Image Processing; Elements of Image Interpretation; Visual Interpretation; Digital Image Processing, Ground Truth Collection; Hyperspectral remote sensing; SAR and Drone data capture and analysis. Familiarization with GEE, Practical demonstration of Image Interpretation	CLO2
III 11 Hours	**Fundamental concept of GIS and GNSS** Concept and definition of GIS, History and development of GIS technology, Applications of GIS in various sectors; Geographic information database management system: data types (map, attributes, image data) and structure; Spatial and non-spatial data; Projection and Geo-referencing; Spatial analysis: overlay, buffer and	CLO3

	proximity, network analysis; Introduction to GNSS; Concepts and types. Group-discussion on GIS and GNSS in different countries	
IV 11 Hours	**Applications of Geospatial Technology** Applications in Environmental science; Geological sciences; Geographical sciences; Sustainable development Goals (SDGs); Urban Planning and Management; Disaster management**.** Case-studies on applications of Geospatial Technology; Think-Pair Share method	CLO4 and CLO5

Suggested readings:

1. Singh, C. K. (2018). *Geospatial Applications for Natural Resources Management,* CRC Press.
2. Shellito, B. (2017). *Geospatial Technologies*, 4th edition, W. H. Freeman Publisher.
3. Shamsi, U. M. (2012). *GIS applications for Water, Wastewater, and Stormwater systems*, CRC Press.
4. Bhatt, B. (2011). *Remote Sensing and GIS,* New Delhi: Oxford university press.
5. Skidmore, A. (2010). *Environmental Modelling with GIS and Remote Sensing*, New Delhi, Crc Press.
6. Abbasi, T. (2010). *Remote Sensing, GIS and Wetland management*, Discovery publishing house.
7. Lillisand, T. M., Keifer, R. W. (2007). *Remote Sensing and Image Interpretation,* USA: John Willey and Sons.
8. Joseph, G. (2003). *Fundamentals of Remote Sensing,* Hyderabad: Universities Press.
9. Chang, K. (2002). *Introduction to Geographic Information Systems,* USA: Tata McGraw-Hill.
10. Barrett, E. C. and Curtis, L. F. (1999). *Introduction to Environmental Remote Sensing,* USA: Chapman and Hall Publishers.
11. Curran, P. J. (1988). *Principles of Remote Sensing,* ELBS: Harlow Longman Scientific and Technical.

Suggested Websites:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. https://nptel.ac.in/courses/105/103/105103193/
3. https://giovanni.gsfc.nasa.gov/giovanni/
4. https://earthobservatory.nasa.gov/

Mode of Transaction: Lecture, power point, demonstration, case study, group discussion, e-learning

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Google Apps, Websites

Course Title: **Environmental Assessment, Management and Auditing**

Paper Code: MEVS.521

L	T	P	C
3	0	0	3

Total teaching hours: 45 h

Course Learning outcomes:

On completion of this course students should be able to:

CLO1: explain the major principles of environmental impact assessment

CLO2: list the different steps within environmental impact assessment

CLO3: evaluate the implications of current rules and regulations in relation to environmental impact assessment

CLO4: outline the key aspects of environmental audit and risk analysis

CLO5: formulate an EIA report

CLO6: analyze different case studies of EIA in practice

Units/Hours	Contents	Mapping with Course Learning Outcome
I 11 Hours	**Unit 1: Introduction** Environment Impact Assessment - Principles, Origin, development and historyof EIA **EIA Methodologies** Methods of Impact prediction: Matrices, Networks, Checklists & overlays. Systematic review by students under teacher's supervision	CLO1 CLO2
II 12 Hours	**Unit 2: EIA notification 2006** EIA notification 2006 and its Amendments: EIA standards and guidelines, public participation- procedure of public hearing, presentation, review and decision making. EIA consultant empanelment scheme (NABET/QCI), Class assignments	CLO3
III 12 Hours	**Unit 3: EIA components and Case studies** Components of EIA – project screening, scoping, baseline data, impact identification, prediction, evaluation, mitigation. Assessment techniques – cost benefit analysis, analysis of alternatives etc. Terms of Reference, EIA Manuals, EIA Forms, Case-based evaluation	CLO4 and CLO5
IV 10 Hours	**Unit 4: Environmental Management** Definition and types of audits, Guidelines for environmental auditing, methodologies for Environmental Auditing. Environment	CLO6

	Quality Management system, Water Audit,Hazardous waste Audit,environmental, social,and governance (ESG), Carbon foot print, carbon taxes – principles and calculation, emission trading, Cap and trade scheme, Carbon offsetsCase-study	

Suggested Readings

1. Khandeshwar, S. R., Raman, N. S., Gajbhiye, A. R. (2019). *Environmental Impact Assessment*,Dreamtech Press.
2. Hosetti, B. B., Kumar, A. (2013). *Environmental Impact: Assessment and Management*, New Delhi: Daya Publishing House.
3. Chitkara, M. G. (2013). *Environmental Impact Assessment*, New Delhi: APH Publishing Corporation Eccleston C. H. (2011). *Environmental Impact Assessment: a guide to best professional practices*, CRC Press.
4. Shrivastav A. K. (2011). *Environmental Impact Assessment*, APH Publishing Corporation.
5. Kulkarni, V., Ramachandra, T. V. (2009). *Environmental Management.* New Delhi: Capital Pub. Co.
6. Morris, P., Therivel, R. (2009). *Methods of Environmental Impact Assessment*, London: Routledge.
7. Fischer, T. B. (2007). *Theory and Practice of Strategic Environmental Assessment*, London: Earthscan.
8. Glasson, J., Therivel, R., Chadwick, A. (2006). *Introduction to Environmental Impact Assessment*, London: Routledge.
9. Petts, J. (2005). *Handbook of Environmental Impact Assessment*. Volume 1 and 2, UK: Blackwell Publishers.
10. Lawrence, D. P. (2003). *Environmental Impact Assessment: practical solutions to recurrent problems*, Hoboken NJ: John Wiley & Sons.
11. Wood, C. (2003). *Environmental Impact Assessment – A Comparative Review*, Prentice Hall, London.
12. Petts, J. (1999). *Handbook of Environmental Impact Assessment.* volume 1 and 2, Oxford: Blackwell Science.
13. Therivel, R., Partidario, M. R. (1996) (eds). *The Practice of Strategic Environmental Assessment*, London: Earthscan.
14. Canter, W. L. (1995). *Environmental Impact Assessment*, New York: McGraw-Hill Science/ Engineering/ Math.
15. Morris, P., Therivel, R. (1995). *Methods of Environmental Impact Assessment*, London: UCL Press.
16. Vanclay, F. Bronstein, D. A. (1995) (eds). *Environmental and Social Impact Assessment*, Chichester: Wiley & Sons.

Suggested Websites:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. http://environmentclearance.nic.in/
3. https://nptel.ac.in/courses/120/108/120108004/
4. http://www.fao.org/3/v9933e/v9933e02.htm

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Websites

Course Title: Environmental Pollution-II (Practical)
Paper Code: MEVS.522

L	T	P	C
0	0	4	2

Total practical hours: 60 h

Course Learning Outcomes:
On completion of this course, students will be able to:
CLO1: Sample and measure the outdoor air particulate ($PM_{2.5}$ & PM_{10})
CLO2: Sample and analyze outdoor & indoor gaseous pollutants (SO_2 NO_2, NH_3, and O_3)
CLO3: Interpret of the data of Continuous Air Quality Monitoring System
CLO4: Measure the noise level in different zones of Campus
CLO5: Prepare the biodiesel in laboratory conditions
CLO6: Test the fuel oil physical characteristics essential for its standard use

Units/Hours	Contents	Mapping with Course Learning Outcome
I 15 Hours	1.Study of PM_{10} in ambient air 2.Study $PM_{2.5}$ in ambient air. 3. Particles' mean diameter calculation and lognormal size distribution	CLO1
II 15 Hours	4.Determination of SO_2, NO_x, and O_3 in ambient air. 5.Study and interpret the data of continuous Ambient air quality monitoring system 6. Air quality Index- calculation and interpretation 7. Plume rise estimation and pollutant dispersion modelling	CLO2 CLO3
III 15 Hours	8.Sampling and analysis of Noise.	CLO4
IV 15 Hours	9.Preparation of biodiesel and study its characteristics a)Calorific Value b)Viscosity c)Flashpoint d)Cloud and pour point e)Acid value	CLO5 CLO6

Suggested readings

1. Gupta, P. K. (2018).*Methods in Environmental Analysis: Water Soil and Air*, 2nd Edition.Jodhpur, India:Agrobios Publication.
2. Hess-Kosa, K. (2018). *Indoor Air Quality: The latest sampling and Analytical methods*, London: CRC press.
3. Patnaik, P. (2017).*Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil and Solid Wastes*, 3rd Edition, London: CRC press.

4. Lodge, J. P. (2017). *Methods of Air Sampling and Analysis*, 3rd Edition, New York: Taylor &Fransic Group.
5. Maiello, M., Hoover, M. D. (2011). *Radioactive Air Sampling methods*, 1st Edition. CRC Press Book.
6. Seinfeld, J.H., Pandis, S.N., (2006): Atmospheric Chemistry and Physics: From Air Pollution to Climate Change.Awileyinterscience publication.
7. Radojevic, M., Bashkin, V. N. (2015). Practical Environmental Analysis. United Kingdom: Royal Society of Chemistry.
8. Khopkar, S. M. (2007). Environmental Pollution Monitoring and Control. India: New Age International (P) Limited.

Evaluation criteria:

Continuous Assessment **(10 Marks):** Based on attendance in practical class, practical record, involvement in practical, etc.

End Semester Exam **(40 Marks)**: Subjective Type with experimental performance (30 Marks) and viva-voce (10 Marks)

Total Marks: 50

Course Title: Basics of Geospatial Technology (Practical)
Paper Code: MEVS.523

L	T	P	C
0	0	2	1

Total practical hours: 30 h

Course Learning Outcome:

The students will be able to:
CLO1: Familiarize with the working environment of ArcGIS and QGIS tool
CLO2: Design various experiments for familiarization with satellite images, mapping and layout.
CLO3: Apply remote sensing and GIS software for pre-processing, image classification and interpretation
CLO4: Familiarize with the working of GPS for mapping and spatial data analysis

Units/Hours	Contents	Mapping with Course Learning Outcome
I 12 Hours	1. **QGIS and ArcGIS Tool:** Software interface, creating a project, importing vector data, linking csv file to GIS platform, creating a basic map, QGIS plugins, GEE interface and data input. 2. **Georeferencing:** Georeferencing of topographic sheet and scanned map using QGIS/ArcGIS	CLO1
II 10 Hours	3. **GIS database mining:** point, polygon and line features capture, Digitization,editing and manipulation, topology building, Conversion of Raster to vector and Vector to Raster layer 4. **Satellite data mining:** downloading and familiarization of satellite imagery, reading metadata and basic characteristics of images	CLO2
III 10 Hours	5. **Image classification and interpretation:** visual interpretation, digital image processing (supervised, unsupervised and hybrid classification), Image classification by using GEE.	CLO3
IV 10 Hours	6. **Mapping and layout**: Map template design, map layout design based on scale, export and publishing. 7. **Mobile data collection using GPS:** GPS data collection,displaying GPS data in GIS platform, Strategies for data collection, recording way points.	CLO1 and CLO4

Suggested readings

1. Kennedy, M. (2013). *Introducing geographic information systems with ArcGIS: A workbook approach to learning GIS,* Wiley & Sons Publications.
2. Kennedy, M. (2010). *The Global positioning system and ArcGIS*. Crc Press.

Mode of Transaction: Lecture, demonstration, Experimentation, Tutorial, Problem solving, Self-learning, E-tutoring

Tools: Google meet, Google Classroom, Swayam, e-PG Pathshala, YouTube, Slide share, Google Apps, Websites

Evaluation criteria:

Continuous Assessment **(10 Marks):** Based on attendance in practical class, practical record, involvement in practical, etc.

End Semester Exam **(40 Marks)**: Subjective Type with experimental performance (30 Marks) and viva-voce (10 Marks)

Total Marks: 50

Course Title: Advanced Geoinformatics and Geospatial Modeling (Practical)
Paper Code: MEVS. 524

L	T	P	C
0	0	2	1

Total practical hours: 30 h

Course Learning Outcome:

The students will be able to:
CLO1: Familiarize with the working environment of advanced tools of GIS and R
CLO2: Able to perform terrain modeling on GIS platform
CLO3: Apply Geospatial techniques for site suitability analysis
CLO4: Familiarize with the working of Hydrological models

Units/Hours	Contents	Mapping with Course Learning Outcome
I 6 Hours	Introduction to advanced GIS software tools (Spatial analysis, Geostatistics, 3D modeling),Geospatial data analysis in R, Familiarization with Drone data and LiDAR Data.	CLO1
II 6 Hours	Terrain modeling: Introduction to Digital Elevation Model (DEM) data, Triangulated Irregular Network (TIN), Generation of slope, aspect, and watershed analysis.	CLO2
III 8 Hours	Multi-criteria decision analysis (MCDA) in GIS, Overlay analysis, Network analysis (route optimization and accessibility analysis) Site suitability for rain water harvesting and waste disposal.	CLO3
IV 10 Hours	Introduction to GIS based Hydrological model SWAT, analyzing impact of Landuse change on surface runoff, Tracking changes in vegetation, water resources and land use by using Google Earth Engine. (GEE).	CLO4

Suggested readings:

1. Kennedy, M. (2013). *Introducing geographic information systems with ArcGIS: A workbook approach to learning GIS,* Wiley & Sons Publications.
2. Kennedy, M. (2010). *The Global positioning system and ArcGIS*. Crc Press
3. https://swat.tamu.edu/
4. https://earthengine.google.com/

Mode of Transaction: Lecture, demonstration, Experimentation, Tutorial, Problem solving, Self-learning,

Tools: Laboratory, Computer, GIS software and internet

Evaluation criteria:

Continuous Assessment **(10 Marks):** Based on attendance in practical class, practical record, involvement in practical, etc.

End Semester Exam **(40 Marks)**: Subjective Type with experimental performance (30 Marks) and viva-voce (10 Marks)
Total Marks: 50

Course Title: Instrumental Methods of Analysis (Practical)

Paper Code: MEVS.525

L	T	P	C
0	0	4	2

Total practical hours: 60 h

Course Learning Outcomes

On completion of the course the student will be able to:

CLO1: Get workingknowledge of handling spectrophotometer and voltameter
CLO2: Apply the instruments MP-AES and AAS in analyzing chemical contaminants in water
CLO3: Characterize water and wastewater using IC and TOC
CLO4: Describe the principle and applications of Viscometer and Bomb calorimeter

Units/Hours	Contents	Mapping with Course Learning Outcome
I 4 Hours	1. Calibration of water quality meter for physico-chemical analysis 2. To determine fluoride in water using spectrophotometer	CLO1
II 3 Hours	3. Sample digestion using Microwave digestion system 4. Preparation of samples and calibration curve for heavy metal analysis in MP-AES	CLO2
III 4 Hours	5. Sample preparation and analysis in IC chromatography 6. Determination of TC, IC, and TN using TOC analyser	CLO3
IV 4 Hours	7. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter.	CLO4

Suggested Readings

1. George E. Totten, RJ Shah, SR Westbrook. (2019). *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing,* 2nd Edition, ASTM International
2. Ahluwalia V. K. (2015). *Instrument Methods of chemical analysis,* Ane Books Pvt. Ltd.
3. Holler F. J, Crouch S.R. (2014). *Skoog & West's Fundamental of Analytical Chemistry,* 9th edition, CENGAGE learning.

4. Chatwal, G. R., Anand, S. K. (2013). *Instrumental Methods of Chemical Analysis,* New Delhi: Himalaya Publishing House
5. American Public Health Association (APHA) (2012). *Standard method for examination of water and wastewater*, 22nd edn. APHA, AWWA, WPCF, Washington.
6. Yadav, M. S. (2008). *Instrumental methods of chemical analysis*, Campus Books International. Delhi.
7. Rajvaidya, N., Markandey, D. (2005). *Environmental Analysis and Instrumentation*, APH Publisher.
8. APHA (2005). *Standard methods for the examination of water and wastewater*, 21sted. Washington, DC, New York: American Public Health Association; 2005.
9. Shukla, S. K., Srivastava, P. R. (1992). *Methodology for environmental monitoring and assessment*, New Delhi: Commonwealth Publishers.

Evaluation criteria:

Continuous Assessment **(10 Marks):** Based on attendance in practical class, practical record, involvement in practical, etc.

End Semester Exam **(40 Marks)**: Subjective Type with experimental performance (30 Marks) and viva-voce (10 Marks)

Total Marks: 50

Interdisciplinary Courses

Course Title: Waste Management in Our Daily life
Paper Code: MEVS.506

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning Outcomes:

The students should be able to:

CLO1: Learn different types of waste
CLO2: Understand various waste management option
CLO3: Analyze the issues and concerns of waste

Units/Hours	Contents	Mapping with Course Learning Outcome
I 7 Hours	**Unit 1: Waste** What is waste? Sources of waste generation; Composition and classification of waste; Sorting and segregation of waste at source of generation; Waste prevention; 7Rs of Sustainability Group Discussion, Student generated Questions, Case Studies.	CLO1
II 8 Hours	**Unit 2 Waste management** Waste collection – sample collection bins; storage and transport; Waste processing – size and volume reduction; Group tasks-assignments, Case Studies.	CLO2
III 8 Hours	**Unit 3: Waste treatment** Composting – vermicomposting; anaerobic digestion – biogas, manure; waste to energy – incineration, pyrolysis, refuse derived fuels Group Discussion, Case Studies, Debate, Think- Pair-Share method.	CLO2
IV 7 Hours	**Unit 4: Disposal of waste** Open dumping - problems of open dumping and burning; Controlled dumping - landfills; diseases associated with waste handling; Best practices for solid waste disposal Student generated Questions, Group tasks-assignments, Case Studies, Debate.	CLO2; CLO3

Suggested Readings:

1. Ramachandra, T.V., (2009). *Management of municipal solid waste*, published by TERI Press, New Delhi

2. Dhamija, U. (2009). *Sustainable solid waste management: issues, policies, and structures*. Academic Foundation, New Delhi.
3. Williams, P. T. Williams A. (2005). *Waste treatment and disposal*, 2nd Edition Wiley publications, UK.

Suggested Websites:

1. https://cpcb.nic.in/rules-2/
2. https://vikaspedia.in/energy/environment/waste-management/solid-waste-management-rules
3. https://swachhbharat.mygov.in/
4. http://www.indiaenvironmentportal.org.in/content/about-us/

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Course Title: Environmental Conservation
Paper Code: MEVS.507

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning Outcomes
Student will be able to:
CLO1: Discuss need and scope of environmental conservation
CLO2: Apply methods of soil and water conservation
CLO3: Illustrate the approaches for biodiversity conservation
CLO4: Assess the ways to conserve energy at different sectors

Units/Hours	Contents	Mapping with Course Learning Outcome
I 7 Hours	**Unit 1: Introduction to global environmental issues** Concept of environment, Different layers of earth system; Global environmental issues- global warming, Climate change, Acid rain, Ozone depletion, Photochemical smog, Asian brown clouds, Plastic pollution; Importance of environmental conservation, waste as a resource, Waste management, Swachh Bharat Mission – Gramin. Learning Activities: Group Discussion, Student generated Questions, Think- Pair-Share method.	CLO1
II 8 Hours	**Unit 2: Soil and Water conservation** Land resources; concept of soil, Land degradation; Soil Pollution; soil erosion, conservation measures; Soil fertility restoration, organic farming, Rashtriya Krishi Vigyan Yojana. Water resources; water pollution- surface water, ground water; need for sustainable water management, Micro irrigation techniques, watershed management, rain water harvesting,Jal Jeevan Mission,National Water Mission. Learning Activities: Student generated Questions, Group tasks-assignments, Case Studies, Think- Pair-Share method, Jigsaw method.	CLO2
III 8 Hours	**Unit 3: Biodiversity conservation** Biodiversity; significance of biodiversity conservation, threats to biodiversity, man- wildlife conflicts, strategies for biodiversity conservation, wildlife conservation projects,Green India Mission; Learning Activities: Group Discussion, Student generated Questions, Group tasks-assignments, Case Studies, Jigsaw method.	CLO3
IV		

7 Hours	**Unit 4: Energy conservation** Energy resources- renewable and non-renewable energy sources; solar collectors, photovoltaics, biofuel, Energy conservation- home, buildings; energy efficiency – electrical appliances; CFL, LEDs, OLEDs, clean fuels for vehicles, electric vehicles, PM KUSUM; Learning Activities: Group Discussion, Student generated Questions, Case Studies, Debate,Think- Pair-Share method, Interactive demonstration.	CLO4

Suggested Readings:

1. Kumar, P. and Verma, C. (2022). Environmental ecology and impacts of pollution on ecosystem. Orange book publication, Chattisgarh
2. Das, S. (2022). Environmental Studies, Blue rose publishers
3. Arumugam, T., Sapna, K. (2020).*A Text Book of Environmental Science*, Walnut Publication, Bhubaneswar.
4. Das, S. K. (2018). *Watershed Development and Livelihoods: People's action in India*, Routledge India. New Delhi.
5. Singh, S. P., Singh, J. S. (2017). *Ecology Environmental Science and Conservation*, S. Chand (G/L) & Company Ltd., Chandigarh.
6. Rajagopalan, R. (2015). *Environmental Studies*. Oxford University Press, United Kingdom.
7. Ahluwalia, V. K. (2013). *Environmental Studies: Basic concepts*, TERI, New Delhi.
8. Fatik B. M., Nepal, C. N. (2013). *Biodiversity: concepts, conservation and biofuture*, Asian Books Pvt. Ltd, New Delhi.
9. Prasad, G. (2013). *Conservation of Natural Resources*, Discovery Publishing, New Delhi.
10. Fa, J. E. (2011). *Zoo Conservation Biology* (Ecology, Biodiversity and Conservation), Durrell Wildlife Conservation Trust, Cambridge University Press, United Kingdom
11. Misra, S. P, Pandey, S. N. (2010). *Essential Environmental Studies*. Ane Books Pvt. Ltd., New Delhi.
12. Burchett, S. (2010). *Introduction to wildlife conservation in farming*, Wiley- Blackwell, United States.
13. Bhatt, S. (2004). *Environment protection and sustainable development*, APH Publishing Corporation, New Delhi.

Suggested Websites:

1. http://envis.nic.in/ENVIS_html/ENVISSubject/subject.html
2. https://www.iucn.org/
3. https://www.cbd.int/

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Course Title: Environmental Geology
Paper Code: MEVS.508

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning outcomes:

On completion of this course, students will be able to:

CLO1: Gain insight about basic knowledge on environmental geology

CLO2: Analyze the geogenic and anthropogenic cause of soil and water pollution and ways to prevent pollution

CLO3: Understand geologic hazards and explain how the human activities contribute to natural disasters

CLO4: Identify the current environmental issues in India and possible solutions

Units/Hours	Contents	Mapping with Course Learning Outcome
I 7 Hours	**Unit I: Fundamental of Environmental Geology** Concept and principle of Environmental Geology. Domains of the Earth: lithosphere, hydrosphere, atmosphere, biosphere. Soils and rock types and their formation processes Chemical composition of soil and rocks, Different water types and their chemical composition; Student generated questions.	CLO1
II 8 Hours	**Unit II: Environmental Pollution** Definition of environmental pollution and its types - point and non-point sources. Physical, chemical and biological characteristics of water and soil. Types of pollutants (Inorganic, organic, microbiological, emerging) in environment, Geogenic contamination, Source, cause and effect water and soil pollution. Water and soil quality assessment; Group discussions.	CLO2
III 8 Hours	**Unit III: Natural and manmade hazards** Concept and principles of natural hazards and disasters such as floods, droughts, earthquake, cyclones, tsunami, and landslides. Humans add to natural disaster, Man-made disasters, (Bhopal gas tragedy, Love Canal Tragedy, Minamata disease, and Nuclear disaster). Case studies in India. Disaster mitigation and management; Group assignments	CLO3
IV 7 Hours	**Unit IV: Current Environmental Issue and possible solutions**	CLO4

	Global warming, Ozone layer depletion, Acid rain, Acid Mine drainage (AMD) issues in India, Groundwater contamination with uranium, arsenic and fluoride, Climate change and sustainable development, Water stress and management; Debate, Student generated questions.	

Suggested Readings:

1. Montgomery, C. W. (2020). *Environmental Geology* (7th Edition), New York, NY: McGraw-Hill Education
2. Gupta D. K., Chatterjee, S., (2018). *Arsenic Contamination in the Environment*: The Issues and Solution, Springer, end edition.
3. Scheibe, T. D., Mays, D. C. (2018). *Groundwater contamination and remediation*, MDPI.
4. Arora, S. (2018). *Environmental issues & challenges in India*. Shrinkhala Publishing House
5. Bennet, M. R., Doyle P (2016). *Environmental Geology: Geology and Human Environment*. John Wiley & Sons.
6. Gill, R. (2015). *Chemical Fundamentals of Geology and Environmental Geosciences*. Wiley Blackwell.
7. Abel, D. C., (2014). *Environmental Geology Today*. Jones & Bartlett learning.
8. Andrew, D. W., Dorothy, M., Kirsten M. (2014). *Environmental Geology: An Earth Systems Approach*. Publisher: WH Freeman; 2nd ed. 2014 edition.
9. Bhattacharya, R. (2012). *Environmental Issues in India*. Pragun Publication.
10. Bell, F.G. (2007). *Basic Environmental and Engineering Geology*. CRC Press, London.
11. Barbar, W., Murk et. al., (1996). *Environmental Geology*, John Wiley & Sons, New York.

Suggested Websites:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
2. https://nptel.ac.in/courses/105/105/105105106/

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, presentation, case study

Course Title: Environmental Issues and Policies in India
Course Code: MEVS.509

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning Outcomes:

On completion of this course, students will be able to:
CLO1: Evaluate the state of air pollution in India and its emerging health risks
CLO2: Assess the government initiatives to air pollution and their success
CLO3: Assess the of water pollution, and Ganga River cleaning progress
CLO4: Apply waste management practices as per waste management rules
CLO5: Evaluate the new technologies used for waste management
CLO6: Evaluate the current energy issues and their progress

Units/Hours	Contents	Mapping with Course Learning Outcome
I 7 Hours	**Unit:1 Air quality and pollution status** Air quality: major air pollutants, their impacts on human health; State of pollution in major Indian cities; air quality index, Greenhouse Gas (GHG) emissions, Climate change. Government initiatives to tackle air pollution: Central Pollution Control Board (CPCB), Continuous emissions monitoring system, National Clean Air Programme, Comprehensive Action Plan; Group Discussion, Case Studies.	CLO1 CLO2
II 8 Hours	**Unit: 2 Water quality and pollution control** Water quality: state of water pollution of major Indian rivers. Government action plans: National Water Quality Monitoring Programme, Namami Gange, and Zero Liquid Discharge. Groundwater depletion and pollution; Freshwater status and conservation in India; Student generated Questions, Group tasks-assignments, Case Studies.	CLO3

III 8 Hours	**Unit: 3 Waste management** Municipal, plastic and electronic waste, generation, collection system and disposal. Sanitation, open defecation, eradication of open defecation in India, community approaches to total sanitation, Swachh Bharat Abhiyan. Degradation of land and major causes; Group Discussion, Student generated Questions, Case Studies, Debate	CLO4 CLO5
IV 7 Hours	**Unit: 4 Energy usage and trends** Energy situation and related environmental problems; coal & oil combustion pollution. Clean and green fuel; Pradhan Mantri Ujjwala Yojana, Ujala Yojna. Biodiversity: value of biodiversity, biodiversity conservation- in situ, ex situ; man and biosphere, project Tiger; Group Discussion, Case Studies.	CLO6

Suggested Readings:

1. Akitsu, T. (2019). *Environmental Science: Society, Nature, and Technology*. Jenny Stanford Publishing
2. Simon, S. J. (2018). *Protecting Clean Air: Preventing Pollution*. Momentum Press
3. Metcalf & Eddy. (2015). *Wastewater Engineering Treatment and Reuse*. McGraw Hill Education (India) Private Limited.
4. John, H. (2015). *Global Warming: The Complete Briefing*. Cambridge University Press.
5. Abbi, Y., Jain Shashank. (2015). *Handbook on Energy and Environment management*. The Energy Resources Institute.
6. Sinha, M., Sinha, R. K.(2016). *Swachh Bharat.* Prabhat Prakashan.

Suggested Websites:

1. https://www.ipcc.ch
2. https://www.unep.org/
3. https://cpcb.nic.in/
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14
5. http://www.indiaenvironmentportal.org.in/content/about-us/

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

Course Title: Climate Change and Sustainability
Course Code: MEVS.510

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning Outcomes:
The students will be able to
CLO1: Explain and evaluate the science of human induced climate change
CLO2: Quantify the impacts of climate change on natural resources and human health
CLO3: Analyse the importance of climate change adaptation and mitigation
CLO4: Explain and analyse the concept of sustainability and its importance

Units/Hours	Contents	Mapping with CLOs
I 8 hours	**Introduction to Climate Change Science** Overview of weather and Climate. Earth Atmosphere structure and gaseous Composition, Greenhouse gases, greenhouse effect, Global warming. Anthropogenic drivers of climate change, and its major sources, Earth energy budget, radiative forcing, feedback processes and climate sensitivity. **Students' activities**- Identification of GHGs emission sources and case studies.	CLO 1
II 8 hours	**Global Climate Change projection and Impacts of Climate Change** Discussion on observed and projected future trends of climate change based on recent global data., Impacts on surface temperature, precipitation, water resources, Cryosphere, and Marine Environment. Climate change and human health. Climate change and agriculture. **Students' activities-** Presentation and discussions on IPCC AR6 report	CLO2
III 8 hours	**Climate Change Adaptation and Mitigation** Introduction to the concept of climate change adaptation, Concept of climate change vulnerability,framework for assessing climate vulnerability, Discussion on important national and international adaptation initiatives and programme. Introduction to climate change mitigation: Concept of Carbon footprint, Carbon sequestration, concept of net zero, The national action plan of India on climate change. **Student activities**- Calculation of carbon footprint	CLO3
IV 8 hours	**Introduction to Environmental sustainability** Introduction to sustainability, Indicators of sustainability, Concept of Sustainable Development, Sustainable Development Goals (SDGs). Water and Energy Sustainability: A case study in Indian context, **Student activities**- How you can cut GHGs emissions in your day-to-day life	CLO4

Suggested Reading:

1. Dessler, A., 2012, Introduction to Modern Climate Change, Cambridge University Press.
2. Pant, G. B., and Rupa Kumar, K., 1997, Climate of South Asia, Wiley.
3. McGuffie, K., and Henderson-Sellers, A., 2014, The Climate Modelling Primer (4 th Edition), Wiley.

Suggested Reports/Websites

1. IPCC. 2021. The IPCC Sixth Assessment Report—Climate Change 2021: The Physical Science Basis https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/.
2. Department of Science and Technology, India, 2021 report -Climate Vulnerability Assessment for Adaptation Planning in India Using a CommonFramework'dst.gov.in/sites/default/files/Full Report %281%29.pdf

Mode of Transaction: Lecture, demonstration, Power point, E-tutoring, discussion, assignments, case study

VALUE BASED COURSE

Course Title: Turning Waste into Product
Paper Code: MEVS.512

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning Outcomes:

On completion of this course, students will be able to:
CLO1: Evaluate the waste generation sources, rates and trends
CLO2: Evaluate the current scenario of waste utilization in energy conversion
CLO3: Assess the potential of different waste to use as a source of energy
CLO4: Apply the compositing method to convert waste to fertilizer
CLO5: Evaluate the pros and cons of plastics and their recycling or conversion to products

Units/Hours	Contents	Mapping with Course Learning Outcome
I 7 Hours	**Unit: 1 Introduction to waste generation** Waste: definition, types, and characterization; origin and waste generation status in India, collection system, transfer and transport,impact waste on health, livestock, and environment, Student-generated questions	CLO1
II 8 Hours	**Unit: 2 Waste to energy conversion** Waste to Energy: major waste to energy conversion routes – thermochemical, biochemical, and physico-chemical. Biofuels: liquid fuels, such as ethanol, methanol, biodiesel, Fischer-Tropsch diesel; and gaseous fuels, Refuse-derived fuel,Guidelines on usage of Refuse Derived Fuel in industries. Group assignments	CLO2 CLO3
III 7 Hours	**Unit: 3 Waste Composting** Waste to fertilizer: utilization of waste for fertilizer production: Animal Manure, Composting, Vermicomposting, Sewage sludge treatment; Bio fertilization in agriculture and their environmental impact, Group discussions	CLO4
IV 8 Hours	**Unit: 4 Plastic Waste recycling** Waste to useful material; plastic waste: Recycling and transformation of plastic waste into useful material; methods of recycling plastic. Case study: identify a type of waste and provide potential solutions to turn it into a value product, Case studies	CLO5

Suggested Readings:

1. Rogoff, M., Screve, F. (2019). *Waste-to-Energy: Technologies and Project Implementation*. Academic Press.
2. Letcher, T. M.; Vallero, D. A. (2019). *Waste: a handbook for management*. Academic Press.
3. Polprasert, C., Koottatep, T. (2017). *Organic Waste Recycling: Technology, Management and Sustainability*. IWA Publishing.
4. Ramachandra T.V. (2009). *Management of municipal solid waste*. TERI Press
5. Williams, P. T. (2013). *Waste treatment and disposal*, John Wiley Publishers.
6. The Composting Handbook: A How-to and why Manual for Farm, Municipal, Institutional and Commercial Composters. (2021). Netherlands: Elsevier Science.

Suggested Websites:

1. https://nptel.ac.in/courses/120/108/120108005/
2. https://vikaspedia.in/energy/environment/waste-management/solid-waste-management-rules
3. https://swachhbharat.mygov.in/
4. http://www.indiaenvironmentportal.org.in/content/about-us/

Mode of Transaction: Lecture, demonstration, Power point, discussion, assignments
Tools: Google meet, Google Classroom, YouTube, Slide share, Google Apps, Websites

Semester III

Course Title: Dissertation/Internship/Project - Part I

L	T	P	C
0	0	40	20

Paper Code: MEVS.599-1

Total practical hours: 40 x 15

Students will carry out their research work under the supervision of a faculty member. Students will interact with the supervisors through meetings and presentations on a regular basis. After completion of the research work, students will compile the results and prepare their dissertation that includes chapters on introduction, literature review, methodology, results and discussions, summary and conclusions and bibliography

Semester IV

Course Title: Dissertation/Internship/Project - Part II

L	T	P	C
0	0	40	20

Paper Code: MEVS.599-2

Total practical hours: 40 x 15

Students will carry out their research work under the supervision of a faculty member. Students will interact with the supervisors through meetings and presentations on a regular basis. After completion of the research work, students will compile the results and prepare their dissertation that includes chapters on introduction, literature review, methodology, results and discussions, summary and conclusions and bibliography