Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
("A++" Grade, NAAC Accredited)

Syllabus
for
Post Graduate Programme

M. Sc. Environmental Science

as per NEP 2020
Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF
With effect from the session 2024-25 (in phased manner)

INSTITUTE OF ENVIRONMENTAL STUDIES
FACULTY OF LIFE SCIENCE

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119

HARYANA, INDIA

Core Course (CC-1)

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	Ist semester		
Name of the Course	Biophysical Environment		
Course Code	M24-EVS-101		
Course Type	CC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Have in-depth knowledge of the process of origination of earth with help of various theories. CLO 2: Acquire knowledge about rocks faults, weathering and volcanism. CLO 3: Gather information about various parameters of atmosphere and meteorology and be able to predict their role in weather prediction and climate science. CLO 4: Have in-depth knowledge of the process of Atmospheric general circulation and atmospheric moisture.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Environmental Geo-science**: Origin of the Earth, Primary differentiation and formation of core, mantle, crust, magma generation, Earth's orbit, Kepler's laws of planetary motion. Structure of the Earth - the Geosphere, Atmosphere and Hydrosphere. Theory of Plate Tectonics – Wegener theory of continental drift, Holmes theory of convection in the mantle, Hess theory of sea floor spreading, Vine and Matthews theory of magnetic reversals and Glomar Challenger theory of age of oceanic floors.	15
II	Geomorphological Processes: Formations and classification of rocks rock cycle, Fold, and Fault, Major types of fold and faults. Weathering and their types, Mass wasting and its types Volcanism , types, volcanic materials , process and effects of volcanism. Transport and deposition of earth's material by running water, wind, glaciers. Thermal, magnetic and	15

	gravitational fields of earth. Soil profile, soil classification, soils of India.	
III	Atmosphere: Composition and structure; heat budget, lapse rate , thermal inversion and mixing height; cloud formation, winds, coriolis force; waves and currents; ocean circulation and global pressure belt system, El nino, La nina and monsoons, Applied aspects of meteorology: weather and climate, spatial scales (micro, meso, synoptic and global scales), wind roses.	15
IV	**Weather and Climate**: Energy balance in atmosphere, greenhouse effect, Atmospheric general circulation. Atmospheric moisture: Forms of cloud condensation; Precipitation, Thunderstorms, floods and droughts. Global Climate variability and climate change. Introduction to weather forecasting models.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Botkin, D.B. and Keller E.A (2004). *Environment Science: Earth as a Living Planet*. John Wiley & Sons Inc., New York.
2. Robert E. Ricklefs (2001). *The Ecology of Nature*. Fifth Edition, W.H. Freeman and Company.
3. Bennett, M. R. and Doyle, P. (1997). Environmental Geology: - Geology and the Human Environment. John Wiley and Sons.
4. Steffen, W., Sanderson, A., Tyson, P.D., Jager, J., Matson, P.M., Moore, III, B., Oldfield, F., Richardson, K., Schnellnhuber, H.J., Turner, II, B.L. and Wasson. R.J (2004). *Global change and the Earth System: A Planet under Pressure*. Springer-Verlag, New York, New York, USA Reference books.
5. Keller, E.A. (2007). *Introduction to Environmental Geology*. 4th ed. Prentice Hall of India.

Core Course (CC-2)

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	Ist semester		
Name of the Course	Environmental and Green Chemistry		
Course Code	M24- EVS-102		
Course Type	CC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Develop understanding on the concept of minerals, soil composition, properties and chemistry. CLO 2: Understand about composition and reactions in atmosphere, greenhouse gases and global warming. CLO 3: Obtain knowledge about water structure, composition, standards and aquatic chemistry. CLO 4: Know about the use of different biocatalysts as environmentally friendly reagents and industrial applications of green chemistry.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Lithosphere and Soil chemistry: Chemical composition of the earth, origin of mineral deposits and fossil fuels, major rock forming minerals, elements and isotopes. Interaction between atmosphere, hydrosphere and lithosphere. Soil Profiles, chemical and mineralogical composition of soils; soil organic matter, soil nutrients; soil properties of fundamental importance in soil management.	15
II	Atmospheric Chemistry: Chemical composition of atmosphere-atmospheric water and CO_2; ions and radicals in atmosphere, formation of particulate matter, Photo-chemical and chemical reactions in the atmosphere, thermal inversion, particles in atmosphere; photochemical smog, acid rain, chemistry of ozone layer depletion; greenhouse gases and global warming.	15
III	Aquatic Chemistry: Structure and properties of water; water quality	15

	parameters, chemistry of inland water bodies- lakes, streams, rivers estuaries and wetlands, solubility of gases in water, carbonate system in water, redox reaction (oxidation-reduction); aquatic microbial chemistry-a brief account.	
IV	Green Chemistry: Definition, fundamental principles and tools. Catalysis for Green Chemistry: Use of biocatalysts- Biochemical Oxidation, Biochemical Reduction, Enzyme-Catalyzed Hydrolytic Process, Goals of Green Chemistry- Significance and basic components of green chemistry in research - industrial applications of green chemistry. Products from natural materials- Green fuels and E-Green propellants- Zeolites- Biocatalysts.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Botkin, D.B. and Keller E.A (2004). *Environment Science: Earth as a Living Plant.* John Wiley & Sons Inc., New York.
2. Manahan, S.E. (2000). *Environmental Chemistry*. Seventh Edition. Lewis Publishers, New York
3. Mitsch, W.J. and Jorgensen, S.E. (eds.) (1989). *Ecological Engineering: An Introduction to Ecotechnology*. John Wiley and Sons, New York.
4. Pierzynski, G.M., Sims, J.T. and Vance, G.F. (2000). *Soils and Environmental Quality*. Second Edition. CRC press, New York.
5. Sanghi, R. and Srivastava, M. M. (Eds.). (2003). *Green Chemistry: Environment Friendly Alternatives*. Alpha Science Int'l Ltd.

Core Course (CC-3)

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	Ist semester		
Name of the Course	Ecology and Ecosystem Dynamics		
Course Code	M24- EVS-103		
Course Type	CC-3		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Students will have in-depth knowledge about biotic and abiotic factors that are related to individual, population, community and ecosystem, as well as interrelationships CLO 2: The students will understand and be able to analyze evolutionary changes and environmental adaptations. CLO 3: Students will understand the concept of different food interactions, trophic levels, energy transfer, energy flow and sedimentary cycles. CLO 4: Student will analyze the importance of various ecosystems such as territorial ecosystems, freshwater ecosystems, ocean ecosystems and wetlands.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction : Aims and scope of ecology, biological levels of organization-genes biosphere; tolerance range and limiting factors, adaptations, ecotypes and ecads. Population ecology: Characteristics, evolutionary strategies r and k selection; population growth and regulation, Species Interactions: Competition, mutualism, parasitism, predator-prey relations, allelopathy, behavioural ecology-a brief accou	15
II	Community structure and Organization: nature of community, life-forms, vertical and horizontal stratification; functional role and niche, keystone species, ecotone and edge-effect; plant-animal interaction. Ecological Succession –concept, primary and secondary succession; concept of climax and types of climax; changes in ecosystem properties	15

	during succession.	
III	The Ecosystem concept, biotic and abiotic components; ecosystem processes-photosynthesis and decomposition; ecological pyramids, food webs, trophic levels, energy transfer, ecological efficiencies, models of energy flow. Biogeochemical cycles, gaseous and sedimentary cycles-carbon cycle, nitrogen cycle, sulphur cycle and phosphorus cycle, Man's impact on nutrient cycles.	15
IV	Biome and aquatic systems- distribution, characteristics, climate and biota. Distinguishing characters of forests, grasslands, and arid lands. A brief account of lakes and wetlands, and coral reefs. Natural and anthropogenic disturbances, Invasive species: ecology, impacts and control.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Brewer, R. (1994). The Science of Ecology, Sanders College Publishing Co., Tokyo.
2. Lieth, H. and Whittaker, R.H. (Eds). (1975). *Primary Productivity of the Biosphere.* Springer-Verlag, New York.
3. Odum, E.P and Barrett, G.W. (2004). Fundamentals of Ecology. 5th edition. Thomson Brooks/Cole, Belmont, California.
4. Odum, E.P. (1983). *Basic Ecology*, W.B. Saunders, Philadelphia.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.
6. Jakhar, S. (2024). *Fundamentals of Ecology*. Techsar Pvt. Ltd., New Delhi.
7. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.
8. Townsend, C.R., Begon, M. and Harper, J.L. (2003). *Essentials of Ecology.* Second Edition. Blackwell Publishing, Oxford.

Core Course (CC-4)

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	Ist semester		
Name of the Course	Environmental Modeling and Statistics		
Course Code	M24- EVS-104		
Course Type	CC-4		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the idea, methodology and basic tools of environmental modeling, their scope, limitations and applications. CLO 2: Gain knowledge about different analytical models and their applications in Ecological studies. CLO 3: Describe how basic statistical methods can be used to analyze environmental data. CLO 4: Gain knowledge about experimental designs and computer graphics.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Concept of models and ecosystem modeling; model classification- deterministic models, stochastic models steady state models dynamic models. Different stages involved in model building. Ecosystem stability, Cybernetics and ecosystem regulation. Ecoinformatics- A brief account and scope in environmental analysis.	15
II	Elementary aspects of System Analysis: Systems theory, ecological models- characteristics and applications, compartment model, matrix model, statistical model, mathematical model, energy circuit analog model. Box model, Gaussian plume model. Analytical models in Ecology: logistic model of population growth; Hardy- Weinberg model; Lotka - Volterra model of competition and predation; models of succession.	15
III	Statistics- Measures of central tendency – Mean, Median, Mode, Geometric Mean and Harmonic Mean, measures of dispersion, moments, standard deviation, variance skewness and kurtosis Basic laws of probability, definition of a random variable and concept of a probability density function; binominal,	15

	poison and normal distributions.	
IV	Principles of experimental design-randomization; replication and local control, randomized block design; application of one-way and two-way analysis of variable. Correlation and linear regression of one independent variable. A basic idea of computer graphics, use of different software; information retrieval and data management.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Gomez, K.A. and Gomes, A.A. (1984). Statistical Procedures for Agricultural Research, John Wiley and Sons, New York.
2. Gupta S.C. (1981). Fundamentals of Statistics, Himalaya Publishing House, Mumbai.
3. Hoshmand, A.R. (1998). Statistical Methods for Environmental and Agricultural Sciences, CRP Press, New York.
4. John, W. and Mark, M. (Eds). (2004). Environmental Modeling: Finding Simplicity in Complexity, John Wiley and Sons Inc., New York.

Practicum Course PC- 1

Session: 2024-25			
Part A– Introduction			
Name of the Programme	M.Sc. Environment Science		
Semester	Ist Semester		
Name of the Course	Practical-I		
Course Code	M24- EVS-105		
Course Type	PC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Provide students with a comprehensive understanding of the principles, techniques, and applications of soil and water analysis CLO 2: Describe the significance of hardness in water quality and its impact on domestic, industrial, and agricultural use. CLO 3: Develop accuracy in executing standard operating procedures for soil analysis and to evaluate soil biological activity and health. CLO 4: Develop the ability to critically analyse experimental data and draw meaningful conclusions for domestic, industrial and agricultural use.		
Credits	**Theory**	**Practical**	**Total**
1	0	**4**	**4**
Teaching Hours per week	0	**8**	**8**
Internal Assessment Marks	0	**30**	**30**
End-Term Exam Marks	0	**70**	**70**
Max. Marks	0	**100**	**100**
Examination Time	0	6 hours	

Part B-Contents of the Course

Practicals	Contact Hours
1. To estimate the total hardness and temporary hardness of water. 2. To estimate total Ca and Mg content from given water samples. 3. To determine the organic carbon content in a given soil sample. 4. To determine the CO_2 evolution rate from a given soil sample. 5. To separate the soil aggregates from the given soil sample. 6. To determine the height of a particular point on a cliff with the help of a Brunton compass. 7. To determine the maximum water-holding capacity of a given soil sample. 8. To find out the pH of water and different soil samples. 9. To estimate the electrical conductivity of given soil and water solutions. 10. To estimate alkalinity in water samples. 11. To study the geological time scale 12. To study different types of maps (Climate, Geological, Agriculture crops) 13. Draw the wind roses from the given data and conclude the results. 14. To determine the soil texture with the help of the Soil Texture Triangle. 15. To determine available nitrogen in given soil sample by Kjeldhal method. 16. To determine free CO_2 in different water samples.	120

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Rice, E. W., Bridgewater, L. and American Public Health Association (Eds.). (2012). *Standard methods for the examination of water and wastewater* (Vol. 10). Washington, DC: American Public Health Association.
2. Bartram, J. and Ballance, R. (1996). *Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes*. CRC Press.
3. Jones, J. (2018). *Soil analysis handbook of reference methods*. CRC press.
4. Carter, M.R. and Gregorich, E.G. (2007). *Soil sampling and methods of analysis*. CRC press.
5. Boyd, C. E. (2019). *Water quality: an introduction*. Springer Nature.

Practicum Course (PC-2)

Session: 2024-25			
PartA - Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	Ist semester		
Name of the Course	Practical-II		
Course Code	M24-EVS-106		
CourseType	PC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Collect and interpret data related to ecological fieldwork using quadrat and transect methods. CLO 2: Apply statistical tools (Pearson's correlation, regression analysis, variance, standard deviation) to ecological data. CLO 3: Estimate chlorophyll content and analyzing leaf anatomy between C3 and C4 plants. CLO 4: Interpret ecological models, such as the logistic growth curve, nitrogen cycle compartment model, and box model for pollutant concentration.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	6 hours	

Part B-Contents of the Course

Practicals	Contact Hours
1. To estimate the chlorophyll content of C3 and C4 plants. 2. To determine the frequency distribution of plants in a patch of vegetation by quadrat method. 3. To study frequency, density, basal areas of plants by using line transect method. 4. To calculate the IVI of vegetation of a given area. 5. To calculate the Simpson index of plant diversity and to draw the dominance diversity curve. 6. To compare anatomy of C3 and C4 leaves. 7. To study invasive species in a given area. 8. To find a correlation between two sets of data by using Karl's pearson method. 9. To apply regression analysis on the given data.	120

10. To prepare logistic growth curve for a hypothetical population. 11. To calculate the measures of central tendency from given set of data by using excel software. 12. To calculate SD variance and coefficient of variation from given set of data by using excel software. 13. To prepare compartment model of N_2 cycle in grassland ecosystem. 14. To prepare the flow diagram of century model. 15. To estimate pollutant concentration over an area by box model concept.	

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1 Magurran, A. E. (2004). *Measuring Biological Diversity*. Blackwell Publishing.
2 Molles, M. C. (2015). *Ecology: Concepts and Applications*. McGraw-Hill Education.
3 Zar, J. H. (2010). *Biostatistical Analysis* (5th ed.). Pearson.
4 Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant Physiology and Development* (6th ed.). Sinauer Associates.
5 Southwood, T. R., & Henderson, P. A. (2000). *Ecological Methods* (3rd ed.). Wiley-Blackwell.

Seminar

Session: 2024-25	
Name of the Programme	M.Sc. Environmental Science
Semester	Ist Semester
Name of the Course	Seminar
Course Code	M24- EVS-107
Course Type: (CC/DEC/PC/Seminar/CHM/OEC/EEC)	Seminar
Level of the course	400-499
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Demonstrate a sound technical knowledge of the seminar topic. CLO 2: Improves his/her presentation skills and develop confidence.
Credits	Seminar
	2
Teaching Hours per week	2
Max. Marks	50
Internal Assessment Marks	0
End Term Exam Marks	50
Examination Time	1 hour
Instructions for Examiner: Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/viva-voce examination.	

Core Course (CC-5)

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	2nd Semester		
Name of the Course	Natural Resource Management		
Course Code	M24- EVS-201		
Course Type	CC-5		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Acquire knowledge about water and land resources and their conservation and management. CLO 2: Become familiar with various energy and mineral resources and their environmental impacts. CLO 3: Obtain knowledge about forest and marine resources, rangelands and deforestation. CLO 4: Develop understanding about economic categories of resources, theories and economically sustainable management of resources.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Resources: Types, Renewable & non-renewable resources; resource degradation a conservation; Human impact on natural resources. Land resources: Land degradation and desertification; Soil erosion and control; reclamation & management of waste lands with special reference to India. Water resources: Pools of water and hydrological cycle; Surface water, ground w Human use of freshwater. Rain water harvesting; watershed management	15
II	Energy resources: Renewable & non-renewable. Fossil fuels, hydropower nuclear energy, solar energy, wind energy. Energy from biomass. Mineral resources: Origin, types, exploration and production, conservation and recycling, bacterial leaching of metals from low grade ores. Environmental issues related with mineral extraction and processing.	15

III	Forest resources: Forests, their importance, types, global distribution; primary and secondary products, forest resources of India. Impact of deforestation; Sustainable forest Management. Range lands: Types, uses, grassland types and management in India. Medicinal plant resources and bioprospecting-a brief account. Fisheries and Marine resources- a general account; aquaculture	15
IV	Economics, environment and development: Economic categories of resources; the market, environment and natural resources; the economics theory- market, demand and supply relationships. The limit of growth; cost benefit ratio; natural resources accounting; market based mechanisms for environmental protection. Economically sustainable forest management designs- green certification, resource conservation, community forest management; ecotourism. Economic efficient model of sustainable fisheries; designs for renewable energy resources.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Brown, L. (2001). *State of the World 2001.* World watch Institute in association with Earthscan, London.
2. Chape, S., Fish, L., Fox, P. and Spalding, M. (2003). *United Nations list of protected areas.* IUCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge
3. Cunningham, W.P. and Cunningham, M.A. (2002*). Environmental Science: Inquiry and Applications.* A Global Concern. Tata McGraw-Hill Publishing Company, New Delhi.
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.

Core Course (CC-6)

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	2nd Semester		
Name of the Course	Conservation and Biodiversity		
Course Code	M24- EVS-202		
Course Type	CC-6		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Become familiar with principles of conservation biology and acquire knowledge about levels of biodiversity. CLO 2: Build an understanding about biodiversity patterns, biodiversity of mangroves, wetlands and coral reefs. CLO 3: Gain knowledge about biodiversity uses, services and threats to biodiversity (aquatic and marine). CLO 4: Become familiar with the various biodiversity conservation strategies and approaches.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B - Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Principles and importance of conservation biology; genetic variations, r selection, genetic drift and gene flow, minimum viable populations, genetic swam Biodiversity, magnitude, global accumulation; levels biodiversity- species, genet ecosystem diversity; species diversity indices, rank abundance patterns.	15
II	Biodiversity gradient – latitudinal and altitudinal, regional patterns of biodiversity; factors affecting biodiversity patterns; Biodiversity and ecosystem functioning; Terrestrial and marine hotspot of biodiversity. Biodiversity of mangroves, wetlands and coral reefs – A general account.	15
III	Biodiversity uses and ecosystem services; threats to biodiversity- habitat loss, habitat fragmentation, exotic species and environmental pollution; species extinction ; IUCN threat categories- global and national status; Threats to aquatic and marine biodiversity. Endangered and threatened species of India; Biodiversity assessment and	15

	monitoring.	
IV	In situ Biodiversity conservation strategies and approaches: Protected areas, biosphere resource, protected areas in India – Sanctuaries, national parks and biosphere resources. Ex Situ Biodiversity conservation: Species management plans, captive breeding, field gene banks, seed gene banks, cryopreservation, gene banks. National and international efforts for biodiversity conservation- CITES, Ramsar Convention, Convention on biological diversity, IPR and Patent rights.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Chandel, K.P.S., Shukla, G. and Sharma, N. (1996). Biodiversity in Medicinal and Aromatic Plants in India Conservation and Utilization, National Bureau of Plant Genetic Resources, New Delhi.
2. Heywood, V. (ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.
3. Huston, M.A. (1994). *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press, Cambridge.
4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.
5. Soule, M.E. (ed.) (1986): Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

Core Course (CC-7)

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	2nd Semester		
Name of the Course	Environmental Pollution		
Course Code	M24- EVS-203		
Course Type	CC-7		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Identify and quantify the magnitude and intensity of ambient air pollution. CLO 2: Understand the sources, effects and control of indoor air pollution. CLO 3: Assess the causes and sources of water and soil pollution and to treat them. CLO 4: Understand the sources and effects fate of noise and radioactive pollutants.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Pollution: Definition and Types. Pollutants and contaminants: Definition, Primary and secondary pollutants, point source and non-point source pollutants. Air Pollution: definition, sources of ambient air pollution, major ambient air pollutants, criteria pollutants, Trans boundary pollution, air quality index, the effects of air pollution, measurements of pollutants, air pollution control technologies. Air quality standards.	15
II	Indoor Air Pollution: Types, Causes and Effects, Indoor Combustion, Biological Pollutants, Radon, Carbon monoxide, Asbestos, Formaldehyde. Control Measures for indoor air pollution, sick-building syndrome and building related illness.	15
III	Water pollution: Causes and effects of surface water, groundwater, marine water and thermal pollution. Control measures of water pollution. Case studies. Water quality guidelines. Soil pollution: Causes and effects. Behavior and fate of soil pollutants Remedial measures of soil pollution. Self cleaning ability of soil environment.	15
IV	Noise pollution-Sources and measurement indices of noise pollution,	15

	Noise exposure level and standards, Noise control and abatement measures, Impact of noise on human health, Mitigation of noise Pollution. Radioactive pollution: Sources, effects and control.	
		Total Contact Hours 60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Mirsal, IA. (2008). Soil Pollution Origin, Monitoring & Remediation, Springer-Verlag Berlin Heidelberg.
2. Manahan, S.E. (2000). *Environmental Chemistry*. Seventh Edition. Lewis Publishers, New York
3. Pierzynski, G.M., Sims, J.T. and Vance, G.F. (2000). *Soils and Environmental Quality*. Second Edition. CRC press, New York.
4. Botkin, D.B. and E.A. Keller (2004). *Environment Science: Earth as a Living Planet.* John Wiley & Sons Inc., New York.
5. Miller Jr., G.T. (1997). *Environmental Science: Working With the Earth*. Wadsworth Publishing Company, Belmont, California

Core Course (CC-8)

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	2nd Semester		
Name of the Course	Environmental Methods and Analytical Techniques		
Course Code	M24- EVS-204		
Course Type	CC-8		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Learn characters of vegetation and measurement of biodiversity with different methods. CLO 2: Use microbiology knowledge and skills to analyze environmental problems involving microbes. CLO 3: Demonstrate a broad and coherent knowledge and understanding of analytical chemistry and instrumental methods of analysis (photometry, spectrophotometry, chromatography). CLO 4: Use spectroscopic techniques to analyze various pollutants in environment and understand theory and techniques for their measurements of pollutants.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Analytic and synthetic characters of vegetation, methods of vegetation analysis; Species diversity and measurement of diversity; primary and secondary production, methods of measuring primary productivity; techniques for quantifying nitrogen fixation; estimation of ecosystem nutrient budget. Germ plasm evaluation and conservation- survey, inventorization, and analysis.	15
II	Techniques in environmental microbiology and its applications. Methods of analyzing soil microbial populations and diversity Measurement of microbial activity in environmental samples: microbial biomass, nitrogen mineralization soil respiration, microbial respiration and enzymatic activities. Assessment and characterization of arbuscular mycorrhizal fungal	15

	the soil-plant system.	
III	Instrumentation Principles and applications of Spectrophotometry (UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry); Chromatographic techniques (Paper chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography, Column chromatography), Fluorometry, X-ray diffraction.	15
IV	Analytical Techniques: Air, Water and Soil samples. Sampling and analysis of air pollutants. Chemical and bacteriological sampling and analysis, water quality parameters, criteria and standards. Soil analysis - sample preparation and chemical methods of soil analysis. Vocational prospects in field of environmental analysis and research.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Chapin, F.S., Matson, P.A. and Mooney, H.A. (2002). *Principles of Terrestrial Ecosystem Ecology*. Springer-Verlag, New York
2. Clark, R.N. (1999). *Spectroscopy of Rocks and Minerals, and Principles of Spectroscopy*. U.S. Geological Survey, Denver
3. John Wainwright and Mark Mulligan (Eds). (2004). *Environmental Modeling: Finding Simplicity in Complexity*. John Wiley & Sons Inc., New York.
4. Manahan, S.E. (2000). *Environmental Chemistry*. Seventh Edition. Lewis Publishers, New York

Practicum Course (PC-3)

Session: 2024-25			
PartA - Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	2nd Semester		
Name of the Course	Practical-III		
Course Code	M24-EVS-205		
CourseType	PC-3		
Level of the course	400-499		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes(CLO) After completing this course, the learner will be able to:	1. Plot a standard graph or calibration curve and determine protein concentration from any sample. 2. Determine species diversity indices from the given community data. 3. Estimate Acid, Detergent, Fiber content from the given plant material and oil content from given seed sample. 4. Plot the water budget of the earth, groundwater system, sedimentary basin, and soil types of India.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	**0**	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B-Contents of the Course

Practical's	**Contact Hours**
1. To determine the oil content from various oil yielding plants by using Soxhlet extractor apparatus. 2. To draw the calibrations curve of Bovine Serum Albumin with protein binding dye (Brad ford method). 3. To determine the Acid Detergent Fiber (ADF) content from the given plant material. 4. To determine the Simpson Dominance - Diversity Index from a given set of community data. 5. To determine α, β and γ biodiversity from the given set of community data. 6. To determine Shanon Weiner's diversity index from a given community data set. 7. Visit the Herbal Garden (List of Medicinal Plants). 8. Discuss and plot the water budget of earth in Pi-Diagram 9. Plot groundwater system in a block diagram and show confined aquifer, unconfined aquifer and artesian condition of a well.	120

10. To study various designs of rooftop water harvesting systems. 11. Divide world into different natural regions and note their characteristic of climate, soil vegetation flora and fauna. 12. To study the physiographic, soil type, vegetation of India. 13. Plot sedimentary basin map of India and delineate different petroliferous basins. 14. To study the Moho's scale of hardness. 15. To study the physical properties of some important minerals.	

SuggestedEvaluationMethods

InternalAssessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Magurran, A. E. (2004). *Measuring Biological Diversity*. Blackwell Publishing.
2. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*. S. Chand Publishing, New Delhi.
3. Aery, N. C. (2010). *Manual of environmental analysis*. Ane Books Pvt Ltd.
4. Mitchell, B. (2013). *Resource and environmental management*. Routledge.
5. Jain, S. K. and Singh, V. P. (2023). *Water resources systems planning and management*. Elsevier.

Practicum Course (PC-4)

Session: 2024-25			
PartA - Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	2nd semester		
Name of the Course	Practical-IV		
Course Code	M24- EVS-206		
CourseType	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)	-----		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	1. Understand the principles of microbiological techniques and methods (serial dilution and agar plating method) and assess soil microbial diversity and population diversity. 2. Evaluate the forest and grassland productivity and ecological significance of agroforestry systems. 3. Estimate physio-chemical properties of water samples; assess water quality and suitability to various uses. 4. To analyze particulate matter and different gases in the ambient air.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B-Contents of the Course

Practicals	**Contact Hours**
1. To compute the Mean Annual Increment (MAI) and Annual Increment (AI) in a forestry plant area for given set of data 2. To analyse above ground and below ground productivity of an agroforestry system on the basis Dbh . 3. To determine the total plant biomass of a grass land system by harvest method. 4. To determine the dissolved oxygen (DO) content in a given water sample by WINKLER's Method. 5. To determine the carbonate and bicarbonate content from the given water sample. 6. To determine chemical oxygen demand (COD) of a given wastewater sample 7. To isolate and enumerate micro-organisms from soil by serial dilution agar plating method. 8. To isolate Vesicular Arbuscular Mycorrhizal (VAM) spores from the soil. 9. To measure the concentration of particulate matter PM2.5 using High-volume sampler. 10. To measure the concentration of particulate matter PM10 using High-volume sampler. 11.To Measure the concentration of Carbon Monoxide (CO) Using Non-Dispersive	120

Infrared (NDIR) instrument.

12. To measure concentration of NO_2 concentration using the Jacobs & Hochheiser method.
13. To determine the concentration of SO_2 using modified West and Geake method.
14. To prepare basic solid media and to study microflora of indoor and outdoor air.
15. To perform Lactophenol blue staining of fungi isolated from air.
16. To determine λmax of the given chemical compound using spectrophotometer.

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Hurst, C. J., Crawford, R. L., Garland, J. L. and Lipson, D. A. (Eds.). (2007). *Manual of environmental microbiology*. American Society for Microbiology Press.
2. Pansu, M. (2006). *Handbook of soil analysis*. Springer.
3. Paul, E., & Frey, S. (Eds.). (2023). *Soil microbiology, ecology and biochemistry*. Elsevier.
4. Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R. (2015). *Introduction to spectroscopy*.
5. Rice, E. W., Bridgewater, L. and American Public Health Association (Eds.). (2012). *Standard methods for the examination of water and wastewater* (Vol. 10). Washington, DC: American public health association.
6. West, P. W. and West, P. W. (2009). *Tree and forest measurement* (Vol. 20). Berlin: Springer.

Core Course (CC-9)

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Environmental Biotechnology and applications		
Course Code	M24- EVS-301		
Course Type	CC-9		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the basic techniques of biotechnology and its role in degradation of xenobiotic compounds. CLO2: Aware of the basic concepts of genetic engineering and role of microbes in environment management.. CLO3: Understand the application of Plant genetic engineering and bio safety concerns of GMOs in agriculture. CLO4: Knowledge of use of biotechnology for wastewater treatment and phytotechnology for remediation of environmental contaminants.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	The scope of environmental biotechnology; Biodegradation of macromolecules; biodegradation of xenobiotics, Pesticides. Bioremediation of metal contaminated soils, spilled oil and grease deposits Biosensors to detect environmental pollutants.	15

	Fermentation technology (Bioreactors).	
II	Basic techniques in genetic engineering: Genetic manipulation, Restriction endonucleases. Introduction of cloned genes into new hosts using plasmid and phage vector systems. RFLP, Polymerase chain reaction. Environmental genomics/metagenomics - a general account. Microbes and environmental management. Microorganisms and organic pollutants; Extremophiles.	15
III	Basic concepts of genetic engineering of plants and its applications-herbicide and stress tolerant plant. Biotechnological strategies in forestry and wasteland management. Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA banks. Genetically modified organisms and Biosafety- a general account.	15
IV	Bioenergy, Liquid waste treatment; Biofilters, activated sludge systems; membrane bioreactors. Biotechnological approaches for solid waste management, Vermicomposting. Phytotechnology- terrestrial phytosystems, metal phytoremediation. Phytotechnology-aquatic phytosystems, nutrient film techniques, algal treatment systems.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Evans, G.M. and Furlong J.C. (2003). Environmental Biotechnology: Theory and Application. John Wiley and Sons.
2. Glick, B.R. and Pasternak J.J. (2007). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C. ASN Press.
3. Horton, H.R., Moran L.A., Perry M.D. and Rawn J.D. (2006). Principles of Biochemistry, Pearson Education International.
4. Metcalf and Eddy (Eds). (2003). Wastewater Engineering: Treatment and Reuse. Tata McGraw-Hill, New Delhi.
5. Sathyanarayanan. B.N and Varghese, D.B. (2007). Plant Tissue Culture Practices and New Experimental Protocols. I. K. International, New Delhi.

Core Course (CC-10)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Remote Sensing and Geographical Information Systems		
Course Code	M24-EVS-302		
Course Type	CC-10		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Build a foundation of Remote Sensing, Geographic Information System and GPS - its scope and usage, and types, process, platforms and sensors used in remote sensing. CLO 2: Build an understating about the visual image interpretation of satellite images, digital image processing, photogrammetry and aerial photography. CLO 3: Acquire knowledge on GIS data structure and conversion, spatial analysis techniques, problem-based designing and management of GIS projects. CLO 4: Acquire knowledge on the application of Remote Sensing and GIS with real world examples.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	History of Remote Sensing, Electromagnetic spectrum, Electromagnetic radiation laws, Electromagnetic energy interaction in the atmosphere, Electromagnetic energy interactions with earth surface features, atmospheric windows, spectral signature, Global Positioning System - introduction and working principle, Components and indexing of topographic sheets.	15

II	Basic concepts and types of remote sensing. Scanning technologies. Optical, thermal and microwave remote sensing. Airborne remote sensing - Drone and LiDAR. Ground truth surveys. Visual image interpretation. Digital image processing - geometric and radiometric errors and corrections, Image enhancement, NDVI, Supervised and unsupervised image classification. Basic concepts of aerial photography and photogrammetry, Types of aerial photographic film.	15
III	Basic concept of GIS. Components of GIS, Spatial and aspatial data. GIS tasks, GIS workflow - general concept. GIS software, GIS data structure and file format. GIS Data conversion, Spatial analytical techniques. GIS project management - design, implementation and evaluation. 3-D data in GIS - TIN and Digital Elevation Model, topology. Role of Artificial intelligence in geospatial technology.	15
IV	Real world examples of Remote Sensing and GIS in Environmental monitoring: land use land cover evaluation, land use planning, soil mapping, vegetation analysis, crop monitoring, biomass and productivity estimation, coastal zone management, water resource management, disaster management - flood, drought, earthquake, landslide, forest fire etc., Vocational aspects in geospatial domain.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lillesand, T. M., Kiefer, R. W., Chipman, J. W. (2015). Remote Sensing and Image Interpretation. John Wiley and Sons.
2. Tempfli, K., Norman, K., Huurneman, G. C., Janssen, L. L. F. (Eds.). (2009). Principles of Remote Sensing: An introductory textbook. ITC Netherland.
3. Campbell, J. B. and Wynne, R. H. (2011). Introduction to Remote Sensing. Routledge.
4. Ian, H. (2010). An Introduction to Geographical Information Systems. Pearson Education India.
5. Reddy, M. A. (2008). Textbook of Remote Sensing and Geographical Information Systems. B. S. Publications.
6. Francis, H. (2008). A Primer of GIS: Fundamental Geographic and Cartographic Concepts. The Guilford Press.
7. Boris Escalante-Ramírez (Ed.). (2012). Remote Sensing Applications. InTech, Croatia.

Discipline Elective Course (DEC-1)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Ecotoxicology and Environmental Health		
Course Code	M24- EVS-303		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the concepts of ecotoxicology and toxicity of different metals and gases. CLO 2: Understand the symptoms, epidemiology and control of ector and water borne diseases. CLO3: Understand about the core components of Environmental Health. CLO4: Discuss about the sustainable development strategies.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Ecotoxicology: introduction and importance. Indices of Toxicology, Detoxification; Types of toxic elements- inorganic, organic and radionuclide. Types of exposure-acute and chronic. Distribution and fate of toxic substances-physical, chemical and biological processes. Ecological monitoring and tests; Ecological risk assessment of toxic chemicals. Dose response relationships; biomagnification, bioaccumulation.	15
II	Biochemical aspects of toxicity of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, O_3 and PAN, Pesticides, MIC, Carcinogens and Carcinogenicity. Symptoms, epidemiology and control of vector borne diseases: amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis. Water borne diseases and their control-cholera, diarrhea.	15

	Control of Malaria, Tuberculosis and AIDS.	
III	Core components of Environmental Health: Community Health; Food Safety; Occupational Health and Safety; Pollution Control; and Built Environment. Hazardous and non hazardous health-care waste, Radioactive waste management. Environment health education-Public participation. Recycling of waste material. Waste minimization technologies.	15
IV	Concept and strategies of Sustainable development. Household water treatment methods: boiling; point of use chlorination; biosand filtration; solar disinfection; three pot system; cloth filtration; and ceramic filtration. Environmental Health indicators. Waste management at house hold level, Sanitation and hygiene.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Botkin, D.B. and. Keller E.A (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Manahan, S.E. 2000. Environmental Chemistry. Seventh Edition. Lewis Publishers, New York.
3. Principles of Ecotoxicology. 2nd edition. Walker CH, Hopkin SP, Sibly RM, Peakall DB. Taylor & Francis Group, 2001.
4. Singh, J.S. and Sharma V.P. (Eds) 2005. Glimpses of the work on environment and development in India. Angkor New Delhi.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). Ecology, Environment and Resource Conservation, S. Chand Publishing, New Delhi.

Discipline Elective Course (DEC-1)

Session: 2024-25			
PartA – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Environmental Planning, Policy and Law		
Course Code	M24- EVS-304		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: To understand various environmental policies, planning, procedure and constitutional framework governing environment in India. CLO 2: To develop skills in identifying the problems and loop-holes in policies and to understand its legal issues and legislative provisions. CLO 3: To have in-depth knowledge of various environmental legislations in India. CLO 4: To understand the emerging environmental issues and key international treaties for environment protection.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Policy Frameworks on environment in India. National Environmental Policy 2006 -Approaches, Objectives, Principles and Framework. Policy parameters related to conserving environmental resources-forests and wildlife, Biodiversity fresh water resources and coastal resources. Policy perspectives for land degradation and desert ecosystems. Sustainable food policy challenges and institutional designs for improving	15

	food production. Scheme of labeling of environmentally friendly products (Ecomark).	
II	Basic concepts of Environmental Planning, Integrated land –use planning land-use patterns, urban planning-impact of population growth. Water Resources planning in India: Ground water; water harvesting technologies; interlinking of rivers in India. Institutional design for renewable energy resources, hazardous waste management and handling rules, 1989; resource management; disaster management.	15
III	Constitutional provisions for environmental protection in India. Environmental legislation India: Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Environmental Protection Act,1986; Wild Life Protection Act 1972, Forest Conservation Act,1980; Public Liability Insurance Act, 1991and rules, National Green Tribunal Act (2010).	15
IV	International Conventions and Agreements on environmental issues: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);Convention on Biological Diversity (CBD); United Nations Convention to Combat Desertification; Ramsar Convention. United Nations Convention on the Law of the Sea; Antarctic Treaty; Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). United Nations Framework Convention on Climate Change (UNFCCC); Climate change Convention and CDM; Montreal Protocol; Basel Convention - Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Barrow, C.J. (2005). Environmental Management and Development. Taylor and Francis Group, London and New York.

2. Divan S. and Rosencranz A. (2002). Environmental law and policy in India: cases, materials and statutes. Oxford University Press.
3. Ferrey S. (2004). Environmental Law: Examples and Explanations. Aspen Law & Business. Springer-Verlag New York, LLC.
4. James C., Werksman H. and Roderick P. (2006). Improving compliance with International Environmental Law, Earth Scan London.
5. Pushpam, K. (2005). Economics of Environment and Development. ANE Books, New Delhi.
6. Stavin, R.N. (2005). Economics of the Environment: Selected Readings. W.W. Norton and Comparus, London.
7. Vig, N.J. and Axelrod R.S. (Eds) (1999). The Global Environment: Institutions, Law and Policy. EarthScan London.

Discipline Elective Course (DEC-1)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Climatology and Global Climate Change		
Course Code	M24-EVS-305		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (ifany)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Explain the fundamental principles of climatology, its relationship with meteorology, and weather forecasting techniques. CLO2: Classify global, regional, and local climates using genetic and empirical methods, and analyze climate variability and its impact on human life. CLO3: Assess the greenhouse effect, sources of greenhouse gases, and the potential impacts of global warming CLO4: Utilize tools like paleoclimatic records and climate models to study climate change and evaluate mitigation strategies, including carbon sequestration and global environmental policies.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Nature and Scope of Climatology; fundamental principles of climatology; weather forecasting-short, medium and long range. Relationship of climatology with meteorology. Terrestrial heat balance and other components of radiation balance. Radiation climatology of India.	15

	Temperature, pressure and wind distribution over the globe and Indian region.	
II	Global, regional and local climate-classification of climate-genetic and empirical; Climate Classification schemes and their applications: KöppenScheme, Thronwaite's Schemes, Trewartha Scheme Climate types and climate zones. Trends of climate and its variability; climate modification. Local and Regional Climate Influences: Urban Heat Islands, Sea Breezes, Role of climate in human life.	15
III	Global climate change: Greenhouse effect, greenhouse gases-sources, trends, radiative forcing, warming potential of gases. CO_2 fertilization effect on plants; potential impacts of global warming on polar ice caps and melting of glaciers, sea level increase, weather extreme, ecosystems, human health, coral leaf bleaching , surface ocean chemistry, biogenic calcification in oceans.	15
IV	Tools to study global climate change- paleoclimatic records, ice cores, general circulation models. Mitigation strategies for global warming: biological & geological carbon sequestration. Policy and Economic Approaches: Kyoto protocol & Paris Agreement, carbon trading, Green investments & subsidies, Urban planning & Smart Cities. Behavioral& Societal Changes: Sustainable Consumption, Waste Management and Circular Economy, Climate Education & Advocacy. Global environmental change programmes, IPCC; Indian initiative for mitigating global climate change.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Barry, R. G. & Chorley, R. J. (2010). Atmosphere, Weather and Climate. Routledge
2. Steffen, W., Sanderson, A., Tyson, P.D., Jager, J., Matson, P.M., Moore, III, B., Oldfield, F., Richardson, K., Schnellnhuber, H.J., Turner, II, B.L. and Wasson. R.J. 2004. Global change and the Earth System: A Planet under Pressure. Springer-Verlag, New York, USA.
3. Barry, R. G. and Hall-McKim, E.A. 2014. Essentials of the Earth's Climate System. Cambridge University Press.
4. Houghton, J. 2004. Global Warming: The Complete Briefing. Cambridge University Press; 5th edition, UK.
5. Schneider, S.H., Rosencranz, A., Mastrandrea, M.D. and Kuntz-Duriseti, K. 2009. Climate Change Science and Policy. Island Press.

Discipline Elective Course (DEC-2)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Industrial Ecology		
Course Code	M24- EVS-307		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the concept and principles of industrial ecology. CLO 2: Identify the benefits and limitations of material flow analysis. CLO 3: Learn the concepts of life cycle assessment. and management. CLO 4: Gain knowledge about life cycle design exergy efficiency and ISO 14000 series.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Industrial Ecology: Definition, goals, and boundaries. Environment and the anthrosphere., Ecosystem classifications: Natural and industrial ecosystems, Type I, II, and III ecosystems. Beginnings of industrial activity and industrial revolution. Cradle-to-Grave and Cradle-to-Cradle approaches approach in life cycle assessment, fundamental principles of Cradle-to-Cradle approach. Strategies related to industrial ecology. Industrial Ecology and the circular economy. Industrial symbiosis.	15
II	Material and energy flow and their transformations. Materials cycle: open *vs*, closed-loop systems. Material flow analysis (MFA): Types, procedures and MFA-based indicators. Extraction, in-use stock, service life, discards, recycling. Natural *vs* anthropogenic pollutant cycles. Substance flow analysis (SFA). Cleaner production: Principles, operational pathways to cleaner production.	15
III	Life cycle assessment (LCA): Components, applications. Life cycle inventory analysis: System boundaries, process flow diagram, input / output	15

	analysis. LCA-recycling. Life cycle impact assessment and interpretation. Life cycle management and green supply chains. Environmental accounting, Internal costs: conventional, hidden, liability, less tangible costs and external costs. Extended producer responsibility.	
IV	Life cycle design: framework and design requirements, Design strategies: Product life extension; material, process and distribution oriented strategies. Designing for energy efficiency. Design for environment. Exergy: Exergy efficiency and waste, dematerialization, rematerialization, transmaterialization. ISO 14040 and ISO 14044.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Ayres, R. U. and Ayres, L. W. (2002). A Handbook of Industrial Ecology. Edward Elgar Cheltenham, UK.
2. Green, K and Randles, S. (2006). Industrial ecology and spaces of innovation. Edward Elgar Cheltenham, UK.
3. Boons, F. and Howard-Grenville, J. (2009). The Social Embeddedness of Industrial Ecology. Edward Elgar Cheltenham, UK.
4. Graedel, T. E. and Allenby, B. R. (2003). Industrial Ecology, Prentice Hall, Englewood Cliffs, New Jersey.
5. Manahan, S. E. (1999). Industrial Ecology: Environmental Chemistry and Hazardous Waste. Lewis Publishers, Boca Raton.

Discipline Elective Course (DEC-2)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Waste Management and Regulation		
Course Code	M24- EVS-308		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Identify the sources, segregation, impacts and treatment techniques of solid waste and Hazardous waste . CLO2: Identify the characteristics, impacts and treatment techniques of Biomedical and Electronic waste. CLO 3: Discuss the main sources and disposal methods for Plastic and microplastic waste. CLO 4: Attain knowledge of different rules and regulations related to different waste.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Solid Waste Management: Sources, classification, segregation and effects of solid waste. Sustainable Waste Management Practices. Treatment techniques: Incineration and its types: pyrolysis, gasification. Land filling and leachate treatment, Composting, Deep well injection and Land farming. Hazardous Waste Management: Sources, Classification and effects of hazardous waste. Management techniques: Chemical precipitation, Solidification and stabilization. Thermal treatment, Biological treatment methods.	15

II	Electronic waste: Sources, characteristics and impacts on environment. Waste management practices: storage, collection and transfer. Recycling and recovery of useful materials. Disposal methods: Incineration, Land filling, Acid bath. Sustainable e-waste management practices. Biomedical waste: Sources, classifications, segregation, labeling and effects. Treatment technology: Autoclave, Incineration, Wet treatment technology, Deep burial, Pit, sharp disposal pit.	15
III	Plastic waste Management: Sources, types, color coding, Impacts on environment. Plastic waste disposal methods: Recycling, Pyrolysis, 5Rs. Alternatives for plastic waste. Recycling of PVC, HDPE, PET. Microplastic waste management: sources and effects on environment. Microplastc waste management techniques: Filtration, adsorption, magnetic separation, coagulation, Photocatalysis, Microbial degradation and Bioreactors.	15
IV	Legislation for Management of Waste: Municipal Solid Waste Management Rules: 2016; Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2016; E-waste management rules, 2016; Batteries (management and handling) rules, 2001; Biomedical waste (management and handling) rules, 2016; Plastic waste management rules,2016.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Handbook of Solid Waste Management, George Tchobanoglous. G., Kreith.F (2002), 2nd Edition, The McGraw-Hill Companies, Inc.
2. Hazardous Waste Management: Advances in Chemical and Industrial Waste Treatment and Technologies. Shareefdeen. Z (2022).Springer Cham
3. E-Waste: Regulations, Management, strategies & Current Issues by Zeng, X. (2017).
4. Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solution,T (2020). Academic Press Inc.
5. Solid and Hazardous Waste Management. Bhatia, S (2023). Atlantic Publishers and Distributors (P) Ltd.

Discipline Elective Course (DEC-2)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Industrial Water and Wastewater Treatment		
Course Code	M24-EVS-309		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Identify the sources and composition of industrial wastewater and their discharge limits. CLO 2: Describe the effects of industrial effluents on the environment and human health. CLO 3: Discuss the major industrial wastewater treatment methods. CLO 4: Acquire knowledge about specific waste treatment, disposal, product & energy recovery systems.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Waste water in industries: Sources and composition of industrial wastewater, characteristics of wastewater of some major Industries like Food processing industries, Steel, Sugar, Petroleum Refineries, Textiles, Tanneries and Nuclear power plant. Difference between industrial and municipal wastewater, Industrial wastewater discharge limits, standards, and regulations in India	15
II	Industrial wastewater disposal and environmental impacts. Effects of industrial effluents on receiving water bodies, soil, and human health. Eutrophication – causes, effects, and control measures.	15

	Significance of industrial wastewater treatment in India. Challenges associated with existing wastewater treatment practices.	
III	Key Processes in Industrial Waste Water Treatment: Effluent Treatment Plant (ETP) Preliminary Treatment: Screening, Grit Removal; Primary Treatment: Sedimentation, Flotation; Secondary Treatment: Biological Treatment, Activated Sludge Process, Biofilters; Tertiary Treatment: Filtration, Disinfection, Chemical Treatment; Sludge Treatment: Thickening, Dewatering, Stabilization.	15
IV	Advanced Technologies in wastewater treatment, Membrane processes for wastewater treatment, Photodegradation of dyes, Role of microorganisms in wastewater treatment, Emerging biotechnological approaches for wastewater treatment. Acid mine drainage: occurrence, effects and treatment technologies, Disposal of treated Waste Water, Product and energy recovery.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Metcalf & Eddy., Wastewater Engineering Treatment disposal reuse. Tata McGraw Hill, 2003.
2. Eckenfelder, W.W., Industrial Water Pollution Control. McGraw-Hill. 2000.
3. Patwardhan., Industrial Waste Water Treatment. PHI Learning Pvt. Ltd, 2009
4. Gurnham, C.G., Principles of Industrial Waste Engineering. New York John Wiley, 1955.
5. Karia G.L. and Christian R.A., Wastewater Treatment Concepts and Design Approach. Prentice Hall of India Pvt. Ltd., New Delhi, 2001.

Practicum Course PC-V

Session: 2024-25			
Part A–Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Practical-V		
Course Code	M24-EVS-311		
Course Type	PC-V		
Level of the course	500-599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Develop laboratory skills in microbial analysis, tissue culture techniques, and biochemical estimations for environmental applications. CLO2: Gain expertise in toxicity assessment, bio-indicator analysis, and the impact of pollutants on biological systems. CLO3: Understand conservation strategies, legal frameworks, and biodiversity assessment techniques for ecosystem protection. CLO4: Analyze climate variability, meteorological data, and the impact of human activities on climate change.		
Credits	**Theory**	**Practical**	**Total**
	0	**4**	**4**
Teaching Hours per week	0	**8**	**8**
Internal Assessment Marks	0	**30**	**30**
End-Term Exam Marks	0	**70**	**70**
Max. Marks	0	**100**	**100**
Examination Time	0	**4 hours**	

Part B-Contents of the Course		
	Practicals	**Contact Hours**
M24-EVS-301	1. To study about the different instruments used in Environmental biotechnology laboratory. 2. To estimate the effectiveness of sterilization agents on the growth of microbes. 3. To isolate dye degrading bacteria /fungi 4. To isolate xylanase producing bacteria. 5. To perform the Gram staining in the given bacterial sample. 6. To prepare MS media for the tissue culture technique. 7. To inoculate different explants as for the tissue culture technique. 8. Bacteriological analysis of wastewater by multiple tube fermentation.	120
M24-EVS-303	1. To determine heavy metal concentration in the water sample. 2. To determine the effect of industrial wastewater on the germination percentage of cereals and pulses. 3. To determine sodium content in the given water sample. 4. To determine potassium content in a given water sample. 5. To study about the LD_{50} (lethal dose) value of a common pesticide. 6. To study the LC_{50} value by acute paper contact method. 7. To study the bio-indicators for determining the health of water bodies.	
M24-EVS-304	1 To review the role of Indian Judiciary in environmental conservation. 2 To study National Green Tribunal Act, (2010) and Environmental Jurisprudence. 3 To study the salient features of Wildlife Protection Act, 1972. 4 To study the salient features of Environmental Protection Act. 5 To study the Ambient Air quality standards as per the CPCB Guidelines. 6 To study the Institutional Framework for renewable energy in India 7 Case-study of landmark IPL (M.C. Mehta *vs* Union of India)	

	(Ganga Pollution 1988) 8 Case study analysis of environmental compensation: Bandwari Landfill and the role of the NGT.	
M24-EVS-305	1. To track and analyse the daily fluctuations in meteorological data of your area. 2. To analyse the long-term climate data for a region to identify trends and variability patterns. 3. To study the radiation climatology over different regions of India. 4. To analyse the trends of melting of major glaciers in India. 5. To identify and map different climate zones in India. 6. To measure and compare temperatures in urban and rural areas of your city to document urban heat island effect. 7. To calculate individual carbon footprint and suggest measures to reduce it. 8. To compare climate policies from different countries.	

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Caumette, P., Lebaron, P., Matheron, R., Normand, P., & Sime-Ngando, T. (2015). Environmental microbiology: fundamentals and applications.
2. Landis, W., Sofield, R., & Yu, M. H. (2017). *Introduction to Environmental Toxicology: molecular substructures to ecological landscapes*. CRC Press.
3. Primack, R. B. (2006). *Essentials of Conservation Biology* (Vol. 23). Sunderland: Sinauer Associates.
4. Aguado, E., & Burt, J. E. (2015). Understanding weather and climate. Available at: *https://www.pearson.com/us/higher-education/product/Aguado-Understanding-Weatherand-Climate-7th-Edition/9780321987303.html*

Practicum Course PC-VI

Session: 2024-25			
Part A–Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	3rd Semester		
Name of the Course	Practical-VI		
Course Code	M24-EVS-312		
CourseType	PC-VI		
Level of the course	500-599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Develop proficiency in remote sensing, GIS, and photogrammetric techniques for land use classification and spatial analysis. CLO2: Analyze case studies of industrial symbiosis and sustainable industrial practices to understand resource efficiency and waste reduction. CLO3: Gain expertise in hazardous waste identification, solid waste analysis, and regulatory frameworks for effective waste management. CLO4: Develop skills to assess water quality parameters, wastewater treatment efficiency, and environmental impact of pollutants		
Credits	**Theory**	**Practical**	**Total**
	0	**4**	**4**
Teaching Hours per week	0	**8**	**8**
Internal Assessment Marks	0	**30**	**30**
End-Term Exam Marks	0	**70**	**70**
Max. Marks	0	**100**	**100**
Examination Time	0	**4 hours**	
Part B-Contents of the Course			

	Practicals	Contact Hours
M24-EVS-302	1. To study various physical and land use land cover features of the given topographic sheet. 2. To georegister the given raw topographic sheet in a particular projection system. 3. To study the given aerial photograph and observe it using a pocket lens stereoscope. 4. To identify land use land cover features present in the given false colour composite (FCC) satellite image using visual image interpretation technique. 5. To classify the given satellite image into land use land cover classes using a supervised classification technique. 6. To classify the given satellite image into land use land cover classes using an unsupervised classification technique. 7. To estimate the height of an object using the Forestry Laser Range Finder 8. To study the Global Positioning System (GPS) and find the geographic position (latitude and longitude) at any particular point. 9. Photogrammatically compute the height of an object in a vertical photograph using single photo method. The altitude of a camera above local datum surface (flying height above ground), the radial distance from the principal point to the top of the object and the relief displacement is given. 10. Photogrammatically compute the height of an object from the stereo photographs using stereoscopic parallax method. The altitude of a camera above local datum surface (flying height above ground), the parallax difference between the top and bottom of the object on the two photographs (stereo images) of any object point ('A'), distance between camera positions while capturing the stereo images (photo base) is given.	120
M24-EVS-307	1. To study Kalundborg symbiosis as a successful industrial ecology case study. 2. To assess the functional aspects of the Nanjangud industrial area in Mysuru and its relation with industrial ecology. 3. To discuss the aspects which relates the Humber Estuary, UK to industrial ecology. 4. To describe the industrial ecology case study of Dow Chemical's waste reduction always pays program. 5. To discuss a case study of an industrial park/zone or smart city based on an ecological system.	
M24-EVS-308	1. To identify the carcinogenic chemicals in the laboratory and suggest precautionary measures for their safe handling. 2. To determine the sludge volume index of the given water sample. 3. To determine the moisture content and volatile matter of the given	

	sample. 4. To estimate the ash content of given solid waste material. 5. To determine the carbon and nitrogen content of the composite waste. 6. To visit and determine the carbon and nitrogen content of the vermicompost collected from the KUK campus. 7. To characterize the different components present in the solid waste.	
M24 EVS-309	1. Estimation of chlorides by Argentometric Method in given water sample. 2. Estimating biological oxygen demand (BOD) in a given water sample. 3. Estimating chemical oxygen demand (COD) in the given water sample. 4. To Estimate the total suspended solids (TSS) and total volatile solids (TVS) in a given wastewater sample. 5. Determination of nitrate and phosphate concentration in water. 6. Working and study of effluent treatment plant (ETP) – industrial visit and reporting. 7. To study principle, working and design aspects of UASBR (Upflow Anaerobic Sludge Blanket Reactor).	

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation. Wiley.
2. Graedel, T. E., & Allenby, B. R. (2010). Industrial ecology and sustainable engineering.
3. Theisen, H., & Vigil, S. A. (1993). *Integrated solid waste management: Engineering principles and management issues*. McGraw-Hill.
4. Kumar, A., Yadav, J., Vohra, R., & Sebastian, A. (2024). Water and Wastewater Engineering. In *Advanced Geospatial Practices in Natural Environment Resource Management* (pp. 26-37). IGI Global.

OPEN ELECTIVE COURSE (OEC)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	3rd semester		
Name of the Course	Global Climate Change		
Course Code	M24-OEC-324		
Course Type	OEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Understand the concept of changing climate, sources, trends and radioctive forcing of greenhouse gases CLO2: Gain knowledge of impacts of climate change on different environmental components, ecosystems and human health. CLO3: Describe various tools to study climate change and explain various mitigation strategies CLO4: Explain various national and international programs, protocols and measures to combat the problem of changing climate		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Global Climate Change, Greenhouse Effect. Greenhouse Gases: sources, trends, radiative forcing, warming potential of gases. Trends of climate and its variability	7
II	CO_2 fertilization effect on plants; Impacts of global warming on melting of	8

	polar ice caps and glaciers, sea level rise, weather extremes, impacts on ecosystems and human health and on coral reef bleaching	
III	Tools to study global climate change- paleoclimatic records, ice cores, general circulation models. Mitigation strategies for global warming: biological & geological carbon sequestration. Policy and Economic Approaches: Kyoto protocol & Paris Agreement, carbon trading,	8
IV	Behavioural & Societal Changes: Sustainable Consumption, Climate Education & Advocacy. Global Environmental Change Programmes, IPCC; Indian initiative for mitigating global climate change.	7
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory:**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. IPCC (Intergovernmental Panel on Climate Change) (1990). Climate Change: The IPCC Assessment. Cambridge University Press, Cambridge.
2. Sorokhtin, O.G., Chilingar, G.V. and Khilyuk, L.F. (2007). Global warming and global cooling: Evolution of climate and earth, Elsevier, Netherland.
3. Steffen, W., Sanderson A., Tyson P.D., Jager J., Matson P.M., Moore B., Oldfield F., Richardson K., Schnellnhuber H.J., Turner B.L. and Wasson R.J. (2004). Global change and the Earth system: a Planet under Pressure, Springer-Verlag, New York, USA
4. Barry, R. G. and Hall-McKim, E.A. 2014. Essentials of the Earth's Climate System. Cambridge University Press.
5. Houghton, J. 2004. Global Warming: The Complete Briefing. Cambridge University Press; 5th edition, UK.
6. Schneider, S.H., Rosencranz, A., Mastrandrea, M.D. and Kuntz-Duriseti, K. 2009. Climate Change Science and Policy. Island Press.

Core Course (CC-11)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th semester		
Name of the Course	Agroecology and Agroforestry		
Course Code	M24- EVS-401		
Course Type	CC-11		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Attain knowledge of different agricultural ecosystems and sustainable agricultural practices. CLO2: Develop the understanding of agrochemicals, their impact on environment and pest management techniques. CLO3: Knowledge of seed regulatory and certification systems and biosafety issues associated with agriculture. CLO4: Apply the knowledge of agroforestry for the betterment of biodiversity and soil health.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Agricultural ecosystems; Agricultural practices; Green revolution-environmental implications; Ecology of shifting agriculture. Sustainable agriculture, organic farming, eco-farming, dry-land farming, zero-	15

	tillage, bio fertilizer, plant growth promoting bacteria. Agro biodiversity and sustainability.	
II	Environmental impacts of agriculture; Soils and agriculture, Irrigation practices, water logging and secondary salinization; agrochemicals, pesticide residues. Crop Protection: biodegradable and non-biodegradable pesticides; pesticide resistance. Biological and ecological pest control, integrated pest management, pesticide safety and microbial insecticides. Biosafety issues in agriculture. The role of microbes in agriculture-beneficial root-microbial interaction.	15
III	Seed quality and seed testing; Hybrid seed production. Seed regulatory and certification systems. Soil productivity and Crop residue management. Weather and crop productivity. Impact of global warming on agriculture and food security.	15
IV	Scope and importance of Agroforestry. Classification of agroforestry systems. Models of agroforestry systems. Traditional agroforestry systems of India. Agroforestry for soil management and carbon sequestration. Agroforestry for mitigating climate change. Agroforestry for conserving soil biodiversity.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Gliessman, S.R. (2002). *Agroecosystem Sustainability: Developing Practical Strategies*. CRC Press.
2. Kumar, B.M. and Nair P.K.R. (eds.) (2006). *Tropical Homegardens*: A Time-Tested Example of Sustainable Agroforestry. Series, Advances in Agroforestry, Vol. 3. Kluwer Academic Publishers, Dordrecht, The Netherlands.
3. Lynggaard, K. (2006). *The Common Agricultural Policy and Organic Farming: An Institutional Perspective on Continuity & Change*. CAB International.
4. Newton, Paul C.D., Carran R.A., Edwards, G.R. and Niklaus, P.A. (2007). *Agroecosystems in a Changing Climate.* Advances in Agroecology Vol.12 CRC/Taylor & Francis.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation,* S. Chand Publishing, New Delhi.
6. Young, A. (1997). *Agroforestry for Soil Management*, CAB International, UK.

Core Course (CC-12)

Session: 2024-25			
PartA – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Environmental Impact Assessment and Auditing		
Course Code	M24- EVS-402		
Course Type	CC-12		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Understand the legislative framework for EIA and role of EIA in decision making. CLO2: Develop understanding through various case-Studies and develop the professional skills to undertake EIA. CLO3: Develop critical thinking for shaping strategies for environmental management planning, environment auditing and risk assessment. CLO4: Conduct various environmental and energy audits of various industries and institutions.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours	0	

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	EIA origin, development, purpose and aims; core values and principles of Ecological Impact Assessment, EIA Methodology, EIA processes: Project screening, scoping, environmental components of EIA, base-line data, impact identification; prediction and impact evaluation, methods of evaluation of environmental impacts, impact mitigation, consideration of alternatives and Environmental Management Plan, Public participation, presentation, review and decision making, monitoring and auditing.	15

II	Environmental Appraisal procedures in India, Impact identification methods. Environmental impacts of mining industry; textile industry; pulp and paper industry; pesticide manufacturing industry; fertilizer industry, building projects Case studies of EIA – Hydroelectric dam and river valley projects; thermal power plants and petroleum exploration.	15
III	Risk Analysis: Definition of risk, environmental risk analysis, risk assessment, and risk management. Basic steps in risk assessment - Hazard identification. Dose-response assessment, Exposure assessment, Risk characterization, Risk assessment in EIA. Strategic Environmental Assessment (SEA)-principles and potential, improving the effectiveness of EIA.	15
IV	Public involvement in EIA; Public involvement methods; General audit process- preparation, excretions, performance valuation and execution. Environmental risk insurance; Environmental audit and EIA, Vocational prospects in EIA, Auditing and EMS. Types of environmental audits: Assessment and compliance audit, occupation health and safety; Energy audits. ISO 14001. Environmental Management systems in India; Drivers for the development of audit programme.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Canter, L.W. (1996). Environmental Impact Assessment. 2nd edition, McGraw–Hill, NewYork.
2. Glasson, J., Therivel R. and Chadwick A. (1994). Introduction to Environmental Impact Assessment. UCL Press. London.
3. Morgan, R.K. (2002). Environmental Impact Assessment: A Methodological Perspective, Kluwer Academic Publishers, London.
4. Morris, P. and Thesivel, R. (eds.) (2001). Methods in Environmental Impact Assessment. UCL Press, London.
5. Therivel, R., Wilson E., Thompson O., Heaney D. and Pritchard D. (1992). Strategic Environmental Assessment. Earthscan, London.
6. Treweek, J. (1999). Ecological Impact Assessment. Blackwell Science, UK.

Discipline Elective Course (DEC-3)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th semester		
Name of the Course	Ecotechnology and Ecological Restoration		
Course Code	M24- EVS-403		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Aware about the basic concepts of ecotechnology and strategies for restoration. CLO 2: Describe the major ecological principles underlying the successful restoration of ecosystems including concepts of disturbance. CLO 3: Discuss the strategies of restoration of terrestrial ecosystems with the help of case studies. CLO 4: Discuss the strategies of restoration of aquatic ecosystems with the help of case studies.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Basic principles and applications of Ecotechnology. Restoration Ecology-Terms and definitions, Importance of ecological restoration: Strategies of Restoration-Natural recovery, active restoration, rehabilitation; Restoration plan and rehabilitation measures; Reference ecosystem. Natural and anthropogenic disturbances: Characteristics and sources, effects on structure and functioning of terrestrial and aquatic ecosystems. Habitat fragmentation, Ecosystem Stability and regulation. Global change and Human	15

	impact on ecological systems.	
II	Physical, Chemical, Biological tools of restoration. Ecological design principles. Restoration of soil fertility of degraded lands: No-tillage, role of mycorrhizae, forestry Plantations, biofertilizers. Rehabilitation of salt affected soils and water logged soils. Biosaline agriculture- Scope and importance and strategies.	15
III	Ecological restoration of forest and grassland ecosystems. Forest landscape restoration; Basic concepts and case studies. Reclamation of mining sites and disturbed lands. Integrated watershed management and restoration. Prevention and mitigation of invasive species.	15
IV	Ecological restoration of aquatic systems: River corridors, wetlands and lakes. Coastal restoration- mangroves and coral reefs. Rehabilitation of Tsunami affected areas- a general account. Treatment wetlands, Constructed wetlands. Restoration of riparian and floodplain ecosystems.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Harris J.M. and Roach, B. (2009). The Economics of Global Climate Change. Global Development and Environment Institute, Tufts University, Medford, USA.
2. Harris, J. and Roach, B. (2014). Environmental and Natural Resource Economics: A Contemporary approach,3rd edition, Routledge.
3. Harris, J.M., Wise, T.A., Gallagher, K.P. and Goodwin, N.R. (2001). A Survey of Sustainable Development: Social and Economic Dimensions. Island Press, Washington, D.C.
4. Smith, S. (2011). Environmental Economics: A Very Short Introduction, Oxford.

Discipline Elective Course (DEC-3)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th semester		
Name of the Course	Ecological Economics		
Course Code	M24-EVS-404		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Have in-depth knowledge of the relationship between economic growth and the deterioration of the environment, including the types, causes, theory, policy, and measurement. CLO 2: Acquire knowledge about the carbon credit and carbon market, various pollution control mechanism and cost-benefit analysis. CLO 3: Gather information about various principle, policies and strategies to achieve Global and National sustainability. CLO 4: Have in-depth knowledge about the environmentally integrated economic instruments to achieve sustainability.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Scope and importance of ecological economics. The market mechanisms and choices; Market based instruments for controlling pollution; Measuring the costs and benefits of pollution control. Demand and Supply, market price and quality. Environmental externalities and the problem of social cost. Economic valuation methods of natural resources - revealed, and stated preference methods. National Clean Development Mechanism - introduction and methodologies.	15
II	Economic analysis of climate change. Cost and benefits of climate change. Green accounting. Carbon footprint calculation methods. Cost and benefits	15

	of controlling greenhouse gases. Systems of integrated environmental accounting. Carbon credit mechanism. Global and Indian carbon market - trends and cases. Carbon Neutral Economy in Indian Context - introduction and challenges. Green economy, Industrial ecology - concepts, material flow and life cycle analysis.	
III	Sustainable development and sustainability indicators. Global challenges of sustainable development. Guiding principles of sustainable development. Global action and sustainable development. Strategies for global sustainability. India's sustainable development policy initiatives and strategies. Environmental performance index. Instruments for implementing sustainability. Integrated policymaking for promoting sustainable development, Specific Policy Instruments.	15
IV	Ecological and economic sustainability of natural resources. An economic and ecological perspective to sustainability - circular flow models. Findings right prices for implementing sustainability. Sustainability models - The Solow-Hartwick Sustainability Rule, World Bank Approach, Daly's Steady State principles, Critical rental capital, Safe Minimum Standard, Non-declining Natural Capital Stocks, Common-Perrings model, Total Environmental Stress Approach of FFRC, Wuppertal Approach. Biocapacity and ecological footprint.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Harris J.M. and Roach, B. (2009). The Economics of Global Climate Change. Global Development and Environment Institute, Tufts University, Medford, USA.
2. Harris, J. and Roach, B. (2014). Environmental and Natural Resource Economics: A Contemporary Approach, 3rd edition, Routledge.
3. Harris, J.M., Wise, T.A., Gallagher, K.P. and Goodwin, N.R. (2001). A Survey of Sustainable Development: Social and Economic Dimensions. Island Press, Washington, D.C.
4. Harris J. M. and Codur, A-M. (2004). Microeconomics and the Environment. Global Development and Environment Institute, Tufts University, Medford, USA.
5. Smith, S. (2011). Environmental Economics: A Very Short Introduction, Oxford.
6. Asafuu-Adjaye, J. (2005). Environmental Economics for Non-economists - Techniques and Policies for Sustainable Development. World scientific publishing Co. Pvt. Ltd.
7. Cleveland, C. J., Stern, D. I., Costanza, R. (Eds.). (2001). The Economics of Nature and the Nature of Economics. Edward Elgar Publishing, Inc., USA.

Discipline Elective Course (DEC-3)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M. Sc Environmental Science		
Semester	4th semester		
Name of the Course	Environmental Health and Industrial Safety		
Course Code	M24-EVS-405		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Analyze environmental disease vectors and implement appropriate control strategies CLO2: Evaluate workplace safety using risk assessment methodologies and recommend appropriate personal protective equipment CLO3: Study of formulation of industry-specific safety policies aligned with national and international standards CLO4: Study developing hazard identification protocols and emergency response plans for handling hazardous substances		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper Setter: The examiner will set nine questions, two from each unit and one compulsory question, taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least four parts covering the entire syllabus. The examinee will be required to attempt five questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction, Environmental Epidemiology, Agents of Environmental diseases: Zoonotic and water-borne disease (Jaundice and diarrhea); Toxic metals and elements; Pesticides and other organic compounds. Transmissible diseases: Symptoms, epidemiology and control of vector borne diseases amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis, life cycle of Plasmodium, Control of malaria, and tuberculosis. Bio-Terrorism.	15
II	Occupational health concepts and workplace disease spectrum, Classification of occupational diseases and their characteristics, Preventive approaches, Occupational health service implementation	15

	framework, Personal protective equipment (PPE): selection criteria and application protocols, Respiratory protection systems and their effectiveness evaluation	
III	Industrial Safety Frameworks: Safety management systems and organizational structures, Regulatory landscape: national and international safety legislation, Safety accountability: roles and responsibilities across organizational levels, Bureau of Indian Standards on safety: 14489-1998 and 15001-2000 ILO conventions and recommendations for workplace safety Career pathways and professional development in industrial safety	15
IV	Classification and identification systems for hazardous chemicals Transportation protocols and hazchem code implementation Storage infrastructure requirements and handling procedures Waste management strategies for hazardous industrial byproducts Major accident prevention and mitigation approaches Emergency response planning and safety audit methodologies.	15
Total Contact Hours		60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test, etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Friis, R. H. (2018). *Essentials of environmental health*. Jones & Bartlett Learning.
2. World Health Organization. (2022). *Guidelines for drinking-water quality: incorporating the first and second addenda*. World Health Organization.
3. Marhavilas, P. K., Pliaki, F. & Koulouriotis, D. (2022). International management system standards related to occupational safety and health: An updated literature survey. *Sustainability*, *14*(20), 13282.
4. DiNardi, S. R. (2003). *The occupational environment: its evaluation, control, and management* (Vol. 111, pp. 18-27). Fairfax: AIHA Press (American Industrial Hygiene Association).
5. Stellman, J. M., Rau, S., & Thaker, P. (2021). Occupational Safety And Health Management. *Handbook of Human Factors and Ergonomics*, 573-596.
6. Stellman, J. M. (1998). The ILO encyclopedia of occupational health and safety: A multidisciplinary challenge. *International Labour Review*, *137*(3), 410.

Discipline Elective Course (DEC-4)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Environmental Disasters Management		
Course Code	M24-EVS-407		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Explain disaster management, its types, causes, and interdisciplinary nature. CLO 2: Analyze natural disasters, their impacts, and mitigation strategies. CLO 3: Assess anthropogenic disasters and propose risk mitigation measures. CLO 4: Evaluate disaster impacts, policies, and recovery approaches.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction to Disaster Management: definition, types of disaster (anthropogenic and natural); Cause of disaster; Disaster management cycle; Approaches to preparedness and planning: Early warning systems, mock drills. Brief history of disaster management in India and the world; The emerging techniques of disaster management. Multidisciplinary nature of disaster management as applied disciplines.	15
II	Different types of disasters: Characteristics, Causes, effects, and management of tsunamis, floods, cyclones, avalanches, Earthquake	15

	landslides, rock falls, Volcanic landforms, and eruptions, drought, desertification. Risk Mitigation strategies, Weather forecasting. Disaster mitigation methods.	
III	Anthropogenic disaster: Characteristics, Causes, effects, and management of Industrial disasters, Mining disasters, High rise buildings, Fire disasters; terrorist attacks on buildings, Biological warfare. Case studies related to Anthropogenic Disasters. Risk assessment and mitigation methods.	15
IV	Economic Implication of Disaster; Impact of disaster on development; Recovery management approaches – centralized versus decentralized, Policy for disaster reduction. Mitigation Planning and Policy Strategies: Local, State and Central level. Disaster Management Act, 2005, Institutions of governance NDMA, SDMA, NIDM, National and state Disaster Management Plans. Mapping Vulnerability (Social, Economic and Political vulnerabilities)	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1 Smith, K. & Petley, D. (2009). *Environmental Hazards: Assessing Risk and Reducing Disaster* (5th ed.). Routledge.
2 Hyndman, D., & Hyndman, D. (2016). *Natural Hazards and Disasters* (5th ed.). Cengage Learnin
3 National Disaster Management Authority (NDMA), India – https://www.ndma.gov.in
4 United Nations Office for Disaster Risk Reduction (UNDRR) – https://www.undrr.org
5 National Institute of Disaster Management (NIDM), India – https://www.nidm.gov.in
6 Federal Emergency Management Agency (FEMA), USA – https://www.fema.gov
7 World Meteorological Organization (WMO) – https://public.wmo.int/en
8 SWAYAM (Government of India's e-learning platform) – https://swayam.gov.in

Discipline Elective Course (DEC-4)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Energy Resources and Environment		
Course Code	M24-EVS-408		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
The Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Analyze different energy resources, their potential and environmental impacts. CLO 2: Acquire knowledge about the working principles, applications and challenges associated with solar, hydro and wind energy. CLO 3: Develop understanding about ocean energy potential, geothermal resources, and nuclear power. CLO4: Become familiar with hydrogen fuel, biofuel production, and energy-efficient technologies.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions, asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Importance of energy resources, classification of energy resources: non-renewable and renewable sources, Fossil fuels: Coal, petroleum, and natural gas. Global and national energy demand and consumption trends. Conventional energy resources: availability and limitations. Comparison between conventional and non-conventional energy resources.	15
II	Solar energy: Solar photovoltaic cells, solar panels, solar thermal energy, application of solar energy in sustainable development. Hydropower: working of hydroelectric power plant, types, and the impacts of large dams on the environment and society.	15

	Wind energy: working principles, advantages, and limitations.	
III	Ocean energy potential: Tidal energy, Ocean Thermal Energy Conversion (OTEC) Systems, key technologies and challenges. Geothermal energy: types of Geothermal Energy Resources, Geothermal Power Plants and applications. Nuclear energy: Nuclear Power Generation and environmental concerns.	15
IV	Hydrogen as a fuel and applications, Biomass energy, Biofuel production technologies. Environmental impacts of energy resources, climate change, global warming, Policies and regulations for renewable energy development. Green building concepts and energy-efficient technologies, Electric Vehicles and the Smart Grid, Emerging Energy Technologies, carbon trading, and carbon sequestration.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End-Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Kumar, M. (2020). Social, Economic, and Environmental Impacts of. Wind solar hybrid renewable energy system, 227.
2. Bhatia, S. C., & Gupta, R. K. (2018). Textbook of renewable energy. Woodhead Publishing India PVT. Limited.
3. Ginley, D. S., & Cahen, D. (Eds.). (2011). Fundamentals of materials for energy and environmental sustainability. Cambridge University Press.
4. Ristinen, R. A., Kraushaar, J. J., & Brack, J. T. (2022). Energy and the Environment. John Wiley & Sons.
5. Twidell, J. (2021). Renewable energy resources. Routledge.
6. Ehrlich, R., Geller, H. A., & Cressman, J. R. (2022). Renewable energy: a first course. CRC press.
7. Boyle, Godfrey. "Renewable Energy: Power For A Sustainable Future." TIDEE: TERI Information Digest on Energy and Environment 23.1/2 (2024): 120-120.

Discipline Elective Course (DEC-4)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th semester		
Name of the Course	Water Resource Management		
Course Code	M24-EVS-409		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Explain the hydrological cycle, water balance, and the global distribution of water resources. CLO2: Evaluate water quality parameters, sources of pollution, and wastewater treatment methods for environmental sustainability. CLO3: Understand different water conservation techniques and their role in sustainable water use. CLO4: Critically examine the effects of climate change on water resources and assess water policies and governance frameworks.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction to Water Resources-Definition and Importance of Water Resources; Hydrological Cycle and Water Balance; Types of Water Resources: Surface Water, Groundwater, Rainwater; Water Use (domestic, industrial agricultural, in-stream) and Availability: Global and National Water Distribution; Water Scarcity and its Causes; Sustainable	15

	Development Goals (SDG-6): Clean Water and Sanitation.	
II	Water Quality and Pollution Management: Water Quality Parameters and Standards, Sources and Types of Water Pollution, overexploitation, Impact of Pollution on Aquatic Ecosystems and Human Health, Wastewater Treatment and Recycling Methods, Industrial and Agricultural Water Management, Policies and Regulations on Water Pollution Control	15
III	Water Resource Planning and Development: Principles of Water Resource Planning, Integrated Water Resource Management (IWRM), Water Harvesting and Conservation Techniques, Watershed Management and River Basin Planning, Dams, Reservoirs, and their Environmental Impact, Traditional and Modern Irrigation Techniques	15
IV	Climate Change and Water Governance: Impact of Climate Change on Water Resources, Floods, Droughts; Water Laws and Policies (Global and National Perspectives), Interlinking of river Projects, Ganga Action Plan, Yamuna Action Plan, Role of Government and NGOs in Water Governance, Community Participation in Water Management, Future Challenges and Innovations in Water Sustainability.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. CPCB (Central Pollution Control Board) (1999). *Water quality Status and Statistics* (1996 and 1997). Central Pollution Control Board, New Delhi.
2. DeBarry, P.A. (2004). Watersheds: Processes, Assessment and Management. John Wiley and Sons, Inc, Hoboken, New Jersey.
3. Grafton R.Q. and Hussey, K. (eds.) (2011). Water Resources Planning and Management. Cambridge University Press.
4. Manahan, S.E. (2000). *Environmental Chemistry*. 7th Edition. Lewis Publishers, New York.
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). *Ecology, Environment and Resource Conservation*, S. Chand Publishing, New Delhi.

Practicum Course PC-VII

Session: 2024-25			
Part A–Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Practical-VII		
Course Code	M24-EVS-411		
Course Type	PC-VII		
Level of the course	500-599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Develop practical skills in soil nutrient analysis to assess soil fertility across different agroecological systems. CLO2: Understand and evaluate ecological restoration techniques for degraded ecosystems, including mined sites, wetlands, and forests CLO3: Develop analytical skills to assess market equilibrium, conduct economic valuation of environmental resources, and evaluate sustainability policies using various economic methods CLO4: Evaluate workplace safety using risk assessment methodologies and recommend appropriate personal protective equipment		
Credits	**Theory**	**Practical**	**Total**
	0	**4**	**4**
Teaching Hours per week	0	**8**	**8**
Internal Assessment Marks	0	**30**	**30**
End-Term Exam Marks	0	**70**	**70**
Max. Marks	0	**100**	**100**
Examination Time	0	**4 hours**	

Part B-Contents of the Course		
Practicals		**Contact Hours**
M24-	1. To determine the available Nitrogen content in the soil from different	120

EVS-401	agroforestry systems. 2. To determine the carbon content in given soil samples of different agroecological systems. 3. To determine the calcium & magnesium content of given soil samples of different agroecological systems. 4. To determine the chloride content of given soil samples of different agroecological systems. 5. To determine the sodium content of given soil samples of different agroecological systems. 6. To determine the potassium content of given soil samples of different agro-ecological systems. 7. To determine the phosphorus content of given soil samples of different agro-ecological systems.	
M24-EVS-403	1. To study about the restoration of mined degraded site. 2. To study about the restoration of salinity affected area. 3. To study about the restoration of Sukhomajari Watershed. 4. To study about the ecological restoration of Lake Badkal in Faridabad. 5. To study about the restoration of Kali Baen river. 6. To study about the restoration of Forest ecosystem. 7. To study about the restoration of wildlife habitat.	
M24-EVS-404	1. To study the given data and draw the competitive market equilibrium. 2. To perform the cost-benefit analysis of a proposed project. 3. To estimate the economic value of recreational park from the given data set using travel cost method. 4. To estimate the economic value of ecosystem services by Hedonic Price method with the help of case study. 5. To estimate the economic value of ecosystem services by Contingent Valuation method with the help of case study. 6. To study the details of CDM Project of Sand Dunes in Sirsa, Haryana. 7. Compare India's EPI score with other nations and discuss policy improvements.	
M24-EVS-	1. To identify and classify common disease vectors and study their transmission mechanisms. 2. To evaluate different types of personal protective equipment and	

405	determine their effectiveness against specific workplace hazards. 3. To study documented industrial accidents using root cause analysis techniques and recommend a preventive action plan. 4. To conduct a safety audit of a laboratory using standardized protocols and prepare a detailed compliance report. 5. To assess water quality parameters relevant to environmental health and identify potential contamination sources. 6. To perform workplace environmental monitoring for occupational hazards using appropriate sampling techniques.	

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Nair, P. R., Kumar, B. M., Nair, V. D., Nair, P. R., Kumar, B. M. & Nair, V. D. (2021). Soils and Agroforestry: General Principles. *An Introduction to Agroforestry: Four Decades of Scientific Developments*, 367-382.
2. Clewell, A. F. & Aronson, J. (2012). *Ecological restoration: principles, values, and structure of an emerging profession*. Island Press.
3. Tietenberg, T. & Lewis, L. (2023). *Environmental and natural resource economics*. Routledge.
4. Levy, B. S. & Wegman, D. H. (1983). Occupational health: Recognizing and preventing work-related disease.

Practicum Course PC-VIII

Session: 2024-25			
PartA–Introduction			
Name of the Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Practical-VIII		
Course Code	M24-EVS-412		
Course Type	PC-VIII		
Level of the course	500-599		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes (CLO) After completing this course, Students will develop skills to:	CLO1: Assess environmental impacts using different evaluation methods and auditing techniques for sustainable project planning. CLO2: Acquire practical knowledge of disaster risk assessment, mitigation strategies, and emergency preparedness to enhance resilience CLO3: Gain proficiency in energy resource evaluation, auditing techniques, and policy analysis for sustainable energy management. CLO4: Develop expertise in water quality assessment, conservation techniques, and wastewater treatment for sustainable water management		
Credits	**Theory**	**Practical**	**Total**
	0	**4**	**4**
Teaching Hours per week	0	**8**	**8**
Internal Assessment Marks	0	**30**	**30**
End-Term Exam Marks	0	**70**	**70**
Max. Marks	0	**100**	**100**
Examination Time	0	**4 hours**	

Part B-Contents of the Course		
	Practicals	**Contact Hours**
M24-EVS-402	1. To study the Environmental Impacts of Coal Mining in India. 2. To study the Environmental Management Systems in India 3. To study the Environmental Impacts of the Thermal Power Plant project. 4. To study the Environmental Impacts of Petroleum Exploration. 5. To identify the Environmental Impacts by matrix method of a project. 6. To identify the Environmental Impacts by the Battelle method of a project. 7. To make a detailed format of the Environmental Audit of an industry	120
M24-EVS-407	1. Analyze the effectiveness of early warning systems (EWS) for various disasters. 2. Develop a flood vulnerability map highlighting high-risk zones. 3. Case Study: Bhopal Gas Tragedy and Industrial Disaster Management. 4. Analyze the impact, response, and preparedness measures for tsunamis. 5. Visit to Seismological Observatory in KUK for Earthquake Monitoring 6. Hands-on training in using fire extinguishers and emergency evacuation procedures. 7. Assess disaster awareness and preparedness levels in local communities. 8. Assess disaster awareness and preparedness levels in local communities	
M24 EVS-408	1. Measurement of solar radiation using a pyranometer. 2. Characterization of biomass (proximate and ultimate analysis). 3. Conducting a basic energy audit of a laboratory or building. 4. Mapping of nuclear power plants, hydropower plants, and thermal power plants in India. 5. To plot the energy consumption scenario in a pie diagram in the Indian context. 6. To determine the calorific value of given material. 7. To study policies and regulations for renewable energy development	

	in India.	
M24-EVS-409	1. To analyse the monthly, seasonal and annual precipitation trends of an area. 2. To assess the general physico-chemical properties of water from various local water resources (tap water, tubewell, canal etc.) 3. To test different water samples for potential presence of coliform bacteria. 4. To study indigenous water conservation methods. 5. To prepare report on traditional and modern irrigation techniques through field survey. 6. To study the working of sewage treatment plant. 7. To analyse and compare the inlet and outlet wastewater quality from a sewage treatment plant. 8. To map major interlinking river projects in India.	

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
8. Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Glasson, J. & Therivel, R. (2013). *Introduction to environmental impact assessment*. Routledge
2. Coppola, D. (2006). Introduction to international disaster management. Elsevier.
3. Coppola, D. P. (2015). Hazards. *Introduction to international disaster management*, 40.
4. Boyle, G. (2024). Renewable Energy: Power For A Sustainable Future. *TIDEE: TERI Information Digest on Energy and Environment*, *23*(1/2), 120-120.
5. Weissbrodt, D. G., Winkler, M. K. & Wells, G. F. (2020). Responsible science, engineering and education for water resource recovery and circularity. *Environmental Science: Water Research & Technology*, *6*(8), 1952-1966.

Employability and Entrepreneurship Skills Course (EEC)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Environment, Energy and Safety Audit		
Course Code	M24-EVS-413		
Course Type	EEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Have in-depth knowledge of the environmental audit and its applications. CLO 2: Have in-depth knowledge of the energy audit and its applications. CLO 3: Have in-depth knowledge of the safety audit and its applications. CLO 4: Understanding environmental standards and Environment management system, and application of environment, energy and safety audit.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Environmental Audit**: Aims and objectives of environmental audit; methodology of environmental audit; Guidelines for conducting environmental audit - audit of biodiversity, audit of air environment, audit of water environment, audit of waste management, audit of climate change; Environmental audit report format; Types of environmental audit: compliance audit, performance audit.	8
II	**Energy Audit**: Aims and objectives of energy audit, Types and methodology of energy audit; Energy audit report format; Understanding energy costs; Energy audit instruments; Calculation of carbon footprint - CO_2 emission from electricity and transportation; Demand Side Management; Role of BEE in India.	8

III	**Safety Audit**: Aims and objectives of safety audit; Types and methodology of safety audit; Safety audit report format; Methods adopted for reducing accidents, Safety at workplace - introduction, policy, duties and responsibilities.	7
IV	**Standards, System and Case Studies**: Supreme Audit Institution (SAI) in India: ISO series of standards for environmental auditing; Environment management system; Environmental audit of Common/Captive Treatment, Storage and Disposal Facilities. Energy audit of buildings. Safety in boilers.	7
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory:**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C - Learning Resources

Recommended Books/e-resources/LMS:

1. Simon Watson Pain, Safety (2018). *Health and Environmental Auditing - A Practical Guide*. CRC Press.
2. The Comptroller & Auditor General of India (2010). *Environment and climate change - Auditing Guidelines*. CAG, New Delhi.
3. Central Pollution Control Board (2021). *Guidance document for conducting environmental audit of Common/Captive Treatment, Storage and Disposal Facilities (TSDFs)*. CPCB, New Delhi.
4. Bureau of Energy Efficiency (2023). *Impact of Energy Efficiency Measures for the Year 2021-22*. BEE, Ministry of Power, Govt. of India, New Delhi.
5. International Organization for Standardization (2015). *Introduction to ISO 14001:2015*. Geneva, Switzerland.

DISSERTATION

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Environmental Science		
Semester	4th Semester		
Name of the Course	Dissertation		
Course Code	M24- EVS-414		
Course Type	Dissertation		
Level of the course	500-599		
Pre-requisite for the course (if any)	The student must have studied courses relevant to the proposed research problem till 3rd Semester, along with statistical concepts and instrumentation techniques in their program.		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Develop understanding of research principles and methods. CLO 2: Acquire knowledge about a specialized field of environmental science. CLO 3: Demonstrate creativity and initiative to analyze the interactions among environmental components. CLO 4: Apply skills for carrying out applied research and meaningful investigations to formulate evidence based solutions to real world problems of significance.		
Credits	Theory	Practical	Total
	0	12	12
Teaching Hours per week			
Evaluation of Dissertation			200
Viva-Voce			100
Max. Marks			300
Examination Time			

Part B-Contents of the Course

Instructions:

The student will undertake independent research on a chosen research or interdisciplinary topic under faculty supervision. The student will write a well-structured dissertation that would reflect critical thinking, analytical depth, and scholarly engagement with primary and secondary texts (As per clause 5.6 of the PG Ordinance (NEP-2020) available at https://kuk.ac.in/wp-content/uploads/2024/08/Annexure-40-1-43.pdf)

Total Contact Hours	60

Suggested Evaluation Methods

The dissertation will be evaluated by an external examiner out of 300 marks

Evaluation of Dissertation: 200	**Viva-Voce: 100**

Total:200+100=300

Part C - Learning Resources

Recommended Books/e-resources/LMS:

1. Cantero, C. (2019). How to Write a Literature Review. San José State University Writing Center. Available at: https://www.sjsu.edu/writingcenter/docs/handouts/Literature%20Reviews.pdf
2. Hon, L. C. (2007-2008). Guidelines for writing a thesis or dissertation. Available at https://www.jou.ufl.edu/grad/forms/Guidelines-for-writing-thesis-or-dissertation.pdf