Department of Environmental Science & Engineering

Scheme and Syllabus for
Post Graduate Program

Under Multiple Entry and Exit, Internship and
CBCS-LOCF as per NEP-2020
w.e.f. session 2025-26

M.Sc. Environmental Science

Department of Env. Sc. & Engg.
Guru Jambheshwar University of Science and Technology
Hisar-125001, Haryana
(A^+ GRADE NAAC Accredited)

Guru Jambheshwar University of Science and Technology
Hisar-125001, Haryana
('A+' Grade NAAC Re-Accredited State Govt. University)

Scheme of Examination and Syllabus for Post Graduate Program w.e.f. session 2025-2026
For M.Sc. Env. Sc. (UTD) according to NEP-2020 for 1st and 2nd years (1st to 4th Semesters)

M.Sc. Environmental Science

SEMESTER-I

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
Discipline Specific Course	U25EVS101T	Foundation of Environmental Science	4	4	30	70	100	3
	U25EVS102T	Ecology and Systems Analysis	4	4	30	70	100	3
	U25EVS103T	Environmental Pollution	4	4	30	70	100	3
Discipline Elective Course	U25EVS111T	Natural Resources and Biodiversity	4	4	30	70	100	3
Practicum	U25EVS104P	Ecology, Resources and Biodiversity Lab	3	6	25	50	75	4
	U25EVS105P	Environmental Pollution Lab	3	6	25	50	75	4
VAC		To be opted from the pool of VAC	2	2	15	35	50	2
Total			**24**	**30**			**600**	

SEMESTER-II

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
Discipline Specific Course	U25EVS201T	Physical Environment	4	4	30	70	100	3
	U25EVS202T	Instrumentation for Environmental Analysis	4	4	30	70	100	3
	U25EVS203T	Environmental Microbiology	4	4	30	70	100	3
Discipline Elective Course	U25EVS211T OR U25EVS212T	Environmental Health and Toxicology OR Resource Conservation and Management	4	4	30	70	100	3
Practicum	U25EVS204P	Ecotoxicology and Bioremediation Lab	3	6	25	50	75	4
	U25EVS205P	Environmental Microbiology Lab	3	6	25	50	75	4
Seminar	U25EVS201S	Seminar	2	2			50	2
Internship	U25EVS201I	Internship (4-6 weeks)*	4	4			100	-
Total			**24+4***	**30+4***			**600+100***	

***Internship will be of 4-6 weeks (120 Hrs).**

SEMESTER-III

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
Discipline Specific Course	U25EVS301T	Environmental Chemistry	4	4	30	70	100	3
	U25EVS302T	Environmental Awareness and Law	4	4	30	70	100	3
	U25EVS303T	Environmental Biotechnology	4	4	30	70	100	3
Discipline Elective Course	U25EVS311T OR U25EVS312T	Agriculture and Environment OR Natural Disasters and Management	4	4	30	70	100	3
Practicum	U25EVS304P	Environmental Chemistry Lab	3	6	25	50	75	4
	U25EVS305P	Environmental Biotechnology Lab	3	6	25	50	75	4
OEC		To be opted from pool of OEC	2	2	15	35	50	2
Total			**24**	**30**			**600**	

SEMESTER-IV (Option A)

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
Discipline Specific Course	U25EVS401T	Pollution Management	4	4	30	70	100	3
	U25EVS402T	Environmental Impact Assessment and Risk Analysis	4	4	30	70	100	3
Discipline Elective Course	U25EVS411T OR U25EVS412T	Environmental Stress Physiology OR Remote Sensing, GIS and Environment Statistics	4	4	30	70	100	3
Discipline Elective Course	U25EVS413T	Solid Waste Management OR MOOC	4	4	30	70	100	3
Practicum	U25EVS403P	Industrial Pollution Management Lab	3	6	25	50	75	4
	U25EVS404P	Solid Waste Management Lab	3	6	25	50	75	4
SEC/EEC/VOC			2	2	15	35	50	2
Total			**24**	**30**			**500**	

OR

SEMESTER-IV (Option B)

Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours	Internal Marks	External Marks	Total Marks	Duration of Exam (Hours)
Discipline Specific Course	U25EVS401T	Pollution Management	4	4	30	70	100	3
	U25EVS402T	Environmental Impact Assessment and Risk Analysis	4	4	30	70	100	3
Discipline Elective Course	U25EVS414T OR U25EVS415T	Ecotechnology OR Environmental Nanotechnology OR MOOC	2	2	15	35	50	2
SEC/EEC/VOC		To be opted from pool of SEC/EEC/VOC	2	2	15	35	50	2
Dissertation	U25EVS433D	PROJECT WORK/ DISSERTATION	12				300	
Total			**24**	**12**			**500**	

Syllabi for Post Graduate Program in M.Sc. Environmental Science

Semester - I

Session: 2025-26

Name of Program	**M.Sc. EVS**	**Program Code**	**--**
Name of the Course	**FOUNDATION OF ENVIRONMENTAL SCIENCE**	**Course Code**	**U25EVS101T**
Hours per Week	**4**	**Credits**	**4**
External Marks **Internal Marks**	**70** **30**	**Time of Examinations**	**3 hrs**

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course introduces basic environmental concepts, Earth′s life support systems, and impacts of human activities. It covers population growth, sustainability, environmental ethics, and key national policies for environmental protection.

Unit 1: Environment: Definition and scope, A brief account of Earth′s life support system; hydrosphere, lithosphere, atmosphere, biosphere; concepts of carrying capacity, assimilative capacity, carbon and ecological footprint**,** Environmental ethics.

Unit 2: Major human cultural changes: Agricultural and industrial revolution in relation to their environmental impacts, Natural & Man-made disasters, urbanization**,** concept of green-building, eco-cities.

Unit 3: Human population and environment: Historical and present global trends of population growth; human demography: Fertility, birth rates, mortality rates, life expectancy, doubling time, zero population growth, demographic transaction; Population explosion and related environmental problems, population stabilization (Case studies: China and India).

Unit 4: Sustainable development: Concept of sustainability principles and strategies of sustainable development, environmental consumerism, green consumerism, environmentalism, human-centric and earth centric views of development; National Environment Policy – salient features.

Suggested readings:

1. Living in the Environment - T.J. Miller
2. Understanding Environment - Cunningham Saigo

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall key environmental concepts like Earth's systems, ethics, carrying and assimilative capacities, and ecological footprints.

CO2: Explain environmental impacts of human cultural shifts and concepts like urbanization and disaster types.

CO3: Apply demographic principles to assess population dynamics and related environmental issues.

CO4: Analyze links between population growth, human activities, and environmental degradation.

CO5: Evaluate environmental policies and development models from human- and earth-centric perspectives.

Name of Program	**M.Sc. EVS**	**Program Code**	**--**
Name of the Course	**ECOLOGY AND SYSTEMS ANALYSIS**	**Course Code**	**U25EVS102T**
Hours per Week	**4**	**Credits**	**4**
External Marks **Internal Marks**	**70** **30**	**Time of Examinations**	**3 hrs**

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course provides an overview of ecological principles, ecosystem structure and functions, and population and community interactions. It covers energy flow, biogeochemical cycles, succession, and ecosystem stability. Students will also learn about ecological models, species interactions, and strategies for ecosystem restoration and regulation.

Unit 1: Introduction: Aims and scope of ecology, Historical background; Ecology in India. Interaction of ecological factors, Ecological concepts of species (Liebig′s law of minimum, Shelford′s law of Tolerance, Combined concept of limiting Factors).

Unit 2: Ecosystem: Structural components, ecological pyramids, food webs, trophic levels, ecological efficiencies, models of energy flow, primary and secondary production, methods of measuring primary productivity, biogeochemical cycles, gaseous and sedimentary cycles-carbon cycle, nitrogen cycle, sulphur cycle and phosphorus cycle.

Unit 3: Population & **Community ecology**: Characteristics, evolutionary strategies r and k selection; population growth. Population Interaction: Competition, Lotka-Volterra equations, mutualism, parasitism, predator prey relations**.**
Landscape ecology, Theory of Island Biogeography, biological invasion.
Community Ecology: Analytic and synthetic characters, community structure and composition. concept of niche, keystone species, ecotypes, plant indicators. Ecad, Ecotone and Edge effect, Endemic species.

Unit 4: Ecological Succession-Concepts of ecological succession, general process of succession, types of succession, structural and functional changes in succession. Ecosystem degradation and restoration-factors/threats of ecosystem, restoration of ecosystem
Ecosystem stability: Species diversity, Stability, Cybernetics and ecosystem regulation.

Suggested readings:
1. Basic Ecology- E.P.Odum
2. Ecology & Field Biology-R.L.Smith
3. Fundamentals of Ecology- E.P. Odum
4. Principles of Ecology-Rickleffs

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall and define key ecological concepts, historical development, laws, and factor interactions.

CO2: Explain ecosystem structure, energy flow, biogeochemical cycles, and ecological models.

CO3: Apply ecological theories to population and community dynamics and evaluate ecological patterns.

CO4: Analyze succession, species diversity, ecosystem stability, and regulatory mechanisms.

CO5: Evaluate ecosystem degradation, restoration strategies, and concepts of landscape and island ecology.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL POLLUTION	Course Code	U25EVS103T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course provides an understanding of the sources, types, and impacts of water, soil, air, and noise pollution. It covers sampling and analysis techniques, pollution indicators, and environmental quality standards. Emphasis is placed on pollutant behavior, health effects, and strategies for pollution control and remediation.

Unit 1: Water Pollution: Sources, types of pollutants, consequences, ecological and biochemical aspects of water pollution, characteristics of domestic, industrial and agricultural wastes, their effects on water bodies, chemical and bacteriological sampling and analysis, water quality parameters, criteria and standards. Marine pollution: thermal pollution.

Unit 2: Soil Pollution: Sources, type of soil pollutants, Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, industrial effluents and surfactants. Detrimental effects of soil pollutants, Remedial measures for soil pollution, soil conservation, wasteland reclamation, soil sediments as pollutant. Chemical methods of soil analysis- sample preparation and soil analysis. Radioactive pollution.

Unit 3: Air Pollution: Sources, classification and properties of air pollutants, behaviour and fate of air pollutants, effects of air pollution on human health & materials, sampling and analysis of air pollutants, SOx, NOx, CO, Ozone, hydrocarbons and particulate matter**,** Atmospheric Aerosols, meteorological aspects of air pollutant dispersion, air quality.

Unit 4: Noise Pollution: Definition, sound pressure level, combining decibels, frequency weighting networks, noise-monitoring-sound level meter, equivalent continuous noise level and other noise indices. Effects of noise pollution.

Suggested readings:

1. Industrial Noise Control- Bell & Bell
2. Introduction to Environmental engineering & Science- Gilbert Masters
3. Geo-environment- An Introduction – V. Aswathanarayan
4. Soil Chemistry- Bolt & Buggenwert.

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall types, sources, and definitions of various environmental pollutants.

CO2: Explain impacts of pollutants and relevant sampling methods and standards.

CO3: Apply techniques for pollutant analysis and suggest suitable control strategies.

CO4: Analyze pollution pathways and their effects on ecosystems and health.

CO5: Evaluate pollution control, remediation methods, and regulatory frameworks.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	NATURAL RESOURCES AND BIODIVERSITY	Course Code	U25EVS111T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course offers an overview of physical, energy, and biological resources, emphasizing their types, uses, and environmental impacts. It highlights the importance of biodiversity, threats to its conservation, and strategies for protection. The course also discusses national and global efforts toward sustainable resource and biodiversity management.

Unit-1 Physical resources: Renewable & non-renewable resources. Soil resources: soil type, soil profile and soil erosion. Water resources: Surface water, ground water, hydrological cycle. Mineral resources: Types, their characteristics & uses, minerals from the sea.

UNIT-2 Energy resources: Fossil fuels, nuclear energy, solar energy, wind energy, tidal energy, geothermal energy, hydropower. Hydrogen as a source of energy, energy from biomass, bioconversion technology, energy plantations and petro-crops. Environmental impacts of various forms of energy use. Renewable energy scenario at national and global level.

Unit -3 Biological resources: Forests, their importance, types, primary and secondary products -value & uses, forest resources of India. Wildlife of India. Range lands: Types, significance, range lands in India. National and International conventions on biodiversity.

Unit-4 Biodiversity : Definition; Historical and geographical causes for diversity; Types of diversity; threats to biodiversity and species extinction, threatened and endangered species, Measurement of Biodiversity : diversity indices, hot spots of biodiversity, biodiversity conservation strategies - in situ and ex situ conservation ; Protected Area Network, National wilderness areas, biosphere reserves, gene banks, germ plasma banks, ethics in conservation of biodiversity.

Suggested readings:

1. Natural Resources conservation-Oliver S Owen & Chiras
2. Living in the Environment –T.J.Miller
3. Environmental Science- Cunningham Saigo
4. Ecology of Natural Resources-Ramade
5. Global Biodiversity-W.R.L. IUCN
6. Soils-Miller, W & R.L. Donhau

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall key concepts and classifications of natural resources and biodiversity.

CO2: Explain values, threats, and conservation strategies for resources and biodiversity.

CO3: Apply sustainable management practices and conservation technologies.

CO4: Analyze links between resources, development, biodiversity loss, and climate change.

CO5: Evaluate sustainability and policy frameworks for resource and biodiversity conservation.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ECOLOGY, RESOURCES AND BIODIVERSITY LAB	Course Code	U25EVS104P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVE: To develop practical skills in vegetation analysis and biodiversity assessment using ecological field methods and mapping techniques

List of experiments:

1. To determine minimum quadrat size for herbaceous vegetation by area curve method.
2. Determination of minimum number of quadrats for studying vegetation in a grassland.
3. To study the plant population frequency by quadrat method.
4. To study the plant population density by quadrat method.
5. Estimation of the abundance of plant species in grassland using quadrat method.
6. Study the association between two species using correlation coefficient (r).
7. Determination of similarity and dissimilarity indices between a disturbed (grazed) and undistributed (protected) grassland community.
8. Determination of Abundance: Frequency (A: F) of a community.
9. To plot important National Park on geographical maps of India along with the total cover with flora and fauna found in them.
10. To plot the important bird sanctuaries on the geographical map of India with the major species of Bird Projected and in which year it was formed.
11. Evaluation of importance value index (IVI) of species of grassland community.
12. Estimation of index of diversity, richness, evenness and dominance of species.
13. To determine the species diversity of grassland community.

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

CO1: Recall and define ecological field methods, biodiversity indices, and sampling concepts.

CO2: Explain ecological parameters and their use in biodiversity assessment.

CO3: Apply field techniques to estimate plant population and biodiversity.

CO4: Analyze ecological data for species distribution and community structure.

CO5: Evaluate biodiversity patterns and ecological value of Indian protected areas

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL POLLUTION LAB	Course Code	U25EVS105P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVE: To impart hands-on experience in analyzing water, soil, and air pollutants, and to understand key techniques for assessing environmental pollution and control methods

List of experiments:

1. To determine total solids, suspended solids, volatile solids, in given water sample
2. To determine conductivity of water sample using electro conducto-meter.
3. To determine organic carbon in soil sample
4. To determine COD of given water samples
5. To determine total hardness of given water samples.
6. To determine alkalinity of given water sample
7. To study different type of particulate matter
8. To study about cyclone separator
9. To determine amount of sulphate in water samples
10. To study working & principle of high-volume respirable air sampler
11. To study PM 10 in ambient air
12. To determine DO in given water sample.
13. Estimation of nitrate in water, Nitrates, Sulphates determination.

COURSE OUTCOMES:

CO1: Recall key terms and parameters related to water, air, and soil pollution.

CO2: Explain principles of pollution monitoring instruments and testing procedures.

CO3: Apply lab techniques to estimate pollutants in environmental samples.

CO4: Analyze pollution data to identify types, sources, and levels of pollutants.

CO5: Evaluate analytical methods for their effectiveness in pollution monitoring.

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

Semester –II

Name of Program	**M.Sc. EVS**	**Program Code**	**--**
Name of the Course	**PHYSICAL ENVIRONMENT**	**Course Code**	**U25EVS201T**
Hours per Week	**4**	**Credits**	**4**
External Marks **Internal Marks**	**70** **30**	**Time of Examinations**	**3 hrs**

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers the basics of atmospheric, aquatic, and terrestrial systems, including weather patterns, landforms, and water bodies. It also introduces climate change, its causes, and environmental impacts.

Unit 1: Atmospheric Environment: Composition of atmosphere, vertical distribution of temperature in atmosphere, relationship of earth with sun, heat budget of the earth-atmospheric system, scales of meteorology, various kinds of lapse rates, vertical stability of atmosphere, cloud classification and formation, winds, wind roses, Coriolis force, global pressure belt system, monsoons, El nino, La nina

Unit 2: Aquatic Environment: Global water balance. Ice sheets and fluctuations of sea levels. Origin and composition of sea water. Hydrological cycle. Inland water bodies like lakes, streams, rivers, estuaries and wetlands, coral reefs

Unit 3: Terrestrial Environment: Igneous, sedimentary and metamorphic rocks, weathering, erosion, transportation and deposition of earth`s material by running water, wind, glaciers. The land use plan, soil surveys in relation to land use planning, methods of site selection and evaluation.

Unit 4: Global climate change: History of climate change, Milankovitch′s theory of climate change, greenhouse gases and their effects, role of humans in climate change, western disturbances, climatic feedback mechanisms, possible impacts of global climate change.

Suggested readings:

1. The atmosphere: An introduction- F.K. Lutgens
2. Atmospheric Science Wallace & Hobbs
3. Confronting Climate change- I.M. Mintzer
4. Atmosphere, weather & Climate- Navarra
5. Earth Science: A holistic approach- Conti, Thompson and Moses
6. Oceanography- Grand Gross
7. Oceanography: An introduction to the Marine Environment- Richard A. Davis.

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall and define key terms and concepts related to atmosphere, hydrosphere, and lithosphere.

CO2: Explain processes like weather systems, sea level changes, and climate feedbacks.

CO3: Apply concepts of meteorology, hydrology, and land use in environmental planning.

CO4: Analyze interactions among physical systems and their impact on environmental stability.

CO5: Evaluate climate change drivers and their environmental consequences.

Name of Program	**M.Sc. EVS**	**Program Code**	**--**
Name of the Course	**INSTRUMENTATION FOR ENVIRONMENTAL ANALYSIS**	**Course Code**	**U25EVS202T**
Hours per Week	**4**	**Credits**	**4**
External Marks **Internal Marks**	**70** **30**	**Time of Examinations**	**3 hrs**

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers basic principles and applications of analytical instruments used for environmental sample analysis, including spectroscopy, microscopy, and chromatography techniques

Unit 1: Method of collection of Air, Water & Soil samples. Principles working and applications of Spectrophotometry (UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry, Fourier transform Infrared Spectroscopy (FTIR)

Unit 2: Principles, working and applications of X-Ray diffraction, XRF, Titrimetry, Gravimetry Colorimetry and polarimetry, Fluorometry, ICP-MS

Unit 3: Principles, working and applications of Microsocopy- Phase contrast, fluorescent, SEM, TEM

Unit 4: Principles, working and applications of Chromatographic techniques (Paper chromatography Column chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, lon exchange chromatography, GC-MS)

Suggested readings:

1. Undergraduates Instrumental Analysis- James W. Robinson
2. Modern methods of Chemical analysis- Robert, Shields, Cairns, William.

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall basic principles and terms related to environmental sampling and instrumental techniques.

CO2: Explain the working and applications of key analytical instruments and methods.

CO3: Apply instrumental techniques for analyzing air, water, and soil samples.

CO4: Analyze the suitability of various instruments for specific pollutants and media.

CO5: Evaluate analytical tools for accuracy, effectiveness, and selection in environmental monitoring.

Name of Program	**M.Sc. EVS**	**Program Code**	**--**
Name of the Course	**ENVIRONMENTAL MICROBIOLOGY**	**Course Code**	**U25EVS203T**
Hours per Week	**4**	**Credits**	**4**
External Marks **Internal Marks**	**70** **30**	**Time of Examinations**	**3 hrs**

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers the role of microbes in water, soil, and biodegradation processes. It focuses on microbial applications in environmental cleanup, nutrient cycling, and pollution control

Unit 1: Introduction: Definition and importance of Environmental microbiology, Fermentative technologies, microbial enzymes, Batch and continuous culture of microbes for commercial use.

Unit 2: Aquatic Microbiology: Microbes in aquatic systems, measuring activity of microbes in water, Pathogens in water, Water borne diseases**,** Water health standards, bio-films.

Unit 3: Soil microbiology: Microbes in soils and their role, microbial interactions, mineralization and immobilization of nutrients in soil, Microbial degradation of cellulose and lignin, Microbe mediated C, N and S transformations mycorrhiza and their environmental significance.

Unit 4: Biodegradation microbiology & Applied Environmental Microbiology: Interaction of biological, chemical and environmental factors in Biodegradation processes. Bioremediation processes; Definition and classification including in situ and ex situ types. Biodegradation of pesticides and hydrocarbons, Sewage sludge treatment using microbes, biohydrometallurgy and microbial recovery of oil.

Suggested readings:

1. Microbiology- J.G. Black
2. Microbial Biotechnology-A.N. Glazer
3. Microbial Ecology- R.M. Atlas &Bartha
4. Microbiology- Pelczar
5. Introduction to Environmental Microbiology - Barbara Kołwzan, Waldemar Adamiak, Kazimierz Grabas and Adam Pawełczyk

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall basic concepts, microbial types, enzymes, and their ecological roles.

CO2: Explain microbial roles in soil, water, pathogen dynamics, and nutrient cycles.

CO3: Apply microbial techniques in water testing, biodegradation, and bioremediation.

CO4: Analyze microbial interactions, biofilms, and environmental transformation processes.

CO5: Evaluate microbial technologies for pollution control and resource recovery.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL HEALTH AND TOXICOLOGY	Course Code	U25EVS211T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers the impact of pollutants on human health, occupational hazards, and vector- and waterborne diseases. It introduces principles of toxicology, effects of toxic substances, and mechanisms of carcinogenicity and mutagenesis, along with environmental health assessment and control strategies.

Unit 1: Pollution and human health: Trace element deficiency and disorders, occupational health hazards & its type, levels of prevention, Role of WHO in occupational health, healthy workplace & its principles**,** biogeochemical factors in environmental health, epidemiological issues- goitre, fluorosis, arsenic poisoning.

Unit 2: Transmissible diseases: Symptoms, epidemiology and control of vector borne diseases-amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis, life cycle of Plasmodium, control of Malaria, tuberculosis and AIDS. Waterborne diseases: Jaundice & diarrhoea.

Unit 3: Principles of toxicology: Toxic chemicals in the environment and their effects, Heavy metals, Biochemical aspects of heavy metals & metalloids, Pesticides. Mode of entry of toxic substances, biotransformation of xenobiotics, detoxification, indices of toxicology.

Unit 4: Genetic Toxicology: Carcinogenesis; Carcinogens, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Oncogenes and tumour suppressor genes. Environmental carcinogenicity testing. Mutagens, Environmental mutagen testing- Bacterial mutagenesis assays, gene mutation chromosome damage assays, DNA damage and repair assays.

Suggested readings:

1. Kothari C.R. (2004). Research Methodology: Methods and Techniques (2nd ed). New Age International Publishers
2. Rastogi V. B. (2015). Biostatistics (3rd ed). MEDTECH
3. S.P. Gupta (1978) Elementary Statistical Methods, S. Chand Publications, New Delhi.
4. Spiegel, M.R., Stephens L.J. (2014). Statistics, (5th ed) Schaum′s outlines, McGraw-Hill Education.
5. Masters, G. M & Ela, W. P (2015). Introduction to Environmental Engineering and Science (3rd ed). Pearson

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Recall key terms in pollution, health hazards, and toxicology principles.

CO2: Explain disease mechanisms, toxicant behavior, and detoxification pathways.

CO3: Apply epidemiological and toxicological concepts to assess health risks.

CO4: Analyze pollutant impacts, physiological effects, and assay-based evaluations.

CO5: Evaluate health strategies, WHO efforts, and testing tools for disease and toxicity control.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	RESOURCE CONSERVATION AND MANAGEMENT	Course Code	U25EVS212T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers conservation principles and sustainable management of natural, biological, and energy resources. It includes restoration efforts, biodiversity protection, and the use of remote sensing and GIS in environmental monitoring

Unit 1: Conservation: Principles of resource conservation, World conservation Strategy, IUCN, International Geosphere-Biosphere Programme. Conservation and management of natural resources- humans and conservation vice-versa, conservation and protection, sustainable use of natural resources. Natural resource management approaches: Community based natural resource management (CBNRM) and Integrated natural resource management (INRM).

Unit 2: Biological Resource Management: Management of forests, effects of deforestation, desertification, rangeland management, management of wetlands and freshwater ecosystems, wildlife management, conservation efforts for threatened species in India, CITES. Biodiversity Management Plan & Biodiversity Risk Assessment. National Afforestation Programme & Green India Mission

Unit 3: Physical Resource Management: Water management; management of watersheds, Recovery of eutrophicated lakes, rehabilitation of polluted rivers-Ganga Action Plan, Yamuna Action Plan; Rainwater harvesting; Soil conservation; wasteland problems, reclamation & management of wastelands with special reference to India. Namami Gange Programme, National River Conservation Plan (NRCP), National Coastal Management Program

Unit 4: Energy Management: Energy conservation: Challenges and Opportunities, Bioenergy-Prospects in India. Energy use pattern in various parts of the world and its impact on the environment.
Applications of Remote Sensing: Principles of remote sensing, Applications of remote sensing and GIS in resource mapping and modelling, environmental monitoring, disaster assessment, natural resource management, forestry and ecology, environmental management.

Suggested readings:

1. Conservation Ecology –G.W.Cox,
2. Restoration of degraded lands (Ed.) –J.S. Singh
3. Natural Resource Conservation-Owen &Chiras
4. Biotechnological Environmental Management – Biotol series
5. Introduction to Environmental Remote Sensing – Curtis

Course Outcomes (CO): After completion of course, students will be able to:
CO1: State importance of water resources and watershed management as well as various river action plans.
CO2: Understand various kinds of natural resources and their types.
CO3: Apply efforts for resource conservation strategies at national and international level.
CO4: Analyse energy conservation strategies, opportunities and challenges.
CO5: Evaluate the concept of remote sensing and GIS and its environmental applications.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ECOTOXICOLOGY AND BIOREMEDIATION LAB	Course Code:	U25EVS204P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVE: To develop practical skills in assessing soil and water toxicity and bioremediation potential, and to gain hands-on experience with microbial techniques, instrumentation, and pollutant analysis relevant to ecotoxicology

List of experiments:

1. Introduction to bioremediation and its types.
2. Introduction to basic principles of instruments used during experimentation procedures of bioremediation.
3. EC of soil sample.
4. pH of soil sample.
5. Particulate material
6. Available calcium and magnesium in given sample.
7. Heavy metal concentration in soil sample using AAS.
8. Potassium and Sodium estimation by flame photometry
9. Calorific value of given sample
10. Total Organic Carbon in soil sample.
11. BOD of given sample.
12. Experiment to perform oil spill bioremediation.
13. Available phosphorus in soil sample.
14. CEC of given soil sample.
15. Turbidity of water sample using nephelometer.
16. Culture media preparation– Semi-synthetic and Synthetic media. Liquid, Solid and semisolid media, Nutrient agar, PDA media.
17. Gram-staining techniques for the detection of gram-positive and gram-negative bacteria
18. Study of fungi (medium – Rose Bengal agar).
19. Bacteriology of drinking water and domestic sewage -MPN techniques for total *coliform*, Faecal *coliform* and Faecal *Streptococci* (FS).
20. To use dilution and plating of broth cultures of a bacterium to introduce students to cultural methodologies and concepts of bacterial growth.
21. Examination of Soil Microorganisms via Microscopic and Cultural Assay.

COURSE OUTCOMES: After completion of course, students will be able to:
CO1. Describe about bioremediation and basic principles of instruments used during experimentation.
CO2. Understand various properties of environmental samples.
CO3. Demonstrate the preparation of culture media for microbial growth.
CO4. Analyze the microbial quality of water samples.

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL MICROBIOLOGY LAB	Course Code	U25EVS205P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVE: To provide hands-on training in microbial staining, culturing, isolation, and biochemical characterization, enabling students to understand microbial diversity and their environmental applications

List of experiments:

1. Introduction to the microscope
2. Comparison of sizes and shapes of microorganisms.
3. Protozoans, fungi, and animal parasites
4. Cell count by hemocytometer
5. Simple staining of micro organism
6. Gram staining of microorganisms
7. Aseptic techniques
8. Preparation of culture media for growth of microorganisms
9. Isolation of microorganisms from different sources
10. Transfer of microorganisms
11. Control of microorganisms by using physical agents
12. Control of microorganisms by using antimicrobial chemotherapy
13. Isolation of pure cultures from a mixed population
14. Enumeration of microorganisms: plate count method
15. Bacteriological examination of water for its potability
16. Starch hydrolysis test
17. Gelatin hydrolysis test
18. Catalase test
19. Oxidase test
20. Methyl red test

COURSE OUTCOMES: After completion of course, students will be able to:
CO1: Define the problem of water contamination by various kinds of biological agents.
CO2: Understand microbial activities and suitable culture media for the microbial growth.
CO3: Analyse various microbes present the different environmental conditions.
CO4: Evaluate the morphology, shape, size and physical appearance of different microorganisms.
CO5: Formulate the presence of bacteria, algae, fungi and protozoa in the environmental samples.

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

Semester –III

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL CHEMISTRY	Course Code	U25EVS301T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers basic chemical principles and their application to air, water, and soil systems, focusing on pollution processes and environmental quality

Unit 1: Fundamentals of Environmental Chemistry
Stoichiometry, Mole concept, Chemical kinetics, Thermodynamics: (laws, derivation and applications), enzyme catalysis, Michaelis-Menten equation, Chemical equilibrium: acid-base equilibria, solubility products, oxidation-reduction reactions)

Unit 2: Atmospheric Chemistry: Chemical composition of atmosphere-particles, ions and radicals, formation of particulate matter, Photo-chemical and chemical reactions in the atmosphere, smog, acid rain, chemistry of ozone layer depletion.

Unit 3: Soil Chemistry: Weathering of rocks, Soil profile, Inorganic and organic components of soils, Major rock forming minerals, Soil forming factors, Soil properties, Chemical and mineralogical properties of soils.

Unit 4: Water Chemistry: Water quality parameters, standards, chemistry of inland water bodies like lakes, streams, rivers estuaries and wetlands, solubility of gases in water, carbonate system, redox potential.

Suggested readings:

1. Environmental Chemistry-Mannahan
2. Fundamentals of Soil Science-Henry D. Futh
3. Text book of Limnology-G.A.Cole
4. Environmental Chemistry-Sharma & Kau

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Understand physical, chemical and biological composition of the atmosphere.

CO2: Solve the various physico-chemical reactions in the environment and describe various laws of the thermodynamics.

CO3: Analyse various parameters of water quality as well as national and international standards.

CO4: **E**valuate different gases and their solubility as well as chemistry of inland water bodies.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL AWARENESS AND LAW	Course Code	U25EVS302T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course promotes environmental awareness through media, movements, and ethics, while introducing key international treaties and national laws. It covers major environmental acts, rules, and government programs aimed at conservation and pollution control

Unit 1: Environmental awareness approaches: Role of media in environmental awareness, role of NGOs in environmental movements, Movements for tree preservation: Chipko movement, Appiko movement etc, Ecomark scheme, ESG. Principles of Guru Jambheshwar Ji Maharaj, Anthropocentrism, stewardship, biocentrism, ecocentrism, cosmocentrism, conservation ethics, traditional value system in India.

Unit 2: International environmental initiatives: The Stockholm Declaration, Earth Summit, World Summit on Sustainable Development, Rio+20, Convention on protection of environment, Ramsar convention on wetlands, Outer space treaty, Vienna convention & Montreal Protocol, Kyoto Protocol.

Unit 3: Environmental Acts: Pollution control through legislation in India with special reference to the Water Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Environmental Protection Act, 1986, Wildlife Protection Act, 1972 and their amendments.

Unit 4: Rules & Acts: Plastic Waste Management Rules, 2016; E-Waste Management Rules, 2016; Forest (Conservation) Act,1980; Biological Diversity Act, 2002; National Green Tribunal Act, 2010; Schemes and programs of Government- Swachchh Bharat Abhiyaan, Coastal Regulation Zone (CRZ), National Green Hydrogen Mission, National Clean Air Programme (NCAP)

Suggested readings:

1. Economics and Environment – Good Steie
2. Environmental Planning, Policies &Programmes in India – K.D. Saxena
3. Land – Use and Environment – S.M. Mujtava
4. Environmental Administration and Law- Paras Diwan.

Course Outcomes (CO): After completion of course, students will be able to:

CO1: State international treaties and protocols for the protection and conservation of the environment.
CO2: Understand schemes, movements and role of various organizations for environmental conservation.
CO3: Apply rules and regulations meant for the control of environmental pollution.
CO4: Examine traditional values and importance of ancient Indian tradition and culture.
CO5: Evaluate different environmental movements and their importance.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL BIOTECHNOLOGY	Course Code	U25EVS303T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course explores biotechnological tools for pollution control, waste management, and bioenergy production. It covers biodegradation, bioremediation, biosensors, and microbial applications. Students also learn molecular techniques and industrial processes relevant to environmental biotechnology.

Unit 1: Introduction: The scope of environmental biotechnology; Biodegradation of macromolecules; biodegradation of xenobiotics; Vermicomposting. Bioremediation of spilled oil and grease deposits and synthetic pesticides. Biosensors to detect environmental pollutants

Unit 2: Biotechnological Approaches: Bioenergy, ethanol fermentation, liquid waste treatment; biofilters, activated sludge systems; membrane bioreactors. Biotechnological approaches for solid waste management, microorganisms and organic pollutants; extremophiles. Microbial communication system; Quorum sensing.

Unit 3: Industrial Applications: Basic principles in bioprocess technology; Media Formulation; Sterilization; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Gene cloning and different associated steps.

Unit 4: Biotechnological Analysis: Denaturing Gradient Gel Electrophoresis (DGGE), 16S rDNA sequencing, DNA finger printing, Sequencing of nucleic acids, southern, northern, western blotting techniques, polymerase chain reaction (PCR), Hybridoma, Monoclonal Antibodies, ELISA.

Suggested readings:

1. Gene V – Levine
2. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter. Winter-VCH. 2005
3. Biology of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
4. An Introduction to Environmental Biotechnology by Milton Wain Wright.
5. KluwarAcadPubl.Group, Springer, 1999.
6. Environmental Biotechnology – Sayler & Fox
7. Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001- S.B.Primrose, R.M. Twyman and R.W.Old

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Understand different biotechnological approaches and their role.

CO2: Solve the problem of environmental contamination by making use of the biological techniques.

CO3: Analyse biofuels and their production methods and various methods to produce bioenergy.

CO4: Evaluate biomolecules, their production and importance of biotechnology for the environmental conservation.

CO5: Formulate metabolites, enzymes and role of monoclonal antibodies and bioassays.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	AGRICULTURE AND ENVIRONMENT	Course Code	U25EVS311T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers sustainable farming practices, pest and crop management, and the environmental impacts of agriculture, including fertilizers, pesticides, and climate change

Unit 1: Agricultural Practices: Sustainable agriculture, organic farming, dry-land farming, zero tillage, agro-forestry, social forestry, Joint forest Management (JFM), water logging and secondary salinization, environmental impacts of irrigation projects.

Unit 2: Crop Protection: Pesticides: Classification, pesticide resistance; biological & ecological pest control, Integrated Pest management, Implication of Pesticides, Pest resurgence, Pesticide safety.

Unit 3: Crop Production: Bio-fertilizers, vermicomposting, allelopathy, Biosafety issues in agriculture, Biotechnological innovations in crop protection. GM crops & their impacts on environment.

Unit 4: Weather & crop productivity: Impact of global warming on agriculture and food security; Green-Revolution- environmental implications, NPK fertilizers and their environmental impacts, Soil productivity, Soil Microbes & crop residue management.

Suggested readings:

1. Sustainable Agriculture – H.R. Sharma
2. Global Climate Change – Pary Martin
3. Allelopathy – S.S. Narwal
4. Environmental Chemistry – Mannahan
5. Soils – Miller and Donhau
6. Environment and Agriculture – Dhaliwal, Jairath and Hansra

Course Outcomes (CO): After completion of course, students will be able to:

CO1: State various advanced agricultural practices for sustainability.

CO2: Understand role of pesticides, their environmental impacts and biological pest control methods.

CO3: Apply plant based allelochemicals and their role as well as soil microbes' interactions and mechanisms.

CO4: Evaluate the problem of soil fertility, microbes-based fertilizers and their importance.

CO5: Formulate the role of chemical fertilizers in improving soil fertility, their environmental impacts and describe the role of excess salts in soil infertility.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	NATURAL DISASTERS AND MANAGEMENT	Course Code	U25EVS312T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers the causes and impacts of natural and manmade disasters, including droughts, floods, earthquakes, and tsunamis. It focuses on disaster management strategies, preparedness, response, and rehabilitation, highlighting the roles of government, NGOs, and remote sensing

Unit 1: Earth's Processes: Natural and manmade disasters, Effects of hazards, Earths processes; El Nino and their effects. Factors leading to drought, drought consequences, strategies for drought mitigation, Desertification – Factors causing desertification.

Unit 2: Geological Hazards: Catastrophic geological hazards; Study of floods, landslides, earthquakes, volcanism; Tsunami, ice sheets and fluctuations of sea levels, marine pollution by toxic wastes; Prediction and perception of the hazards and adjustments to hazardous activities.

Unit 3: Disaster Management: Disaster management Continuum, Disaster Prevention, preparedness, response and recovery; National and International efforts for disaster management; Role of governmental organization and NGO in disaster management. Role of mass media and society in disaster management; role of remote sensing in disaster management.

Unit 4: Rehabilitation, Reconstruction and Recovery: Reconstruction and rehabilitation as a means of development; Damage assessment; Development of physical and economic infrastructure; Information management structure; Long term recovery and counter disaster Planning, Impact of hazards on human and environment, Disaster risk & resilience, CDRI

Suggested readings:

1. D. Alexander Natural Disaster, UCL, 1993
2. E. Bryant, Natural Hazard, Cambridge University Press, 1985
3. D. Chapman Natural Hazards, OUP, 1999
4. F.G. Bell Environmental Geology - Principles and Practice, Blackwell Science, 1998
5. Introduction to Environmental Engineering and science (Third edition): Masters & Ela (PHI)
6. K. Beven and D. Carling Flood: Hydrological, Sedimentological and Geomorphologic Implications, John Wiley and Sons, 1989

Course Outcomes (CO): After completion of course, students will be able to:
CO1: State various Earth Processes and their role in various cycles.
CO2: Understand different catastrophic events in relation to the environment.
CO3: Illustrate various hazards and disasters and their environmental implications.
CO4: Analyse different disasters, related issues and management of natural as well as manmade disasters.
CO5: Evaluate various disasters and role of mass media and NGO in disaster control as well as relief.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL CHEMISTRY LAB	Course Code	U25EVS304P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVE: To develop practical skills in analyzing water, soil, and air quality parameters using standard environmental chemistry techniques and instruments for pollution assessment

List of experiments:

1. Determination of sulphate content in the given water sample.
2. Determination of COD in the given water sample.
3. Estimation of acidity and alkalinity of given water sample.
4. Determination of hardness in the given sample of water.
5. Determination of pH/Electrical Conductivity of given water sample.
6. To evaluate the content of residual chlorine in the given water sample.
7. To determine the chloride content of given water sample.
8. To determine the nitrate and phosphate levels in water.
9. To measure Total dissolved solid and Total suspended solid in given water sample.
10. To determine the turbidity of water sample using nephelometer.
11. To determine the Dissolved Oxygen content in water sample.
12. Determination of TOC in soil sample given.
13. To determine the Carbonate content of given soil sample.
14. To Estimate the water holding capacity of soil sample.
15. To determine the oxidation reduction potential (ORP) of given soil sample.
16. To study the working and principle of spectrophotometer.
17. Estimation of Respirable Suspended Particulate Matter (RSPM) in air.

COURSE OUTCOMES (CO): After completion of course, students will be able to:
CO1: Understand quality of water and wastewater samples in relation to the environment.
CO2: Illustrate levels of various salts in in the water and wastewater samples and their environmental impacts.
CO3: Analyse the problem of water pollution and methods to treat the wastewater.
CO4: Evaluate the levels of various contaminants in the wastewater streams and water bodies.

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL BIOTECHNOLOGY LAB	Course Code	U25EVS305P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVES: To equip students with fundamental biotechnology lab skills including microbial techniques, DNA isolation, bioinformatics tools, and molecular analysis methods for environmental applications

List of experiments:

1. Introduction to basic principle of instruments used in biotechnology lab.
2. Sterilization methods
3. Bacterial Growth Curve
4. MPN
5. Introduction to NCBI.
6. Introduction to BLAST and its types.
7. Steps to download FASTA sequence using NCBI-BLAST.
8. Steps to make phylogenetic tree using Mega software.
9. Experiment to perform DNA quantification and analysis using agarose gel-electrophoresis.
10. Introduction to PCR and its protocol.
11. Protocol for operating AAS and its applications.
12. Isolation of genomic DNA from pure bacterial culture using grocery products (detergent).
13. Isolation of DNA from onion using detergent.
14. To carry out spectrophotometric analysis of genomic DNA.
15. To perform southern blotting of DNA.

COURSE OUTCOMES (CO): After completion of course, students will be able to:
CO1: Define the concept of biotechnological techniques and their environmental applications.
CO2: Understand importance of various sterilization methods in the microbiology and biotechnology.
CO3: Demonstrate different phases in the bacterial growth and growth curve.
CO4: Analyse the problem of microbial contamination and to get the pure culture and its implication using PCR technique.
CO5: Evaluate various biotechnological tools and software and their environmental applications.

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

SEMESTER-IV (Option A)

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	POLLUTION MANAGEMENT	Course Code	U25EVS401T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course focuses on the sources, effects, and control methods of water, air, soil, and noise pollution. It covers wastewater treatment processes, air pollution control technologies, and soil remediation techniques, including bioremediation and phytoremediation strategies

Unit 1: Introduction: Standards for water and air quality, waste management processes like reduction in volume, strength reduction, Neutralization, Equalization, proportions of waste. Sources of soil pollution, Effects of pollutants on human beings, plants and animals.

Unit 2: Wastewater treatment: Primary treatment methods – screening, grit removal, primary sedimentation, secondary treatment methods, activated sludge process, trickling filters, rotating biological contactors, oxidation ponds and lagoons. Advance waste water treatment- removal of nutrients and solids. Waste water reuse and sludge disposal, MINAS

Unit 3: Air Pollution control- Control methods for particulates-gravitational settling chambers, Centrifugal collectors, Wet collectors, Fabric filters, electro static precipitators. Control methods for gaseous pollutants-adsorption, absorption, condensation, combustion.
Noise Pollution- Absorbing materials, barrier materials, damping materials, acoustical enclosures, Reactive silencers and filters; Active noise control methods.

Unit 4: Soil Pollution abatement: Measures of remediation of organic chemicals, pesticides and heavy metals. Bioremediation-approaches and techniques. Land farming and phytoremediation, Fly ash problems and management.

Suggested readings:

1. Environmental Engineering – Peary
2. Introduction to Environmental Engineering and Science – Gilbert Masters
3. Air Pollution and Control – K.V.S.G. Murlikrishnan
4. Industrial Noise Control – Bell&Bell

Course Outcomes (CO): After completion of course, students will be able to:

CO1. Understand wastewater treatment methods and process, air sampling methods of gaseous and particulate air pollutants.
CO2. Describe environmental sampling and analysis with respect to noise pollution
CO3. Examine the Sources and generation of solid waste
CO4. Apply Methods of solid waste disposal
CO5. Design environmental control/management plan for environmental pollution problems.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL IMPACT ASSESSMENT AND RISK ANALYSIS	Course Code	U25EVS402T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers EIA principles, methods, and regulations, along with impact assessment, public participation, and environmental management. It also includes industry-specific impacts and basics of risk analysis

Unit 1: EIA**:** Origin, goals, principles and significance; Regulatory bodies, Concept of rapid and comprehensive EIA, Cumulative EIA, Strategic Environmental Assessment (SEA) – Principles and process; EIA notification (MOEF&CC) 1994, 2006, 2020**;** Steps of EIA; Screening and scoping; Acquisition of base line data and importance.

Unit 2: Impact Identification methods, Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided), impact prediction, models of prediction.
Impact evaluation – Cost benefit analysis, methods of monetary evaluation of environmental parameters, multi-criteria approach.
Mitigation of impacts – approaches and methods in relation to different development projects

Unit 3: Public participation in EIA**,** presentation and review process, methods and role of monitoring in EIA, Environmental auditing, Environmental Management Plan, ISO 14000, Principles of Environmental Management System.

Unit 4: Environmental Impacts of mining industry, nuclear and thermal power plant, textile industry, paper and pulp industry.
EIA of a dam (one case study), Linear development,
Risk analysis: definition; risk characterization and methods of risk assessment.

Suggested readings:

1. Environmental Impact Assessment – John Glasson
2. Methods of Environmental Impact Assessment – Morris & Therivel
3. Environmental Impact Assessment – L.W. Canter
4. Chemical Principles of Environmental Pollution – Alloway & Ayers
5. Industrial Environment – Assessment and Strategy – S.K. Aggarwal
6. Introduction to Environmental Engineering and Science – Gilbert Masters
7. Handbook of Environmental Assessment, (Vol.-I & II) – Judith Petts

Course Outcomes (CO): After completion of course, students will be able to:
CO1. Define EIA origin, goals and significance.
CO2. Understand the impact identification, prediction and cost benefit analysis.
CO3. Interpret the public participation in EIA, Environmental auditing, and environmental management plan.
CO4. Evaluate the environmental impacts of various industries like mining, nuclear and thermal power plants, and textile industry.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL STRESS PHYSIOLOGY	Course Code	U25EVS411T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers physiological responses of plants and animals to environmental stresses like heat, drought, salinity, pollutants, and altitude, along with their adaptation and tolerance mechanisms

Unit 1: Plant responses to physical environment: Concept of stress and strain, Plant responses to UV radiations, high temperature and low temperature stress, water stress responses and adaptations to drought and flooding, desiccation tolerance.

Unit 2: Plant responses to chemical environment: Responses of halophytes and non-halophytes to salt stress, ionic regulation and osmo-regulation, salt tolerance, metal toxicity and metal tolerance, plant responses to air pollutants like SOx, NOx and ozone.

Unit 3: Photosynthetic responses: Plant responses to enriched CO_2 environment, ecological significance of different CO_2 fixation pathways, modelling photosynthetic responses to environment, Circadian rhythms and biological clock.

Unit 4: Animal response to environmental stress: Osmoregulation in fish, water conservation in desert animals; hibernation and aestivation, animal responses to high altitude and deep-sea environment.

Suggested readings:

1. Physiological Plant Ecology- Encyclopedia (Vol.I-IV) Springer Verlag
2. Plant Physiology- Salisbury & Ross
3. Plant Ecophysiology – Prasad
4. Adaptive Animal Physiology – Nelson Schmidt.

Course Outcomes (CO): After completion of course, students will be able to:

CO1. Define the mechanism of stress and strain in plants and responses of plants during adverse environmental conditions.

CO2. Explain the mechanism of plant responses to various chemical environments.

CO3. Demonstrate the various photosynthetic responses of plants like responses of plants to carbon enrichment circadian rhythms and biological clocks.

CO4. Differentiate the animals' response to environmental stresses and different adaptations in the animals.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	REMOTE SENSING, GIS AND ENVIRONMENT STATISTICS	Course Code	U25EVS412T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course introduces the principles and applications of remote sensing, GIS, and environmental statistics. It covers satellite data interpretation, image processing, and their use in environmental monitoring and resource management. Basic statistical tools for environmental data analysis are also included

Unit 1: General Introduction to Remote Sensing: Definition ,concepts and scope of remote sensing; History of remote sensing; Electromagnetic radiations(EMR)and electromagnetic spectrum and atmosphere window; Platforms, sensors and types of scanning systems; Basic characteristics of sensors: salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites; Earth′s and atmospheric interaction with EMR; Spectral reflectance of vegetation, soil and water.

Unit 2: Applications of Remote sensing: Application of remote sensing in EIA, groundwater, Mining, Forest Management, Characterization & monitoring of biodiversity, mapping of Wetlands

Unit 3: Geographic Information System (GIS): Introduction and basic principle and scope of GIS; Brief outline of Digital Image Processing. Satellite image – characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system. Principals involved in thermal IR image and microwave image interpretation. Applications of different types of images in earth Sciences, Environmental Sciences, Marine studies, Forestry, Soils, Hazard management etc. GPS applications- Impact Assessment, Pollution Monitoring, Land Degradation- Desertification, Industry – Mining, Ground Water Modelling – Damage Assessment – Coastal and Marine applications – Global Change-Case studies.

Unit 4: Environmental Statistics: Measurement of central tendency- mean, mode and median;
Dispersion-standard deviation, standard error, mean deviation and coefficient of variation; Simple and multiple correlation and regression coefficient; Basic laws and concept of probability; Test of hypothesis and significance; t, F, chi square tests; ANOVA.

Suggested readings:

1. Remote Sensing Techniques for Environmental Analysis, Estes J. E., and Senger, L.W. (1973), John Wiley and Sons New York.
2. Remote Sensing and GIS for Environmental Planning, Murali krishna, I.V (1995). Tata- McGraw Hill.
3. Environmental Monitoring: Applications of Remote Sensing and GIS, Singh, R.B (1992), Geocarto International Centre, Honk Hong.
4. Digital Image Processing, William K Pratt (2001), John Wiley & Sons.
5. Geographic Information Systems for Geoscientists, Volume 13: Modelling with GIS (Computer Methods in the Geosciences) Paperback – January 25, 1995 by G.F. Bonham Carter.
6. Principles of Geographic Information Systems: An introductory textbook Otto Huisman and Rolf A. de by (2009).

Course Outcomes (CO): After completion of the course, the students will be able to:

CO1: Building the foundation for understanding Remote Sensing and Geographic Information System (RS-GIS) as a powerful tool for geo spatial analysis
CO2: Learn about data and sources (RS based and other sources, field data) and GIS software
CO3: Develop capability to handle at least one GIS software with understanding
CO4: Ability to demonstrate sound understanding on descriptive and analytical statistics.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	SOLID WASTE MANAGEMENT	Course Code	U25EVS413T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course covers types, sources, and handling of solid and hazardous wastes, along with treatment, disposal, and resource recovery methods. It also includes relevant waste management rules and planning for sustainable waste handling

Unit 1: Introduction: Types, sources and characteristics of solid waste. Solid waste generation, handling and storage. Collection of solid waste- Collection services, types of collection system and their analysis, transfer and transport. Solid waste management. An overview, reduction, reuse and recovery.

Unit 2: Treatment and disposal of solid waste: component separation, incineration, pyrolysis, landfilling, deep well injection etc. biogas plant, fly ash utilization. Solid waste management plan, waste treatment and disposal.

Unit 3: Hazardous waste management: definition and classification of Hazardous waste, characteristics and Transportation of Hazardous Waste, treatment, storage and disposal, Physico-chemical properties of hazardous waste needed in management, Hazardous waste control, treatment and management, E-Waste, Biomedical Waste

Unit 4: Rules: Municipal Solid Waste (Management and Handling) Rules, 2000, Fly ash management, Fly ash Management Rules, (1999), Biomedical Waste (Management and Handling) Rules, 1988, Hazardous Waste (Management and Handling) Rules (1989) and (2000) Amendments, (Radioactive waste, E- Waste, Biomedical waste).

Suggested readings:

1. Solid Waste Management Manual CPCB, New Delhi
2. Ecotechnology for Pollution Control and Environmental Management by Trivedy R.K. and Arvind Kumar
3. Basic Environmental Technology Nathanson, J.A.

Course Outcomes (CO): After completion of course, students will be able to:
CO1. Define the various sources of solid wastes.
CO2. Describe the solid waste, hospital waste and biomedical waste management and handling rules.
CO3. Demonstrate the fly ash management rules sources, classification and hazard communication.
CO4. Evaluate the hazardous waste management, its control and treatment.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	INDUSTRIAL POLLUTION MANAGEMENT LAB	Course Code:	U25EVS403P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVES: To determine and equip the students with industrial pollution management – TOC, toxic heavy metals, carbonate content in soil, aluminium sulphate & ferric sulphate as a coagulant, etc.

List of experiments:

1. To determine TOC in the given soil sample.
2. Analysis of toxic heavy metals in soil and water sample.
3. To prepare standard curve using spectrophotometer
4. To study dye removal using adsorbent.
5. To study SPM in ambient air using high volume air sampler.
6. To estimate carbonate content in the given soil sample.
7. To study the effect of heavy metals on seed germination
8. To determine the effectiveness of aluminium sulphate as a coagulant for a given sample at room temperature.
9. To determine the minimum dose of coagulant required to coagulate a given sample & to compare the effectiveness of aluminium sulphate& ferric sulphate as a coagulant for a given sample.
10. To determine free CO_2 in given water sample.
11. To determine chloride content in given sample by argentometric method.
12. Case study / Industrial visit / Visit to wastewater treatment plant.

COURSE OUTCOMES (CO): After completion of course, students will be able to:
CO1: Define Air, Water and Soil quality.
CO2: Understand the use of various instrumentation techniques for the analysis of air, water and soil samples.
CO3: Analyse various pollutants their impacts and possible remedial measures.
CO4: Evaluate effects of toxic heavy metals on various components of the environment.

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	SOLID WASTE MANAGEMENT LAB	Course Code	U25EVS404P
Hours per Week	6	Credits	3
External Marks Internal Marks	50 25	Time of Examinations	4 hrs

COURSE OBJECTIVE: To impart practical knowledge of solid waste characterization, treatment techniques like composting and biogas production, and evaluation of environmental impacts through field and laboratory experiments

List of experiments:

1. To determine calorific value by calculation, bomb calorimeter.
2. To determine the physical composition of solid wastes.
3. To determine NPK in compost and vermin-compost.
4. To determine C/N ratio.
5. To determine the moisture content of vegetable and fruit solid waste
6. To determine the pH of solid waste potentiometric method
7. To determine the electrical conductivity (EC) of given organic waste.
8. To prepare compost from solid waste of organic origin
9. The study the production of biogas from solid waste
10. To study TOC and ash content solid waste samples by combustion method.
11. To determine per capita waste generation in an Indian household based on family size.
12. A visit to a normal and secured landfill site, and biological composting/vermicomposting units in the city.

COURSE OUTCOMES: After completion of course, students will be able to:

CO1: Define the sources and generation of solid waste.
CO2: Describe the methods of solid waste disposal.
CO3: Apply techniques of energy and material recovery from solid waste
CO4: Demonstrate the methods of handling and management of hazardous waste
CO5: Select various rules and regulations for handling and management of hazardous waste

Note: This list of experiments is indicative only. Addition and deletion in the list of experiments may be made from time to time by the departments depending on the availability of resources.

SEMESTER-IV (Option B)

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	POLLUTION MANAGEMENT	Course Code	U25EVS401T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course focuses on pollution control methods for water, air, soil, and noise. It covers wastewater treatment, air purification technologies, soil remediation techniques, and related environmental standards for effective pollution management

Unit 1: Introduction: Standards for water and air quality, waste management processes like reduction in volume, strength reduction, Neutralization, Equalization, proportions of waste. Sources of soil pollution, Effects of pollutants on human beings, plants and animals.

Unit 2: Wastewater treatment: Primary treatment methods – screening, grit removal, primary sedimentation, secondary treatment methods, activated sludge process, trickling filters, rotating biological contactors, oxidation ponds and lagoons. Advance wastewater treatment- removal of nutrients and solids. Wastewater reuse and sludge disposal, MINAS

Unit 3: Air Pollution control- Control methods for particulates-gravitational settling chambers, Centrifugal collectors, Wet collectors, Fabric filters, electrostatic precipitators. Control methods for gaseous pollutants-adsorption, absorption, condensation, combustion.
Noise Pollution- Absorbing materials, barrier materials, damping materials, acoustical enclosures, Reactive silencers and filters; Active noise control methods.

Unit 4: Soil Pollution abatement: Measures of remediation of organic chemicals, pesticides and heavy metals. Bioremediation-approaches and techniques. Land farming and phytoremediation, Fly ash problems and management.

Suggested readings:

1. Environmental Engineering – Peary
2. Introduction to Environmental Engineering and Science – Gilbert Masters
3. Air Pollution and Control – K.V.S.G. Murlikrishnan
4. Industrial Noise Control – Bell & Bell

Course Outcomes (CO): After completion of course, students will be able to:

CO1. Understand wastewater treatment methods and process, air sampling methods of gaseous and particulate air pollutants.
CO2. Describe environmental sampling and analysis with respect to noise pollution
CO3. Examine the Sources and generation of solid waste
CO4. Apply Methods of solid waste disposal
CO5. Design environmental control/management plan for environmental pollution problems.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL IMPACT ASSESSMENT AND RISK ANALYSIS	Course Code	U25EVS402T
Hours per Week	4	Credits	4
External Marks Internal Marks	70 30	Time of Examinations	3 hrs

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Objective: This course introduces the basics of Environmental Impact Assessment (EIA), impact prediction and mitigation, and risk analysis. It covers legal frameworks, public participation, and sector-specific case studies

Unit 1: EIA: Origin, goals, principles and significance; Regulatory bodies, Concept of rapid and comprehensive EIA, Cumulative EIA, Strategic Environmental Assessment (SEA) – Principles and process; EIA notification (MOEF) 1994, 2006, 2020**;** Steps of EIA; Screening and scoping; Acquisition of base line data and importance.

Unit 2: Impact Identification methods, Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided), impact prediction, models of prediction.
Impact evaluation – Cost benefit analysis, methods of monetary evaluation of environmental parameters, multi-criteria approach.
Mitigation of impacts – approaches and methods in relation to different development projects

Unit 3: Public participation in EIA**,** presentation and review process, methods and role of monitoring in EIA, Environmental auditing, Environmental Management Plan, ISO 14000, Principles of Environmental Management System.

Unit 4: Environmental Impacts of mining industry, nuclear and thermal power plant, textile industry, paper and pulp industry.
EIA of a dam (one case study), Linear development,
Risk analysis: definition; risk characterization and methods of risk assessment.

Suggested readings:

1. Environmental Impact Assessment – John Glasson
2. Methods of Environmental Impact Assessment – Morris & Therivel
3. Environmental Impact Assessment – L.W. Canter
4. Chemical Principles of Environmental Pollution – Alloway & Ayers
5. Industrial Environment – Assessment and Strategy – S.K. Aggarwal
6. Introduction to Environmental Engineering and Science – Gilbert Masters
7. Handbook of Environmental Assessment, (Vol.-I & II) – Judith Petts

Course Outcomes (CO): After completion of course, students will be able to:
CO1. Define EIA origin, goals and significance.
CO2. Understand the impact identification, prediction and cost benefit analysis.
CO3. Interpret the public participation in EIA, Environmental auditing, and environmental management plan.
CO4. Evaluate the environmental impacts of various industries like mining, nuclear and thermal power plants, and textile industry.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ECOTECHNOLOGY	Course Code	U25EVS414T
Hours per Week	2	Credits	2
External Marks Internal Marks	35 15	Time of Examinations	2 hrs

Note:
The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus having 3 marks each. In addition to this, four more questions (each question may be of 2-3 parts) will be set consisting of two questions from each unit. The student/candidate is required to attempt three questions in all selecting one question from each unit consisting of 10 marks each including compulsory Question No. 1.

Course Objective: This course focuses on eco-design and sustainable development through natural processes. It covers ecosystem-based approaches, wetland treatment systems, bioremediation (in-situ and ex-situ), and phytoremediation for environmental clean-up

Unit 1: Basic concepts of ecosystem dynamics, eco-designing, ecotechnological approaches, applications of ecotechnology for societal welfare and sustainable development.

Unit 2: Wetland ecosystems-ecological significance, natural purifying potential, constructed wetlands-their design, structure, functioning and applications. Decontamination of polluted sites, In-situ and ex-situ bioremediation techniques, phytoremediation technology: - Phyto stabilisation, phytovolatilization, rhizofiltration and phytoextraction, types of bioremediation, bioremediation of waste waters.

Suggested readings:

1. Mitsch, W.J. and Jorgensen, S.E. 1989. Ecological Engineering: An Introduction to Ecotechnology John Wiley & Sons, New York.
2. Kadlec, R.H., Knight, R.L. 1986. Treatment Wetlands Lewis Publishers, Boca Raton, FL.

Course Outcomes (CO): After completion of course, students will be able to:

CO1. Describe the basic concepts of ecosystems and ecotechnological approaches.

CO2. Understand the wet land ecosystem its significance, importance and applications.

CO3. Apply the reclamation of pollutes sites using phytoremediation approach and treatment of wastewater by bioremediation.

CO4. Formulate the restoration of degraded ecosystems using ecological approaches.

Name of Program	M.Sc. EVS	Program Code	--
Name of the Course	ENVIRONMENTAL NANOTECHNOLOGY	Course Code	U25EVS415T
Hours per Week	2	Credits	2
External Marks Internal Marks	35 15	Time of Examinations	2 hrs

Note:
The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus having 3 marks each. In addition to this, four more questions (each question may be of 2-3 parts) will be set consisting of two questions from each unit. The student/candidate is required to attempt three questions in all selecting one question from each unit consisting of 10 marks each including compulsory Question No. 1.

Course Objective: This course introduces about the fundamentals of nanotechnology and its synthesis, characterization, and properties. It also explores the application of nanomaterials in environmental remediation, pollution control, and sustainable energy solutions

UNIT-1: Synthesis & Characterization of Nanomaterials: Nanotechnology: its introduction, history and synthesis approach; Physical and chemical method of synthesis for carbon nanomaterials, Metal nanoparticles and Metal oxide and Chalcogenide, polymer nanoparticles. Biologically Synthesized Green synthesis process; Protein-Based Nanostructure Formation; DNA-Templated Nanostructure Formation; Protein Assembly - Biologically Inspired Nanocomposites;

Characterization: Advanced Characterization methods and techniques for nanomaterials; Physico-chemical properties, Carbon nanotubes: electrical properties, vibrational properties, mechanical properties and applications of carbon nanotubes. Semiconductor nanostructures Quantum dots – electronic properties, optical behavior and quantum confinement

UNIT-2: Application of Nanomaterials in Environment: Nanomaterial in Environment: Identification and characterization of hazardous waste, Natural Nano pollution in Air, Water and Soil.
Application in environmental Remediation: Nanotechnology for water remediation and purification: Nano-adsorbents; Photo-Fenton process, Nano-photocatalyst for pollutants degradation, Nano-filters for organics & inorganics and pathogens, Nanomembranes in Drinking water treatment and Sea desalination. Nanomaterials in air remediation, Nanomaterials for soil remediation, Agriculture and Food Industry
Application of Nanomaterial in energy production: fuel Cell, Solar cell hydrogen storage.

Suggested readings:

1. Balaji S., (2010). Nanobiotechnology, MJP Publishers, Chennai.
2. Poole, C. P. Jr. and Owens F. J. (2009). Introduction to nanotechnology, Wiley India, New Delhi.
3. Mark Wiesner, Jean-Yves Bottero (2007) Environmental Nanotechnology: Applications and Impacts of Nanomaterials: Applications and Impacts of Nanomaterials, McGraw Hill Professional
4. Dasgupta, N. (2020). Environmental Nanotechnology Volume 4. S. Ranjan, & E. Lichtfouse (Eds.). Springer International Publishing.
5. Wiesner, M. R., & Bottero, J. Y. (2017). Environmental nanotechnology: applications and impacts of nanomaterials. McGraw-Hill Education.
6. Fulekar, M. H., & Pathak, B. (2017). Environmental nanotechnology. CRC Press.
7. Hu, A., & Apblett, A. (Eds.). (2014). Nanotechnology for water treatment and purification.
8. Switzerland: Springer International Publishing.

Suggested Web Sources:

1. https://swayam.gov.in/
2. https://nptel.ac.in/courses/

Course Outcomes (CO): After completion of course, students will be able to:

CO1: Develop and synthesize various nanomaterials by different synthesis methods.
CO2: Identify and evaluate the characteristics and properties of synthesized nanomaterials.
CO3: Create understanding about the application of nanomaterials in environment remediation.
CO4: Acquire knowledge about toxicology due to nanomaterials.