DR. HOMI BHABHA STATE UNIVERSITY

HBSU

THE INSTITUTE OF SCIENCE, MUMBAI

DEPARTMENT OF ENVIRONMENTAL SCIENCE

SYLLABUS FOR THE COURSE OF
M. SC ENVIRONMENTAL SCIENCE

CREDIT BASED SEMESTER GRADING SYSTEM
W.E.F THE ACADEMIC YEAR 2023-24

Course structure with Course name & Course code

Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT/FF	Cum. Cr/Sem	Degree/Cu m. Cr.
		Mandatory	Elective							
6	I	DSC1 -1 Ecology & Biodiversity MSEVDC101T, + MSEVLB101P (4+2)	DSE1 -1 Environmental Pollution MSEVDE101T + MSEVLB103P (4+2)	RM Research Methodology MSEVRM101T (4)	--	--	--	--	**22**	**44 PG Diploma in Discipline**
		DSC1 -2 Environment & Natural Resources MSEVDC102T + MSEVLB102P (4+2)								
	II	DSC1 -3 Environmental Monitoring & Assessment MSEVDC201T + MSEVLB201P (4+2)	DSE1 -2 Green Chemistry & Instrumentation MSEVDE201T + MSEVLB203P (4+2)		--	--		OJT/FP On job training/ Field Project MSEVOJ201T (4)	**22**	
		DSC1 -4 Pollution Control Technologies & Environmental Laws MSEVDC202T +								

		MSEVLB202P (4+2)								
	Cum Cr.	**24**	**12**	**4**				**4**	**44**	
Exit Option: Award of PG Diploma in Discipline with 44 credits OR Continue with Discipline.										
6.5	**III**	DSC1 -5 Biostatistics (4+2)	DSE1 -3 Industrial Hygiene & Chemical Safety (4+2)					RP Review Paper (4)	**22**	**88 PG Degree in Discipline**
		DSC1 -6 Environmental Toxicology (4+2)								
	IV	DSC1 -7 Ecotechnology & Climate Change Mitigation (4+2)	DSE1 -4 Environmental Management & Modelling (4+2)					RP Research Project (4)	**22**	
		DSC1 -8 Sustainable Development (4)								
	Cum Cr.	**46**	**24**	**4**				**14**	**88**	
Two-year PG Degree in Discipline with 88 Credits.										

Abbreviations:

Generic/ Open Electives: OE; Vocational Skill and Skill Enhancement Courses: VSEC;Vocational Skill Courses: VSC; Skill Enhancement Courses: SEC; Ability Enhancement Courses: AEC; Indian Knowledge System: IKS; Value Education Courses: VEC; OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; Co-curricular Courses: CC; Community Engagement & Service: CEP; RM: Research Methodology; Research Project: RP ** OJT/FP: Student has to earned the requisite 04 credits of on-the-job training (OJT) / Field Project (FP) during summer break, after completion of the second semester of the first year in the respective Major Subject.

Semester – I

Paper 1

	Course Code: **MSEVDC101T**	**Course Title:** **Ecology and Biodiversity**	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I: Concept of Ecology and Ecosystem** ● Definition and scope of ecology ● Concept of ecosystem ● Biotic and Abiotic components ● Aquatic ecosystem: ● Freshwater, marine, estuarine, littoral zones – zonation, fauna, distribution and adaptation ● Mangroves: Definition, functions, importance and distribution in India Exclusive Economic Zone (EEZ) ● Terrestrial ecosystem: Biomes, Forests – types in India, Grasslands, Deserts, Biosphere: ● Geographical classification and zones of India		**15 Hrs**
2	**UNIT II: Dynamics of Ecosystem** ● Food chain, food web, ecological pyramid ● Edge Effect, ecotone, niche, limiting factors, Liebig's law of minimum and Shelford's law of tolerance ● Concept and mechanism of ecological succession (primary, secondary succession, climax community) ● Population and Community Ecology Concept of population ecology, Population dynamics Characteristics of population: Natality, mortality, emigration, immigration, density, fecundity, age distribution, population explosion, J and S curve, carrying capacity ● Interspecific and intraspecific competition:		**15 Hrs**

	Predation, parasitism, antibiosis, commensalism, mutualism, predator and prey relationship ● Bioaccumulation and biomagnification ● Biogeochemical cycles: Carbon, oxygen, nitrogen, sulphur, phosphorous, water	
3	**UNIT III: Concept of Biodiversity** ● Definition, types (genetic, species, ecosystem diversity) Keystone species, Flagship species, Indicator species, Endemic species, Umbrella species ● Ecological and economical value of biodiversity ● Biodiversity hotspots ● Threats to Biodiversity: Habitat destruction, Invasive species Ballast water, Pollution, Population, Overexploitation, Illegal activities ● Climate and its threats to biodiversity - Introduction to climate, Difference between climate and weather, Climates of India, Indian Monsoon, Weather forecasting, Drought, Floods, Tropical cyclones, Western disturbances, El Nino, La Nina, Global warming and ozone depletion, Geo-economic significance of climate, Heat balance of the earth and threats to bidiversity	**15 Hrs**
4	**UNIT IV: Biodiversity Conservation** ● In situ conservation: Protected areas, Biosphere reserves, National parks, Wildlife sanctuaries, Wildlife corridor management ● Ex situ conservation: Zoos, aquariums, botanical gardens, herbariums, gene bank (DNA bank, pollen bank), tissue culture ● Role and functions of organizations: WWF, CITES, TRAFFIC, IUCN and Red List, Project Tiger, Project Elephant ● Fundamental Duties for Environment Protection, Forest and Biodiversity laws: The Indian Forest Act, 1927 and Forest (Conservation) Amendment Rules, 2016, The Wildlife (Protection) Act, 1972 and The Wildlife (Protection) Amendment Bill, 2013, The Wildlife (Protection) Amendment Bill, 2013, The Biological Diversity Act, 2002, Wetlands (Conservation and Management) Rules, 2017, Ramsar Convention on Wetlands,	**15 Hrs**

	1971, Convention on Desertification 1996, Convention on Biodiversity (CBD), Cartegena Protocol on Biosafety	
	Suggested Reading: ● Principles of Ecology – P.S. Verma, V.K. Agarwal, S. Chand and Co. Delhi. ● Principles of Environmental Science – Wart K.E.F. (1973) Mc Graw Hill Book Company. ● Basic Ecology – E. Odum ● Environmental Science – S.C. Santra ● Ecology and Environmental Science – S.V.S. Rana ● National Parks and Sanctuaries in Maharashtra – Pratibha Pandey	
	Course outcomes (Students will be able to……)	
	● Define ecological systems and its functionality along with stability concept of ecosystem ● Recognize ecological succession, concept of climax and degraded ecosystem. ● Identify the value of wildlife, its ecological importance and its scientific, commercial and ethical values. ● Examine the threats and causes of loss of wildlife, extension of wildlife species from India. ● Assess different wildlife conservation methods and importance of protected area such as national parks, biosphere reservoirs, zoo, botanical gardens and gene bank, management of wildlife corridors.	

	Course Code: MSEVLB101P	**Course Title: Ecology and Biodiversity**	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		
	Major Practical:		
1.	Determination of Important Value Index of species in a plant community		
2.	Comparison of two plant communities and study of the community by line, belt transect and profile diagram		
3.	Determination of primary productivity by light and dark method		
4.	Study of qualitative and quantitative characters of plant community by quadrate method		
	Minor Practical:		
1.	Determination of diversity indices in plant communities		
2.	Determination of chlorophyll content from plant species		
3.	Determination of biomass by harvest method		
4.	Prepare a map of India showing bio geographical zones		

Paper 2

	Course Code: MSEVDC102T	**Course Title: Environment and Natural Resources**	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I: Introduction to Natural Resources** ● Concept Types: Renewable and Non-Renewable, Conventional and Non-Conventional ● Agricultural and Soil Resources: Types of soil in India and their importance in agriculture, crop diversity across the country, agriculture in India ● Management of Soil Resources: Conservation, transformation of intensive agriculture to sustainable agriculture ● Food Resources, World Food Problem ● Wastage and degeneration of soil: modern agriculture, diversion of prime cropland to other uses, over expansion of agriculture, intensive agriculture and its lack of sustainability		**15 Hrs**
2	**UNIT II : Water and Fishery Resources** ● Water Resources: ● Global distribution of freshwater and its sources ● Freshwater resources of India and its requirements, resource base (surface, ground water) ● Causes of wastage and degeneration of fresh water ● Use of sea water as an alternative of freshwater (Desalination) ● Wastage and degeneration of water resources (Freshwater and sea water) ● Conservation of Water resources ● Rejuvenation and restoration of water bodies. ● Fishery Resource: ● Global and Indian harvest from freshwater and marine aquatic systems ● Capture fisheries: Capture fishery in freshwater, capture fishery in marine water (Coastal and deep-sea fishing) ● Coastal Regulation Zone Notification, 2011 and Amendment CRZ Notification, 2015.		**15 Hrs**

3	**UNIT III: Mineral and Energy Resources** ● Mineral Resources: ● Formation of mineral deposits/resources ● Global and National status of Mineral wealth (distribution) ● Human Consumption ● Causes and consequences of overexploitation, Conservation ● Energy Resources: ● Global and national energy consumption ● Energy resources of India, Potential in India ● Conventional Sources: Biomass, fossil fuels, hydroelectric power ● Alternative sources: Wind, Tidal, Geothermal, Solar, Hydrogen ● The Energy Conservation Act, 2001, and The Energy Conservation (Amendment) Bill, 2010 ● National Renewable Energy Act 2015	**15 Hrs**
4	**UNIT IV: Forest Resources** ● Forest wealth of India ● Deforestation ● Major Causes: Expansion of agriculture, shifting cultivation, extension of cultivation on hill slopes, cattle ranching, fire wood collection and timber extraction, Effect of urbanization ● Consequences of deforestation,	**15 Hrs**
	Suggested Reading: ● Basic concepts of soil science – A.K. Kolay, Willey Western ltd., New Delhi. ● Chemical methods for Environmental Analysis Water and sediments – R. Ramesh, M. Anbu. Macmillan India. Ltd. New Delhi. ● Participatory Natural Resource Management – S.S. Negi ● Environment forest, ecology and man – Dixit R.K. Rastogi Publication, New Delhi. ● Basic Ecology – E. Odum ● Environmental Science – S.C. Santra	

	Course outcomes (Students will be able to……) ● Examine nature and status of renewable and non-renewable energy resources, mineral resources and energy resources. ● Understand the measures to conserve the resources. ● Understanding the global and national distribution of the various natural resources. ● Awareness about various important macronutrients required for agriculture and their management	

	Course Code: MSEVLB102P	**Course Title: Environment and Natural Resources**	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		
	Major Practical:		
1.	Isolation of microorganisms by T streak and Quadrant streak method and enumeration of microorganisms from the soil by spread plate method.		
2.	Study of Soil profile for their height, colour, texture, pH and Electrical Conductivity.		
3.	Determination of SAR value of soil.		
4.	Determination of phosphorus content of soil.		
	Minor Practical:		
1.	Study of Population: Population Pyramids, J & S shaped curve		
2.	Determination of water holding capacity of soil.		
3.	Determination of potassium content of soil.		
4.	To plot different water distribution patterns of India		

Paper 3

	Course Code: MSEVDE101T	Course Title: Environmental Pollution	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I : Pollutants and Noise pollution** ● Definition of Environment, Physicochemical and biological characteristics of Environment, Structure And composition of: Hydrosphere, Lithosphere, Atmosphere ● Entry of pollutants, transfer, transport, and dilution of pollutants ● Abiotic Transformation, entry into the biosphere ● Types of Pollutants: Biodegradable and non-biodegradable ● Biodegradation of Pollutants: Agents, necessary conditions, nature of biodegradation reaction, dynamism of biodegradation reaction ● Policies in India: Majhi Vasundhara, ● Noise Pollution: Concept of sound and noise, measurement of noise, equipment used in noise measurements, noise control techniques, effects of noise, Control measures, Noise Pollution (Regulation and Control) Rules, 2000 and The Noise Pollution (Regulation and Control) (Amendment) Rules, 2010		**15 Hrs**

2	**UNIT II : Air and Radioactive Pollution** ● Air Pollutants: Types, PAN, photochemical smog, acid rain, sink of atmospheric gases, effects of air pollutants ● Interdependence of Human activities, meteorology and air pollution: wind speed and direction, atmospheric stability, temperature inversion, mixing heights, plume characteristics under lapse conditions, precipitation and humidity ● Policies in India - National Clean Air Programme (NCAP) and other initiatives ● Radioactive Pollution: Radioactive decay, units of radioactivity and radiation dose, health hazards and biological impacts, treatment and disposal, radioactive isotopes in wastewater and air pollution analysis ● Rules related to Environment Protection and Climate: ● The Environment (Protection) Rules, 1986 and Environment (Protection) Fifth Amendment Rules, 2016 ● The National Green Tribunal Act, 2010 ● National Environment Policy 2006 ● The Ozone Depleting Substances (Regulation and Control) Rules, 2000 ● The Climate Change Bill, 2012 ● Kyoto Protocol, 1997 ● International Environmental Agencies – UNEP, GEF, UNFCCC, and IPCC	**15 Hrs**
3	**UNIT III: Water, Thermal and Oil Pollution** ● Water pollution: Introduction and classification of water pollutants, Causes of water quality degradation ● Eutrophication: Concept, causes, effects ● Thermal Pollution: Definition, sources, chemical and biological effects Thermal pollution from power plants and their control, Ecological effects (warm water & cold water) ● Oil Pollution: Sources, factors affecting fate of oil after spillage, Problems associated: Light and medium fraction of crude oil, heavier fraction, greases, waxes, tar, etc., Effect on marine environment	**15 Hrs**

4	**UNIT IV: Land and Soil Pollution** ● Plant Nutrients and their functions: Major and micronutrients, Functions of Nutrients in Crop Production (Carbon, Hydrogen, Nitrogen, Phosphorous, Potassium, Copper, etc.), Fate of Elementary Nutrients in soil (Crop removal, Erosion, Leaching, Volatilization, Denitrification, and Fixation) ● Introduction and concept, causes of soil and land pollution: Acidification, salination and sodification, Agrochemical pollution, Urban and industrial pollution, Residual toxicity ● Types of synthetic fertilizers and their interaction with soil components, Industrial effluent and their interaction with soil pollution, Contamination by radioactives ● Solid waste pollution: Sources, nature, classification and environmental effects ● Battery Waste (Management and Handling) Rules, 2001, Battery Waste (Management and Handling) (Amendments) Rules, 2020	**15 Hrs**
	Suggested Reading: ● Textbook of environmental chemistry and pollution control – S.S. Dara ● Environment: Problems and Solution – Asthana and asthana ● Environmental Chemistry- G.S. Sodhi. ● Environmental pollution analysis – S.M. Khopkar ● Environmental Chemistry – A.K. De	
	Course outcomes (Students will be able to……)	
	● Basic knowledge about sources and effects of different types of pollution. ● Understanding of different methods to estimate the level of pollutants ● Awareness about impacts of pollution on the environment. ● Understanding the different strategies used to control pollution.	

	Course Code: MSEVLB103P	**Course Title: Environmental Pollution**	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		
	Major Practical:		
1.	Study of Heavy metal toxicity: Bioassay kirby-bauer method		
2.	Determination of physical parameters of water sample.		
3.	Determination of Dissolved Oxygen of water sample by Winkler's method. Demonstration of BOD		
4.	Determination of Chemical Oxygen Demand of water sample.		
	Minor Practical:		
1.	Determination of total solids from the given water sample.		
2.	Determination of total hardness of a water sample.		
3.	Preparation of station-based wind rose.		
4.	Determination of relative humidity using whirling psychrometer.		

Paper 4

	Course Code: MSEVRM101T	Course Title: Research Methodology	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I : Introduction to Research** ● Definition of research, Objectives of research, Research approaches, Significance of research, Research and scientific methods, Innovation and research, Research process, Criteria of good research		**15 Hrs**
2	**UNIT II : Research Design** ● Defining the research ● problem, Technique involved in defining a problem, Research design, Important components and concepts related to research design, Developing a perspective research plan		**15 Hrs**
3	**UNIT III: Academic Writing** ● Definition of academic writing ● Types of academic writing ● Planning your writing ● Structuring written work ● Checking grammar, spelling and vocabulary, Editing and Proofreading.		**15 Hrs**
4	**UNIT IV: Research Paper Writing** ● Types of research papers and journal articles ● Preparing manuscript for publication in a journal ● Steps in organizing the manuscript ● Tips for doing the literature review ● Advanced searching tools ● Plagiarism: Types of plagiarism, Ways to avoid plagiarism ● Referencing ● Reference management software (e.g., Mendeley, Zotero) ● Journal metrics: Abstract and Citation Databases (Scopus, SCIE, etc.), Impact factor, Cite Score, Source Normalized Impact per Paper (SNIP), SCImago Journal Rank (SJR) ● Matrices for authors: Citations, h-index, i-10 index ● Open Access Resources: National Digital Library, e-PG Pathshala		**15 Hrs**

	• Technical or project report writing	
	Suggested Reading: • Research Methodology-Methods and Techniques , By Kothari C.R.(2011); New Age International Publisher, new Delhi • "Fundamentals of Research methodology and statistics" by Yogesh Kumar Singh , New Age International Publication, New Delhi. • Fundamental Of Research Methodology by Khanna. Kamini, Published Year : 2015 • Research Methodology by Garg K.K., Published Year : 2010 • Practical Guide To Research Methodology by Lalchandani S. , Lalchandani K.S., Published Year : 2013 • Hartley J. (2008). Academic Writing and Publishing – A Practical Handbook. 1st edition, Taylor and Francis Group. • Korner A. M. (2008). Guide to Publishing a Scientific Paper. 1st edition, Taylor and Francis Group. • Jenkins S. How to write a paper for a scientific journal. https://www.ugresearch.umd.edu/documents/jenkins_howtowritearticle.pdf • https://www.sydney.edu.au/students/writing/help-support.html • https://www.scribbr.com/category/academic-writing/ • https://paperpile.com/g/types-of-research-papers/https://www.springer.com/gp/authors-editors/authorandreviewertutorials/writing-a-journal-manuscript/types-of-journal-articles/10285504 • https://www.elsevier.com/connect/six-things-to-do-before-writing-your-manuscript • https://www.elsevier.com/connect/11-steps-to-structuring-a-science-paper-editors-will-take-seriously	

	Course outcomes (Students will be able to……) 1. Gaining knowledge about the different research approaches, scientific methods, criteria for good researches. 2. Identification of the problems encountered while working on research plan, trouble shooting mechanism, field and laboratory problems. 3. Acquire knowledge of data collection, presentation of data, data analysis and presentation of samples 4. Understand the basic concepts and importance of academic writing. 5. Learn about the different aspects of research papers. 6. Use the knowledge gained to write the research paper based on their dissertation work.	

Semester - II

Paper 1

	Course Code: **MSEVDC201T**	Course Title: **Environmental Monitoring and Assessment**	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I: Sampling and Analysis of Air and Water** ● **Environmental monitoring** - Introduction, Methods of assessment of environmental quality, Significance of environmental monitoring ● **Air Quality Monitoring** Introduction and objectives. Guidelines for air quality monitoring. Guidelines for deciding location of sampling stations. Design of an air quality surveillance network. Sampling of gaseous and particulate pollutants – Typical sampling setup, Methods used, Sample storage and preservation. ● **Water Quality Monitoring – Water bodies** Steps in Water Quality Monitoring. Water sampling from various sources. Sample storage and preservation. Types of samples – Grab, composite and integrated. Laboratory work and Data analysis. Quality Assurance and Quality Control ● **Treatment Plant Monitoring** Sewage treatment plant monitoring – Basic concept, sampling locations and methods of sample collection Drinking water treatment plant monitoring – Basic concept, sampling locations and methods of sample collection		**15 Hrs**
2	**UNIT II: Sampling of Soil, Solid waste and Hazardous waste** ● Soil sampling: Introduction, Materials required for soil sampling, Collection of soil samples - Points to be considered, Procedure, Analytical methods for estimation of physical properties and available nutrients, Calibration of soil test with crop response		**15 Hrs**

	correlation, Processing and storage, Soil Testing, Nutrient Indexing of soil, Soil testing for micro and secondary nutrients, Soil Fertility Evaluation Techniques (Nutrient deficiency symptoms, Biological tests, Plant analysis), Soil Testing & Balanced Fertilization ● Solid waste sampling: Stages in solid waste sampling, Sampling - Sampling procedure, Determining Waste Composition - Quartering and Coning sampling procedure, Physical characteristics of municipal waste [Density, Moisture content, Calorific value, Biochemical characteristics] ● Hazardous waste sampling: Sampling strategies and procedures, Standard procedures for sample collection - Approach, Sample type, Sampling equipment [Composite Liquid Waste Sampler (Coliwasa), Weighted Bottle, Dipper, Thief, Trier, Auger, Scoops and Shovels], Preservation and storage of samples	
3	**UNIT III: Environmental Impact Assessment (EIA)**	**15 Hrs**
	● Scope and Objectives of EIA ● Types of Environmental Impacts ● Steps involved in conducting EIA – screening, scoping, Baseline studies, impact analysis, impact mitigation, Report making, public hearing, decision making, monitoring ● Environmental Impact Assessment techniques: Ad hoc, Checklist, Overlay mapping method, Network method, simulation and modelling, matrix method ● Environmental Clearance (EC) procedure ● Consent to establish and operate.	
4	**UNIT IV: Remote Sensing and GIS**	**15 Hrs**
	● Biodiversity census techniques: Pugmark analysis, rosette pattern and strip identification, camera traps, use of radio collaring and geo tagging. ● Remote Sensing ● Definition and concept, Electromagnetic energy and remote sensing ● Active and Passive remote sensing ● Types of energy interactions in the atmosphere – absorption, transmission, scattering	

	● Energy interactions with the earth's surface: reflections (specular and diffuse) ● Sensors: Active and Passive Sensors ● Platforms: Ground based, air borne and space borne ● Resolution (Spatial, temporal and spectral) ● Aerial Photography: concept, key characteristics for image recognition and interpretation, scale as a spatial characteristic, true colour and infra red photography ● Environmental Applications of RS ● Geographical Information System (GIS): ● Principle and concept ● Map projections and coordinate system ● Vector and Raster Data Types, translation of raster data to vector ● Global Positioning System (GPS): Concept, principle and environmental applications	
	Suggested Reading: ● Guidelines for Ambient Air Quality Monitoring. CPCB, 2003. ● Guidelines for Water Quality Monitoring, CPCB, 2007. ● Municipal Solid Waste Management Manual, Part II. CPHEEO, Ministry of Urban Development, Government of India, 2016. ● Toolkit for Solid Waste Management. Ministry of Urban Development, Government of India, 2012. ● Manual on Sampling, Analysis and Characterization of Hazardous Wastes. CPCB, 2013. ● Remote Sensing – Principles and Applications by Dr. B.C. Panda ● MoEF Guidelines for Environmental Impact Assessment and Clearance ● Otto Huisman and Rolf A. De, Principles of Geographic Information Systems, The International Institute for Geo Information Science and Earth Observation (ITC) 2001. ● Sawyer C., McCarty P., Parkin G., Chemistry for Environmental Engineering and Science, McGraw Hill Education; 5th edition 2017.	
	Course outcomes (Students will be able to……)	

	1. Understand the significance of environmental monitoring 2. Gain knowledge about the different aspects of environmental monitoring 3. Understand the basics of GIS and RS working and its application in environment. 4. Gain knowledge about the legal procedures followed for any development plan and clearance protocols.	

	Course Code: **MSEVLB201P**	Course Title: **Environmental Monitoring and Assessment**	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		
	Major Practicals:		
1.	Interpretation of the aerial photographs/ GIS imageries.		
2.	Preparation of baseline data for EIA report generation for any of the following projects (Fertilizer industry, hydropower station, road widening proposal in forest patch, wind farms, urban building development projects, mining)		
3.	Prepare a checklist and/or matrix for the given impacts predicted for any project and analyze it.		
4.	Estimation of green cover of an area/ NDVI using GIS.		
	Minor Practicals:		
1.	Estimation of Particulate Matter using High Volume Sampler (HVS).		
2.	Estimation of residual chlorine from the given drinking water sample.		
3.	Comparison and interpretation of LULC maps of any two regions or any one region of different time periods.		
4.	Estimation of Phosphate from the given waste water sample.		

Paper 2

	Course Code: **MSEVDC202T**	Course Title: **Pollution Control Technologies and Environmental Laws**	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I: Drinking Water and Domestic Wastewater treatment** ● Drinking water treatment: Introduction, General treatment scheme, Basic functions of water treatment units, Raw water source and treatment required. ● Treatment processes: Purpose, Mechanism of operation, Components and Types of – Aeration, Coagulation – Flocculation, Settling, Filtration, Disinfection (UV disinfection, Chlorination, Ozonation, Hydrogen peroxide), Softening (By chemicals, Ion Exchange). ● Domestic Wastewater treatment: Introduction, Concepts related to sewer pipes, Typical characteristics of domestic sewage. ● Sewage Treatment – Preliminary, Primary, Secondary/Biological and Advanced treatment – Need, Mode of operation, Types of - ● Preliminary Treatment: Screening, Grit Removal, Skimming Tanks. ● Primary Treatment: Sedimentation tanks. ● Secondary/Biological Treatment: Basics of biological treatment, Formation of biofilm, Types of biological treatment (Attached growth, suspended growth), Aerobic and Anaerobic processes – Attached growth processes and Suspended growth processes. ● Advanced treatment of drinking water and wastewater and sludge treatment ● Drinking water: Desalination technologies – Reverse osmosis, forward osmosis and Electrodialysis, Thermal desalination. Treatment technologies for groundwater pollutants like Arsenic, Nitrate, Fluoride, and Iron. ● Wastewater: Tertiary treatment of wastewater - Adsorption, Biological removal of phosphorus and nitrogen; Common Effluent Treatment Plant (CETP); Zero Liquid Discharge (ZLD); Basic concept, working principle, Advantages and Disadvantages of –		**15 Hrs**

	Advanced Oxidation Processes (AOPs), Ultrasonic & Sonochemistry, Electrochemical Technologies. ● Sludge treatment: Sludge characteristics and production – Classification of sludge; Main contaminants in sludge - Metals, Trace organics, Pathogens; Treatment technologies available. ● Decentralized wastewater treatment ● Definition, need and overview ● Electro-mechanical Decentralized Wastewater Treatment Technologies: Basics, Operating Principles, Advantages and Disadvantages of – Soil Biotechnology (SBT), Trans biofilter, Tiger biofilter. ● Nature-based Decentralized Wastewater Treatment Technologies: Basics, Operating Principles, Advantages and Disadvantages of – Constructed Wetland, Green bridge, Floating wetland, Nualgi.	
2	**UNIT II: Air Pollution Control Technology** ● Particulate Pollution Control: Introduction, different methods to control air pollution in the environment (natural self-cleansing properties of the environment, source correction methods, equipment modification/replacement, use of mechanical devices), mechanical devices used including instrumentation, working principle, operating conditions, types, and applications of gravity settling chambers, cyclone separators, fabric filters, electrostatic precipitators (ESP), wet collectors/scrubbers, air purification techniques in urban areas. ● Gaseous Pollution Control: ● Common processes used, their working principle, devices used, and applicability of adsorption, absorption, condensation, and combustion. ● Odour Control: Sources of odour, health impacts of odorous compounds, control strategies including prevention, control of odour dispersion, and strategies used for community protection. ● End of pipe treatment: Method of application, mode of action, advantages, and disadvantages of chemical treatment, physical methods, and biological treatment. ● Control of SO2 and NOx emissions: Various technologies used. ● Vehicular exhaust control: Types of engines, emissions and mechanism of formation of emissions, emission norms for vehicular exhausts, emission control measures for petrol and diesel vehicles including engine design parameters, engine add-ons, exhaust	**15 Hrs**

	treatment, use of alternative fuels, and the importance of good maintenance and driving habits. ● Green belt development (CPCB guidelines) ● Indoor Air Quality (IAQ) Management: Basic concepts, definition, sources and pollutants, health impacts, regulatory standards. ● IAQ monitoring protocol. ● Mitigation Strategies: Source management, administrative controls, engineering controls including mechanical filtration, electronic filtration, adsorption, ozonation, UV photolysis, photocatalytic oxidation, cold or non-thermal plasma, botanical purification, membrane separation, combined systems, and other interventions required.	
3	**UNIT III – Management of different types of solid waste and Sustainable agricultural practices** ● Solid Waste Management: Need, strategies, and benefits of waste minimization, Segregation at source, day-to-day waste management, Composting: Feedstock, pre-processing, process, technologies, Management of Construction and Demolition Waste, Disposal of Solid waste to Municipal Sanitary Landfills: Technical aspects of sanitary landfill including waste landfilled, site selection, designing of sanitary landfills, monitoring of sanitary landfills, Solid Waste Management Rules, 2016 and 2020: Salient features, Recycling and Reuse of Solid Waste: Need, technological options available, and advantages, including overview and technical aspects of processes such as Vermicomposting, Waste to energy, Biomethanation, Refuse Derived Fuel, Technologies under development: Pyrolysis, Gasification, Biomining. ● Hazardous Waste Management: Classification of Hazardous waste, Technologies available: Underground injection, Aqueous organic treatment, Incineration, Land disposal (Surface impoundments, Waste piles, Land treatment units, Hazardous Waste Landfills, Liners and Leaks), Hazardous Waste Management Rules 2016: Salient features, Basel Convention, 1989, Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.	**15 Hrs**

	• Biomedical Waste Management: Definition, sources of generation, categories under Bio-Medical Waste Management Rules, 2016 and its amendments, Options available for management of biomedical waste: Incineration, Disinfection, Wet and Dry Thermal Treatment, Microwave irradiation, Land disposal. • Electronic Waste Management: Introduction, constituents present in E-waste, Management Practices for E-Waste: Extended Producer Responsibility (EPR), Take-Back Policy, Collection Centres and Deposit Boxes, Subsidy for starting of E-waste management unit, E-waste (Management) Rules, 2016 and 2019 (Salient features) and its amendments, Techniques for Recycling and Recovery: Recycling of Plastic, Glass, Ferrous Metals and Non-ferrous Metals (Pyrometallurgy, Hydrometallurgy, Biometallurgy or Bioleaching, Electrometallurgy). • Plastic Waste Management: Categories of Plastic packaging waste, Recycling of Plastic: Challenges, innovative technologies and approaches in the area of plastic recycling, recycling process of clean mono-polymer plastic waste, Multi-polymer and Multi-material plastic waste, and management practices for Thermocol waste, Other Treatment/Disposal solutions for Multi-layered Plastics (MLP): Co-processing in cement kilns, Waste to energy plants, Pyrolysis, Plastic to road, Plastic Waste Management (PWM) Rules, 2016, 2018, and amendments.	
4	**UNIT IV – Sustainable Agricultural and Waste Management Practices** • Basic concept, principles of organic farming, • Organic fertilizers: Need, raw material options, impact of addition on soil and plant, Concept of organic certification. Biopesticides and Biofertilizers: Basic concept, need for use, • Biopesticides:	**15 Hrs**

	Microbial biopesticides: Use of Entomopathogenic Fungi or Viruses, Entomopathogenic Nematodes, Insect Pheromones and other Semiochemicals, Plant-based biopesticides: Biochemical Pesticides, Plant-Incorporated Protectants (PIPs), Genetically modified plants, biopesticide formulations. ● Biofertilizers: Types of biofertilizers (Solid and Liquid), mechanism of Nitrogen Fixation (Symbiotic and Non-symbiotic), BGA inoculants, Phosphate Solubilizing Microorganisms (PSM), Mycorrhizal biofertilizers, ● Nanofertilizers: Basic concept and various aspects. ● Hydroponics and Aquaponics system: Principles of aquaponics, Key elements and considerations. ● Bioremediation and Phytoremediation: Basic concept, approaches, and technical considerations, Case studies of bioremediation and phytoremediation	
	Suggested readings	
	1. H. E. Peavy, D. R. Rowe, G. Tchobanoglous. Environmental Engineering. McGraw-Hill International Edition. 2. S. J. Arceivala and S. R. Asolekar. Wastewater Treatment for Pollution Control and Reuse. 3rd Edition, 2008. Tata McGraw-Hill Publishing Company Limited, New Delhi. 3. C. S. Rao. Environmental Pollution Control Engineering. Revised 2nd Edition, 2006. New Age International [P] Limited, Publishers, New Delhi. 4. L. Theodore. Air Pollution Control Equipment Calculations. 2008. John Wiley Sons, Inc., New Jersey. 5. Municipal Solid Waste Management Manual, Part II. CPHEEO, Ministry of Urban Development, Government of India, 2016. 6. Risks of Hazardous Wastes (2011). Chapter 12 - Current Practices in Hazardous Waste Treatment and Disposal, Elsevier Inc. 7. Bhat, R.A., Hakeem, K.R., Dervash, M.A. [Editors]. (2020). Bioremediation and Biotechnology, Vol 2 - Degradation of Pesticides and Heavy Metals. Springer Nature, Switzerland. 8. Singh, A., Ward, O.P. (2004). Applied Bioremediation and Phytoremediation. Springer, USA.	
	Course outcomes (Students will be able to……)	

	1. Learn about the latest technologies involved in treating drinking water and wastewater. 2. Learn about the advances in air pollution control technologies. 3. Understand the national and international legal framework for environmental protection.	

	Course Code: **MSEVLB202P**	Course Title: **Pollution Control Technologies and Environmental Laws**	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		
	Major Practicals:		
1.	To test microbiological quality of drinking water using Most Probable Number (MPN) method. Demonstration of Membrane Filtration technique.		
2.	To estimate the salinity of given water sample by Volhard's titration method.		
3.	To determine the concentration of sulphur dioxide in ambient air by Improved West and Gaeke Method.		
4.	To determine the alkalinity of given water sample.		
5.	To neutralize the effluent sample using acid or alkali		
	Minor Practicals:		
1.	To study the effect of pH on microbial growth.		
2.	To study the effect of temperature on microbial growth.		
3.	To determine the concentration of nitrogen dioxide in ambient air by modified Jacob & Hochheiser Method.		
4.	To estimate Mixed Liquor Suspended Solids (MLSS) and Sludge Volume Index (SVI) of Activated Sludge Process.		
5.	Report on visit to Common Effluent Treatment Plant (CETP).		

Paper 3

	Course Code: **MSEVDE201T**	Course Title: **Green Chemistry & Instrumentation**	
	Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		**Reqd. hours**
1	**UNIT I: Overview, Principles and Concepts of Green Technology, Green Synthesis Methods.** ● Introduction to Green Chemistry ● Concept of Atom Economy along with sums ● 12 Principles of Green Chemistry ● Waste minimization ● Zero Waste technology ● Selection of Starting Material for green processes ● Chemicals toxic to the environment versus Green Chemicals ● Selection of Auxillary Substances: Solvents, Green Solvents, Immobilized Solvents and Ionic Liquids ● Green Chemistry and Catalysts: Heterogenous and Homogenous ● Solventless Processes ● Use of Blocking/ Protecting Groups		**15 Hrs**
2	**UNIT II: Green Nanotechnology & Green Technology Applications** ● Introduction to Nano materials ● Conventional and green Synthesis Methods for: ● Nano particles ● Carbon Nano tubes ● Fullerenes ● Quantum Dots ● Application of Nanotechnology for Environmental Pollution Control ● Use of nanomaterials for removal of different environmental contaminants from air, water (drinking water and wastewater) and soil – Basic operating principle and case studies ● Application of Nanotechnology in Agriculture and Food Industry – Working principle and case studies ● Application of Nanotechnology in Energy Sector - Working principle and case studies		**15 Hrs**

	• Green Chemistry in Industries • Fuel Cells and Electric Vehicles • Green Methods for Hydrogen Production • Energy from Alternate Sources: Bioethanol, Biodiesel, Biomass Energy • Prevention/Minimization of Hazardous Products • Corrosion Problems in Industries, Conventional Corrosion Inhibitors, Green Inhibitors	
3	**UNIT III: Basics of instrumentation techniques & Spectroscopic Techniques** • General Introduction to instrumental methods: Steps: Generation of a signal, transduction, amplification, presentation • Classification of instrumental methods. • Concepts in spectroscopy: Introduction, atomic spectroscopy and molecular spectroscopy • Properties of Electromagnetic Radiation (EMR) and Electromagnetic Spectrum • Types of Molecular Energies: Translational, Rotational, Vibrational and Electronic. • Interaction of EMR with Matter. • Theoretical principles of Atomic spectroscopy. • Visible spectrophotometry and Colorimetry: Introduction, Theory and distinction, instrumentation and applications. • Introduction, Principle, Instrumentation and Application of: • UV spectroscopy • Infrared Spectroscopy (FTIR) • X Ray Spectroscopy – XRD and XRF • Atomic Absorption Spectroscopy (AAS) • Atomic Emission Spectroscopy (AES)	**15 Hrs**
4	**UNIT IV: Chromatographic Techniques & Continuous Monitoring** • Introduction, Principle, Instrumentation and Application of: • Paper Chromatography • Thin Layer Chromatography (TLC) • Ion Exchange Chromatography • High Performance Liquid Chromatography (HPLC) • High Performance Thin Layer Chromatography (HPTLC) • Gas Chromatography (GC) and GC – MS • Introduction, Principle, Instrumentation and Application of:	**15 Hrs**

	● Flame Photometry ● Electrophoresis ● Conductometric titrations ● Potentiometric Titrations ● Thermogravimetric Analysis (TGA) ● Solvent Extraction ● Continuous monitoring techniques: ● Air: SOX, NOX, CO, Ozone and Benzene Toluene Ethylene Xylene (BTEX) and Particulate Matter (PM) ● Water: Introduction, Need, Merits, Basic requirements of an efficient online analyzer, Online and In line Analyzers ● Available technologies – Technologies available for measurement of various parameters, Flow meters ● Systems available – Assessment of technology, Issues with real time monitoring, Site selection, Quantification [including instrument calibration], Reporting, Parameters for online monitoring as per CPCB guidelines.	
	Suggested readings:	
	1. V. Kumar, An Introduction to green Chemistry, first edition (2013), Vishal Publishing Co. **2.** Hornyak, Dutt, Tibbals, Rao, Introduction to Nanoscience, First edition (2019), Crc Press 3. V. K. Ahluwalia, New Trends in Green Chemistry, 1st ed. 2004 edition (2 August 2012), Springer 4. G. R. Chatwal and S. K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition, 2010. Himalaya Publishing House Pvt. Ltd., Mumbai. 5. Guidelines for the Measurement of Ambient Air Pollutants, Volume II, Guidelines for Real Time Sampling & Analyses. CPCB, 2013. 6. Guidelines for Online Continuous Effluent Monitoring Systems [OCEMS]. CPCB, 2018	
	Course outcomes (Students will be able to……)	
	1. Gain knowledge about the alternative and greener methods of synthesis. 2. Learn about the various green technology applications used. 3. Understand the governing principles of various analytical techniques	

	4. Gain knowledge about the environmental applications of the techniques.	

	Course Code: **MSEVLB203P**	Course Title: **Green Chemistry**	
	Course Credit: **2**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**		
	Major Practicals:		
1.	Study of anti – microbial activity of plant extract prepared using green solvents.		
2.	Synthesis of Bio Ethanol & Biodiesel		
3.	Estimation of sulphate from the given water sample using UV Spectrophotometry.		
4.	To study the types of conductometric techniques and to estimate chloride by conductometric titration.		
	Minor Practicals:		
1.	To study the percent removal efficiency of a green adsorbent for dye removal.		
2.	Green Synthesis of Nanoparticles.		
3.	To separate chlorophyll, xanthophyll, caretenoids from the given plant extract using paper/ thin layer chromatography		
4.	Estimation of oil and grease content from a wastewater sample using solvent extraction technique.		

On Job training or field projects for 4 credits

Titles for Sem III & IV papers:

Sem III

1. Biostatistics
2. Environmental Toxicology
3. Industrial Hygiene & Chemical Safety
4. Review Paper

Sem IV

1. Ecotechnology & Climate Change Mitigation
2. Sustainable Development
3. Environmental Management & Modelling
4. Research Project