SYLLABUS AND SCHEME OF EXAMINATION

For

M. Sc. (PG) PROGRAMME

(As per NEP 2020 Scheme)

DEPARTMENT OF ENVIRONMENTAL SCIENCES

FACULTY OF EARTH SCIENCE

M. L. SUKHADIA UNIVERSITY

Udaipur

Session: 2023-24

CBCS COURSE STRUCTURE AS PER NEP GUIDELINES

3. Structural Framework of the Two Years Post Graduate Programme

Table 3: Structural framework of the two years M.A./M.Com./M.Sc. Program under NEP2020

	SEM-1	SEM-II	PG Diploma	SEM-III	SEM-IV
Core Courses	DCC-1-Th (4 Cr) DCC-2 Th (4 Cr) DCC-3 Th (4 Cr) DCC-4 Th (4 Cr) DCC-1 Th/Lab (4 Cr) DCC-2 Th/Lab (4 Cr)	DCC-5-Th (4 Cr) DCC-6 Th (4 Cr) DCC-7 Th (4 Cr) DCC-3 Th//Lab (4 Cr) DCC-4 Th/Lab (4 Cr)	Student who opt to exit after completion of the I year securing 480 credits will be awarded a PG Diploma in the relevant subject.	DCC-8-Th (4 Cr) DCC-9 Th (4 Cr)	DCC-10-Th (4 Cr)
Discipline Specific Elective/ Generic Elective Courses	-	GEC-(1-4) Th (4 Cr)		DSE-(5-8) Th (4 Cr) DSE-(9-12) Th (4 Cr) DSE-(1-4) Th/Lab (4 Cr) GEC-(5-8) Th/Lab (4 Cr)	DSE-(13-16) Th (4 Cr) DSE-(17-20) Th (4 Cr) DSE-(21-24) Th (4 Cr) DSE-(9-12) Th/Lab (4 C DSE-(13-16) Th/Lab (4
	24+0=24	20+4=24		8+16=24	4+20=24
	56(DCC)+40(DSE/GEC)=96				

M. Sc. CBCS CURRICULUM (PG403XX)

(UNDER NEP)

for Environmental Sciences, 2023-24

Semester I

LEVEL	SEMESTER	COURSE TYPE	Course code	Title of course	L-T-P	NO. OF CREDITS	MAX. MARKS		TOTAL
							UNI. EXAMS	INT.ASSESSMENT	
8	I	DCC	EVS8000T	Basic concepts of ecology and environment	4-0-0	4	80	20	100
			EVS8001T	Earth processes and natural cycles	4-0-0	4	80	20	100
			EVS8002T	Natural resources and their conservation	4-0-0	4	80	20	100
			EVS8003T	Environmental pollution and monitoring	4-0-0	4	80	20	100
		DCC	EVS8000P	Field Ecology Lab I	0-0-8	4	80	20	100
			EVS8001P	Aquatic Ecology Lab	0-0-8	4	80	20	100
		TOTAL				24	480	120	600

Semester II

LEVEL	SEMESTER	COURSE TYPE	Course code	Title of course	L-T-P	NO. OF CREDITS	MAX. MARKS		TOTAL
							UNI. EXAMS	INT.ASSESSMENT	
8	II	DCC	EVS8004T	Biodiversity conservation	4-0-0	4	80	20	100
			EVS8005T	Environmental chemistry	4-0-0	4	80	20	100
			EVS8006T	Environmental hazards and Management	4-0-0	4	80	20	100
		***GEC	EVS8100T	Environmental sustainability and management	4-0-0	4	80	20	100
		DCC	EVS8002P	Field Ecology Lab II	0-0-8	4	80	20	100
			EVS8003P	Soil Ecology Lab	0-0-8	4	80	20	100
		TOTAL				24	480	120	600

M. Sc. CBCS CURRICULUM (PG403XX)

(UNDER NEP)

for Environmental Sciences, 2023-24

Semester III

LEVEL	SEMESTER	COURSE TYPE	Course code	Title of course	L-T-P	NO. OF CREDITS	MAX. MARKS		TOTAL
							UNI. EXAMS	INT.ASSESSMENT	
9	III	DCC	EVS9007T	Environmental engineering and management	4-0-0	4	80	20	100
			EVS9008T	Environmental Laws and ethics	4-0-0	4	80	20	100
		**DSE	EVS9101T	Environmental toxicology	4-0-0	4	80	20	100
			EVS9102T	Remote Sensing and GIS in environment					
		**DSE	EVS9103T	Instrumental and environmental analysis	4-0-0	4	80	20	100
			EVS9104T	Industrial Waste management					
		**DSE-Lab	EVS9105P	Air Analysis Lab	0-0-8	4	80	20	100
			EVS9106P	Instrumentation Lab					
		***GEC	EVS9107T	Energy and environment	4-0-0	4	80	20	100
			EVS9108T	Environmental geosciences					
				TOTAL		24	480	120	600

Semester IV

LEVEL	SEMESTER	COURSE TYPE	Course code	Title of course	L-T-P	NO. OF CREDITS	MAX. MARKS		TOTAL
							UNI. EXAMS	INT.ASSESSMENT	
9	IV	DCC	EVS9009T	Environmental and occupational health	4-0-0	4	80	20	100
		**DSE	EVS9109T	Environmental Planning & Biostatistics	4-0-0	4	80	20	100
			EVS9110T	Environmental Microbiology And Biotechnology					
		**DSE	EVS9111T	Environmental Impact Assessment	4-0-0	4	80	20	100
			EVS9112T	Restoration Ecology					
		**DSE-Lab	EVS9113P	Biostatics Lab	0-0-8	4	80	20	100
			EVS9114P	Environmental Biotechnology Lab					
		**DSE-Lab	EVS9115P	Environmental training	0-0-8	4	80	20	100
			EVS9116P	Restoration ecology Lab					
		DSE (PROJECT)	EVS9117S	Environmental Training & skill	6 weeks	4	80	20	100
				TOTAL		24	480	120	600

**A minimum of 50% of the total admitted strength is required to run the options of papers as proposed in Semester IV, DSE & DSE-LAB papers in PG Programme.

***Intake in GEC paper will be decided considering availability of Resources and Faculty

M.Sc. (Two Years Degree Program under NEP scheme)	
Subject-Environmental Sciences	
First Semester	
Code of the Course	**EVS8000T**
Title of the Course	**BASIC CONCEPTS OF ECOLOGY AND ENVIRONMENT**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-1)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To develop basic intuitiveness and critical approach about the basics of the subject
Learning outcomes	After completion , the student will be able to learn about basics of the subject, critical overview of the hierarchy in ecosystem and different types of environment
Syllabus	
UNIT-I	Basic concept of ecology and Environment: components- Topographic, climatic, edaphic factors; Scope of ecology and its relations with other disciplines; Principles pertaining to ecosystem; ecosystem components: food chains, food web, ecological pyramids; Ecosystem energetics; energy budget and ecological efficiency; Processes of primary productivity, gross and net productivity; Homeostasis; Principles of limiting factors. (12 lectures)
UNIT -II	Biogeochemical cycles in Environment-concepts and significance, Carbon , Nitrogen, Phosphorus, oxygen, hydrological, Sulphur cycle; Autecology and synecology-Basic principles; Concept of population growth and survivorship; population characteristics and dynamics; population growth forms and concept of carrying capacity; Population regulation K and R selection, population changes. (12 lectures)

UNIT-III	Biotic community: concept and classification; community characteristics-Qualitative,Quantitative,phytosociologicalmethods: quadrats, Transects & IVI; Ecotone and continuum concept, Life forms and biological spectrum; Community coefficients; Ecological dominance and ecological niche; ecological succession, concept of climax and community stability; Biotic interactions, ecads; Ecological succession- types, causes and effects, climax community, succession models of ecosystem developments; Micro versus macro evolution. (12 lectures)
UNIT-IV	Aquatic ecosystems: Lentic and lotic-Physicochemical characteristics of fresh water environment, Biotic communities of pond and lakes, thermal stratification of lakes, conservation and management of fresh water habitats; Physicochemical characteristics of Marine ecosystem, biotic communities of oceanic regions, coral reefs and mangroves; estuarine ecology; Concepts of wetland ecosystem, Ramser wetlands, wetlands with special reference to Rajasthan. (12 lectures)
UNIT-V	Terrestrial Environment: Physicochemical characteristics; Biomes of the world-Forest, Grassland, Desert and Tundra; Flora and Vegetation of India with special reference to Rajasthan; Endemism, Age and Area hypothesis, Dispersal dynamics; Role of ecotone in conservation and management of Biomes. (12 lectures)
Reference Books	• FUNDAMNETAL OF ECOLOGY - E.P. ODEM • ECOLOGY AND ENVIRONMENT – PD SHARMA • ENVIRONMENTAL SCIENCE- SC SANTRA • SWIFT, HEAL- STUDIES IN ECOLOGY VOL-5 • ENVIRONMENTAL SCIENCE-DANIAL BOTKIN AND KELLER • ENVIRONMENTSAL SCIENCE- NEBEL WRIGHT • ECOLOGY- J.L. CHAPMAN
-Suggested E-resources	• https://www.classcentral.com/course/swayam-wildlife-ecology-20021 • https://www.classcentral.com/course/swayam-msd-012-ecosystem-and-natural-resources-32191

First Semester	
Code of the Course	**EVS8001T**
Title of the Course	**EARTH PROCESSES AND NATURAL CYCLES**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-2)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To have a better understanding of relationship between environment, climate change, topography and meteorology
Learning outcomes	One can critically analyze the relationship between environment and climate change, role of geographical and geological aspects with changes across timeline
Syllabus	
UNIT-I	Evolution of atmosphere; Chemical composition and thermal stratification of present day atmosphere; Atmosphere and earth radiation balance, Latitudinal and seasonal variation of Insolation, temperature, pressure, wind belts , Humidity, cloud types & formation, precipitation; Circulation of earth's atmosphere and world precipitation pattern, precipitation to evaporation ratio; Hydrological cycle. (11 Lectures)
UNIT -II	Elements of climate: temperature, pressure, wind, Altitude, latitude, longitude, Horizontal and vertical distribution of air masses, Interrelationship between various elements of climate, properties of air masses, air circulation system in the tropics; Climate classification, World climate regimes; Climate types of India, Indian Monsoon; El Nino & La Nina; Climate control and distribution of plants and animals, Gaia hypothesis, Climate and biosphere-feedback mechanisms, Climate elements in crop production: temperature and crops, frost moisture, drought . (13 Lectures)
UNIT-III	Climate and habitable areas; climate and rural housing; climate and buildings; Micro climate and architectural design, modification of macro and micro climates with special reference to urban areas; Human body and heat balance; climate and human health, climate and race temperament, clothing insulation and clothing zones of the world. (11 Lectures)
UNIT-IV	Meteorology fundamentals– Pressure, temperature, wind, humidity, radiation, atmospheric stability adiabatic diagrams, turbulence and diffusion; Emission and absorption of terrestrial radiation, radiation windows, Net Radiation Budget- thermodynamic diagram; thermal inversion process ; entropy and enthalpy, thermodynamics of dry and moist air and adiabatic processes; Applications of micrometeorology to vegetated surfaces, urban areas, human beings, animals; Application of meteorological principles to transport and diffusion of pollutants. (13 Lectures)

UNIT-V	Scavenging processes; Effects of meteorological parameters on pollutants and vice versa; Wind roses; Topographic effects; Pollution climatology; theories of climate change: forecasting climate, climate trends and climatic cycles; Preliminary concepts of climate change – global warming , sea level rise, ozone depletion, green house gases, smog, fog formation and dispersal. (12 Lectures)
Reference Books	• CLIMATOLOGY- SUBHASH MEHTA • SCIENCE OF WEATHER & ENVIRONMENT-ANNELTE BALGER • ATMOSPHERIC CHEMISTRY & PHYSICAL - JOHE H. SEINFIELD • GENERAL CLIMATOLOGY- HOWARD J CRITCHFIELD • APPLIED CLIMATOLOGY- RUSSELL D. THOMPSON
Suggested E-resources	• https://www.classcentral.com/course/swayam-ecology-and-environment-14021 • 1519194090ENV_P8_Module-28_e-text.pdf • 1519277999ENV_P8_Module-24_e-text.pdf • 1513921840ENV_P8_Module-12_e-text.pdf

First Semester	
Code of the Course	**EVS8002T**
Title of the Course	**NATURAL RESOURCES AND THEIR CONSERVATION**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-3)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Learning outcomes	One can relate oneself with types and conservation of natural resources ,energy conservation, mineral, nuclear and forest resources

Syllabus	
UNIT-I	Natural Resources : Definition, Types & Classification, Concepts of Reserves & Resource availability, Environmental impacts of resource exploitation, Understanding Resource Ecology & life supporting capacity of Natural Resources- Economic models: Green Building concept & Green technology concept, Natural Resource Management. (11 Lectures)
UNIT -II	Definition of Energy-Types & units; Energy production and consumption pattern of world & India; Renewable and Non renewable Energy Resources, Principles of generation of Hydro electric power, Tidal power, Thermal energy conversion, wind and geothermal energy, Solar energy- Solar collectors, Photovoltaics, Solar ponds & Solar equipments- Heaters, driers, cookers; Harnessing Solar energy, solar electricity generation; Impact of large scale exploitation of solar, wind, hydro and ocean energy, Energy conservation policies. (13 Lectures)
UNIT-III	Non-renewable energy resources: Fossil fuel classification, composition and physico-chemical characteristics; energy content of petroleum and natural gas -formation, reserves, exploration/ Mining and uses of Coal; Environmental problems associated with mining, processing & transportation ; uses of Fossil fuels. (11 Lectures)
UNIT-IV	Bio energy: Biomass, Biogas, Refuse, Organic residues; Biomass fuel types- Solid, liquid and gaseous fuels, Availability of Biomass fuels in India; Biogas production and uses; Conversion processes– pyrolysis, charcoal production, compression, gasification and liquefaction; Anaerobic digestion; Energy from solid wastes- sources , types and energy production; Energy plantations- Carbohydrate crops, petro crops and Energy weeds. (12 Lectures)
UNIT-V	Mineral resources- origin, distribution and uses of economic minerals; Impact of mineral exploitation on environment, conservation of mineral resources; Mineral resources with special reference to Rajasthan; Forest Resource Management: distribution, wood Production , forest land-use changes in India, future demand of forests -carbon sequestrations; Nuclear energy resources-fission and fusion, nuclear fuel types, sustainable use. (13 Lectures)
Reference Books	• V. RAGHUPATHY – NATURAL RESOURCES • RESOURCES ECOLOGY- S. K. AGRAWAL • NATURAL RESOURCES- JERRY L. HOLECHEK CALE, FISHER • NATURAL RESOURCES CONSERVATION-OALI,NAVAID SHABIR QAZI
Suggested E-resources	• https://www.classcentral.com/course/swayam-ecology-and-environment-14021 • https://www.classcentral.com/course/edx-natural-resources-for-sustainable-development-8500

First Semester	
Code of the Course	**EVS8003T**
Title of the Course	**ENVIRONMENTAL POLLUTION AND MONITORING**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-4)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Learning outcomes	One can understand the types ,impacts, effects and preventive measures associated with different types of pollution
Syllabus	
UNIT-I	Environmental Pollution – concepts & Introduction, Global, regional and local prospective of environmental Pollution; Natural and anthropogenic sources of pollution; primary and secondary pollutants; Transport and diffusion of pollutants; Air pollution: source, effect of gaseous air pollutants on plants and animals, TSP and their effect on plants and animals; Principles of air monitoring; Air Pollution Tolerance Index, effect of meteorological & topographical factors on transport and dispersion of pollutants ; Lotka-voltera, prey-predator model, Gaussian plume model; Air Quality Standards, control of air pollution, Euro standards, Indoor and vehicular air pollution. (12 Lectures)
UNIT -II	Water pollution: types, Sources and consequences of water pollution; Principles of water quality monitoring, ecological and biochemical aspects of water pollution ,effects of domestic industrial and agricultural wastes on water bodies, physicochemical and bacteriological sampling and analysis of water quality; water quality standards; water pollutants and their control; Ganga Action Plan; Marine pollution; Thermal pollution. (12 Lectures)
UNIT-III	Radiation sources in environment- natural and man made; Sources and classification of Radioactive pollution, effect of radioactive pollution on biological system; Basic properties of noise, sound pressure, loudness and intensity levels, Sources and measurement of noise pollution, noise exposure levels and standards; noise pollution control and abatement measures; Noise survey - equipments and sampling. (12 Lectures)

UNIT-IV	Physicochemical and bacteriological sampling and analysis of soil; Sources of Soil pollution, Heavy metals sources and effects on biological systems; Pesticides sources and effect on biological systems, Detrimental effects of soil pollutants on soil micro biota, Ecological consequences and soil pollution control. (12 Lectures)
UNIT-V	Sources and characteristics of solid wastes, Environmental Problems associated with solid wastes disposal practices; Solid waste disposal and management, Biomonitoring of air, water and soil environment, concept of indicator species and their environmental significance, Introduction to pollutant- sensitive and resistant plants; environmental impacts of biomedical wastes: sources and waste minimization. (12 Lectures)
Reference Books	• ENVIRONMENTAL POLLUTION - TIMMY KATYAL • S.M. SHAJI – ENVIRONMENTAL POLLUTION • MARINE POLLUTION- A.P. DIWAN • NUCLEAR AND THERMAL POLLUTION- P.R. TRIVEDI GURDEEP RAJ
Suggested E-resources	• 1523277253Paper9_Module4_e-text.pdf • 1519193193paper10_Module3e-text.pdf

Environmental Sciences	
Semester I PRACTICAL-I (DCC-LAB I)	
Code of the Course	**EVS8000P**
Title of the Course	**Field Ecology lab I**
Credit of the course	04
Learning outcomes	To have basic knowledge of field experiments in form of quadrats, climatic parameters, graphs and working and operations of weather instruments
EXPERIMENT DETAILS	

	1. To determine minimum size of quadrate by species area curve method. 2. To study the vegetation by line transect method 3. To determine frequency, Density and Abundance of the given area 4. Find out the IVI of specified vegetational area 5. Find out the similarity and dissimilarity indices between disturbed and undisturbed grassland. 6. Determination of pattern (non randomness) in vegetation. 7. Estimation of total chlorophyll content of herbaceous vegetation on per square meter of land area basis 8. Study of biotic interactions and their ecological significance 9. Representation of climate data by (1) Simple graph (2) Hytherograph (3) Rainfall variability graph (4) Wind rose (5) Combine bar and line graph (6) Climograph 10. Observation of India weather maps. 11. Preparation of wind rose. 12. Construction, principle and working of weather instruments : Thermometer, Rain gauze, Anemometer, Barometer, Pedometer, Compass, lux meter ,hygrometer 13. To find out Index of Dominance in given area
	SPOTTING: : Thermometer, Rain gauze, Anemometer, Barometer, Pedometer, Compass, lux meter, hygrometer , • weather graph, temperature, wind rose, WEATHER GRAPHS, • Biotic interactions: proto cooperation, mutualism, parasitism, amensalism, symbiosis • Plant interactions : lichens ,root nodules, epiphytes, macrophytes, insectivorous plant
Reference Books	• Environmental Science Practical BY Pandey and Sharma
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

Semester I PRACTICAL-II (DCC-LAB II)

Code of the Course	**EVS8001P**
Title of the Course	**Aquatic ecology Lab**
Credit of the course	04
Learning outcomes	After learning , student will be well aware of physico –chemical analysis of water samples ,sampling instruments and aquatic environment
EXPERIMENT DETAILS	
	1. Analysis of water samples: a) PHYSICAL ANALYSIS :Temperature, Turbidity, Conductivity, PH b) CHEMICAL ANALYSIS: Bicarbonates and Carbonates ,Total dissolved solids, Total suspended particulates, Salinity, Free CO2, Alkalinity, Dissolved oxygen, COD, BOD, Primary productivity, Phosphate, Silicate, DOC & DOM , Total hardness, Nitrates, Chlorides 2. To study faecal coli forms in water sample by M.P.N. method 3. Qualitative and quantitative analysis of water samples for zooplanktons and phytoplanktons. 4. Preparation of field report of any case study carried out in any areas to assess the pollution status. 5. Temporary slide preparation of phyto and zooplanktons
	SPOTTING : • Sampling equipments : BOD Bottle, Sechhi disc, Plankton net, components of simple and compound microscope • Phytoplanktons : *microcystis, anabena, volvox, nostoc, occillatoria*, • Zooplanktons: moina, Cyclops, Daphnia, zoea larva, chyronomus larva, nauplius larva, ticks, mites
Reference Books	• Environmental Science Practical BY Pandey and Sharma • Handbook of methods in Environmental studies by S. K. Maiti
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

M.Sc. (Two Years Degree Program under NEP scheme)

Subject-Environmental Sciences

Second Semester

Code of the Course	**EVS8004T**
Title of the Course	**BIODIVERSITY CONSERVATION**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-5)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To develop basic intuitiveness and critical approach about the conservation stretegies
Learning outcomes	After completion , the student will be able to learn about basics of the subject, critical overview of the biodiversity and its relation with environment

Syllabus

UNIT-I	Concepts and component of biodiversity- genetic, species and ecosystem biodiversity, evolution of organisms & distribution in space and time, levels of biodiversity, biodiversity indices, value of biodiversity, biodiversity trends, modern techniques of measurement and monitoring of biodiversity, bio perspecting, patent protection and bio piracy . (12 lectures)
UNIT -II	Major threats to biodiversity, IUCN threat categories, Red data book, threatened plants & animals of India; Endangered flora and fauna of India and Rajasthan, Mega diversity zones of India, Hot spot concept and hot spots of India, Biodiversity informatics, International efforts in biodiversity conservation. (12 lectures)

UNIT-III	Conservation of biodiversity- *In-situ*- Sanctuaries, biospheres Reserves, National Parks, Nature Reserves, Preservations plots; *Ex-situ* - Botanical gardens, Zoos, Aquaria, Home Garden & Herbarium, In vitro conservation: Germplasm & gene banks, tissue culture, pollen and spore bank, DNA bank; Wildlife reserves in India, Theory of reserve design, Restoration of biodiversity; Ecosystem people and traditional conservation mechanism; Importance of biodiversity in Ecotourism; endemic flora and fauna of tropics and India with special reference to Rajasthan (12 lectures)
UNIT-IV	National and International programmes for biodiversity conservation; Conservation of wildlife-significance and status of India, Wildlife reserves- Biosphere and nature reserves, Project tiger, sanctuaries and national parks in India; Impact of tourism on wildlife and problem in wildlife protection; Role of WWF,WCU,CITES, TRAFFIC . (12 lectures)
UNIT-V	Conservation of forests; Indian strategies and planning; Agroforestry, Social forestry; Management of forest products; Forests and tribals; Chipko Aandolan; Coral reefs, mangroves and estuarine biodiversity and their conservation; wetland conservation with special reference to Rajasthan; Biodiversity and agenda-21; Biodiversity conventions. (12 lectures)
Reference Books	• ECOLOGY AND ENVIRONMENT – P D SHARMA • SC SANTRA – ENVIRONMENTAL SCIENCE • GLOBAL BIODIVERSITY – P C TRIVEDI • TERRESTIAL ECOSYSTEMS – ASHOK MALIK • CONSERVING BIODIVERSITY OF RAJASTHAN – ASHOK VERMA • ECOLOGICAL BASIS OF AGROFORESTRY – DAIZY RAIN BATISH
Suggested E-resources	https://www.classcentral.com/course/swayam-ecology-and-environment-14021 https://onlinecourses.swayam2.ac.in/nou23_ge09/preview

Second Semester

Code of the Course	**EVS8005T**
Title of the Course	**ENVIRONMENTAL CHEMISTRY**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-6)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To have a better understanding of chemical changes occurring in environment and its relation with climate change
Learning outcomes	One can critically analyze natural chemistry occurring in ecosphere
Syllabus	
UNIT-I	Concept and Scope of Environmental Chemistry; segments of environment; Principles and cyclic pathways in the environments; Chemistry of Biologically Important Molecules: Chemistry of Water: Unusual physical properties, hydrogen bonding in biological systems, unusual solvent properties, changes in water properties by addition of solute. Protein structure and biological functions, enzymes, enzyme metabolism (12 lectures)
UNIT -II	Basic chemistry: Structure of atoms, their properties, their nuclear stabilities and their arrangement in the periodic table; fundamentals of chemical thermodynamics and solution formation-Normality, Molarity, Molality, Molecular weight, Equivalent weight, Mole concept; basic organic chemistry and biochemistry; Stochiometry, Gibb's energy, Chemical potential, chemical equilibria, acid-base reactions; Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons. (12 lectures)
UNIT-III	Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter; Thermochemical and photochemical reactions in the atmosphere; Basic concepts of surface and interface chemistry: Absorption, adsorption, catalysis; collides, surfactants; carbonate system, radionuclides, radioactivity, decay of parent and growth of daughter nuclides & methods of radiometric dating; C14 dating system and procedure, stable isotopes – their fractionation and application to geo thermometry and paleo climates. (12 lectures)

UNIT-IV	First law of thermodynamics, enthalphy, adiabatic transformations; second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium; third law of thermodynamics, enzymes catalysis, Michaelis/ Menten equation; Concept, principle and utility of green chemistry, green reagents, green catalysts, industrial interest in green chemistry. (12 lectures)
UNIT-V	Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog, Chemistry of water, concept of D.O., B.O.D., and C.O.D. Water treatment: Sedimentation, Coagulation, Filtration, tertiary and advanced treatment; Redox potential; Inorganic and organic components of soil; nitrogen pathways and NPK in soils. Bio transformation and bio magnification; Principles of photo chemistry- Photo chemical & photo sensitized reactions, energy transfer. (12 lectures)
Reference Books	• ENVIRONMENTAL CHEMISTRY – A.K. DE • ENVIRONMENTAL CHEMISTRY –PETER O NEIL • INTRODUCTION OF ATMOSPHERE CHEMISTRY –PETER V HOBLES • OZONE DEPLETION AND ENVIRONMENTAL IMPACTS – HS SHARMA • CHEMISTRY OF GREEN ENVIRONMENT – M M SHRIVASTAVA • BASIC CONCEPTS OF ENVIRONMENTAL CHEMISTRY – RES W CONNELL • ENVIRONMENTAL CHEMISTRY – SAMIR K BANERJI • ENVIRONMENTAL CHEMISTRY AND POLLUTION - MANTA V SACHDEVA
Suggested E-resources	• https://www.classcentral.com/course/swayam-environmental-chemistry-19858 • 1515046627paper16_module3_etext.pd • 1516345405paper16_module_06_etext.pdf • 1515393654paper16_module_08_etext.pdf • 1516343247paper16_module_15_etext.pdf

Second Semester	
Code of the Course	**EVS8006T**
Title of the Course	**Environmental Hazards and Management**

Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences (DCC-7)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Learning outcomes	To have a detailed concept of occurrence of natural hazards and disasters, their impact and preventive measures
Syllabus	
UNIT-I	Introduction to hazards, classification and types: –Natural Hazards, Chemical hazards, Physical hazards, Biological hazards; Basics of hazard management and mitigation, natural Hazards –causes, continental drift, plate tectonics and sea floor's spreading; hazard analysis, potential risk; Human perturbation and natural hazards – impact of deforestation, land use and developmental activities on natural hazards, Role of climate change; Man Made hazards - Dams & reservoirs, NPP; Desertification-causes, evaluation, Mitigation. (12 lectures)
UNIT -II	Natural Disasters: nature, causes and effect, Cyclone, tornadoes, floods, earthquakes, avalanches, Tsunami ,land slides, drought, fires, volcanism, Case study of disasters- community reaction to disasters, coping mechanism; disaster management- pre disaster phase, actual disaster phase, post disaster phase. (12 lectures)
UNIT-III	Disaster assistance-technological assistance, relief camps, food requirement, water needs, sanitation security, information administration, fire fighting training, Safety Measures – a general account, emergency rescue, disaster education- alternatives and new direction, Forecasting and warning systems (12 lectures)
UNIT-IV	Concept of disaster recovery- mitigation and preparedness, program planning and management, Vulnerability analysis, Training needs – Target Groups, emergency preparedness plan, occupational risk analysis survey and health evaluation, behavioral studies, Man-made disasters-occupational injury, Industrial Safety Management Techniques – Industrial Safety Standards, Industrial Accidents and Disasters - Frequency Rate, Prevention and Control; Dispersion of Radioactive material and release of Toxic and inflammable materials (12 lectures)
UNIT-V	Environmental hazards, protective measure while handling hazardous substance, hazardous waste disposal. Hospital waste handling and disposal, guidelines for their disposal, fire and explosion hazards, radiation hazards. Case studies related to hazardous waste accidents, simplified measures for their assessment. Various diseases related to handling of hazardous waste. Nasal cancer and other fatal diseases- their symptoms, prevention and control (12 lectures)

Reference Books	• ENVIRONMENTAL DISASTERS CAUSES, IMPACTS AND REMEDIES – MAHESH V JOSHI • DISASTERS – B K KHANNA • DISASTER MANAGEMENT – K K SINGH • DISASTERS – B K KHANNA • NATURAL DISASTER – ROBERT CONRADS • ENVIRONMENTAL POLLUTION HEALTH HAZARDS IN INDIA – R KUMAR
Suggested E-resources	• https://onlinecourses.swayam2.ac.in/nou21_bt06/preview • https://www.classcentral.com/course/swayam-natural-hazards-17703 • https://www.classcentral.com/course/swayam-plate-tectonics-184179

Second Semester	
Code of the Course	**EVS8100T**
Title of the Course	**Environmental Management and Sustainability**
Qualification Level of the Course	NHEQF Level 6.0
Credit of the course	4
Type of the course	Generic Elective Course in Environmental Sciences (GEC-01)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	Student from any stream can opt for this course as it is related to certification and sustainable development

Learning outcomes	After the completion, one can understand the certification details and course related to sustainable development
Syllabus	
UNIT-I	Introduction, concept and scope of environmental management; Systems and approaches, International summits and treaties-Vienna convention, Montreal protocol, Kyoto protocol, Copenhagen convention; International Organization of Standardization (ISO): concept, significance and scope. (12 lectures)
UNIT -II	Sustainable development –concept & growth of idea, energy issues, Sustainable use of natural resources, Sustainability in industry and agriculture; relation of EIA with sustainable development; ecolabelling , eco marketing, eco restoration, green funding . (12 lectures)
UNIT-III	Basic concept of ISO 9001- scope, structure, guidelines, implementation and certification process. (12 lectures)
UNIT-IV	Basic concept of ISO 14000- scope, structure, guidelines, implementation and certification process; Environmental Audit, Environmental accounting; Environmental Management of Industrial pollution in relation to ISO 14000. (12 lectures)
UNIT-V	Management system OHSAS 18001 (occupational health & safety), ISO 26000 (social responsibility) AND ISO 50001 (energy management) - scope, structure, guidelines, implementation and certification process. (12 lectures)
Reference Books	• ENVIRONMENTAL MANAGEMENT – MICHAEL V RUSSO • ENVIRONMENTAL MANAGEMENT – N K UBEROI • ENVIRONMENTAL MANAGEMENT – R B SINGH • ENVIRONMENTAL MANAGEMENT - G N PANDEY • ENVIRONMENTAL CONCERN AND SUSTAINABLE DEVELOPMENT – SAKARAMA SOMAYA • GREEN TECHNOLOGIES FOR ENVIRONMENT MANAGEMENT AND SUSTAINABLE MANAGEMENT – RAJIV K SINHA
Suggested E-resources	• https://www.classcentral.com/course/swayam-environment-and-development-43590 • https://www.classcentral.com/course/sustainability-development-umich-93003 • https://www.classcentral.com/course/sustainable-development-goals-people-place-and-en-74851

Semester II PRACTICAL-I (DCC-LAB)	
Code of the Course	**EVS8002P**
Title of the Course	**Field Ecology Lab II**
Credit of the course	04
Learning outcomes	To have knowledge of field experiments, observations and statistical indexes
EXPERIMENT DETAILS	
	1. Find out the percentage frequency values of grassland species using 1 x 1 size quadrat. Classify the species into frequency classes A to E and prepare the frequency diagram. Compare result with Raunkiers standard frequency diagram. 2. Determine the biomass of producers. 3. Find out the effect of various quadrat size 25 x 25, 50 x 50, 75 x 75 and 1 x 1 m on percentage frequency result on same grassland plot considered in exercise I 4. Find out the species diversity index in disturbed and protected vegetation area. 5. Find out the leaf area index of crop field. 6. Study of anatomical features of ecological adaptation in selected hydrophytes and xerophytes. 7. Study of climatic conditions obtained in open field and under the shade of trees for temperature, light intensity, wind velocity, R.H and comparison of ground vegetation of these areas. 8. To determine the age of forest patch by DBH. 9. To determine the vegetation by Point frame quadrate method.
	SPOTTING: : • **Xerophytes**: *Nerium* – Stem & leaf; *Calotropis* Stem; *Capparis* Stem; *Pinus* Needle; *Opuntia; Euphorbia, Casurina* • **Hydrophytes**: *Ecchornia, Hydrilla, Trapa, Nymphea, Chara, Potemogeton, Scirpus, Nelumbo* • Point frame

	• **Xerophytic animals**: *Phyrnosoma ,Draco* • **Aquatic animals**: *Exocetus, Hyla, Gappi, Katla, Rohu, Gambusea*
Reference Books	• Environmental Science Practical BY Pandey and Sharma
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

Semester II PRACTICAL-II (DCC-LAB)	
Code of the Course	**EVS8003P**
Title of the Course	**Soil Ecology Lab**
Credit of the course	04
Learning outcomes	After learning , student will be well aware of physico –chemical analysis of soil environment and related instruments
EXPERIMENT DETAILS	
	1. Analysis of Soil samples (1) Texture (2) Moisture (3) pH (4) conductivity (5) Water holding capacity (6) Bulk density & porosity (7) Calcium carbonate

	(8) Sulphate (9) Carbonate and bicarbonate (10)Organic carbon & organic matter (11)Chlorides (12)Nitrates (13)Available phosphorus 2. To compare the wilting coefficient of a xerophytic and mesophytic plant. 3. Assessment of noise pollution in different zones of the city by Sound level meter. 4. Study of soil for biotic components like bacteria, fungi & soil nematodes.
	SPOTTING : • Instruments- Spectrophotometer, sound level meter, colorimeter, refrigerated centrifuge • Foot prints- of wild animals as available for demarcation of territory. • Soil fauna-Micro & macro fauna: Milipede, centipede, earthworm, nematodes, actinomycetes • Soil fungi and soil bacteria • Seives set for soil texture
Reference Books	• Environmental Science Practical BY Pandey and Sharma • Handbook of methods in Environmental studies by S. K. Maiti • Methods in Environmental analysis water soil and air - P.K.Gupta
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

M.Sc. (Two Years Degree Program under NEP scheme)

Subject-Environmental Sciences

Third Semester

Code of the Course	**EVS9007T**
Title of the Course	**Environmental Engineering and Management**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To develop basic skills and critical approach about the engineering techniques being applied to environment conservation
Learning outcomes	After completion , the student will be able to learn about basics of the subject, critical overview of the engineering and technology being applied for environment pollution abatement

Syllabus

UNIT-I	Waste water treatment-primary, secondary and tertiary treatment; various technologies related to water treatment- ozonation, chlorination, reverse osmosis, ion exchange, disinfection, coagulation, UV treatment. (12 lectures)
UNIT -II	Air pollution control technologies-wet scrubbers, electro static precipitators, cyclone separator, gravitational settling chambers , bag filters, adsorption and absorption methods, incineration. (12 lectures)
UNIT-III	Solid waste treatment technologies: land fill & sanitary land fill, composting, incineration; hazardous and industrial waste management; municipal solid waste management. (12 lectures)
UNIT-IV	Energy conservation: renewable energy technologies-solar, wind, bio energy, geothermal, hydro power; nuclear energy production-process and functioning of nuclear reactors (12 lectures)

UNIT-V	Effluent treatment plant (ETP) & sewage treatment plant (STP) - design and working; eutrophication – control and management procedure; reuse and recycling of plastic and metal. (12 lectures)
Reference Books	• N.K. OBEROI, ENVIRONMENTAL MANAGEMENT, (2ND EDITION) EXCEL BOOKS, NEW DELHI, 2003 • WATER AND WASTEWATER TECHNOLOGY, HAMMER M.J. AND HAMMER JR M. J. (2001), PRENTICE HALL OF LNDIA PVT. LTD., NEW DELHI. • ENVIRONMENTAL ENGINEERING, HOWARD S PEAVY (2003), TATA MC GRAW HILL PUBLISHING COMPANY LTD., NEW DELHI.
Suggested E-resources	• 1519197339paper10_Module5e-text.pdf • 1519197409paper10_Module7e-text.pdf • 1512551261Module10e-text.pdf • 1511174041Paper_11_module_5_yoga_etext.pdf • 1520595756paper11_module_19_etext.pdf

Third Semester

Code of the Course	**EVS9008T**
Title of the Course	**Environmental Laws and Ethics**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To have a better understanding of legal applications related to environment
Learning outcomes	One can critically analyze laws that favor and support environment protection and social behavior and ethics towards its protection

Syllabus

UNIT-I	Environment (protection) act 1986; Environmental (prevention) rules 1986; Central and state boards for prevention and control of air and water pollution; provision of constitution of India regarding environment (Article 48 A & 58 A). (12 lectures)
UNIT -II	Air (prevention and control of pollution) Act 1981; Air (prevention and control of pollution) Amendment Act 1987 and rules 1982; The Water (prevention and control of pollution) Act 1974; (12 lectures)
UNIT-III	The water (prevention & control of pollution) amendment 1988 & rules 1975; Legislation related to forest and wild life conservation; Forest Conservation Act 1980; Indian Forest Act, 1970, revised 1982; Wildlife Protection Act 1972 and amendment 1991; Biological Diversity Act, 2002. (12 lectures)
UNIT-IV	Code of criminal procedure and environmental protection; guidelines issued by the government of India for inspection of Industries under pollution control laws; Scheme of lebeling of environmentally friendly products (ecomark); Public liability Insurance Act. 1991; Environment guidelines for industries which required industrial licensing, Industrial licensing procedure; Environmental Clearance Process; Consents for handling hazard substances; Environment protection issues & problems, international & national efforts for environment protection. (12 lectures)
UNIT-V	Environmental ethics : Concept and definition ; Anthropocentrism and Ecocentrism; Indian situation of ethics; shallow and deep ecology . (12 lectures)
Reference Books	• Environmental and Laws - C.S. Mehta • Environmental Protection and Laws - Chetan Singh Mehta • Biological diversity & International Environmental Laws - Arjun Prasad • Climate Ethics - Gardiner, Caney, Jamieson and Shue

Suggested E-resources	• 1512043005module_2_etext.pdf • 1512043211module_11_etext.pdf • 1512114482Paper13_module_09_etext.pdf • 1512113087module_12_etext.pdf • 1512043005module_2_etext.pdf • 1512113718module_7_etext.pd

Third Semester	
Code of the Course	**EVS9101T**
Title of the Course	**Environmental Toxicology**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Discipline Specific Course (DSE) in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Learning outcomes	To have a detailed concept of toxins present in environment, their impact and preventive measures
Syllabus	
UNIT-I	Toxicology: definition, Origin, classification & general nature of toxicants in environment; Principles in toxicology: Concept of dose response relationship, Chronic toxicity, Sub acute toxicity and acute toxicity, concept of LC 50 & LD 50, Median tolerance limit, Statistical concepts of LD_{50}; Safe limits, MATC, threshold concentration, NOEL,NOAEL & bioaccumulation; Risk assessment; Biological and chemical factors that influence toxicity; Influence of ecological factors on the effects of toxicity. (12 lectures)

UNIT -II	Toxicity testing: Holistic and numeric approach; Drug toxicity and abuse; Heavy Metal toxicity in animals; mutagenesis ,Teratogenicity and carcinogenicity; Practical problems in toxicity testing; Global dispersion of toxic substance; Dispersion and circulating mechanisms of pollutants; degradable and non-degradable toxic substances in food chain; Eco-system influence on the fate and transport of toxicants. (12 lectures)
UNIT-III	Route of entry of pollutants into ecosystem-Surface water, land, Air; Uptake of toxic substances by plants, metabolic basis of toxicity of SO_2, NO_2, O_3 and heavy metals in plants; Microbial transport of toxic metals; Air and water borne toxins and diseases; Radiation toxicity and safety measures; Biomonitoring and bioindicators of toxicants; response of ecosystem to toxicants ; biodegradable and non-biodegradable toxic substance. (12 lectures)
UNIT-IV	Uptake of toxic substances by animals; Accumulation and chemical localization of toxic substances by animals; detoxification and excretion of toxic substances by animals; Metabolism of toxic substances by animals.; Aquatic toxicity testing ,Response of planktons to animals; pest & pesticides: classification, surveillance, resistance & residual effects. (12 lectures)
UNIT-V	Toxic effect of pollution on terrestrial animals; xenobiotics in environment, bio concentration, biological and non-biological degradation, detoxification; chemical hazard assessment and communication; Information management system in Eco-toxicology; fumicatoris and masticatories; Microbial toxicology-concepts and principle , Algal toxins, Mycotoxins, Cyanobacteria; Eco toxicology-legal perspectives and animal ethics. (12 lectures)
Reference Books	• INTRODUCTION TO ENVIRONMENTAL TOXICOLOGY- WAYNE .G. LANDIS, MING HO YU, 3RD ED. (2002) LEWIS PUBLISHERS, CRC PRESS , NY. • ESSENTIALS OF TOXICOLOGY – KLASSEN CD, WATKN J.B (2003) 3RD ED., MC GREW HILL, NEW YORK • FUNDAMENTAL OF ECOTOXICOLOGY- NEWMAN • ENVIRONMENTAL TOXICOLOGY AND POLLUTION- CHARLES • TOXIC METALS AND ENVIRONMENTAL ISSUES- V.P. SINGH
Suggested E-resources	• chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.atsdr.cdc.gov/training/toxmanual/pdf/module-1.pdf • https://open.umn.edu/opentextbooks/textbooks/940 • hrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.routledge.com/rsc/downloads/2._10.1201_9781315117867-1_(1).pdf • https://www.academia.edu/40198716/ENVIRONMENTAL_TOXICOLOGY_Second_Edition_Biological_and_Health_Effects_of_Pollutants

Third Semester

Code of the Course	**EVS9102T**
Title of the Course	**Remote Sensing and GIS applications in environment**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Discipline Specific Course (DSE) in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Learning outcomes	To have a detailed concept of remote-sensing and GIS techniques, physical principles, sampling, statistics and image-analysis for earth ,environment and natural resources
Syllabus	
UNIT-I	Introduction to remote sensing. Principles, scope and definitions; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; Platforms, Sensors and type of scanning systems. Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites. aerial photography and image interpretation (12 lectures)
UNIT -II	Spectra of Environmental components, its application to mining of mineral resources, landslides, land subsidence and earthquake. Waste land mapping; RS & GIS applications to ocean, atmosphere, land, geology ,water resources, disaster mapping. (12 lectures)
UNIT-III	Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; (12 lectures)
UNIT-IV	land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping and their use to solve environmental problems. Concept. Scope and applications of GPS. (12 lectures)
UNIT-V	GIS and spatial distribution of environmental data. Use of GIS software, Remote sensing and GIS applications in Management and monitoring of Environment, conservation of resources, natural resources, forest fire, coastal zone management. (12 lectures)
Reference Books	• Burrough, P. A. and McDonnell, R.A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York • Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London • Lillesand, T. M., Kiefer, R. W. and Chipman, J. W.(2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi • Jensen, J.R. (2006). —Remote Sensing of the Environment – An Earth Resources Perspective‖, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi.

Suggested E-resources	• 1515386624Paper-06_Module-02_etext.pdf • 1511163301Paper_6_Module_06_PC_Puneeta_Fundamental • 1532682622Paper-06_Module-10_etext.pdf • 1511167279Paper_6_Module_20_PC_Puneeta_DataStructurein

Third Semester	
Code of the Course	**EVS9103T**
Title of the Course	**Instrumental and environmental analysis**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Discipline Specific Course in Environmental Sciences (DSE)
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To impart knowledge on instruments and equipments used in different environmental analysis
Learning outcomes	After the completion, one can opt it for skill development and as a professional career line
Syllabus	
UNIT-I	Basic concepts of instrumentation, current, voltage and power; pH meter, conductivity meter, TDS meter, Visible spectrophotometer, Homogenizer, Autoclave, colony counter . (12 lectures)
UNIT -II	Introduction of basic field instruments: Handy air sampler, Noise level/Sound level meter; lux meter; pedometer; compass; Anemometer; High volume air sampler-construction, principle and working . . (12 lectures)
UNIT-III	Introduction to advance concepts of Instrumentation –theory, principle & working and application of UV-Spectrophotometer, flame photometer, CO_2 analyzer, AAS, methane analyzer, refrigerated centrifuge, plant growth chamber, HPLC, gas chromatography, Paper chromatography, NMR, X-ray, Infra red gas analyzer. (12 lectures)

UNIT-IV	Introduction to solution preparation; calculation of concentration of solution using specific gravity and molecular weight; units of concentration of solution; inter conversion; ionic product of water, pH, p^{oH} , buffer solutions. (12 lectures)
UNIT-V	Selection of sampling sites, analytical methods and selection of appropriate analytical technique; sample blank preparation and solvent blank preparation ; efficiency of sampling; preparation of serial dilutions and standard curves for air, water ,soil and plant analysis. (12 lectures)
Reference Books	• S. MORRIS MEASUREMENT AND INSTRUMENTATION PRINCIPLES, PRENTICE HALL OF INDIA, NEW DELHI, • G. D. CHRISTIAN ANALYTICAL CHEMISTRY, JOHN WILEY AND SONS • FUNDAMENTAL OF ENVIRONMENTAL SAMPLING & ANALYSIS- CHUNLANG ZHANG • HANDBOOK OF METHODS IN ENVIRONMENTAL STUDIES- S.K. MAITI
Suggested E-resources	• chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://download.e-bookshelf.de/download/0000/5840/61/L-G-0000584061-0002361013.pdf • 15239564287modulee-Text.pdf • 1523956501Module-08Paper1-IE-TEXT.pdf • 1523956529Module-09Paper1-E-TEXT(1.pd • 1523956735Module-12Paper-1-E-TEXT.pdf • https://www.academia.edu/52575954/Randy_D_Down_and_Jay_H_Lehr_Eds_Environmental_instrumentation_and_analysis_handbook?uc-sb-sw=38819407

Third Semester	
Code of the Course	**EVS9104T**
Title of the Course	**Industrial Waste Management**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Discipline Specific Course in Environmental Sciences (DSE)

Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To impart basic knowledge of waste management
Learning outcomes	After the completion, one can opt it for skill development and as a professional career line/ To evaluate the health risks posed by abandoned waste sites and waste disposal operations and involve chemistry and its associated applications.
Syllabus	
UNIT-I	Sources and generation of solid waste, their classification and chemical composition; characterization of municipal and industrial solid waste; hazardous waste and biomedical waste. (12 lectures)
UNIT -II	Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of landfill leachate on soil characteristics and ground water pollution. (12 lectures)
UNIT-III	Different techniques used in collection, storage, transportation and disposal of solid waste (industrial, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques. (12 lectures)
UNIT-IV	Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant. (12 lectures)
UNIT-V	Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification. Green techniques for industrial waste treatment. (12 lectures)
Reference Books	• US EPA. 1999. Guide for Industrial Waste Management. Washington D.C. • Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press • McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons. • Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.
Suggested E-resources	• 1522921989paper11_module_4_etext.pdf • 1520335712paper11_module_35_etext.pdf • 1519278491paper11_module_28_etext.pdf • 1511175561Paper_11_module_12_yoga_etext.pdf

Semester III PRACTICAL-I (DSE-LAB)	
Code of the Course	**EVS9105P**
Title of the Course	**Air Analysis Lab**
Credit of the course	04
Learning outcomes	To have knowledge of field experiments, observations, sampling and analysis related to air and air pollution
EXPERIMENT DETAILS	

	1. To determine the LAI, chlorophyll content, soluble leaf protein, ascorbic acid, phenol, carbohydrate and air pollution tolerance index (APTI) of selected plants species and comparison of plants for their relative susceptibility to pollution
	2. Estimation of chlorophyll a, b and total chlorophyll from commercial, roadside and industrial areas.
	3. Estimation of crude proteins
	4. To evaluate bryophytes and lichens for their sensitivity to different pollutants
	    1. Number of species
	    2. Degree of cover
	    3. Frequency of each species
	    4. Growth and development
	    5. Biomass
	    6. Chlorophyll content
	5. Permanent Preparation of slides- xerophytes, hydrophytes, zooplankton and phytoplankton in polluted and non polluted areas.
	6. Determination of the dust capturing capacity and percent leaf area injury of selected plant species.
	7. Effect of heavy metals on seed germination and early seedling growth.
	8. Effect of heavy metals on ascorbic acid content in plant leaves.

	9. Effect of heavy metals on chlorophyll content, soluble protein, phenols and carbohydrates. 10. Determination of the following in ambient air by high volume sampler: 1. SPM 2. RSPM 3. SOX 4. NOX 11. Study on the effect of selected air pollutants on some plants 12. An air quality survey report of given area
	SPOTTING: : • Air pollution indicator plants • Pollutant sensitive and resistant plant species • RDS • HVS • CO_2 analyser • Methane analyser • Spectrophotometer • Heavy metal sensitive and resistant plant species
Reference Books	• ENVIRONMENTAL SCIENCE PRACTICAL BY PANDEY AND SHARMA • HANDBOOK OF METHODS IN ENVIRONMENTAL STUDIES BY S. K. MAITI
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

Semester III PRACTICAL-II (DSE-LAB)	
Code of the Course	**EVS9106P**
Title of the Course	**Instrumentation Lab**
Credit of the course	04
Learning outcomes	After learning , student will be able to operate instruments used in air, water, soil and noise pollution analysis
EXPERIMENT DETAILS	
	1. Working and principles of handling various equipments: a) High volume air sampler b) Spectrophotometer c) Refrigerated centrifuge d) Homogenizer e) Flame photometer f) Gas analyzer g) Growth chamber h) Atomic Absorption Spectrophotometer i) Autoclave j) Polarograph k) Muffle furnace l) Bomb calorimeter Diagram, working and instrumentation of all the equipments mentioned above

	2. Use of animals in terrestrial and aquatic ecosystem as bio indicators/ bio monitors (mammals/micro arthropods/earthworms/wood lice/molluscs 3. Measurement of noise in silent, industrial, residential and commercial zones.
	SPOTTING : • pH meter, conductivity meter, TDS meter , turbidity meter, weigh balance ,sound level meter • Principle & working of STP's and ETP's • Heavy metal identification • Field excursion
Reference Books	• ENVIRONMENTAL SCIENCE PRACTICAL BY PANDEY AND SHARMA • HANDBOOK OF METHODS IN ENVIRONMENTAL STUDIES BY S. K. MAITI • METHODS IN ENVIRONMENTAL ANALYSIS WATER SOIL AND AIR - P.K.GUPTA
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

Third Semester	
Code of the Course	**EVS9107T**
Title of the Course	**Energy and Environment**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Generic Elective Course in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	The course covers environmental impact of energy production and consumption

Learning outcomes	Students are expected to be able to summarize the basic concepts of energy, its distribution and its relation to environment pollution
Syllabus	
UNIT-I	Definition of Energy, energy resources, Energy units, Energy production and consumption pattern-world and India, Renewable and non renewable sources of energy. (12 lectures)
UNIT -II	Fossil fuels- classification, composition, physicochemical characteristics and energy content of coal, petroleum and natural gases, fission and fusion. (12 lectures)
UNIT-III	Renewable Energy Resources : Principles of generation of hydroelectric power, Tidal and OTEC, wind, geothermal, solar energy, solar radiation and its spectrum , solar collector, photovoltaic, solar pond, geothermal energy, hydrogen energy; Biomass for bio-energy and biofuels-different routes of biomass conversion . (12 lectures)
UNIT-IV	Environmental impacts of non-renewable and renewable energy:, air pollution and thermal pollution from fossil fuels, radioactive wastes from nuclear power plants, hazards related to hydropower; Energy Use and its Environmental Impact ;Energy use pattern in different parts of the world; Environmental implication. (12 lectures)
UNIT-V	Energy Resource Management ; Energy crisis; Energy Conservation and Management; Energy audit; Promise and problems of Nuclear energy. Impacts of large-scale exploitation of Solar, Hydro and Wind energy. (12 lectures)
Reference Books	• R. A. Ristinen and J. J. Kraushaar Energy and the Environment, John Wiley and Sons,1998 • Chichester, 2010. Renewable Energy and Climate Change. John Wiley & Sons Ltd • G.D. Rai, Non-Conventional Sources of Energy, Khanna Publishers, 1997
Suggested E-resources	• 1511327362Paper7_EnergyEnv_module_2_etext-Solarradiation.pdf • 1522918941Paper7__module_14_etext.pdf • 1511327847Paper8_EnergyEnv_module_18_etext-Nuclearenergy.pdf • 1522920652Paper7_module_32_etext.pdf • 1522918457Paper7_module_33_etext.pdf

Third Semester	
Code of the Course	**EVS9108T**
Title of the Course	**Environmental geosciences**
Qualification Level of the Course	NHEQF Level 9.0
Credit of the course	4
Type of the course	Generic Elective Course in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	The course will introduce students to the fundamental scientific understanding of environment and its relation to geology of earth and its different processes
Learning outcomes	Student will be able to learn about fundamentals of geosciences and evolution of earth with the impact of changes on environment due to hazards, natural calamities on living system
Syllabus	
UNIT-I	Solar system formation and planetary differentiation; formation of the Earth- formation and composition of core, mantle, crust, atmosphere and hydro-sphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans, role of humans in shaping landscapes. (12 lectures)
UNIT -II	Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents, paleontological evidences of plate tectonics; continental collision and mountain formation with specific example of the Hima-laya. (12 lectures)

UNIT-III	Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers. (12 lectures)
UNIT-IV	Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes. (12 lectures)
UNIT-V	Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis,etc. Formation of the Himalaya; development of glaciers, perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, arrival of humans; evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw. (12 lectures)
Reference Books	• Keller, E.A. (2007). Introduction to Environmental Geology, 4th Edition. Prentice Hall of India. • Grotzinger, J., & Thomas, H.J. (2007). Understanding the Earth, 5th Edition. FRANK PRESS and RAYMOND SIEVER, • Bridge, J. & Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press
Suggested E-resources	• https://groundwater.ucdavis.edu/files/156562.pdf https://opengeology.org/textbook • 1515493121paper4module01_etext.pdf • 1522991363paper4_module16_etext.pdf • 1518524233paper4module_25_etext.pdf • 1519204012paper4module_37_etext.pdf • 1522991522Paper4module17_etext.pdf

M.Sc. (Two Years Degree Program under NEP scheme)

Subject-Environmental Sciences

Fourth Semester

Code of the Course	**EVS9009T**
Title of the Course	**Environmental and occupational health**
Qualification Level of the Course	NHEQF Level 6.5
Credit of the course	4
Type of the course	Discipline Centric Compulsory Course (DCC) in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To understand basics of environmental and occupational health
Learning outcomes	After completion , the student will be able to learn about the pathogens present in environment, occupation related hazards and their prevention

Syllabus

UNIT-I	Basic principle of environmental health; Environmental factors and human health; Physiological responses of man to relevant stresses in the environment; Disease causing infectious organisms (Virus, bacteria, and parasites); teratogens and mutagens; Detailed account of AIDS and sexually transmitted diseases (STD); Environmental health management. (12 lectures)
UNIT -II	Air pollution and human health; causes of air pollution and air borne diseases, Soil pollution- Sources and effect on human health; Water pollution- sources and effects on human health; water borne diseases; Risk assessment and preventive measures; Toxicogenomics- interaction of pollutants with biological systems at different levels-organism, organ and organelles.(12 lectures)
UNIT-III	Environmental health management in India; Occupational health safety and health administration; Environmental health in indigenous tribal communities- problems and remedies; Environmental health protection - Issues and problems; Industrial safety management techniques and standards. (12 lectures)

UNIT-IV	Definition of occupational health, Occupational hazards and associated diseases- silicosis, anthrax and other lung diseases; WHO standards of working conditions; factors affecting occupational health (physical, chemical and biological); prevention of occupational diseases; Various international organizations (WHO, ILO, UNICEF) on human health, Lead poisoning, occupational cancers, Dermatitis (12 lectures)
UNIT-V	Nuclear pollution and human health- case studies; Agriculture chemicals and human health; Hazardous wastes- human health and management; Noise pollution and human health hazards; Human health education and awareness. Hazard evaluation in polluted environment with specific emphasis on radiological health; Causes and consequences of hazardous wastes in soil, water and air with respect to human health; Industrial hygiene application and statistical methods through medical records, in study of health problems of human population in green environment (12 lectures)
Reference Books	• Environmental Health : Monroe T. Morgan • Handbook of Environmental Health and Safety – principle and practices : H. Koren; Lewis Publishers
Suggested E-resources	• chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ksumsc.com/download_center/Archive/3rd/435/Teams/Community%20Medicine/2nd%20semester/Environmental%20and%20occupational%20health%20part%201.pdf • https://link.springer.com/book/10.1007/978-3-030-41486-3

Fourth Semester

Code of the Course	**EVS9109T**
Title of the Course	**Environmental Planning & Biostatistics**
Qualification Level of the Course	NHEQF Level 6.5
Credit of the course	4
Type of the course	Discipline Specific Course (DSE) in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To have a better understanding of planning and statistical applications related to environment
Learning outcomes	One can understand planning related to environment and biostatistics applied to the subject
Syllabus	
UNIT-I	Basic concepts of Environmental planning; Environmental priorities in India; Urban planning; Environmental problems of urban planning; Rural environmental planning; National and State Environmental policies**.** (12 lectures)
UNIT -II	Land use and degradation; Land use planning; Waste land and their reclamation\; Water logging; Salinization of lands; Strategies for sustainable land management**.** (12 lectures)
UNIT-III	Watershed management and planning in India; Structure and functioning of MOEF, CPCB, SPCB; Wetlands planning and management; Eco friendly technologies for natural resources. (12 lectures)
UNIT-IV	Fundamentals of Biostatistics -basic concept & introduction to sampling methodology; measures of central tendency and graphical representation of data: Mean (arithmetic, harmonic and geometric), Median and Mode; Measures of central tendency & dispersion; Skewness and Kurtosis, Poisson and binomial distribution; Standard deviation; Standard error of mean. (12 lectures)
UNIT-V	Null hypothesis, t test and pair T test; Chi square test, Coefficient of association (measure of association); Analysis of variance; Probability –definition, addition and multiplication laws; concept of random variable; Correlation coefficient- testing of significance of correlation coefficient; Regression coefficient and the line of best fit; relationship between correlation and regression. Introduction to multivariate methods for environmental sciences– ANOVA (one way & two way), PCA, factor analysis and cluster analysis. (12 lectures)
Reference Books	• Statistical Methods, Gupta, S.P. (1996) Sultan Chand & Sons Publications, New Delhi • Practical Statistics (vol 1&2): Singh; Atlantic Publishers

Suggested E-resources	• chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://primumnilnocerefiles.wordpress.com/wp-content/uploads/2017/06/key-concepts-in-environmental-planning1.pdf • chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://drshahpak.weebly.com/uploads/5/6/3/3/5633102/statistics_for_environmental_science__management_2nd-manly-crc_press-2008.pdf

Fourth Semester	
Code of the Course	**EVS9110T**
Title of the Course	**Environmental Microbiology and Biotechnology**
Qualification Level of the Course	NHEQF Level 6.5
Credit of the course	4
Type of the course	Discipline Specific Course in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To learn the application of biotechnology and microbiological techniques in environment
Learning outcomes	After the study one have the knowledge of biotechnology and microbiology application to save environment
Syllabus	
UNIT-I	Classification, characteristics, occurrence, distribution and ecological importance of microorganisms; Photo autotrophs, chemo lithotrophs, organotrophs, parasites and their environmental importance; Soil microorganisms and their interactions relative to soil fertility; Detection of microbial toxins. (12 Lectures)
UNIT -II	Fermentation technology; wastes as a source of microorganism; compost and processes of composting; factors effecting the process of composting; microbes in biogas production, microbes in hydrogen and hydrocarbon production; application of immunofilteration; immunoprecipitation and DNA probing methods for detection of microbial pathogens in aquatic environment (12 Lectures)

UNIT-III	Environmental biotechnology- scope and application, scope of cleaner technology, tools and techniques of biotechnology; Application of plants tissues culture technology for micro propogation of stress tolerant plants (12 Lectures)
UNIT-IV	Microbes and their genetic engineering for degradation of pollutants; Application of microbes as biofertilizers and bio pesticides; Microbes in bio mining, bio hydrometallurgy and bio mineralization; Application of recombinant DNA technology for improvement of bacterial strains; Microbial degradation of Xenobiotics, Microorganism in abatement of heavy metal pollution; Bioremediation (12 Lectures)
UNIT-V	Principle and application of biosensors for detection of pollutants; Risk assessment for recombinant biosensors; Anaerobic biotechnology for sustainable waste treatment; oil spills-causes and recovery; Biodegradation of petroleum (hydrocarbon); use of super bugs for removal of oil spills; Aero microbiology, Aeroallergens and microbial pathology in human health (12 lectures)
Reference Books	• Environmental Biotechnology- Raj Mohan Joshi • Environmental Biotechnology- S.N. Jogdand • Handbook of Environmental Microbiology- S. C. Bhatia • A Text Book of Animal Biotechnology- B. Singh
Suggested E-resources	• 1515056403paper15_module_13_etext.pdf • 1515056209paper15_module_14_etext.pdf • 1512628241Paper15EMB_Module38_PCBabitaKhosla_etext.pd • 1513593552Paper15_Module40__etext.pdf

Fourth Semester	
Code of the Course	**EVS9111T**
Title of the Course	**Environmental Impact Assessment**
Qualification Level of the Course	NHEQF Level 6.5
Credit of the course	4
Type of the course	Discipline Specific Course (DSC) in Environmental Sciences

Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Learning outcomes	One will have knowledge about recent methods, programmes and projects, preparation of EIS and EIA reports and institutional requirements of assessment of environmental impacts of policies and plans
Syllabus	
UNIT-I	Introduction to environmental impact assessment; origin and development of environmental impact assessment; relationship of environmental impact assessment to sustainable development; basic concepts, objectives and its significance of EIA; EIA guidelines -1994 and modified in 2006; Generalized approach to impact analysis. (12 lectures)
UNIT -II	Environmental Impact statement process; environmental impact assessment methodologies-Adhoc method; Check list methodologies-Matrix method, LCA method. (12 lectures)
UNIT-III	Introduction to environmental planning, Baseline Information and predictions- land, water, atmosphere, energy and socio-economic status and demographic profile; environmental audit-guidelines concept and process; concept of public participation- public hearing; ISO 9000, 14000 &18001. (12 lectures)
UNIT-IV	Prediction and assessment of impact on water, air, Noise, soil and biological systems; cost benefit analysis . (12 lectures)
UNIT-V	R & R plan(Act).2007; Green belt development; National environmental policies and guidelines in India; condition and approach for EIS review; Case–studies-River valley projects, Thermal power plants, Mining projects, Dams and reservoirs, Oil refineries, Petro chemicals, national Highway Projects; Identification and prediction of Impact mitigation measures. (12 lectures)
Reference Books	• L. Carter Environmental Impact Assessment, McGraw Hill • P. Morris and R.Therivel Methods of Environmental Impact Assessment, Spoon Press • Methods of Environmental Impact Assessment: P. Morris & R. Therivel; UCL Press • Environmental Impact Assessment (2003): A. K. Srivastav; A P H Publishing Corporation • Introduction to Environmental Impact Assessment: Glasson; Research Press
Suggested E-resources	• 1513588249paper13module25-Etext.pdf • chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://shelter cluster.s3.eu-central-1.amazonaws.com/public/docs/GRRT%203%20-%20Environmental%20Impact%20Assessment%20Tools%20and%20Techniques.pdf

Fourth Semester

Code of the Course	**EVS9112T**
Title of the Course	**Restoration Ecology**
Qualification Level of the Course	NHEQF Level 6.5
Credit of the course	4
Type of the course	Discipline Specific Course in Environmental Sciences
Delivery type of the Course	Lecture, 40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment and subject/class activity problem solving. etc
Objectives of the course	To have knowledge about extent of deterioration in environment and methods to restore the damaged system
Learning outcomes	One can gain knowledge about restoring deteriorated ecosystems and opt this as a professional career line

Syllabus

UNIT-I	Contaminated lands: Types of contaminated lands and contaminants; effects of contaminants on biota; Ecology of Disturbed Ecosystems: disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems; Types of waste and its characteristics. (12 lectures)
UNIT -II	Aims and strategies of restoration: Concepts of restoration, single vs. multiple end-points; ecosystem reconstructions; physical, chemical, biological and biotechnological tools of restoration; Restoration of biological diversity: Acceleration of ecological succession, reintroduction of biota. (12 lectures)
UNIT-III	Degradation and restoration of natural ecosystems: Forests, Grasslands, Savanna, Aquatic; Selection of plant species for restoration. (12 lectures)
UNIT-IV	Restoration of degraded soils: Restoration of contaminated soils and soil fertility; mine spoil restoration. Phytoremediation, phyto stabilization, rhizo filte ration, phyto degradation, Conditioning strategies (12 lectures)
UNIT-V	Advances and possibilities in phytoremediation: Plant biochemistry, genetic engineering, transgenic plants, use of bacteria. Application and performances; Case studies: In India and abroad. (12 Lectures)
Reference Books	• The conservation Handbook : research, management and policy- W .J. Sutherland, Blackwell Science • Ecology, Environment and resource conservation – J S Singh ,S. P .Singh and S .R Gupta, Anamaya Publishers, New delhi

Suggested E-resources	• 1522996280paper15_module_5_etext.pdf • 1513592454Paper15_Module39__etext.pdf • https://link.springer.com/book/10.5822/978-1-61091-698-1 • chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/archive/review/documents/swhandbook.pdf

Semester IV PRACTICAL-I (DCC-LAB)	
Code of the Course	**EVS9113P**
Title of the Course	**Biostatistics Lab**
Credit of the course	04
Learning outcomes	To have knowledge of statistical applications on environmental data
EXPERIMENT DETAILS	
	1. Test the difference between means of two samples using 't' test and paired t test. 2. To determine the correlation between two variables. 3. Test of null hypothesis by computing SE of difference between two means. 4. To determine the association between two species by using chi- square test. 5. To determine mean, median and mode between various samples. 6. To determine geometric mean and harmonic mean. 7. Calculation of mean deviation, standard deviation and coefficient of variation. 8. To determine the regression between two variables.
	SPOTTING: : • Identification and study of coal : bituminous, lignite, anthracite, peat • Biomass pellets • Different types of woods : briquettes • Solar equipments: solar cooker, solar lantern, solar water heater, solar dryer, photovoltaic cell • Identification and study of local and migratory birds in and around the wetlands of Udaipur • Study and ecological significance of endemic plants and animals of southern Rajasthan

Reference Books	• Environmental Science Practical by Pandey and Sharma
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)
Semester IV PRACTICAL-II (DSE-LAB)	
Code of the Course	**EVS9114P**
Title of the Course	**Environmental Biotechnology Lab**
Credit of the course	04
Learning outcomes	After learning , student will be able to understand practical application of biotechnological techniques and microbiological applications for air, water, soil remediation
EXPERIMENT DETAILS	
	1. Introduction of biotechnological tools and techniques: principles and applications. 2. Isolation and culture of excised plant parts for micropropagation studies. 3. Isolation, purification and identification of aerobic bacteria from different soil and water sources. 4. Application of stage and ocular micrometer for measurements of microbes. 5. Preparation of different type's media for culture of bacteria, algae and plant tissues. 6. Isolation, purification and identification of mycorrhizal fungi. 7. Demonstration of biogas production by methanogen bacteria. 8. Study of the following: *a)* Organisms as bio fertilizer- *Azolla, Anabena, Nostoc, Aulosira, Plectonema, Oscillaloria, Tolypothrix, Glomus, Gigaspora, Sclerocystis, Rhizobium* Different stages of micropropagation -shoot multiplication, rooting, in vitro hardening
	SPOTTING : • Laminar Flow • Auto Clave • Hot Air oven • Sterlizer

	• Sprit lamp • Instruments for inoculation • Plant growth chamber • Micro Pipette • Stage & ocular Micro meter • Compound Micro scope
Reference Books	• Environmental Science Practical BY Pandey and Sharma • Manual of Microbiology Tools & Techniques - Kanika Sharma • Biotechnical Techniques- Abhilasha Shourie
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

Semester IV PRACTICAL-II (DSE-LAB)	
Code of the Course	**EVS9115P**
Title of the Course	**Environmental Training & Skill**
Credit of the course	04
Learning outcomes	After learning , student will be able to operate instruments used in air, water, soil and noise pollution analysis
EXPERIMENT DETAILS	
	▪ Hands on training and practical knowledge of different instrumental operations, industrial and field applications in environmental Sciences gained during Dissertation supported by attendance records, log book entries etc. ▪ A relevant certificate based on the performance of the student during internship having number of hours spent is must.
EOSE	• Internal Assessment - 20 marks (based on the practical approach) • End semester exams- 80 marks (report submission and PowerPoint presentation – 40 marks ; Viva voce -40 marks)

Semester IV PRACTICAL-II (DSE-LAB)	
Code of the Course	**EVS9116P**
Title of the Course	**Restoration ecology Lab**
Credit of the course	04
Learning outcomes	After learning , student will be able to operate instruments used in air, water, soil and noise pollution analysis
EXPERIMENT DETAILS	
	1. Assessment of different types of soils by Analytical methods. 2. To study the Effect of polluted soil on plants, leaf injury, biomass and dust capturing capacity and Chlorophyll content. 3. Selection of plants to be grown at polluted sites by calculating the APTI. 4. Reclamation of polluted soils (acidic and alkaline) by vermicomposting or vermiculture. 5. Effect of polluted soil on Earthworm health (Growth, Number, size, cocoon production) 6. Observation of certain areas where plants and soil degradation has occurred. 7. Selection of Restoration sites by phytoremediation of soil to gain fertility. 8. Analysis of mine soil for their physicochemical characteristics by tetrimetric method 9. Use of microorganisms for soil restoration
	SPOTTING : 1. Identification and study of ecological feature of some bio-indicator plants species (Acidic, Alkaline, Saline soil). 2. Landfill, Sanitary landfill, composting manure production. 3. Identification of plant Species for heavy metal accumulation 4. Study and identification of minerals and rocks. 5. Toxicity curves
Reference Books	• Environmental Science Practical BY Pandey and Sharma • Handbook of methods in Environmental studies by S. K. Maiti • Methods in Environmental analysis water soil and air - P.K.Gupta
EOSE	• Internal Assessment - 20 marks • End semester exams- 80 marks (Major I- 20; Minor I- 15; Minor II-10; Spotting- 20; Viva- 10 ; Record- 05 marks)

Fourth Semester	
Code of the Course	**EVS9117S**
Title of the Course	**Environmental Training & Skill**
Qualification Level of the Course	NHEQF Level 6.5
Credit of the course	4
Type of the course	Discipline Specific Elective Course in Environmental Sciences
Delivery type of the Course	04 credits (30 hrs/week each) of workload such as Independent / Group work, Field work, Project work / dissertation related to environment
Objectives of the course	To have hands-on training in the field and laboratory work in industry or consultancy related to environment
Learning outcomes	After the completion, one can opt it for a professional career line
Syllabus	
DETAILS	**1.** Minimum 6 weeks training/ project related to Environment in any industry / organization with a minimum attendance of 75%. **1.** Submission of successful Training Certificate along with attendance certificate **2.** Submission of detailed Training Report /Final Work Report in the form of Dissertation (Minimum 25 pages) which shall include following details : **a.** Introduction **b.** Objectives **c.** Detailed methodology **d.** Results including data collection and interpretation **e.** Conclusion and discussion supported with relevant references
EoSE	• Maximum marks for the paper is 100 (equivalent to theory paper - 80 for submission and 20 for internal assessment) • 80 marks (Write up- 40 marks ; clarity and project output -40 marks) • 20 marks - Internal assessment will require submission of short mid-term report of the progress of work being carried out to parent department and mentor will submit the internal marks