

**M.Sc., Environmental Sciences**  
**Semester I**  
**(CORE COURSE -I)**

**MI ENV01-CC01**

**CREDITS: 04**

**BASIC CONCEPTS OF ECOLOGY AND ENVIRONMENT**

**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.

**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.

**Unit III**

Biotic community: concept and classification; community characteristics- Qualitative, Quantitative, phytosociological methods: 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.

**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, Ramsar wetlands, wetlands with special reference to Rajasthan.

**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 .

**M.Sc., Environmental Sciences**  
**Semester I (CORE COURSE- II)**  
**M1 ENV02-CC02**

**CREDITS : 04**

**EARTH PROCESSES AND NATURAL CYCLES**

**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.

**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 tropic; 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 .

**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.

**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.

**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.

**M.Sc., Environmental Sciences**  
**Semester I (CORE COURSE- III)**  
**M1 ENV03-CC03**

**CREDITS : 04**

**NATURAL RESOURCES AND THEIR CONSERVATION**

**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.

**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.

**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.

**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.

**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.

**M.Sc., Environmental Sciences**  
**Semester I (CORE COURSE- IV)**

M1 ENV04-CC04

**CREDITS : 04**

**ENVIRONMENTAL POLLUTION AND MONITORING**

**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.

**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.

**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.

**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.

**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.

**M. Sc. Environmental Sciences**  
**Semester I (PRACTICAL COURSE - CPR-I)**  
**MI ENV05-CP01**

**CREDITS-04**

1. To determine minimum size of quadrat 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 gauge, Anemometer, Barometer, Pedometer, Compass, lux meter ,hygrometer
13. To find out Index of Dominance in given area >

**Spotting:**

- Thermometer,
- Rain gauge,
- 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 plants

**M. Sc. Environmental Sciences**  
**Semester I (PRACTICAL COURSE - CPR-II)**  
**MI ENV06-CP02**

**CREDITS-04**

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 CO<sub>2</sub>, 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, chironomus larva, nauplius larva, ticks, mites

**M.Sc., Environmental Sciences**  
**Semester III**  
**(CORE COURSE- IX)**  
**M3 ENV01-CT 09**

**CREDITS : 04**

**Environmental engineering and Waste management**

**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

**Unit II**

Air pollution control technologies-wet scrubbers, electro static precipitators, cyclone separator, gravitational settling chambers , bag filters, adsorption and absorption methods, incineration.

**Unit III**

Solid waste treatment technologies: land fill & sanitary land fill, composting, incineration; hazardous and industrial waste management; municipal solid waste management.

**Unit IV**

Energy conservation: renewable energy technologies-solar, wind, bio energy, geothermal, hydro power; nuclear energy production-process and functioning of nuclear reactors.

**Unit V**

Effluent treatment plant (ETP) & sewage treatment plant (STP) - design and working; eutrophication control and management procedure; reuse and recycling of plastic and metals

**M.Sc., Environmental Sciences**  
**Semester III**  
**(CORE COURSE- X)**  
**M3 ENV02-CT 10**

**CREDITS : 04**

**ENVIRONMENTAL LAWS AND ETHICS**

**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).

**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;

**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.

**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 labeling 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,

**Unit - V**

Environmental ethics : Concept and definition ; Anthropocentrism and Ecocentrism; Indian situation of ethics; shallow and deep ecology



**M.Sc., Environmental Sciences**  
**Semester III**  
**(DISCIPLINE SPECIFIC COURSE- I)**  
**M3 ENV03-DT 01**

**CREDITS : 04**

**ENVIRONMENTAL TOXICOLOGY**

**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 LD50; 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.

**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.

**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<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub> 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.

**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.

**Unit V**

Toxic effect of pollution on terrestrial animals; xenobiotics in environment, bioconcentration, biological and non biological degradation, detoxification; chemical hazard assessment and communication; Information management system in Eco-toxicology; fumicatoris and masticatoris; Microbial toxicology-concepts and principle , Algal toxins, Mycotoxins, Cynobacteria; Eco toxicology-legal perspectives and animal ethics.

**M.Sc., Environmental Sciences**  
**Semester III**  
**(DISCIPLINE SPECIFIC COURSE- II)**  
**M3 ENV04-DT 02**

**CREDITS : 04**

**Instrumentation and Environmental Analysis**

**Unit I**

Basic concepts of instrumentation, current, voltage and power; pH meter, conductivity meter, TDS meter, Visible spectrophotometer, Homogenizer, Autoclave , colony counter.

**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.

**Unit III**

Introduction to advance concepts of Instrumentation -theory, principle & working and application of UV-Spectrophotometer, flame photometer, CO<sub>2</sub> analyzer, AAS, methane analyzer, refrigerated centrifuge, plant growth chamber, HPLC, gas chromatography, Paper chromatography, NMR, X-ray, Infra red gas analyzer.

**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, pOH, buffer solutions.

**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.

**M. Sc. Environmental Sciences**  
**Semester III**  
**(PRACTICAL COURSE - CCPR-V)**  
**M3 ENV05-EP01**

**CREDITS-04**

1. Determination of the dust capturing capacity and percent leaf area injury of selected plant species.
2. Effect of heavy metals on seed germination and early seedling growth.
3. Effect of heavy metals on ascorbic acid content in plant leaves.
4. Effect of heavy metals on chlorophyll content, soluble protein, phenols and carbohydrates.
5. To calculate the LC 50 in fishes for heavy metals calculation of MATC and threshold concentration.
6. Short term bioassay lists of industrial pollutants in relation to fresh water animals.
  - a) Calculation of 96 hours LC 50
  - b) Assessment of threshold concentration.
  - c) Calculation of MATC ( Maximum acceptable toxicant concentration)
  - d) Calculation of application factor or safe concentration)
7. Observation of stomata movement and measurement of stomatal aperture
8. Observation of various stages of cell division in onion root tips with special reference to heavy metals
9. Observation of plant cell structure in onion peel
10. Study of petro plants and energy weeds
11. Principle, construction and working of biogas plant

> **Spotting:**

- Study and identification of minerals and rocks.
- Toxicity curves
- Heavy metal identification
- Principle & working of STP's and ETP's
- 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

**M. Sc. Environmental Sciences**  
**Semester III**  
**(PRACTICAL COURSE - DSE PR-I)**  
**M3 ENV06-EP02**

**CREDITS-04**

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

> **Spotting:**

- pH meter, conductivity meter, TDS meter , turbidity meter, weigh balance
- 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
- Field excursion

**M.Sc., Environmental Sciences**  
**Semester IV**  
**(CORE COURSE- XI)**  
**M4 ENV01-CT 11 CREDITS : 04**  
**ENVIRONMENTAL AND OCCUPATIONAL HEALTH**

**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.

**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.

**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.

**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.

**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

**M.Sc., Environmental Sciences**  
**Semester IV**  
**(CORE COURSE- XII)**  
**M4 ENV02-CT 12**

**CREDITS : 04**

**ENVIRONMENTAL PLANNING AND BIOSTATISTICS**

**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.

**Unit II**

Land use and degradation; land use planning; waste land and their reclamation; water logging; Salinization of lands; strategies for sustainable land management.

**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.

**Unit IV**

Fundamentals of bios statistics -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.

**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.

**M.Sc., Environmental Sciences**  
**Semester IV**  
**(DISCIPLINE SPECIFIC COURSE- III)**  
**M4 ENV03-DT 03**

**CREDITS : 04**

**ENVIROMENTAL IMPACT ASSESSMENT**

**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.

**Unit II**

Environmental Impact statement process; environmental impact assessment methodologies-Adhoc method; Check list methodologies-Matrix method, LCA method

**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.

**Unit IV**

Prediction and assessment of impact on water, air, Noise, soil and biological systems; cost benefit analysis.

**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.

**M.Sc., Environmental Sciences**  
**Semester IV**  
**(DISCIPLINE SPECIFIC COURSE- IV A)**  
**M4 ENV04-DT 04**

**CREDITS : 04**

**ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY**

**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.

**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 immunofiltration; immunoprecipitation and DNA probing methods for detection of microbial pathogens in aquatic environment.

**Unit III**

Environmental biotechnology- scope and application, scope of cleaner technology, tools and techniques of biotechnology; Application of plants tissues culture technology for micro propagation of stress tolerant plants.

**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

**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.



**M.Sc., Environmental Sciences**  
**Semester IV**  
**(DISCIPLINE SPECIFIC COURSE- IV B)**  
**M4 ENV04-DT 04**

**CREDITS : 04**

**Restoration Ecology**

**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.

**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.

**Unit III**

Degradation and restoration of natural ecosystems: Forests, Grasslands, Savanna, Aquatic; Selection of plant species for restoration

**Unit IV**

Restoration of degraded soils: Restoration of contaminated soils and soil fertility; mine spoil restoration. Phytoremediation, phytostabilization, rhizofiltration, phytodegradation, Conditioning strategies

**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

**M. Sc. Environmental Sciences**  
**Semester IV**  
**(PRACTICAL COURSE – CCPR-VI)**  
**M4 ENV05-EP03**  
**CREDITS-04**

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. Permanent Preparation of slides- xerophytes, hydrophytes, zooplankton and phytoplankton in polluted and non polluted areas.
3. Assessment of respiratory activity with increasing branch diameter
4. Qualitative and Quantitative analysis of plant enzymes
5. Estimation of chlorophyll a, b and total chlorophyll from commercial, roadside and industrial areas.
6. Estimation of crude proteins
7. To evaluate bryophytes and lichens for their sensitivity to different pollutants
  - (a) Number of species
  - (b) Degree of cover
  - (c) Frequency of each species
  - (d) Growth and development
  - (e) Biomass
  - (f) Chlorophyll content
8. Use of animals in terrestrial and aquatic ecosystem as bio indicators/ bio monitors (mammals/micro arthropods/earthworms/wood lice/molluscs)

**M. Sc. Environmental Sciences**  
**Semester IV**  
**(PRACTICAL COURSE – DSE PR-II A)**  
**M4 ENV06-EP04**

**CREDITS-04**

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. Introduction of biotechnological tools and techniques: principles and applications.
7. Isolation and culture of excised plant parts for micropropagation studies.
8. Isolation, purification and identification of aerobic bacteria from different soil and water sources.
9. Application of stage and ocular micrometer for measurements of microbes.
10. Preparation of different type's media for culture of bacteria, algae and plant tissues.
11. Isolation, purification and identification of mycorrhizal fungi.
12. Demonstration of biogas production by methanogen bacteria.
13. Study of the following:
  - a) Organisms as bio fertilizer- *Azolla*, *Anabena*, *Nostoc*, *Aulosira*, *Plectonema*,  
*Oscillaloria*, *Tolypothrix*, *Glomus*, *Gigaspora*, *Sclerocystis*, *Rhizobium*
  - b) 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

**M. Sc. Environmental Sciences**  
**Semester IV**  
**(PRACTICAL COURSE – DSE PR-II A)**  
**M4 ENV06-EP04**

**CREDITS-04**

**Practical Exercises for the special paper**  
**Restoration Ecology**

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. Assessment of different types of soils by Analytical methods.
  7. To study the Effect of polluted soil on plants, leaf injury, biomass and dust capturing capacity and Chlorophyll content.
  8. Selection of plants to be grown at polluted sites by calculating the APTI.
  9. Reclamation of polluted soils (acidic and alkaline) by vermicomposting or vermiculture.
  10. Effect of polluted soil on Earthworm health (Growth, Number, size, cocoon production)
  11. Observation of certain areas where plants and soil degradation has occurred.
  12. Selection of Restoration sites by phytoremediation of soil to gain fertility.
  13. Analysis of mine soil for their physicochemical characteristics by tetrimetric method
- Use of micro organism for soil restoration.
14. Use of micro organism for soil restoration
  15. 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