



**Punyashlok Ahilyadevi Holkar  
Solapur University, Solapur**



**Faculty: Science and Technology**

**Programme: PG**

**M.Sc. Part II**

**Environmental Science**

**Programme Structure and Syllabus**

**As per NEP-2020**

**(w.e.f. 2024-2025)**

**DEPARTMENT OF ENVIRONMENTAL SCIENCE,  
SCHOOL OF EARTH SCIENCES,  
PUNYASHLOK AHILYADEVI HOLKAR  
SOLAPUR UNIVERSITY, SOLAPUR**

**Punyashlok Ahilyadevi Holkar Solapur University, Solapur**  
**M.Sc. Environmental Science Choice Based Credit System (CBCS)**

**Course Structure (As per NEP-2020)**

**M.Sc. Part-II Environmental Science w.e.f. 2024-25**

M.Sc. Part II Semester - III										
Paper Code	Title of the Paper	Credits	Contact hours			Distribution of Marks for Examination				
			Th (L)	Pr (P)	Total	External		Internal		Total
						Th	Pr	Th	Pr	
<b>DSC-5</b>	Environmental Microbiology, Biotechnology & Nanotechnology	4	60	---	60	60	---	40	---	100
<b>DSC-6</b>	Statistical methods in Environmental Science	4	60	---	60	60	---	40	---	100
<b>DSE-3 (Elective – Any One)</b>	1. Hydrology & Watershed Management	4	60	---	60	60	---	40	---	100
	2. Industrial Safety, Health and Environment									
	3. Energy and Environment									
<b>RP - I</b>	Research Project	4	---	120	120	---	60	---	40	100
<b>DSC-5P</b>	Practical 7	2	---	60	60	---	30	---	20	50
<b>DSC-6P</b>	Practical 8	2	---	60	60	---	30	---	20	50
<b>DSE-3P (Elective – Any One)</b>	Practical 9 – Based on (1)	2	---	60	60	---	30	---	20	50
	Practical 9 – Based on (2)									
	Practical 9 – Based on (3)									
<b>Total for Semester-III</b>		<b>22</b>	<b>180</b>	<b>300</b>	<b>480</b>	<b>180</b>	<b>150</b>	<b>120</b>	<b>100</b>	<b>550</b>

M.Sc. Part II, Semester –IV										
Code	Title of the Paper	Credits	Contact hours			Distribution of Marks for Examination				
			Th (L)	Pr	Total	External		Internal		Total
						Th	Pr	Th	Pr	
DSC-7	Environmental Virology, toxicology and Bio-safety	4	60	---	60	60	---	40	---	100
DSC-8	Environmental Impact Assessment, Audit and ESG	4	60	---	60	60	---	40	---	100
DSE-4 (Elective – Any One)	1. Hazards and Disaster Management	4	60	---	60	60	---	40	---	100
	2. Natural Resources Management									
	3. Ecotourism									
RP -II	Research Project	6	---	180	180	---	90	---	60	150
DSC-7P	Practical 10	2	---	60	60	--	30	---	20	50
(Elective – Any One)	Practical 11-Based on (1)	2	---	60	60	---	30	---	20	50
	Practical 11-Based on (2)									
	Practical 11-Based on (3)									
Total for Semester-IV		22	180	300	480	180	150	120	100	550

**Abbreviations:** DSC: Discipline Specific Course, DSE: Discipline Specific Elective,

RM: Research Methodology, RP: Research Project, L: Lectures, P: Practical's, Th: Theory, Pr: Practical's.

✓ 4 Credits of Theory = 4 Hours of Teaching per Week

✓ 2 Credits of Practical = 4 Hours per week

**Choice Based Credit System with Multiple Entry and Multiple Exit Option  
(NEP-2020)**

**M.Sc. Environmental Science Programme  
M.Sc. Part–II Sem-III (Duration Six Months)**

<b>Paper Code / Course Code</b>	<b>Title of the Paper</b>	<b>Credits</b>
<b>DSC-5</b>	Environmental Microbiology, Biotechnology & Nanotechnology	4
<b>DSC-6</b>	Statistical methods in Environmental Science	4
<b>DSE-3 (Elective – Any One)</b>	1. Hydrology & Watershed Management	4
	2. Industrial Safety, Health and Environment	
	3. Energy and Environment	
<b>RP - I</b>	Research Project	4
<b>DSC-5P</b>	Practical 7	2
<b>DSC-6P</b>	Practical 8	2
<b>DSE-3P (Elective – Any One)</b>	Practical 9 – based on (1)	2
	Practical 9 – based on (2)	
	Practical 9 – based on (3)	
<b>Total Credits for Semester-III</b>		<b>22</b>

## SYLLABUS

DSC1-5	Environmental Microbiology, Biotechnology & Nanotechnology	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Microbiology:</b> History of Microbiology, germ theory of fermentation, disease, Scope of Microbiology, General structure, distinctive characteristics of protozoa, algae, bacteria, fungi, viruses, bacteriophages-lytic and lysogenic, Morphological and Ultrastructure of microbial cell (Gram positive and Gram-negative bacterial membrane, spore, pili, flagella), Microbial growth (physical characters - gaseous atmosphere, pH, other conditions and nutrition- nutritional classification. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential and enrichment media		
<b>Unit- 2 (15 Hrs.)</b> <b>Environment and microbes:</b> Environmental factors affecting microbial growth and microbial adaptations to extreme environments (like arctic regions and hot springs), Methods in microbial ecology including introduction to microbial genomics, Microbial habitats (air, soil, subsurface, freshwater, marine and the deep sea), Introduction to geomicrobiology, Natural microbial communities with emphasis on biofilms, Microbial biogeochemical processes of nutrient cycling and biodegradation, Applying microbes in wastewater treatment and solid waste management, Microbial disease ecology and public health, Transmission of microbial diseases through the environment.		
<b>Unit- 3 (15 Hrs.)</b> <b>a) Environment Biotechnology:</b> DNA structure and organization into chromosomes, restriction enzymes, cloning vectors, blotting Techniques. Mechanics of transcription, translation and their regulation in both prokaryotes and eukaryotes, PCR, RAPD and RFLP, Biotechnological applications. Agriculture, concepts of GMO/GEM. The scope, concept and broad outlines of various application areas of biotechnology, waste treatment, biodegradation, hydrocarbon degradation, bio-fuel production, bio-fertilizer, bio-pesticides production, and bioleaching. <b>b) Bioremediation and Phytoremediation:</b> Concept, role of bioremediation in controlling various pollution problems. Abatement of different types of pollution using plants, types of phytoremediation, mechanism involved with case studies. Applications in environmental biotechnology Bioreactors, Biomining. Biomethanation (Agro industrial wastes) and Biomining		
<b>Unit- 4 (15 Hrs.)</b> <b>Nano-Biotechnology:</b> Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals. Types of nanostructure and properties of nanomaterials, Nano Pollution, Air, Water and Soil Contaminants. Environment and Nanotechnology, Environmental Nano Remediation Technology. Application of Nanomaterial in microfuelcell, fuel Cell, hydrogen storage, Green Nanotechnology and its Applications. Use of nanoparticles for environmental remediation. Case studies and Regulatory needs		
<b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. (1982) John Wiley and Sons.</li> <li>2. Elements of Microbiology: Pelczar, M.J. and Chan ECS, 1981 Mc.Graw Hill.</li> <li>3. General Microbiology: Stainer, R.Y., Adelberg, E.A. and Ingraham, J.L. 1977. Macmillan Press.</li> <li>4. Microbial Methods for Environmental Biotechnology : Grainer, J.M. and Lynch, J.M. 1984. Academic Press</li> <li>5. Introduction to Environmental Biotechnology, A.K.Chatterji, Prentice Hall of India Pvt. Ltd, New Delhi</li> <li>6. Environmental Biotechnology-Basic Concepts and Applications Indu Shekhar Thakur I.K. International Pvt. Ltd. New Delhi.</li> <li>7. Environmental Biotechnology S.K. Agawal, APH Publishing Corp., New Delhi.</li> <li>8. Elements of Biotechnology, P.K.Gupta, Rastogi Publishing House, New Delhi.</li> <li>9. Environmental Biotechnology, Jogdand S.N., Himalaya Publishing House, New Delhi</li> </ol>		

10. Biotechnology, B.D.Singh, Kalyani Publishers , New Delhi
11. Molecular Biotechnology- Principles and Applications of Recombinant DNA, Glick and
12. Pasternak. Panima Publishing Corporation, New Delhi
13. A Text Book of Biotechnology, R.C. Dubey, S. Chand & company Ltd., New Delhi

## SYLLABUS

DSC1-6	Statistical methods in Environmental Science	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Fundamentals of Statistics:</b> Statistical sampling, purpose of sampling, principles of sampling, merits of sampling, basics and types of samplings, simple random sampling, Stratified random sampling, Systematic sampling, Multistage sampling. Statistical methods for environmental systems, Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves, pie diagram etc.		
<b>Unit- 2 (15 Hrs.)</b> <b>Measures of central tendency and their properties</b> -mean and its types, median, mode, Measures of dispersion-Variance, Standard Deviation, Mean Deviation, Coefficient of Variation, range and quartile deviation, concept and types of skewness and kurtosis, moments. Concept of probability, addition and multiplication theorem of probability, conditional probability and unconditional, probability, Simple problems on probability.		
<b>Unit- 3 (15 Hrs.)</b> <b>Statistical hypothesis and Tests:</b> Concept and types of hypothesis, Sampling theories and Hypothesis testing, null and alternative hypotheses, tests of hypothesis- t test, f test, z test and Chi-square tests, Sampling techniques and experimental designs. Testing hypothesis: Significance level and X <sup>2</sup> test, t and F test Variables of environmental interest.		
<b>Unit- 4 (15 Hrs.)</b> <b>Applied environmental statistical methods:</b> Concept of Correlation, its types and application in environmental Science, Concept of Regression lines- 'x' on 'y' and 'y' on 'x', regression analysis, large sample test for mean, proportions equality of means. Multivariate data structure, PCA, DCA, cluster analysis, CCA, types of analytical algorithms. Use of advanced statistical methods and tools in environmental data analysis.		
<b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Campbel, R.C., (1974), Statistics for Biologist, Cambridge University Press, UK.</li> <li>2. Ford, E.D. 2000, Scientific methods for Ecological Research. Cambridge University Press, Cambridge.</li> <li>3. Rosner, B. (1986), Fundamentals of Biostatistics, Duxbury Press, Boston.</li> <li>4. Zar, J.H. (1984), Biostatistical Analysis. Prentice-hall, Inc Englewood Cliff, New Jersey.</li> <li>5. Snedecor, W and G. Cochran, (1967), Statistical Methods. Oxford and IBH Publishing Co. Calcutta.</li> <li>6. Bodkin, Daniel D. (1995), Environmental Science- Earth As a Living Planet, John Wiley &amp; Sons, New York.</li> <li>7. Gore, Anil and Paranjpe, S.A. (2000), A Course on Mathematical and Statistical Ecology, Kluwer.</li> <li>8. Ludwig, J.A. and Judwig, J.F. (1988), Statistical Ecology, Wiley and Sons, New York.</li> <li>9. S. E. Jorgeson (1994), Fundamentals of Ecological Modelling, Levis Publications, New York.</li> <li>10. Pielou, E.C. (1997), An Introduction to Mathematical Ecology, John Wiley and Sons, New York.</li> <li>11. Gupta, S. P. 2000. Statistical Methods. Sultan Chand &amp; Sons, New Delhi.</li> </ol>		

12. Bio-statistic : A Foundation for analysis in the health sciences : Wayne W – Daniel John Wiley and sons Inc
13. Survival models and data analysis : Elandt – Johnson and Johnson, John Wiley and sons Inc.
14. Statistical Method for the analysis of Biomedical data : Wool son John wiley and Sons Inc.
15. Statistical Methods for Environmental and Agricultural Sciences A – Reza Horseman CRC Press Boca Raton Network
16. Text book of Environmental Engineering: P. Venugopala Rao, Prentice – Hall of India Pvt. Ltd. Delhi

## SYLLABUS

DSE1-3	1. Hydrology & Watershed Management	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Atmospheric Water System &amp; Hydrological Cycle:</b> Hydrologic cycle, Climate, Weather, Layers in atmosphere, Types and forms of precipitation, Hydro meteorological measurements, Cyclones, Fronts, Winds, Monsoon, Clouds, Requirements for Precipitation. Rainfall - Rain gauges, Adequacy of network, Spatial and Temporal distribution, Frequency and Intensity/duration analysis, Consistency, Missing data, Abstractions, Infiltration, Evaporation, Interception, Process, Estimation and Measurement, depression and detention storages.		
<b>Unit- 2 (15 Hrs.)</b> <b>Watershed:</b> Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multidisciplinary approach for watershed management. Water budget, Characteristics of Watershed, size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socioeconomic characteristics, basic data on watersheds.		
<b>Unit- 3 (15 Hrs.)</b> <b>Measurement &amp; Control of Erosion:</b> Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, Universal Soil Loss Equation (USLE), Soil and Water Assessment Tool model, Measures to Control Erosion, Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, rockfill dams, brushwood dam, Gabion, case studies of dam's erosion problems.		
<b>Unit- 4 (15 Hrs.)</b> <b>Ecosystem Management for watershed:</b> Role of Ecosystem, crop husbandry, soil enrichment, inter, mixed and strip cropping, cropping pattern, sustainable agriculture, bio-mass management, dry land agriculture, Silvi Pasture, horticulture, social forestry and afforestation. Selection of plant species for plantation, Organic farming and organic fertilizers. Agriculture and water management – participatory rural appraisal in watershed programs, community mobilization. Social Institutions: Gram-Panchayat, Self-help Groups for Women, Farmer. Managed small-scale irrigation systems (cooperative – Lift irrigation); Watershed Development Committees. people's participation, preparation of action plan, and role of NGO in watershed management with case studies.		
<b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Common guidelines for watershed development projects (2008). Government of India</li> <li>2. Dhruva N.V.V., Sastry G.O., (1990): Watershed management, ICAR, New Delhi.</li> <li>3. Frevert R.K., Schwab G.O., Edminster T.W., and Barnes K.K. (2009) Soil and water conservation engineering, 4th edition, John wiley and sons, New York.</li> <li>4. Jain S.K. and Sing V.P. (2006) Water resources system planning and management, Elsevier India, New Delhi</li> <li>5. Mukherjee A. (2004) Participatory learning and action: Monitoring and evaluation and participatory</li> </ol>		

monitoring and evaluation, Concept publishing company, New Delhi.

6. Rao K.V.S. (2003) Watersheds: comprehensive development, B.S. Publication.
7. Sharda V.N., Sikka A.K. and Juyal G.P. (2006) Participatory integrated watershed management: A field manual, central soil and water conservation research training institute, Dehradun.
8. Singh R.V. (2003) watershed planning and management, Yash publication, Bikaner
9. Water Resources Projects and their Environment Impact – Abbasi S.A. Discovery Pub. Hous, New Delhi 2001.
10. Land and Water Management by VVN Murthy, - Kalyani Publications.
11. Irrigation and Water Management by D.K. Majumdar, Printice Hall of India
12. Hydrology and Soil Conservation Engineering by Ganshyam Das
13. Watershed Management by JVS Murthy, - New Age International Publishers.
14. Water Resource Engineering by R. Awurbs and WP James, - Prentice Hall Publishers.

DSE1-3	2. Industrial Safety, Health and Environment	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Industrial Safety:</b> History and development of safety movement, Need for safety, Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels. Accident sequence theory, Causes of accidents, Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents, First aid. Financial costs-direct and indirect social costs of accidents. Compilation procedure for financial costs. Cost data, quality and its limitations-Budgeting.		
<b>Unit- 2 (15 Hrs.)</b> <b>Occupational Health Definition:</b> Role of WHO, Common occupational diseases, Occupations involving risk of contracting diseases, Mode of causation of the diseases and its effects, Diagnostic methods used for detecting occupational diseases. Biological monitoring. Evaluation of injuries, Hierarchy of control measures for occupational health risks, Occupational health management services at the work place. Lung function test on Medspirator, Ear testing on Audiometer. Physical health hazards, Chemical health hazards, Industrial dermatosis, Control methods and reduction strategies for air pollutants, noise and radiations. Prevention and control of occupational diseases. Environmental monitoring and occupational exposure limits.		
<b>Unit- 3 (15 Hrs.)</b> <b>Environmental stresses:</b> Physical, chemical, biological and ergonomic stresses, Principles of industrial hygiene, Overview of control measures. Permissible limits. Stress, Exposures to heat, Heat balance, Effects of heat stress, WBGT index measurement, Control Measures. Chemical agents, IS/UN classification, Flammables, Explosives, Water sensitive chemicals, Oxidants, Gases under pressure, Chemicals causing health hazards: irritants, asphyxiates, anaesthetics, systemic poisons and carcinogens, Chronic and acute exposure, Routes of entry, Types of airborne contaminants, Introduction to air sampling and evaluation methods, Engineering control measures, Principles of ventilation.		
<b>Unit- 4 (15 Hrs.)</b> <b>Occupational Safety, Health and Environment Management &amp; Personal Protective Equipment's:</b> Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000 OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM, Personal Protective Equipments - Role of personal protective equipment, Selection criteria for personal protective equipment, Respiratory and non-respiratory type personal protective equipments. Case Study on Safety Aspects in Industries Safety in chemical industry, Safety in textile industry, Safety in pharmaceutical industry, Safety in food industry, Safety in mine industry.		



**Reference Books:**

1. Industrial Safety and pollution control handbook: National Safety Council and Associate publishers Pvt. Ltd, Hyderabad (1993).
2. Handbook of Environmental Health and Safety: Herman Koren and Michel Bisesi, Jaico Publishing House, Delhi (1999).
3. Environmental Toxicology and Chemistry: Donald G. Crosby, Oxford University Press, USA (1998).
4. Handbook of Environmental Risk Assessment and Management: Peter Calow, Blackwell Science Ltd., USA (1998).
5. Principals of Environmental Toxicology: Ian C. Shaw and John Chadwick, Taylor and Francis, USA (1998).
5. The Factories Act-1948, Government Printing Press, Civil lines, Delhi (1994).
6. Risk Assessment and Environmental Management: D. Kofi Asvite-Dualy, John Willey & Sons, West Sussex, England (1998).
7. Introduction to Environmental Engineering & Science: Gilbert M. M., Pearson Education, Singapore (2004).
8. R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems, Khanna publishers , New Delhi (2006)
9. Slote.L.Handbook of Occupational Safety and Health, John Willey and Sons, NewYork .
10. Frank P. Lees, Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London (1991).
11. Industrial Safety -National Safety Council of India.
12. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai
13. Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi (2001)
14. Industrial Safety and pollution control handbook: National Safety Council and Associate publishers Pvt. Ltd, Hyderabad(1993).
15. Handbook of Environmental Health and Safety: Herman Koren and Michel Bisesi, Jaico Publishing House, Delhi (1999).
16. Handbook of Environmental Risk Assessment and Management: Peter Calow, Blackwell Science Ltd. USA (1998).

DSE1-3	3. Energy and Environment	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> Energy forms and significance; heat budget of the earth; global energy flow pattern; Global energy demand: past and current perspective; Energy demand and usage in domestic, industrial, agriculture and transportation sectors. Nature, scope and analysis of local and global impacts of energy use on the environment.		
<b>Unit- 2 (15 Hrs.)</b> a. Non-renewable resources: distribution and availability, fossil fuels-coal, oil and natural gas; Oil: formation, exploration, oil shale; Natural gas: exploration, liquefied petroleum gas, compressed natural gas; Coal: reserves, coal gasification; Environmental impacts of non renewable energy consumption; future energy options and challenges. b. Renewable resources: biomass, hydroelectric power, tidal energy, wind energy, geothermal energy, hydrogen energy; Solar: solar collectors, photovoltaics, solar ponds, solar heating system; Wave, ocean thermal, tidal energy and ocean currents; Geothermal energy; Future energy sources: Hydrogen fuels, Sustainable energy, energy from biomass; bio-diesel.		
<b>Unit- 3 (15 Hrs.)</b> Energy conservation and management local to global scales; Alternate energy generation system, efficiency, utilization and assessment; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.		

Environmental implications of energy use; Energy production as driver of environmental change; energy production, transformation and utilization associated with environmental impacts; Energy over-consumption and its impact on the environment, economy, and global change.

#### **Unit- 4 (15 Hrs.)**

Energy use pattern in India and the world, renewable energy potential in India; Emissions of CO<sub>2</sub> and other greenhouse gases in developed and developing countries including India; Current and future energy use patterns in the world and in India; alternative sources as green energy, need for energy efficiency; energy conservation and sustainability.

#### **Reference Books:**

1. Hossain, J., & Apel, M. (2014). Renewable energy integration: challenges and solutions. Springer Science & Business Media.
2. David E. (2007). Sustainable Energy, Opportunities and Limitations, Sustainable Energy: Opportunities and Limitations (Energy, Climate and the Environment) Publisher: Palgrave Macmillan.
3. Santra, S.C. (2011). Environmental Science, 3rd Edition. New Central Book Agency(P) Ltd, Kolkata, India.
4. Dell, R., & David A. J. R. (2004). Clean energy. Volume 5. Royal Society of Chemistry.
5. Coley, D. (2011). Energy and climate change: creating a sustainable future. John Wiley & Sons.

<b>RP-I</b>	<b>Research Project</b>	<b>Total Contact Hrs. 120</b>
Research Project / Field Work/ Industrial Project: Fieldwork/ industrial visits, nature visits are compulsory (amounting to 4 credits). The field / nature visit/work will be from 10 to 15 days. During the field visit/work students visits to various National, State Research Institutes, Environmental Consultancies, Project sites, industries, forest, sanctuaries, ecosystems, mines etc Component Marks Evaluating Authority Performance of the student in the field (Punctuality, enthusiasm, aptitude, report and presentation).		

## PRACTICAL SYLLABUS

DSC1-5P	Practical - 7	Total Contact Hrs. 60
<b>Practical's based on Environmental Microbiology, Biotechnology &amp; Nano-technology:</b> <ol style="list-style-type: none"> <li>1. Microscopy - a) Use of compound microscope b) Calibration of microscope</li> <li>2. Staining Techniques - a) Monochrome staining b) Negative Staining c) Gram Staining d) Special Staining Methods</li> <li>3. Slide culture techniques for examination of fungi / actinomycetes.</li> <li>4. Estimation of total viable counts in water and soil samples.</li> <li>5. Preparation and sterilization of microbial media.</li> <li>6. Determination of total bacterial and fungal count from garbage piles in housing colonies.</li> <li>7. Staining of bacterial suspension by simple staining method (monochrome)</li> <li>8. Staining of bacterial suspension by Hooker's modification or by Gram's staining.</li> <li>9. Preparation of rhizofertilizers</li> <li>10. Isolation of bacteria and Fungi from Air</li> <li>11. Sampling of aquatic weeds for bioremediation and Design of root zone bed for bioremediation</li> <li>12. Study of nanoparticles for wastewater pollution.</li> <li>13. Study of nanoparticles for air pollution.</li> </ol>		

DSC1-6P	Practical - 8	Total Contact Hrs. 60
<b>Practical's based on Statistical methods in Environmental Science:</b> <ol style="list-style-type: none"> <li>1. Grouping of data and preparation of frequency distribution. Histogram and frequency polygon</li> <li>2. Calculating mean, median and mode for grouped and ungrouped data</li> <li>3. Calculating variance, standard deviation and coefficient of variation for grouped and ungrouped data</li> <li>4. Fitting simple linear regression. Plotting scatter diagram and regression line</li> <li>5. Computing correlation coefficient and testing its significance for grouped and ungrouped data</li> <li>6. Comparison between means of two independent samples. Paired t-test</li> <li>7. Analysis of variance: one way classification</li> <li>8. Analysis of variance: two- way classification</li> <li>9. Fitting statistical model of air pollution to data</li> <li>10. Use of various software's for environmental statistical data analysis</li> </ol>		

DSC1-3P	Practical - 9	Total Contact Hrs. 60
<b>Practical's:</b> <ol style="list-style-type: none"> <li>1. <b>Practical based on Hydrology &amp; Watershed Management</b> <ol style="list-style-type: none"> <li>1. Study of drainage patterns, slopes and slope analysis.</li> <li>2. Watershed survey equipment's with information</li> <li>3. Tracing of watershed and their morphological features from toposheets</li> <li>4. Aerial photographs and satellite imageries with interpretations</li> <li>5. Problems in water budgeting.</li> <li>6. Problems on USLE and SWAT models</li> <li>7. Designing structures for water conservation and harvesting based on field visits.</li> <li>8. Build a physical model of a watershed.</li> <li>9. Identify watershed features such as drainage divides, rivers, tributary</li> <li>10. Use Google Earth to view watershed features.</li> <li>11. Locate watershed in and around campus.</li> <li>12. Describe land cover and population changes within a watershed.</li> </ol> </li> </ol>		

## **2. Practical based on Statistical methods in Environmental Science**

1. Measurement of Sound Levels.
2. Determination of concentration of inflammable vapours.
3. Measurement of Static Charge/Electricity with the help of Static Charge Meter.
4. Determination of Fire Load in a given work place.
5. Measurement of Vibrations of Machines and equipment.
6. Earthing continuity test.
7. Calibration of Rotameter by Wet Test Meter.
8. Detection of Carbon Monoxide, NOx Hydrogen Sulphide, Ammonia, Aromatic Hydrocarbons, SO<sub>2</sub> by Gas Detectors and other direct reading instruments.
9. Measurement of Concentration of Dust using Personal Sampler by Gravimetric Method.
10. Sampling and analysis of Ammonia.
11. Sampling and analysis of SO<sub>2</sub> using Colorimetric method.
12. Assessment of Heat Stress in Work Environment.
13. Plotting of an Audiogram by Audiometer.
14. Assessment of fire & explosion potential and their prevention.
15. Any other experiment as per the syllabus of theory courses and approval of the faculty
16. Visit to Fire and Safety office at MIDC areas.

## **3. Practical based on Energy and Environment**

1. Study of solar cells.
2. Conversion of biomass to alcohol.
3. Case studies on energy efficiency analysis.
4. Study of various agro wastes as substrates for biofuel production.
5. Biological degradation of recalcitrant biomass.
6. Case studies on energy use patterns across the globe.
7. Study of Weather Monitoring station
8. forecasting and calculation of weather data
9. Energy Generation plant visit – Solar, Wind farm, Biogas plant, Thermal plant etc

<b>M.Sc. Part II, Semester –IV</b>		
<b>Code</b>	<b>Title of the Paper</b>	<b>Credits</b>
<b>DSC-7</b>	Environmental Virology, toxicology and Bio-safety	4
<b>DSC-8</b>	Environmental Impact Assessment and Environment Audit	4
<b>DSE-4 (Elective – Any One)</b>	1. Hazards and Disaster Management	4
	2. Natural Resources Management	
	3. Ecotourism	
<b>RP -II</b>	Research Project	6
<b>DSC-7P</b>	Practical 10	2
<b>DSE-4P (Elective – Any One)</b>	Practical 11- based on (1)	2
	Practical 11- based on (2)	
	Practical 11- based on (3)	
<b>Total for Semester-IV</b>		<b>22</b>

### SYLLABUS

<b>DSC1-7</b>	<b>Environmental Virology, toxicology and Bio-safety</b>	<b>Total Contact Hrs. 60</b>
<b>Unit-1 (15 Hrs.)</b> <b>Virology:</b> History and principles of virology, virus taxonomy, introduction to replication strategies. Virus structures, animal and plant viruses, Virus structure and morphology, viruses of veterinary importance and plant viruses. Infrastructure Principles of biosafety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory.		
<b>Unit- 2 (15 Hrs.)</b> <b>Toxicology:</b> Classification of toxic material, Industrial toxicants and hazardous materials, Basic principles of toxicology: Concept of toxicants and xenobiotics, Route of exposure, Environmental Toxicology, Classification of toxic materials. Industrial toxicants and hazardous materials, Physiological and metabolic effects of toxicants, e.g. VOC and organic solvents, used in industry and Heavy metals such as Hg, Pb, AS, Cd etc. Fate of Toxicants in Ecosystems and Environment: Biotransformation, Bioaccumulation & Bio-magnification; Role of biotic and abiotic interactions. Toxicant Effects: Cellular, organismic, population & ecosystem-level effects.		
<b>Unit- 3 (15 Hrs.)</b> <b>Effects and Methods:</b> Intrinsic toxicity, dose, exposure conditions, response of host, Parameters of toxicity testing: Acute toxicity, Chronic toxicity TU, ICP TER, NOEC, LOEC, LC 50, LD50, TLM. Using test animals, non-animal toxicity test methods: In vitro cell and tissue-based method, In silico method and integrated testing method. Toxicity test: Range finding, Screening, Definitive toxicity test, Interaction of toxicants in combination: Additive, synergistic and antagonistic effects, Alternatives to animal tests, Mutagens, Teratogens and Carcinogen: Definition, sources, effects, Prevention, treatment and control. Biochemical and Molecular Ecotoxicology: Metabolism of selected ecotoxicants; Eco physiological toxicity, Role of enzymes, genes and growth regulators, Quantitative and qualitative assessment of biochemical and molecular ecotoxicity.		

**Unit- 4 (15 Hrs.)**

**Biosafety and biosecurity:** Concepts of biosafety and biosecurity - Biosafety Levels and Risk group, Classification, Containment, Good microbiological practices, Disinfection, Decontamination and Sterilization, Agents used, Solid versus liquid waste, Primary Barriers, Respiratory protection (N95, PAPR), Laboratory specific requirement, Fit testing required through Employee Health, Secondary Barriers, isolated zone, Double-door entry, negative pressure with different zoning. Classification of pathogens based on risk, Code of safe laboratory practices, Decontamination & disposal, Health & Medical surveillance, ABSL facilities, Safe shipment of specimens & infectious materials, Safety rules for domestic & cleaning staff, Good microbiological practices, Good clinical practices (GCP), Good clinical and laboratory practices (GCLP), Good Laboratory practices (GLP).

**Reference Books:**

- 1) Principles of Environmental toxicology:-Ian C.Shaw and John Chadwick, Taylor and Francies
- 2) Environmental Toxicology and Chemistry:-Donald G. Crosfy 1998
- 3) Water Toxicology: V. V. Metelev, A. I. Kanaev, N. G. Dzasokhova, Amerind Publishiing Company, Pvt, Ltd, New Delhi (1971).
- 4) Water Pollution and Toxicology: S. K. Shukla & P. R. Srivastava, Commonwealth Publisher, New Delhi (1992).
- 5) Toxicology – Principles & Methods: M. A. Subramanian, MJP, Publishers, Chennai (2004).
- 6) Industrial Toxicology: Raymond D Harbison, A Times Mirror Company, 5th Edition, New Delhi (2006).
- 7) Environmental Science: S.C. Santra, New Central Book Agency, Kolkata (2001).
- 8) Environmental Pollution Health & Toxicology : S V S Rana, Narosa Publishing House, New Delhi (2006).
- 9) Environmental Science Hazardous Gas & Waste : R K Sinha, Commonwealth Publisher, New Delhi (1994).
- 10) Toxicology: P D Sharma, Rastogi & Company, Meerut (1995).
- 11) Industrial Safety and pollution control handbook:- National safety council, New Delhi.
- 12) Handbook of Environmental Health and Safety:- Herman Keren and Michal Biseis (1999).
- 13) Safety Evaluation of Environmental Chemicals: - T.S.S. Diksheth (1995).
- 14) Handbook of Environmental Risk Assessment and Management, Peter Calow (1998) Black well Science Ltd.

**SYLLABUS**

<b>DSC1-8</b>	<b>Environmental Impact Assessment (EIA) and Environment Audit</b>	<b>Total Contact Hrs. 60</b>
<b>Unit-1 (15 Hrs.)</b> <b>Importance of EIA History and objectives</b> – Basis for Environment Impact Assessment, Goals of EIA, Evolution of EIA, NEPA, EIS, Environmental Protection Act, 1986. EIA Notification 1994 and 2006, Approach to EIA studies – mandatory requirements, project screening, scoping, environmental baselines, Public Participation best practices; terms of reference (ToR); Phases of EIA – Identification, Prediction, Evaluation, Decision making and Post Impact Monitoring, Major limitations of Environmental Impact Assessment. NABET, Categories of NABET accreditation, Functional Areas, Environmental clearance and accreditations, approvals for projects procedures, environmental clearance state, district and national portals, Linkage between development and environment; relationship of EIA to sustainable development		
<b>Unit- 2 (15 Hrs.)</b> <b>Methodologies -</b> Definition and concept of impact; Types of impacts (Negative & Positive: Primary & Secondary; Reversible and Irreversible; Tangible and Intangible); Impact identification methods, Adhoc Methods – Checklist Methods – Matrix Methods – Network Methods, Overlays, Leopold matrix, Batelle’s Environmental Evaluation System (BEES), Cost-Benefit Analysis.		

**Unit- 3 (15 Hrs.)**

- a. Components, Assessment and Public participation in EIA:** Environmental Setting; Baseline data; Prediction and evaluation of impacts; Environmental management plan and monitoring, Baseline information, Prediction and Assessment of Impacts on natural Resources – Biota, Surface Water, Ground Water, Air, Noise, Hazards, Historic and Cultural Resources, Transportation, Socio-economic relationships.
- b. Public participation and report writing in EIA:** Decision making, public participation in environmental decision making, Objectives and techniques for public participation, Advantages and Disadvantages of public participation. Preparation and writing of EIA reports - Case Studies: Land Clearing Projects – Dam sites – EIA for Aquaculture, Steel, Mines, Hydel, Thermal, Nuclear, Oil and Gas based Power Plants, Highways projects, new construction, Industrial Projects etc.

**Unit- 4 (15 Hrs.)**

**Environmental Auditing:** Definition of Environment Audit Scope, applicability and objective of environmental audit and its importance for industries, Factories Act. Types of Audit and Definitions, Audit tools and technology, Notification and guidelines for Environmental audit, Life Cycle Assessment, Environmental audit: Pre-Post audit process; International organization for standardization (ISO), ISO 14000 standards and certification, Environmental Management System (EMS), Eco labelling. Procedure of environmental auditing and Safety audit. Concept and procedures of Green, Energy and Environment audits for industries and institutions.

**Reference Books:**

1. Handbook of Environmental Impact Assessment (Vol. I): Judith Petts, Blackwell Science, USA (1999).
2. Handbook of Environmental Impact Assessment (Vol. II): Judith Petts, Blackwell Science, USA (1999).
3. Methods of Environmental Impact Assessment: Peter Morris, Ricky Therivel, UGC Press Limited, London (1994).
4. Environmental Impact Assessment & Management: Daya Publishing House, New Delhi (1998).
5. Environment Impact Assessment: Larry W. Canter, Mc-Graw Hill Inc., New York (1996).
6. Introduction of Environmental Impact Assessment: John Glassion, Rikay Therival and Chadwick, UGC Press Ltd., London (1994).
7. A monograph on Environmental Audit: The Institute of cost and works Accounts of India, New Delhi (1994)
8. Using Environmental Management system to improve profits: B. Pearson, BFP Little and M. J. Brierley, Graham & Thotman, Kluwer Academic Publisher Group, London (1992).

**SYLLABUS**

DSE1-4	1. Hazards and Disaster Management	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Introduction to Hazards and Disasters:</b> Definition - Hazard, vulnerability and risk, differences between disaster and hazards, types of hazards and disasters, natural disasters and manmade hazards. Introduction to Natural and Manmade Disasters; Floods –nature and frequency of flooding, flood hazards, urbanization and flooding, flood hydrographs, Drought, Landslides; Coastal hazards – tropical cyclone, coastal erosion, sea level changes, coastal zone management; Earthquakes - Seismic waves, quake resistant buildings and dams; Tsunamis; Volcanoes; Wild fires; Oil spills; Urban hazards and disasters.		
<b>Unit- 2 (15 Hrs.)</b> <b>a. Hazard Mitigation:</b> Identification of hazard prone belts, hazard zonation and risk assessment; risk reduction in vulnerable areas, developing warning systems, forecasting, emergency preparedness, education and training activities, planning for rescue and relief works. <b>b. Environmental health hazard and risk assessment:</b> biological, chemical, physical and psychological health hazard; health risk assessment and management. Biomedical waste Management Definition biomedical waste, Sources of generation, different categories, colour coding, related health hazards,		



## Treatment and disposal methods

### Unit- 3 (15 Hrs.)

**Disaster management:** Disaster Management: Definition of disaster management; components of disaster management cycle- crisis management & risk management. Crisis management- quick response & relief, recovery, development. Risk management- risk identification and risk assessment, risk reduction- preparedness, prevention and mitigation, risk transfer. Disaster management- act and policy. Strategies for mitigation – warning system, forecasting, Emergency Preparedness, Education and Training Activities, planning for Rescue and Relief works, National and state level planning for hazards mitigation, Engineered structure /structural strengthening techniques- Hazard zonation and mapping- Risk Reduction Measures. Disaster management plan, Social and economic impacts of disasters

### Unit- 4 (15 Hrs.)

**Geospatial technologies in Disaster Management:** Role of GPS, GIS and Remote Sensing in disaster management - Landslides, Volcanoes, Tsunami, Cyclones, Urban and Forest fires, Landslides; Decision-making models and processes; Hazard monitoring, tracking and modelling; Early warning systems; Indian space programme, future satellites for disaster management; Case studies.

### Reference Books:

1. Bryant Edwards (2005). Natural Hazards, Cambridge University Press, U.K.
2. Carter, N W. (1992). Disaster Management: A disaster Manager's Handbook, Asian Development Bank, Manila.
3. Disaster Planning: The Preservation of Life and Property, Harold D. Foster (1980). Springer Verlay, New York.
4. Disaster Management, Shailendra K Singh, Subash C. Kundu and Shobu Singh (1998). Mittal Publications, New Delhi.
5. Gautam Ashutosh. (1994). Earthquake: A Natural Disaster. Ashok Publishing House. New Delhi.
6. Natural Disasters – A Guide for Relief Workers, (1980). JAC Adhyatma Sadhna Kendra-Mehrauli, New Delhi.
7. Roy, P.S. (2000). Space Technology for Disaster management: A Remote Sensing & GIS Perspective, Indian Institute of Remote Sensing (NRSA), Dehradun.
8. Sharma, R.K. & Sharma, G. (2005). (ed) Natural Disaster, APH Publishing Corporation, New Delhi.
9. Singh D K. (2006). Towards Basics of Natural Disaster Reduction, Research book Centre, New Delhi,
10. Singh T. (2006), Disaster Management approaches and strategies, Akansha Publishing House, New Delhi.
11. Environmental Geology; Killer
12. Environmental Geology; K.Valdiya
13. Mineral economics: Sinha and Roy.
14. Indian Bureau of Mines, Govt. of India.
15. Handbook of energy technology by V. Daniel Hunt.

DSE1-4	2. Natural Resources Management	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Fundamentals of Natural Resources:</b> Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management.		
<b>Unit- 2 (15 Hrs.)</b> <b>Types of resources:</b> Forest-land-water-energy-food- fish and marine resources, Mineral resources- Use and exploitation, environmental effects of extracting and using mineral resources, case studies.		



**Unit- 3 (15 Hrs.)**

**Resource Management Paradigms:** Resource management the evolution and history of resource management paradigms. Resource conflicts: Resource extraction, access and control system.

**Approaches in Resource Management:** Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies. Poverty and implications in Resource Management in developing countries – Poverty in developing countries, causes and link with resources scarcity and poverty

**Unit- 4 (15 Hrs.)**

**Management of Common International Resources:** Ocean, climate, international fisheries and management commissions; Antarctica: the evolution of an international resource management regime.

**Ecosystem based Case-studies:** Ecosystem based case studies on mountain and coastal ecosystem. Ecosystem Services: Scope, application, model and examples from India and outside .

**Reference Books:**

1. Coastal Ecology & Management, Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition). Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303.
2. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
3. Agarwal, K.C., 2001. Environmental Biology, Nidhi Publication Ltd. Bikaner.
4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopaedia, Jaico Publishing House.
5. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press.
6. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)

DSE1-4	3. Ecotourism	Total Contact Hrs. 60
<b>Unit-1 (15 Hrs.)</b> <b>Introduction to Tourism and Ecotourism:</b> Tourism concepts and definitions, Evolution and characteristics of ecotourism, Forms and types of tourism, elements of tourism, Motivation of travel, Future trends, Geography of India, India's biodiversity, Tourism global context and national context, aims and objectives of ecotourism, Ecosystem processes, goods and services with special reference to tourism activities; an overview of Tourism-Environment linkages – 'Intangibility', 'Heterogeneity', 'Perishability' and 'Inseparability' of Tourism and their Ecological, Environmental, social, economic, cultural, ethical implications; impacts of mass tourism, environmental concerns, need for environmental conservation, alternative tourism strategies.		
<b>Unit- 2 (15 Hrs.)</b> <b>Recent trends in tourism:</b> Backwater tourism, Island and beach tourism, Mountain tourism, Mangrove Tourism, Wetland Tourism, Health tourism, Wildlife tourism, Pilgrimage tourism, Ethnic and Rural tourism, Farm tourism, Agrotourism, impact ecotourism, economic impact of ecotourism, Eco-Tourism management		
<b>Unit- 3 (15 Hrs.)</b> <b>Tourism and environment:</b> Evolution and characteristics of ecotourism; Eco-development, Sustainable development, carrying capacity and development, Adaptive and sustainable management of ecosystem and its resources with reference to Ecotourism; Eco-tourism industry in India; Potentials and constraints for promoting Eco-tourism in India; Eco-labels, Ecotels and Ecotourism certification programmes. Economic, social, political and environmental impact, Sustainable Ecotourism –prospects and problems, Threats and obstacles to tourism, Tourism planning in India, National Action Plan 1992, Climate and seasons,		

Destination management Festivals, fares and seasonality

**Unit- 4 (15 Hrs.)**

**Development of Ecotourism:** Eco-tourism components and impact monitoring – Ecotourism opportunity spectrum (ECOS), Ecological foot print analysis, Limits of acceptable change (LAC), Visitor activity management (VAM), Visitor impact management (VIM), World Ecotourism Summit; suggestions for long term sustainable Eco-tourism initiatives. Relevance of responsible tourism, World Ecotourism Summit-policies and formulations, laws and rules of ecotourism, Ecotourism development in India, Ecotourism in Maharashtra - possibilities and problems, Case study- ecotourism development in a hill station (existing infrastructural development and alternative measures to be suggested)

**Reference Books:**

1. Bala Krishnamurthy (2009) Environmental Management, PHI Learning, New Delhi
2. Andrew Holden (2008) Environment and Tourism, Routledge, London
3. Shashi Prabha Sharma (2006), Tourism and Environment, Kanishka, New Delhi
4. J Swarbrooke (2010) Sustainable Tourism Management, Rawat Publications, New Delhi
5. David Weaver (2008) Eco-Tourism, John Wiley and sons Australia Ltd
6. Dipankar Dey (2007) Sustainable Development – Perspectives and Initiatives, The ICFAI University Press, Hyderabad
7. Megan Epler Wood, Eco Tourism – Principles, Practices and Policies for Sustainability, UNEP and TIES
8. Aghnihotri, V.2007. A complete book on tourism and Travel Management. Cyber Tech Publishers, New Delhi
9. Ahamed Aizaz, General Geography of India, NCERT, New Delhi
10. Bharadwaj, D.S et al., 2006. Tourism Education: An emerging Essential. Kanishka, New Delhi.
11. Bharadwaj, D.S et al., 2006. International tourism: Issues and Challenges. Kanishka, New Delhi.
12. Bhattacharya, A.K., 2005. Ecotourism and Livelihoods. Concept Publishing Company.

**SYLLABUS**

RP-II	Research Project -II (6 Credits)	Total Contact Hrs. 180
<p>Student will submit their independent Research project work at the end of semester IV. Assessment of the dissertation will be based on the submitted M. Sc. project report and viva-voice examination. The report submitted by the student and the evaluation of report shall be done by internal and external examiner. The students should submit their research project report in the following format.</p> <ol style="list-style-type: none"><li>1. <b>Chapter I:</b> Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the selected topic /subject along with the aims and objectives of the proposed study project.</li><li>2. <b>Chapter II:</b> Review of literature covers International and National level published research work concerned to the proposed research project topic.</li><li>3. <b>Chapter III:</b> Methodology with Material and Methods: Description of the issue, methodology adopted for the proposed research study. Experimental data, data collection methodology, Presentation of data collected and detailed analysis of results.</li><li>4. <b>Chapter IV:</b> Result and Discussion: Discussion on the data and results obtained and Presentation of method suggested to solve the problem.</li><li>5. <b>Chapter V:</b> Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation.</li><li>6. <b>Chapter VI:</b> Suggestions, recommendations and future scope in the same topic.</li></ol>		

**7. Bibliography or References:** A list of references, bibliography and important websites sources and their links as per standard format.

The student has to submit their Project Report in typed on A4 size bond paper with 1.5 line spacing. Times New Roman font with size of text 12 and title bold in format. Illustrations and photographs should be of high quality with geotag formats. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their project report in university format (EMBOSING) in 15 Days before to the university practical examination at the end of M.Sc. II year (4<sup>th</sup> Semester). The project report will carry 150 marks (CA- Internal marks 60 and UA - External marks 90). Assessment of the report will be done at the end of the year. Students also have to present their work in a Power Point Presentation. Assessment of the project report shall be examined by the external examiner appointed by the PAH Solapur University.

**PRACTICAL SYLLABUS**

DSC1-7P	Practical - 10	Total Contact Hrs. 60
<b>Practical's based on Environmental Virology, toxicology and Bio-safety:</b> <ol style="list-style-type: none"><li>1) Estimation of Lead (Pb), Mercury (Hg), Cadmium (Cd), Tin (Sn).</li><li>2) Study the Effect of Temperature on bacterial Growth.</li><li>3) Study the Effect of PH on bacterial Growth.</li><li>4) Determination of LC 50 and LD 50</li><li>5) Effect of NH<sub>3</sub> on Plant material</li><li>6) Effect of SO<sub>2</sub> on plant material</li><li>7) Designing of protocols to evaluate pollutants toxicity.</li><li>8) Study absorption and accumulation of heavy metals by aquatic flora.</li><li>9) Study of Bio-accumulation of pesticides in aquatic faun</li><li>10) Estimation of heavy metals using spectrophotometer.</li><li>11) To synthesize the low-cost adsorbent using a waste material.</li><li>12) Removal of heavy metals from wastewater by Adsorption methods.</li></ol>		

DSE1-4P	Practical - 11	Total Contact Hrs. 60
<b>1) Practical's based on Hazards and Disaster Management:</b> <ol style="list-style-type: none"><li>1) Identification and mapping of natural hazards and zones and terminology of the associated features: viz, floods, landslides, glaciers, with the help of topographic sheets, aerial photographs and LANDSAT imageries.</li><li>2) Determination of pollutants from surface and subsurface water samples. Assessment of the mining hazards with respect to case histories.</li><li>3) Classification of coastal zones and mapping.</li><li>4) Utilization of coastal environmental maps with the help of toposheets, aerial photographs and LANDSAT imageries.</li><li>5) Worldwide distribution of disasters.</li><li>6) Mapping of disaster-prone zone with the help of remote sensing.</li><li>7) Case Studies of case histories of natural disasters in India.</li><li>8) Prepare hazard zonation map of state / India using geospatial technology</li></ol>		

**2) Practical's based on Natural Resources Management:**

- 1) Resource management in mountain ecosystem
- 2) Dry-land ecosystem management
- 3) Grassland ecosystem management
- 4) Forest ecosystem management
- 5) River ecosystem management
- 6) Ocean ecosystem management
- 7) Wetlands ecosystem management
- 8) The management of marine and coastal resources
- 9) Case study of shifting cultivation
- 10) Mangrove ecosystem and their management
- 11) Natural Resources mapping through GIS and Remote sensing technology

**3) Practical's based on Ecotourism:**

- 1) Design and develop tour guidelines for Tourist / tour coordinator
- 2) Demonstrate national / international rules and acts in ecotourism with case study
- 3) Demonstrate an understanding of the contribution that ecotourism makes to the community
- 4) Explain the need to work with the community on events that conserve the environment
- 5) Demonstrate an understanding of delivering standards and developing ecotourism packages
- 6) Identify major and minor environmental impacts on ecotourism
- 7) Assessment and Monitoring of impacts at Eco-tourism site
- 8) Solid waste pollution studies at Eco-tourism site
- 9) Noise pollution monitoring at Eco-tourism site
- 10) Water quality studies at Eco-tourism site
- 11) Flora and fauna (Wild) studies at Eco-tourism site
- 12) Butterfly studies at Eco-tourism site
- 13) Vehicular and transport impact studies at Eco-tourism site
- 14) Seed bank and herbarium studies of rare / extinct / vulnerable and endangered plant species