MANGALORE UNIVERSITY
DEPARTMENT OF BIOSCIENCES

SYLLABUS AND SCHEME OF EXAMINATIONS FOR TWO YEAR (FOUR SEMESTERS) M.Sc. DEGREE PROGRAMME IN ENVIRONMENTAL SCIENCE UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Preamble:

M.Sc. Environmental Science is a Semester Schemetwo years programme under Choice Based Credit System (CBCS) as per the guidelines of the University Grants Commission (UGC), New Delhi, and as considered by the Higher Education Council, Government of Karnataka.The Registrar, Mangalore University has sent a letter (No. MU/ACC/CR 39/2019-20/A2 dated 11.02.2020 and 18.06.2020) to the P.G. BOS in Environmental Science and asked the BOS to revise the existing syllabus of M.Sc. Environmental Science Programme.Accordingly, the internal members of the P.G. Board of Studies in Environmental Science prepared the draft syllabus and placed before the P.G. Board of Studies. The P.G. Board of Studies in Environmental Science thoroughly discussed, modified and finalized the syllabus in the BOS meeting held on 07.07.2020. The same syllabus was approved by the Faculty of Science and Technology and Academic Council of Mangalore University. The present M.Sc. Environmental Science Programme under CBCS-PG Scheme has total 88 credits which include Hard Core credits - 52 (59.09%), Soft Core credits - 30 (34.09%) and Open Elective credits - 06 (6.81%).

Programme outcomes:

After successful completion of the programme, students will be ableto get:

PO1. **Specific positions:**Environmental Science post graduatesmay work in specified positions as Environment consultant, Environmental education officer, Environmental officer, Recycling officer, Marine biologist, Nature conservation officer, Recycling officer, Sustainability consultant, Transport Planner, Waste management officer, a Wildlife filmmaker, etc.

PO2. **Carrier opportunities:**Environmental Science post graduates may get career opportunities in environmental laboratories/ environment agencies/pollution control boards/department for environment/ environmental monitoring organizations/environmental ministries/NGOs/ waste management centres/ EIAconsultancies/ colleges/ universities etc.

PO3. **More opportunities:** Post graduates may get more opportunities in private, public and government sectors with high salary packages.

PO4. **Understandingenvironmental issues**: This programme prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective.

PO5. **Research innovation**: This program gives knowledge to conduct innovative scientific research in the field of Environment.

PO6. **Interdisciplinary approach:**Apply the basic concepts of physical, chemical, mathematical and biological sciences to the discipline of environmental science.

Programme specific outcomes:

PSO1. Understand about the concept of environment, their structure and types, different components and their functions.

PSO2. Perform procedures to analyse and understand interactions between social and environmental processes.

PSO3. Understand key concepts of environmental policies and institutions.

PSO4. Aware about social environment, understanding the relation between man and environment.

PSO5.Get the knowledge of environmental awareness which will be useful for the development of society.

PSO6. Aware about global environmental issues and possible solution associated for the same.

M.Sc. ENVIRONMENTAL SCIENCE
PROGRAMME CONTENTS

I SEMESTERHrs/week Credits

HARD CORE COURSES - THEORY

ESH401 Environmental Chemistry	4	4
ESH402 Environmental Geology 4	4	
ESH403 Environmental Microbiology 4	4	

SOFT CORE COURSES - THEORY(Out of 2 Courses ONE to be offered)

ESS404 Environmental Statistics3	3	
ESS405 Environmental Biotechnology	3	3

PRACTICAL COURSES

ESP406 Environmental Chemistry Lab.	4	2
ESP407 Environmental Geology Lab.	4	2
ESP408 Environmental MicrobiologyLab.	4	2
ESP409 Environmental StatisticsLab.	4	2
ESP410 Environmental Biotechnology Lab.	4	2

II SEMESTER

HARD CORE COURSES - THEORY

ESH451 Water and Wastewater Management	4	4
ESH452 Occupational Health Hazards	4	4

SOFT CORE COURSES - THEORY(Out of 3 Courses TWO to be offered)

ESS453 Advanced Instrumentation	3	3
ESS454 EnvironmentalToxicology	3	3
ESS455 Remote Sensing and GIS 3	3	

PRACTICAL COURSES

ESP456 Water and Wastewater Management Lab.	4	2
ESP457 Occupational Health Hazards Lab.	4	2
ESP458 Advanced Instrumentation Lab.	4	2
ESP459 EnvironmentalToxicology Lab.	4	2
ESP460 Remote Sensing and GISLab. 4	2	

OPEN ELECTIVE COURSES(Out of 2 Courses ONE to be offered)

ESE461Basics of Environmental Science 3	3	
ESE462 Environmental Education and Awareness	3	3

III SEMESTER

HARD CORE COURSES - THEORY

ESH501	Environmental Biology	4	4
ESH502	Solid Waste Management	4	4

SOFT CORE COURSES - THEORY(Out of 3 Courses TWO to be offered)

ESS503	Air, Noise and Radiation Pollution	3	3
ESS504	Environmental Impact Assessment	3	3
ESS505	Human Population and Environment	3	3

PRACTICAL COURSES

ESP506	Environmental Biology Lab.	4	2
ESP507	Solid Waste Management Lab.	4	2
ESP508	Air, Noise and Radiation Pollution Lab.	4	2
ESP509	Environmental Impact Assessment Lab.	4	2
ESP510	Human Population and Environment Lab.	4	2

OPEN ELECTIVE COURSES(Out of 2 Courses ONE to be offered)

ESE511	Natural Resources	3	3
ESE512	Waste Management	3	3

IV SEMESTER

HARD CORE COURSES - THEORY

ESH551	Conservation of Biodiversity	4	4

SOFT CORE COURSES - THEORY(Out of 2 Courses ONE to be offered)

ESS552	Energy and Green Technologies	3	3
ESS553	Environmental Pollution and Management	3	3

PRACTICAL COURSES

ESP554	Conservation of BiodiversityLab.	4	2
ESP555	Energy and Green Technologies Lab.	4	2
ESP556	Environmental Pollution and Management Lab.	4	2

PROJECT WORK

ESP557	Project Work(Report/Dissertation)	4	4

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M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME

(CBCS Semester Scheme)
Scheme of Teaching and Examination
(As per the University Guidelines)
2020-21

I SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH401	Environmental Chemistry	4	3	70	30	100	4
ESH402	Environmental Geology	4	3	70	30	100	4
ESH403	Environmental Microbiology	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 2 Courses ONE to be offered)							
ESS404	Environmental Statistics	3	3	70	30	100	3
ESS405	Environmental Biotechnology	3	3	70	30		
PRACTICAL COURSES							
ESP406	Environmental Chemistry Lab.	4	3	35	15	50	2
ESP407	Environmental GeologyLab.	4	3	35	15	50	2
ESP408	Environmental Microbiology Lab.	4	3	35	15	50	2
ESP409	Environmental StatisticsLab.	4	3	35	15	50	2
ESP410	Environmental Biotechnology Lab.	4	3	35	15		
Total						**600**	**23**

II SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH451	Water and Wastewater Management	4	3	70	30	100	4
ESH452	Occupational Health Hazards	4	3	70	30	100	4
SOFT CORE COURSES – THEORY (Out of 3 Courses TWO to be offered)							
ESS453	Advanced Instrumentation	3	3	70	30		
ESS454	EnvironmentalToxicology	3	3	70	30	100	3
ESS455	Remote Sensing and GIS	3	3	70	30	100	3
PRACTICAL COURSES							
ESP456	Water and Wastewater Management Lab.	4	3	35	15	50	2
ESP457	Occupational Health Hazards Lab.	4	3	35	15	50	2
ESP458	Advanced Instrumentation Lab.	4	3	35	15		
ESP459	EnvironmentalToxicology	4	3	35	15	50	2
ESP460	Remote Sensing and GIS	4	3	35	15	50	2
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)							
ESE461	Basics of Environmental Science	3	3	70	30		

ESE462	Environmental Education and Awareness	3	3	70	30	100	3
Total						**700**	**25**

III SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH501	Environmental Biology	4	3	70	30	100	4
ESH502	Solid Waste Management	4	3	70	30	100	4
SOFT CORE COURSES – THEORY(Out of 3 Courses TWO to be offered)							
ESS503	Air, Noise and Radiation Pollution	3	3	70	30	100	3
ESS504	Environmental Impact Assessment	3	3	70	30	100	3
ESS505	Human Population and Environment	3	3	70	30		
PRACTICAL COURSES							
ESP506	Environmental Biology Lab.	4	3	35	15	50	2
ESP507	Solid Waste Management Lab.	4	3	35	15	50	2
ESP508	Air, Noise and Radiation Pollution Lab.	4	3	35	15	50	2
ESP509	Environmental Impact Assessment	4	3	35	15		

	Lab.						
ESP510	Human Population and Environment Lab.	4	3	35	15	50	2
OPEN ELECTIVE COURSES (Out of 2 Courses ONE to be offered)							
ESE511	Natural Resources	3	3	70	30	100	3
ESE512	Waste Management	3	3	70	30		
Total						**700**	**25**

IV SEMESTER

Paper code	Paper title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES - THEORY							
ESH551	Conservation of Biodiversity	4	3	70	30	100	4
SOFT CORE COURSES - THEORY(Out of 2 Courses ONE to be offered)							
ESS552	Energy and Green Technologies	3	3	70	30	100	3
ESS553	Environmental Pollution and Management	3	3	70	30		
PRACTICAL COURSES							
ESP554	Conservation of BiodiversityLab.	4	3	35	15	50	2
ESP555	Energy and Green Technologies Lab.	4	3	35	15	50	2
ESP556	Environmental Pollution and Management Lab.	4	3	35	15		
PROJECT WORK							

ESP557	Project Work (Report/Dissertation)			70	30	100	4
Total						**400**	**15**
Grand Total						**2400**	**82+6***

IA = Internal Assessment***** Not included for CGPA

Total Credits: 88 (82+6*)
Hard Core credits: 18 + 12 +12+10 = 52 (59.09%)
Soft Core credits: 05 + 10 + 10 +05 = 30 (34.09%)
Open Elective credits: 0 + 03 + 03 + 0 = 06 (6.81%)

NOTE:

BASIS FOR INTERNAL ASSESSMENT:Internal Assessment marks in theory papers shall be awarded on the basis of theory test (70 Marks), Objective Test (MCQs) (15 Marks), Seminars/Assignments (15 Marks). The marks obtained shall be reduced to 30. One or two internal tests may be conducted in a Semester. Practical Internal Assessment marks shall be based on one Practical tests and Records. 30 marks forPractical test and 5 marks for Class Record. The marks obtained shall be reduced to 15. The test may be conducted 14 weeks after the start of a Semester. Internal Assessment marks for project work (Report/Dissertation) is 30.

THEORY QUESTION PAPER PATTERN: Question Papers in all the four semesters consists of three sections (Model question paper enclosed). Section I: Write short notes on any four out of six: (4x4=16 Marks) Section II: Write explanatory notes on any five out of seven: (5x6=30 Marks). Section III: Answer any two out of three: (2x12=24 Marks). Questions are to be drawn from all the units of the syllabus by giving equal weightage to all the units.

PRACTICAL QUESTION PAPER PATTERN: 30 marks for practical exam proper (Major experiment-12 marks, Minor experiment-8 marks, Identify and Comment on-4x2.5=10 marks) and 5 marks for Class record. The Project work may be conducted either in the department or any other Institution or in an Industry. Project Report/Dissertation carries 70 marks and evaluated as per regulations.

Model Question Paper

First Semester M.Sc. Degree Theory Examination, December 2017

(CBCS)

ENVIRONMENTAL SCIENCE

ES

Time: 3 Hours Max. Marks: 70

Write short notes on **any four** of the following (not exceeding **2** pages **each**): **(4x4=16)**

1. a)
   b)
   c)
   d)
   e)
   f)

Write explanatory notes on **any five** of the following (not exceeding **3** pages **each**): (**5x6=30)**

2.
3.
4.
5.
6.
7.
8.

Answer **any two** of the following (not exceeding **8** pages **each**): **(2x12=24)**

9.

10.

11.

M.Sc. ENVIRONMENTAL SCIENCE PROGRAMME

(CBCS Semester Scheme) 2016-17

SYLLABUS

I SEMESTER

HARD CORE COURSES

ESH401 ENVIRONMENTAL CHEMISTRY 52 hrs.

Course Outcomes:

CO1 Understand the fundamentals of environmental chemistry with reference to atmospheric and water chemistry.
CO2 Understand the principles and basics of chemical reactions related to the environment.
CO3 Describe chemical composition of air and classification of elements.
CO4 Discuss on air pollutants and their reactions in the atmosphere.
CO5 Describe the chemical properties of water.
CO6 Study about chemical pollution and reactions.

UNIT I (13 hours)

Fundamentals of Environmental Chemistry: Stoichiometry, Gibbs' energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes in the environment.
Chemical reactions and equations, solutions, units, sampling, and analytical techniques.

UNIT II (13 hours)

Atmospheric chemistry: Chemical composition of Air. Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matters. Thermochemical and photochemical reactions in the atmosphere. CFCs, Oxygen and Ozone chemistry, chemistry of air pollutants, photochemical smog.

UNIT III (13 hours)

Chemical pollution and fundamentals of chemical reactions: Oxidation, reduction, precipitation. Toxic chemicals in the environment, biochemical aspects of As, Cd, Pb, Hg, CO, O_3, PAN, pesticides, MIC and carcinogens in air.Effects of Chemical Pollution.

UNIT IV (13 hours)

Water chemistry:Properties of water, water pollutants - sources & types - heavy metals-metalloids, types of reactions in various water bodies including marine environment. Chemistry of oil based and water based paints, physico-chemical basis of redox processes. Electrochemical theory of corrosion.

References:

1. Ajay Kumar Bhagiand Chatwal, G.R. Text book of Environmental Chemistry.
2. Bhatia, S.C. 2011. Environmental Chemistry, CBS Publishers.
3. Day, A.K. 1984. Environmental Chemistry, Willey Eastern, III Ed.
4. Faust, S.D. and Dly, O.M. 1983. Chemistry of water treatment.

5. Manahan, S.E. 2000. Environmental Chemistry, 7th Ed., Lewis Publications, Florida, U.S.A.
6. Sharma, B.K. and Kaur. 1995. Environmental Chemistry, Goel Publishing House, Meerut.
7. Sawyer, C.N., Mc Marty, P.L. and Perkin G.F. 1994. Chemistry for Environmental Engineering, II Ed., Mc Graw Hill.
8. Tyagi, O.D. and Mehra, M. 1990. Environmental Chemistry, Anmol Publications.

ESH402ENVIRONMENTAL GEOLOGY52 hrs.

Course Outcomes:

CO1 Discuss about the importance of mineral resources and the probable impact on environment by their exploitation.
CO2 Describe the structure and processes of earth.
CO3 Study the basic aspects of environmental geology.
CO4 Learn the structure of earth and its processes.
CO5 Know the various mineral resources available on earth.
CO6 Gain the knowledge of soil conservation.

UNIT I (13 hours)

Environmental Geology: Objectives, scope and significance. Origin of the Earth, earth systems and its interaction with lithosphere, atmosphere, hydrosphere and biosphere.Motions of the earth, seasons.Basics of Geomorphology and edaphology,

UNIT II (13 hours)

Interior of the Earth: Earth's materials – minerals and their definition. Distribution and abundance of elements in the Earth's crust, formation and classification of Rocks. Soil-characteristics, formation of soil, soil erosion and conservation.

UNIT III (13 hours)

Earth's Processes: Endogenic and Exogenic processes: Earthquakes, Tsunami and Volcanism. Geological agents: River, Wind, Glaciers and Ocean action. Floods, Landslides, Cyclone and Avalanche, Concepts of major, trace and REE. Classification and mobility of trace elements, geochemical cycles, human use of trace elements and health.

UNIT IV (13 hours)

Mineral resources and environment: Resources and reserves, depletion trends of natural resources. Environmental impact of exploitation. Land use Planning- Environmental aspects of terrain evolution, methods of site selection and evaluation of land in environmental planning. Geological features of India and Karnataka.

References:

1. Clemente, J. 2016. Earth and Environmental Sciences, Intech Publishers.
2. Dar, I.A. 2016. Earth and Environmental Science, Intech Publishers.
3. Reed Wicander and James and S. Monroe. 2002. Essentials of Geology, Wadsworth Publishing Co.
4. Richard, J. and Ordway, D. Earth Science and the Environment, Van Nostrand and Company, London.
5. Rose, D.A. Introduction to Oceanography.
6. Valdia, K.S. 1987. Environmental Geology.
7. Venkat Reddy and Winker, H.G.F. 1988. Petrogenesis of Metamorphic Rocks. McGraw Hill Publishers.
8. Venkat Reddy. 1995. Engineering Geology for Civil Engineers, Oxford and IBH Publ., Co. Pvt. Ltd., New Delhi.

ESH403ENVIRONMENTAL MICROBIOLOGY 52 hrs.

Course Outcomes:

CO1 Study types of microorganisms, sterilization and culturing techniques.
CO2 Describe the adaptive mechanisms of microorganisms in the extreme environments.
CO3Study in detail milk, air, soil and water microbiology.

UNIT I (13 hours)

Introduction to microbiology, historical perspectives, branches and scope of microbiology.Classification and characteristics of microorganisms. Microbial growth and growth curves, sterilization, culturing techniques and identification of microbes.

UNIT II (13 hours)

Microbial symbiosis, mutualism, plant-microbe interactions (e.g. mycorrhizas), animal-microbe interactions (human, ruminants and non-ruminants). Microbes in hydrothermal vents and coral reefs – adaptive mechanisms. Microorganisms as bio-indicators in the environment.

UNIT III (13 hours)

Milk microbiology: Milk and milk products, milk microflora and their estimation, milk-borne diseases and prevention. Air Microbiology: Microflora of air and methods of their estimation, air-borne diseases and prevention.

UNIT IV (13 hours)

Soil Microbiology: Soil microflora and methods of their estimation. Biological nitrogen fixation (symbiotic and non-symbiotic), microbial phosphorus solubilization and their importance in soil fertility and agriculture.Aquatic Microbiology: Microbes in water and methods of their estimation (e.g. MPN), drinking water standards, water-borne diseases and prevention.

References:

1. Arora, D.R. and Aora, B. 2012. Text Book of Microbiology, CBS Publ. & Dist. Pvt. Ltd., New Delhi.
2. Brock, T.B. and Madigon, M.T. Biology of microorganisms, Prentice Hall.
3. Cambell, R. Microbial Ecology. Blackwell Scientific Publ., London.
4. Kanika Sharma. Manual of Microbology-Tools snd Techniques, Ane Books Pvt. Ltd.
5. Maria, Csuros and CsabaCsuros. Microbiological examination of Water and wastewater.
5. Maier, R.M., Pepper, I.L. and Gerba, C.P. Environmental Microbiology.
6. Patrick, K. Jemba. Environmental Microbiology -Principles and Applications.
7. Pelzar. Text book of Microbiology
8. Rao, A.S. Introduction to Microbiology.
9.Sharma, P.D. Environmental Microbiology
10 Singh S.N. andTripathiR.D. Environmental bioremediation technologies.
11. Text book of Environmental Microbiology, Mohapatra - Technology and Engineering.

SOFT CORE COURSES

ESS404 ENVIRONMENTAL STATISTICS 39 hrs.

Course Outcomes:
CO1 Learn applications of matrices in environmental impact assessment and management.
CO2 Gain the knowledge of fundamental aspects of environmental statistics.
CO3Learn the statistical packages available for environmental data analysis.
CO4 Learn sampling techniques in environmental science.

UNIT I (13 hours)
Types of sampling.Descriptive vs. InferentialStatistics. Measures of location - mean, median, mode. Measures of dispersion - variance, standard deviation, range and interpercentile ranges. Dispersion Percentages, skewness, concepts of outliers. Bi-variate data and scatter diagram. Simple (linear) correlation and regression. Coefficient of correlation and regression and their properties. Fitting of regression line. Multiple and partial correlations and regressions. Graphs and Displays-Introduction, z-Scores and Percentile Ranks, Stem and Leaf Displays.

UNIT II (13 hours)
Matrices and Determinants: Types of matrices, addition and subtraction of matrices. Multiplication of a matrix by a scalar. Products of matrices. Evaluation of 2 × 2 determinants. Inverse of 2 × 2 matrices.Combinations of transformations. Eigenvalue. Applications of matrices in Environmental Impact assessment.

UNIT III (13 hours)
Probability: Definition, random variables, expected value. Probability Distributions - Normal, Binomial and Poisson Distributions.Statistical hypothesis testing-basic approach, alternative hypotheses. One sample tests - Z-test on a mean with known variance, T-test on a mean with unknown variance, Z-test for non-zero correlation.Two sample tests- T-test on unpaired

means with unknown variance. T-test on paired means with unknown variance. F-test for equal variances, Z-test for unpaired equal correlations, Chi Square test, ANOVA.

References:

1. Gupta, S.C. and Kapoor, V.K.2012. Fundamentals of Mathematical Statistics, S.Chand & Co.
2. Aslam Mahmood. Statistical Methods in Geographical Studies, Rajesh Publications, New Delhi.
3. Medhi,J.Statistical Methods: An Introductory Text, New Age International Ltd. Publishers.
4. Singh, Practical Statistics, Vol. 1and2, Atlantic Publishers.
5. Ott, W. R., Environmental Statistics and data analysis, Lewis Publishers, New Jersey.
6. Snedecor,G. W. and Cochran, W.G. Statistical Methods.
7. Piegorsh,W.W.and BailerA. J. Statistics for environmental Biology and Toxicology.

ESS405 ENVIRONMENTAL BIOTECHNOLOGY 39 hrs.

Course Outcomes:

CO1 Study bioremediation techniquesin detail.
CO2 Describe the role of microbes in degradation of waste.
CO3 Study the methods of conversion of waste into a useful product.

UNIT I (13 hours)

Bioremediation: Microbial bioremediation – *in situ* and *ex situ*bioremediation, phytoremediation,advantages and disadvantages. Biogas production and utilization. Biosensors and biochips –types,and applications of biosensors. Intellectual property rights, traditional knowledge digital library (TKDL), biopiracy, bioterrorism and biowarfare.

UNIT II (13 hours)

Biotechnological approaches for the degradation of waste – pesticides, plastic, hydrocarbons, petrochemicals, tannery wastes, textiles, dyes, detergents, distillery and paper. Ecological implications of genetically modified microorganisms.Mariculture, biomolecules from marine organisms.

UNIT III (13 hours)

Biotreatment of waste - biofilters - types and applications. Biofertilizer - importance and classification, vermicomposting. Microbial mining, biofilms, biofouling and its prevention, microbial influenced corrosion and remedies. Natural products: By-products from terrestrial and aquatic organisms, By-products from industrial, agriculture and domestic sources and their utilization.

References:

1. Dubey, R.C. Text book of Biotechnology.
2. Harke and Pande, Environmental Biotechnology and Sustainable Biodiversity, Narendra Publishing House, Delhi.

3. InduShekhar Thakur. Text book of Environmental Biotechnology.
4. Pradipta Kumar Mohapatra. Text book of Environmental Biotechnology.
5. Singh, B.D. Text book of Environmental Biotechnology.

PRACTICAL COURSES

ESP406ENVIRONMENTAL CHEMISTRY LAB.

Course Outcomes:
CO1Determine metal concentration in industrial effluents.
CO2Learn the principles for the estimation of various chemicals present in water and soil.CO3Estimate various soil quality tests.
CO4Understand saponification value of oil.

1. Determination of pH and conductivity of different water and soil samples.
2. Determination of calcium and magnesium in different samples.
3. Determination of total dissolved solids in water samples.
4. Determination of carbonates and bicarbonates in water samples.
5. Determination of chloride in water sample.
6. Estimation of Iodine value of given oil samples.
7. Determination of copper content in industrial effluents.
8. Determination of ferrous ion in the samples.
9. Estimation of the amount of Phenol/Aniline in the water samples.
10. Determination of Saponification value of oil.

ESP407ENVIRONMENTAL GEOLOGYLAB.

Course Outcomes:
CO1 Exercise and compute water budget.
CO2 Observe hand specimens to identify and classify different types of rocks.
CO3 Estimate ground water quality.
CO4 Understand environmental data interpretation.

1. Identification of Minerals and Rocks.
2. Physical properties and chemical composition of various rock forming minerals.
3. Hand specimen study of Igneous, sedimentary and metamorphic rocks.
4. Classification of soils, sediment, their texture, mineralogy.
5. Interpretation of Toposheets.
6. Study of littoral drift in the field and laboratory using dye and tracer techniques.
7. Drainage Basin Analysis and drainage frequency maps.
8. Exercises related to water budget.
9. Exercises related to Potential Evapotranspiration.
10. Compute monthly water budget from the given data.
11. Ground water quality – Impact and Testing.
12. Interpretation of waves, climate, tides and currents for the given data.

ESP408 ENVIRONMENTAL MICROBIOLOGYLAB.

Course Outcomes:
CO1 Isolate and identify microorganisms in air/soil/water samples.
CO2 Learn staining procedures for microorganisms.
CO3 Understand the techniques and instrumentations in environmental microbiology.
CO4 Learn the techniques for coliform analysis.

1. Methods of collectionand preservationof microorganisms.
2. Serial dilution of soil and water.
3. Preparation of different types of microbial culture media.
4. Gram staining techniques.
5. Study of microorganisms in air.
6. Isolation, enumeration and identification of microorganisms in soil samples.
7. MPN techniques for coliform analysis.
8. Effect of heavy metals on microbial growth.
9. Effect of pesticide on soil microorganisms.
10. Microbiological assays.

ESP409 ENVIRONMENTAL STATISTICS LAB.

Course Outcomes:
CO1 Learn the use of statistics in the interpretation of environmental data.
CO2 Gain the knowledge of application of statistics in environmental science.
CO3 Understand statistical hypothesis testing for environmental data.
CO4 Learn the applications of matrices in Environmental Impact assessment.

Practicals based on the theory units.

ESP410 ENVIRONMENTAL BIOTECHNOLOGY LAB.

Course Outcomes:
CO1 Get the practical knowledge of biotechnology in environmental science.
CO2 Exposed to biotechnology experiments which are used for environmental management.
CO3 Learn extraction methods of DNA and RNA from different sources.
CO4 Understand vermicompost preparation and analysis.

1. Study of biomass in polluted soil and water.
2. Determination of catalase activity in a water sample.
3. Study of cellulolytic degradation of organic waste.
4. Determination of sulphates in a given sample.
5. Determination of phosphates in a given sample.
6. Extraction of DNA from a tissue (mammalian liver/fish liver).

7. Extraction of RNA from plant/animal sources.
8. Production of compost.
9. Vermicompost and its analysis.

II SEMESTER

HARD CORE COURSES

ESH451 WATER AND WASTEWATER MANAGEMENT 52 hrs.

Course Outcomes:
CO1 Describe water pollution parameters.
CO2 Learn various methods wastewater treatment.
CO3 Realize the importance of water and water crisis.
CO4 Understand the water purification methods.
CO5 Get the knowledge of ground water quality.
CO6 Understand pollution scenario of Indian rivers.

UNIT I (13 hours)
Hydrology: Sources of water and its characteristics, Distribution of water on Earth. Physical and Chemical properties of Water,types of water demands - per capita demand, water quality standards for various uses. Water Pollution parameters, sources and types of Pollution, pollution scenario of Indian Rivers, water harvesting and watershed management.

UNIT II (13 hours)
Groundwater Hydrology: Occurrence of groundwater, Ground water zones and Groundwater System. Porosity, permeability and types of Aquifers. Water Table, ground water flow, functions and Topography, Ground water depletion, Ground water Quality, Ground water pollution, Saltwater Intrusion, Changes in Ground water Quality.

UNIT III (13 hours)
Water purification: Screening – Treatment system- sedimentation, coagulation, filtration – rapid sand filter, slow sand filter, advantages and disadvantages. Disinfections – Methods of disinfections, water softening process. Taste and odor removal (Aeration).

UNIT IV (13 hours)
Wastewater treatment: Characteristics of wastewater, Screening & Grit chambers, primary treatment – sedimentation and flocculation, equalization, neutralization, secondary treatment – Aerated lagoons, Trickling Filters, Activated Sludge process, Membrane bioreactor, Oxidation pond, Aerobic and Anaerobic decomposition of wastewater, UASB, tertiary treatment, sludge drying beds.

References:

1. American Public Health Association. 1980. Standard Methods for Examination of Water and Wastewater,5th Ed.
2. Fair, G.M., Geyer, T.C. and Okun, D.A. 1984. Water and waste water Engineering, Vol. I and II, John Wiley and Sons, Strauss.

3. Metcalf and Eddy. Waste Water Engineering, Tata Mc Graw Hill.
4. Shirdel, B. 2017. Environmental groundwater and Engineering geology, CBS Publishers.

ESH452 OCCUPATIONAL HEALTH HAZARDS52 hrs.

Course Outcomes:
CO1 Gain the knowledge of occupational environment.
CO2 Know the different occupational health hazards.
CO3 Understand the protective measures for health of workers.
CO4 Get the knowledge of occupational diseases.

UNIT I (13 hours)
Occupational Environment - Physical, Chemical, Biological agent. Occupational hazards- Physical, chemical, Biological. Occupational diseases- Pneumoconiosis - silicosis, Anthracosis, Byssinosis, Bagassosis, Astertosis, Farmers lung, Lead poisoning, Occupational cancer, Occupational Dermatitis, Radiation hazards.

UNIT II (13 hours)
Occupational hazards of agricultural workers- somatic diseases, accidents, toxic hazards, physical hazards, respiratory diseases, accidents in industry, sickness absenteeism, health issues due to industrialization.

UNIT III (13 hours)
Measures for securing safety and health of workers, preservation of occupational diseases- medical measures, engineering measures. Legislation - The Factories Act, 1948. Human health problems due to pollution, public health programs.Food borne diseases: Types, symptoms and prevention. Food poisoning - types of food poisoning, prevention and control, indicators of health, food safety.

UNIT IV (13 hours)
Airborne allergens, seasonal changes, mode of dispersal, disease intensity and control. Influence of physical environment features on Accidents and Crime. Waterborne diseases - Prevention and protection of community health from waterborne diseases.

References:
1. Beaglehole, R., Bonita, R. and Kjellstrome, T. 2006. Basic epidemiology.
2. Benjamin O.Ali. Fundamental principles of occupational health and safety, Handbook of Occupational Safety and Health.
3. David N. Petley.Environmental Hazards: Assessing Risk and Reducing.
4. Gloria J. Hathaway, Nick H.Proctor, James P. Hughes.Chemical Hazards of the Workplace.
5. Jagbir Sing. Disaster Management: Future challenges and Opportunities, I.K. International.
6 Kulakarni, G. K. Implementation of occupational health legislation at work place - Issues andConcerns.
7. Paul R. Hunter. 1997. Waterborne disease: Epidemiology and Ecology, John Wiley and Sons Ltd., Chichester.
8. Peter H. Wald, Gregg M., Stave Proctor and Hughes.Physical and Biological Hazards of

the work place.

9. Wisner, B. and Adams, J.2002. Environmental Health in emergencies and disasters – A Practical Guide, World Health Organization.

SOFT CORE COURSES

ESS453 ADVANCED INSTRUMENTATION 39 hrs.

Course Outcomes:

CO1 Describe the principles and applications of instruments under spectroscopy, nephelometry, turbidometry and chromatography.
CO2 Understand the principles and applications of various instruments in the field of environmental science.
CO3 Get the knowledge of applications of instruments in environmental sample analysis.
CO4 Describe the applications of polarography in the environmental sample analysis.
CO5 Understand radio-chemical techniques.

UNIT I (13 hours)

Optical methods: Various ranges of electromagnetic radiations, interaction of electromagnetic radiation with matter, UV-Visible spectroscopy: Theory, instrumentation and applications to environmental samples, optical fibers in spectroscopy. X-ray fluorescence, X-ray diffraction.

UNIT II (13 hours)

IR and NDIR spectroscopy: Molecular vibrations and vibration frequencies, special features of IR and NDIR instruments, applications for the environmental samples. Continuous monitoring of CO using NDIR spectroscopy, Atomic Absorption Spectrophotometer: Principle, instrumentation and applications in environmental sample analysis. Atomic Emission Spectroscopy: Principle, instrumentation and applications of flame emission spectroscopy.

UNIT III (13 hours)

Nephelometry and turbidimetry: Principles and applications in the determination of turbidity of water. Thermoquality. Radio analytical methods: Radiochemical techniques - Principles and applications of neutron activation analysis and isotope dilution analysis. Polarography: Principles, instrumentation and applications of polarography in the environmental sample analysis. Solvent extraction, thin layer chromatography, gas chromatography, HPLC and Ion exchange chromatography.

References:

1. Bour, E.J. 1982. Introduction to Chemical Instrumentation, 4th Ed., Wiley & Sons.
2. Christian, G.D. 2001. Analytical Chemistry, 5th Ed., John Wiley and Sons Inc., India.
3. Khopkar,S.M. 1998. Basic concepts of Analytical Chemistry, 2nd Edition, New Age International Publ.
4. Khopkar,S.M. 1993. Environmental Pollution analysis, Wiley Eastern Ltd.
5. Skoog, D.A., Holler, F.J. and Nieman,T.A. 1980. Principles of Instrumental analysis, 5th Ed. Thomson Asia Pvt. Ltd., Singapore.
6. Vogel, A.I. 1998. Quantitative analysis, 6th Edition, Prentice Hall Inc.

ESS454ENVIRONMENTAL TOXICOLOGY **39 hrs.**

Course Outcomes:

CO1 Introduce the importance of toxicology in environmental science.
CO2 Learn toxicity testing to detect environmental toxicants.
CO3 Understand various terminologies used in toxicology.
CO4 Describe various toxicants found in the environment.

UNIT I (13 hours)

Introduction to toxicology, scope of environmental toxicology, subspecialties of toxicology, description and terminology of toxic effects, factors influencing toxicity, drug toxicity, biochemical basis of toxicity – mechanism of toxicity and receptor mediated events, acute and chronic toxicity. Selective toxicity. Dose response relationship-graded response time action curves, threshold limit value, $LC_{50,}$ $LD_{50,}$ Margin of safety and toxicity curves.

UNIT II (13 hours)

Bioaccumulation and Biomagnifications of toxic materials in food chain, Toxicology of major pesticides-Environmental impacts of pesticides, biotransformation, biomonitoring, programs and parameters of biomonitoring. Basic concepts of Environmental forensics.

UNIT III (13 hours)

Concepts of Bioassay- types, characteristics. Importance and significance of bioassay, field based microbial bioassay for toxicity testing, particulate matter sources,bioassay for residue analysis; health impacts of specific particulate matter, chronic and acute effects of particulate matter on respiratory system, mechanism of impact of particulate matter on cardio vascular system.

References:

1. Meera Asthana and Astana, D.K. 1990. Environmental pollution and Toxicology, Alka Printers.
2. Sharma, P.D. 1994. Environmental biology and Toxicology, Rastogi andLamporary.
3. Sood, A., Sarup and Sons,1999. Toxicology, New Delhi.
4. Park, J.E. and Park, K.1985. Text book of Preventive and Social Medicine, Banosidas Bharat Publishers, Jabalpur.
5. Anisa Basheer. 1995. Environmental Epidemiology, Rawat Publication, Jaipur, New Delhi.

ESS455 REMOTE SENSING AND GIS **39 hrs.**

Course Outcomes:

CO1 Learn the fundamental aspects of remote sensing and GIS.
CO2 Know the applications of remote sensing and GIS in environmental science.
CO3 Describe the principles of platforms.
CO4 Describe the methods of photogrammetry to assessearth surface features.
CO5 Understand satellites and GIS software.

UNIT I (13 hours)

Fundamentals of Remote sensing: Remote Sensing – history & development, definition, concept and principles.Energy Resources, radiation principles, Electromagnetic radiation, interaction between matter and Electromagnetic radiation, Sensors: Types of sensors, concept of Resolution – Spatial, Spectral, Temporal and Radiometric. Basic concept and principles of thermal, microwave and hyperspectral sensing, spectral reflectance and their characteristics of Earth surface features.

UNIT II (13 hours)

Platforms: Products used in Remote sensing, Images, scale, mosaics, time and seasons of orbital cycles. Aerial photographs, photographic systems, Satellite data products. Photogrammetry - Basic principles, types, steps and elements of image interpretation, visual interpretation, interpretation equipments- digital image processing- image rectification, enhancement, classification, data merging and biophysical modeling- image processing software. Satellites and their characteristics – Geo-stationary and sun-synchronous, Indian Space programme.

UNIT III (13 hours)

Introduction to GIS: GIS and their uses for Environmental monitoring, Remote Sensing Data Products and their procurement, GIS and spatial distribution of environmental data. Data integration and analysis, Data based structure, satellite data analysis, GIS software. Remote sensing and GIS applications - Management and monitoring of Environment, conservation of resources, natural resources, coastal zone management.

References:

1. Jain, H.C. Radiation and Man, National Book Trust, New Delhi.
2. MerrilEisenbud and Thomas Gessell. Environmental Radioactivity from Natural, Industrial and Military sources, Academic Press, London.
3. MurliKrishna.I.V. 1995. Remote Sensing and GIS for Environmental Planning.
4. Srikantaswamy,S. 2008. Essential of Remote Sensing.

PRACTICAL COURSES

ESP456 WATER AND WASTEWATER MANAGEMENT LAB.

Course Outcomes:
CO1 Learn the methodology of determination of physico-chemical parameters of water.
CO2 Learn different methods to assess soil quality.
CO3 Visit to water purification and wastewater treatment plants
CO4 Enhance their knowledge about water and wastewater management.
CO4 Describeinfiltration and runoff characteristics of water.

1. Determination of DO in water and wastewater.
2. Determination of BOD in water and wastewater.
3. Determination of COD in water and wastewater.
4. Determination of porosity and permeability of different soils.
5. Determination of infiltration and runoff characteristics.
6. Determination of nitrite content in water.
7. Determination of phosphate content in water.
8. Visit to water & wastewater treatment plants.

ESP457 OCCUPATIONAL HEALTH HAZARDS LAB.

Course Outcomes:
CO1 Document various occupational diseases and causes.
CO2 Describe about safety devices in industries.
CO3 Learn the type of health hazards faced by the workers in industries.
CO4 Understand occupational health hazards in agricultural workers.
CO5 Know the personal protective equipment used in the industries.

1. Study of byssinosis.
2. Study of bagassosis.
3. Study of pneumoconiosis.
4. Documentation of allergic diseases and causes.
5. Safety devices in industries, including personal protective equipment.
6. Survey and documentation of occupational diseases and causes in given areas.
7. Respiration disorder in industrial workers.
8. Occupational health hazards in agricultural workers.
9. Industrial visit.

ESP458 ADVANCED INSTRUMENTATION LAB.

Course Outcomes:

CO1 Learn the principles of various instruments used in environmental science and to conduct experiments using such instruments.
CO2 Develop the technical skill of handling and operation of various advanced instruments.
CO3 Learn different titration methods.
CO4 Understand air sample analysis.

1. Spectrophotometric determination of trace elements.
2. Conductometric titration of water & Soil extract samples.
3. Extraction of plant pigments and study of TLC and column chromatography.
4. Determination of Fluorides by spectrophotometry.
5. Determination of Organic carbon in soil.
6. Potentiometric titration of Non-aqueous solvents.
7. Determination of Nitrite/Nitrate/Total nitrogen/Ammonia nitrogen in water and soil samples.
8. Determination of sodium and potassium by flame photometry.
9. Determination of pesticides in different samples.
10. Determination of phosphate in water samples.
11. Determination of SO_2 in air sample.

ESP459 ENVIRONMENTAL TOXICOLOGY LAB.

Course Outcomes:

CO1 Determine various toxic chemicals in different samples.
CO2 Study histological processing of organs for toxicological tests.
CO3 Learn microtomy, paraffin section preparation and staining.
CO4 Get the skill of conducting experiments to detect the concentration of toxic chemicals in different samples.

1. Determination of solid food adulteration.
2. Methods of prevention of food poisoning.
3. Determination of liquid food adulteration.
4. Estimation of LC_{50} value in mosquito larvae.
5. Determine the histotoxicity/histopathology of a given sample.
6. Spot test for the detection of nitrate/nitrite poisoning.
7. Histological processing of organs for toxicological tests
8. Determination of fluoride content in a given sample.
9. Determination of differential leukocyte count of the pesticide treated blood smear.

10. Paraffin sectioning and staining techniques
11. Determination of toxic chemicals in different samples.

ESP460 REMOTE SENSING AND GIS LAB.

Course Outcomes:
CO1 Determine pollution status in different areas using map.
CO2 Learn image interpretation of land use.
CO3 Understand GPS survey, compass survey, plane table survey and chain survey.
CO4 Learn different survey method to measure different areas.

1. Survey of a given area using Chain survey method.
2. Survey of a given area using Plane table survey method.
3. Survey of a given area using Compass survey method.
4. Survey of a given area using GPS survey method.
5. Image interpretation of land use/water, vegetation and lithology.
6. Study of geological/contour/drainage pattern maps.
7. Assessment of pollution status in the given map.

OPEN ELECTIVE COURSES

ESE461BASICS OF ENVIRONMENTAL SCIENCE 39 hrs.

Course Outcomes:
CO1 Describe the fundamental aspects of environment and to know the scope of environmental science.
CO2 Understand the structure and composition of atmosphere and hydrosphere.
CO3 Understand fundamental aspects of environment.
CO4 Learn different biogeochemical cycles of elements.

UNIT I (13 hours)
Definition and scope of Environmental Science, Ecosystems - Types, abiotic factors - Soil, Water, Temperature and Light, biotic factors – freshwater, marine water and estuarine habitats. Wetlands and swamps.
Earth and its environment: Structure and Composition. Biosphere-Atmosphere, Lithosphere, Hydrosphere and Water cycle.

UNIT II (13 hours)
Atmosphere: Structure and composition. Temperature, pressure, humidity of atmosphere. Aeroallergens, air particulates and diseases. Winds and clouds – their classification, formation and circulation, artificial rain, acid rain, ozone hole, global warming/greenhouse effect.

UNIT III (13 hours)

Hydrosphere: Water as a resource, sources of water, physico-chemical and biological properties of water, water related issues, purification of water, water management.

Biogeochemical Cycles: Sedimentary cycles, gaseous cycles, cycling of heavy metals and radioactive compounds, Effect of anthropogenic activities on biogeochemical cycles.

References:

1. Agrawal, K.C.2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Arya, S.P.2002. 2nd Ed. Introduction to Micrometeorology.
3. Asthana, D.K. and Meera Asthana, 2006. A text Book of Environmental Studies, S. Chand & Co. Ltd., New Delhi.
4. Gilbertson, D.D., Kent, M. &Pyatt, K.B. 1985. Practical ecology for Geography and Biology: Survey, Mapping and Data Analysis. Hutchinson.
5. Haines – Young, R.H. &Petch, J.R., 1986. Physical Geography: Its nature and Methods. Harper.
6. John, J.W.R. and Geoffrey, F.P. 1998. People and the Earth, Cambridge University Press.
7. Tucker, M., 1988. Techniques in Sedimentology. Blackwell.

ESE462 ENVIRONMENTAL EDUCATION AND AWARENESS 39 hrs.

Course Outcomes:

CO1 Educate and give awareness to the public about the current environmental issues.
CO2 Discuss the major environmental movements in India.
CO3 Understand international agreements on climate change.
CO4 Learn different public awareness programmes.

UNIT I (13 hours)

Introduction to environment, components of environment – biosphere, atmosphere, lithosphere, hydrosphere; biotic and abiotic components; environmental problems including acid rain, ozone hole, global warming, deforestation.

UNIT II (13 hours)

Environmental Education: Definition, goals, objectives, principles; environmental education programmes – PAP (Public Awareness Programme), strategies for environmental education - authorization, curriculum manual teaching methods and evaluations of environmental education. formal and non-formal environmental education, Status and policy of environmental education – Action Plan. Environmental Institutions and NGOs.

UNIT III (13 hours)

Environmental movements: Global and National environmental movements. Major environmental movements in India - Chipko, Silent Valley movement, Appiko movement,

Narmada BachaoAndolana, Tehri dam conflict. Environmental conferences – importance, goals and achievement. International agreements –, United Nations conventions on climate change, earth summit, Copenhagen summit.

References:

1. Agrawal, K.C. 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Asthana, D.K. and Meera Asthana. 2006. A text book of Environmental Studies, S. Chand & Co. Ltd., New Delhi.
3. Behera, Basic Environmental Education, Super Book Service, Bangalore.
4. Essential Learnings in Environmental Education. 1991. A Handbook of Environmental Concepts,Centre for Environment Education.
5. Deshbandu*et al.*,1995. Environmental Education for Sustainable Development, India Environmental Society, New Delhi.
6. Kumar. 2008. Environmental Awareness, Jain Books& Periodicals, New Delhi.
7. Mohanka, R., Environmental Education, Vol. 1 & 2, Agro-Sciences Centre, New Delhi.
8. Nanda A.N. 1996. Environmental Education.
9. Pandey, G.N. 1998. Environmental Science and Technology, Annual Publication, New Delhi.
10. Sharma, P.D. 2012. Ecology and Environment, Rastogi Publications, Meerut.
11. UNESCO. Environmental Education Series.

III SEMESTER

HARD CORE COURSES

ESH501 ENVIRONMENTAL BIOLOGY 52 hrs.

Course Outcomes:
CO1 Gain the knowledge of ecosystems and population ecology.
CO2 Study various environmental factors in detail.
CO3 Understand various terminologies in ecology.
CO4 Learn atmospheric humidity in detail.

UNIT I (13 hours)
Ecosystems: Structure, functions, biotic and abiotic components, food chain, types of food chain, food web, Diversity Stability rule, Homeostasis. Ecological niche, Spatial, Functional, Ecological Dominance. Energy flow in ecosystem, Lindeman model Ecotone & Edge effect, Ecological Pyramids.

UNIT II (13 hours)
Environmental factors: Limiting factors, Ecotone & Edge effect - climatic factors, influence of light on morphology and physiology of plants, characteristics of heliophytes and sciophytes, temperature – thermo periodicity, effect of low and high temperature on plants and animals.

UNIT III (13 hours)
Atmospheric humidity: Relative humidity in relation to metabolism of organism with suitable examples. Wind - mechanical effects of wind; lodging, breakage, deformation, anemophily and anemochory, physiological effects of wind. Edaphic factor - soil complex - soil erosion and soil conservation.

UNIT IV (13 hours)
Population ecology: Characteristics, population density, natality, mortality, age distribution, population growth, causes for population explosion, population control. Biological interactions- Interspecies and interspecies interactions, types of interspecific interaction - neutralism, positive interactions - negative interactions, both positive and negative interactions - Amensalism, mutualism, commensalism, parasitism and predation.

References:

1. Arora, M.P. Animal Behavior, Himalaya Publishing House.
2. Culvinvux, P. 1986. Ecology, John Wiley and Sons.
3. Kormondy. Concepts of Ecology, Prentice Hall.

4. Krebs, J. Ecology, II Ed., Harper International.
5. Kumar *et al.*1995. General Ecology, Vikas Publishing House Pvt. Ltd., New Delhi.
6. Payne, A.I. 1986. The Ecology of Tropical lakes and Rivers, John Wiley.
7. Sharma, P.D. Ecology and Environment, Rastogi Publications, Meerut, India.

ESH502 SOLID WASTE MANAGEMENT 52 hrs.

Course Outcomes:

CO1 Learn solid waste, its management and utilization in detail.
CO2 Studying about solid waste and its management and utilization.
CO3 Get the knowledge of reuse, recycle and reduce waste.
CO4 Learn hazardous waste in detail.

UNIT I (13 hours)

Waste: Introduction, sources, characteristics, composition, classification, waste generated per capita - Global scenario. Solid Waste – collection, storage, segregation - transportation and disposal methods - sanitary landfills and types, composting, anaerobic digestion, incineration, types of incineration, pyrolysis. Medical waste and technology options for biomedical waste treatment.

UNIT II (13 hours)

Hazardous waste: Introduction, characteristics, resource conservation and recovery Act, listed hazardous waste, listing criteria. Classification of hazardous waste and handling of hazardous solid wastes. Radioactive wastes - sources, pollution, types of radioactive waste and its control and management.

UNIT III (13 hours)

Waste management: Waste minimization program, typical material recovery facility operation (TMRF). Reuse and recycling of paper, glass, rubber. Plastic waste status in India, effect of plastic wastes on environment, control and management of plastic waste, e-waste management.

UNIT IV (13 hours)

Waste Utilization: Utilization of wastes - plantation crop waste, domestic waste, poultry waste.

Pharmaceutical waste: Types and management,Refinery waste - Types and disposal methods. Pesticide waste, detergent waste.

References:

1. Baker, K.M. and Herson, B.S. 1994. Bioremediation, Mc. Graw-Hill Inc.
2. Bhide and Sundaresan. 2000. Solid waste management in Developing countries, Indian National Scientific Documentation Center, New Delhi.
3. CPHEEO. Manual on solid waste management.
4. Eweis, J.B., Ergas, S.J., Change, D.P.Y. and Schroeder, E.D. 1998. Bioremediation - Principles, Mc Graw Hill Inc.

5. La Grega, M.D., Buckingham, P.L. and Evans, J.C. 2001. Hazardous waste management, II Ed., Mc Graw Hill Inc.
6. Lie, D.H.F. and Liptak, B.G. 2000. Hazardous Wastes and Solid Wastes, Lewis publishers, New York.
7. MilaryTheiren and Samuel A Vigil. 1993. Solid waste management, George Tehobanaglous Integrated, Mc Graw Hill Inc.
8. WHO. Manual on Solid waste management.

SOFT CORE COURSES

ESS503 AIR, NOISE AND RADIATION POLLUTION 39 hrs.

Course Outcomes:
CO1 Demonstrate the various forms of air pollution and its impact on environment.
CO2 Discuss on noise pollution, effect andprevention.
CO3 Demonstrate radioactivity and its protection methodology.
CO4 Learn industrial noise control.

UNIT I (13 hours)
Air pollution: Natural and anthropogenic sources. Transportation and dispersion of pollutants, gas laws governing the behaviour of pollutants in atmosphere, properties of air pollutants. Air quality - air quality monitoring - objectives, conventional monitoring, non-conventional approaches, sampling methods, gaseous sampling, stack monitoring, monitoring of particulates and smoke - air quality standards.

UNIT II (13 hours)
Noise: Sources of noise, reasons for Noise pollution, physical characteristics of sound waves -anatomy of sound. Theory of noise measurement – sound pressure, loudness, sound intensity. Effects of noise pollution - physico-chemical, social and psychological effects of noise. Prevention and control of noise pollution, Industrial noise control. Government rules to check noise pollution.

UNIT III (13 hours)
Radioactivity: Introduction, disintegration types, units of radioactivity, interaction of radiation with matter, ionization types of exposure, detection and measurement of radiation, Dosimeters. Biological effects of radiation. Stochastic and deterministic effects, Radiation protection, system of dose limitation, protection methodology.

References:
1. Manahan, S.E. 2000. Environmental Chemistry, 7thEd., Lewis Publications, Florida, U.S.A.
2. Sharma, B.K.and Kaur.1995. Environmental Chemistry,Goel Publishing House, Meerut.
3. Santra, S.C. Environmental Science, New Central Book AgencyPvt. Ltd., Kolkota.
4. Sawyer, C.N, Mc Marty, P.L. and Perkin, G.F. 1994. Chemistry for Environmental Engineering,2nd Ed., Mc Graw Hill.
5. Tyagi, O.D. and Mehra, M.1990. Environmental Chemistry, Anmol Publications.

ESS504 ENVIRONMENTAL IMPACT ASSESSMENT 39 hrs.

Course Outcomes:

CO1Discuss the importance of environmental impact assessment in industrialization and other environmental activities.
CO2Describe the meaning of sustainable development.
CO3Learn the methodology of environmental audit in India.
CO4 Learn types of impacts on environment.

UNIT I (13 hours)

Environmental Impact Assessment - Definition, aim, components, methods and significance of impact assessment with case studies - Surveillance and monitoring, environmental conflicts. Preparation of impacts: Negative and positive impacts, primary and secondary impacts; impacts on physical, social and cultural aspects.

UNIT II (13 hours)

Sustainable development, unavoidable impacts, alternative strategies. Integrated approach for environmental quality.Prediction of changes in the specific environmental components (air, water, noise, cultural, flora and fauna,socio-economic) due to projects, policies and planning, project implementation, national and international agencies involved in impact assessment studies.

UNIT III (13 hours)

Need for environmental impact assessment in industrialization, agricultural activities, urbanization, energy utilization-over exploitation. Environmental auditing - Definition, objectives, types, components, methodology, benefits, environmental audit in India. Applications and management of Environmental Impact Assessment.

References:

1. Hosetti, B.B. and Arvind Kumar. 1998. Environmental Impact Assessment and Management, Daya Publishing House, Delhi.
2. Hommadi, A.H. 1990. Environmental and Industrial safety. Indian Bibliographics Bureau, Delhi.
3. Hufschmidt, M.M. 1983. Environment, Natural Systems and Development – An Economic Valuation Guide, John Hopkins University Press, London.
4. Munn, R.E. 1989. Environmental Impact Assessment, Scope 5.
5. Patrick Dixon and Johan Gorecki. 2010. Sustainability, 1st Edition.

6. PetterMoris and RikiTherivel. 2009. Methods of Environmental Impact Assessment, 3rdEd., Taylor & Francis Groups.
7. Rau, J.G. and Woefen, D.C. 1980. Environmental Impact Analysis Handbook.
8. Shrivastava, A.K. 2003. Environment Impact Assessment, A.P.H Publishing Corporation, NewDelhi.
9. ValliManickan and Anjaneyalu, M. 2011. Environmental Impact Assessment – Methodologies, B.S. Publication.

ESS505 HUMAN POPULATION AND ENVIRONMENT39 hrs.

Course Outcomes:
CO1 Discuss the association between population growth and dissemination of environmental pollutants.
CO2 Understand the role of medicinal plants in the control of human diseases.
CO3 Discuss the role of human society in the conservation of natural resources.
CO4 Understand traditional ecological knowledge.
CO5 Understand the role of women in environmental conservation.

UNIT I (13 hours)
Population status in India and the world, population growth and explosion, family welfare programme. Measurement of population - Natality and Mortality, Population density, pattern of population distribution; population dispersal - Emigration, Immigration and Migration; Environmental problems of population growth.

UNIT II (13 hours)
Environment and human health, human rights, value education, women and child welfare, role of environmental education in the management of environment, Environmental Education Programmes. Global Environmental problems - Ozone depletion, greenhouse gases, eutrophication, their causes and effects. Drug abuse and alcoholism as a threat to environment. Environmental ethics - stewardship ethics and lifeboat ethics of Garret Hardin.

UNIT III (13 hours)
Role of natural resources in the human development, role of human society in the conservation of forest, river, ponds and other natural resources, role of women in environmental conservation; medicinal plants and their role to control human population from disease. Traditional ecological knowledge.

References:
1. Agrawal, K.C.2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Agarwal, K. M. Sikdar, P. K. and Deb, S. C. 2002. A text book of Environment, MacMiller India Ltd., Calcutta.
3. Botkin, D.B. 1989. Changing the Global Environment, Academic Press, San Diago.

4. Don Melnick. 2005. Environment and Human Well-being - A Practical Strategy, Earthscan.
5. Lori M. Hunter. 2000. The Environmental Implications of Population Dynamics, Rand Corporation.
6. Nanda, A.N. 1996. Environmental Education.
7. Sharma, P.D. 2012. Ecology and Environment, Rastogi Publications, Meerut.
8. Tyler Miller Jr. G. 1996. Living in the Environment - Principles, Connections and Solutions, Wadsworth Publishing Co., New York.

PRACTICAL COURSES
ESP506 ENVIRONMENTAL BIOLOGYLAB.

Course Outcomes:
CO1 Conduct experiments to detect the physico-chemical and biological properties of water.
CO2 Understand intertidal region and mangrove vegetation.
CO3 Enhance the theoretical knowledge of environmental biology with lab experiments and observation of specimens.
CO4 Learn algal indices.

1. Study of microbial flora/planktons found in water/soil samples including pond bottom sediments.
2. Determination of Total alkalinity of different water samples.
3. Estimation of chloride in the water samples.
4. Determination of DO in water sample.
5. Estimation of Nygaard's algal indices in a given water sample.
6. Positive/ Negative staining of bacterial sample.
7. Determination of Total Hardness of different water samples.
8. Microscopic observations of microbes - Keys to identify microorganisms.
9. Practical exercises in identification of symbiotic organisms.
10. Study of aquatic communities – Aquatic plants and animals.
11. Study of intertidal organisms.
12. Study of mangrove vegetation.
13. Study of seaweeds.
14. Identification of bryophytes, ferns and higher plants.

ESP507SOLID WASTE MANAGEMENTLAB.

Course Outcomes:
CO1 Characterize solid waste from different sources.
CO2 Conduct the experiments using leachate prepared from solid waste.
CO3 Learn compost analysis.
CO4 Know the method of determination of chemicals in solid waste.
CO5 Learn solid waste management methods.

1. Characterization of solid waste from different sources.

2. Designing of secured/sanitary landfills.
3. Study of methods of management of biomedical waste.
4. Characterization of toxicity of hazardous waste from different sources by leaching test procedure.
5. Determination of organic carbon in compost.
6. Field trip to municipal solid waste/zero waste management sites/ Biomedical waste plant.
7. Determination of inorganic phosphate in leachate samples.
8. Determination of total nitrogen in leachate.
9. Determination of TSS/TDS in leachate samples.

ESP508 AIR, NOISE AND RADIATION POLLUTIONLAB.

Course Outcomes:
CO1 Assess air pollutants, noise pollution and radiation in different areas.
CO2 Learn air pollution indicators.
CO3 Assess particulate matters in different areas.
CO4 Learn SO_2, NO_x analysis.

1. Determination of SO_2in different areas.
2. Determination NO_x by spectrophotometric method.
3. Basic radioactive measurement procedures using GM counter.
4. Studies on indicators of air pollution.
5. Measurement of noise level in different environments by sound level meter (SLM).
6. Determination of particulate matters PM_{10} and $PM_{2.5}$.
7. Field visit to assess air and noise pollution.
8. Determination of radiation in a given area using dosimeter.

ESP509 ENVIRONMENTAL IMPACT ASSESSMENT LAB.

Course Outcomes:
CO1 Assess and predict the impact on environmental components.
CO2 Prepare model environmental audit report for any industry/process/ operation.
CO3 Learn the methodologies of environmental impact assessment and environmental audit.
CO4 Understand the impact of urbanization on environment.

1. Assessment and prediction of impact on air and water.
2. Assessment and prediction of impact on flora and fauna.
3. Criteria for EIA of water related projects.
4. Criteria for transport related EIA.
5. Environmental guidelines for EIA of industrial establishments.
6. Measurement of suspended particulate matter in air.
7. Study on agricultural activities and their impact on environment.
8. Impact on environment due to urbanization.
9. Preparation of model environmental audit report for the financial year ending 31st March for any industry/process/operation.

ESP510 HUMAN POPULATION AND ENVIRONMENT LAB.

Course Outcomes:
CO1 Measure population growth.
CO2 Collect and identify medicinal plants.
CO3 Learning different methods of representation of population growth rates.
CO4 Know to identify common medicinal plants and learn their medicinal properties.

1. Study on population growth.
2. Graphical representation of Indian and world population.
3. Diagrammatic representation of population growth rates.
4. Regional population growth.
5. Study of medicinal propertiesby collecting and identifying some common medicinal plants.
6. Measurement of population.
7. Study of population density in India and world.

OPEN ELECTIVE COURSES

ESE511 NATURAL RESOURCES 39 hrs.

Course Outcomes:
CO1 Discuss about natural resources and their management.
CO2 Describe energy crisis and conservation of energy resources.
CO3 Get a detailed knowledge of various renewable and non-renewable energy sources.
CO4 Understand energy crisis, conservation and management.

UNIT I (13 hours)
Natural Resources: Classification, uses, distribution.Threats to natural resources. Protection and conservation of natural resources – air, water, soil, forest resource, wildlife resource, fossil fuel, mineral resource.Management of natural resources.

UNIT II (13 hours)
Renewable energy sources: Definition, classification, solar energy - solar cells and solar photovoltaic technology, solar thermal technology, solar energy programmes; wind energy, wind energy programmes; hydropower - hydel projects in India; Geothermal energy, Geothermal energy programmes; Ocean energy – Tidal power, thermal energy, wave energy, salinity energy; biogas, biogas programmes.

UNIT III (13 hours)
Non-renewable energy sources:Definition, classification. Coal – composition.Petroleum - components and refinery process, natural gas - reserves, fuel wood.Nuclear Power – Nuclear reactors – types. Energy crisis and conservation of energy resources. Management of biotic and abiotic energy sources.

References:

1. Agrawal, K.C.2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Bennett, H.H. 2002. Soil Conservation.
3. Deka, M.M. 2002. Joint Forest Management of Water Projects.
4. Gangstad, E.O. 2002. Environment Managements of Water Projects.
5. Khan, T.I. 2000. Global Biodiversity and Environment Conservations. Pointer Publishers, Jaipur.
6. Khenshoo, T.N. Environment Concerns and Strategies.
7. Maitra, M.K. 2002. Watershed Management; Project, Planning, Development and Implementation.
8. RajendraManeria, Environment Conservation and Planning.
9. Tiwari, S.K.1997. Wildlife Sanctuaries of Madhya Pradesh.
10. Ural, O. 1980. Soil and Water Conservation.

ESE512 WASTEMANAGEMENT 39 hrs.

Course Outcomes:

CO1 Discuss about the production of waste from different sources.
CO2 Understand different methods of solid waste management and liquid waste treatment.
CO3 Learning different type of waste released to the environment from different sources.
CO4 Know various methods of liquid waste treatment and solid waste management.

UNIT I (13 hours)

Waste: Introduction, classification - Solid waste and liquidwaste.Solid waste - Definition, classification and components; Municipal, industrial, domestic, hazardous, biomedical waste. Environmental standards - emission standards, drinking water standards.Effects of solid waste on environment;physical and chemical properties of solid waste.

UNIT II (13 hours)

Solid waste Management: Physical, chemical and biological methods. Microbiological treatment of solid wastes – composting, land farming, bioreactors. Waste management and utilization of plantation crop wastes, aquatic weeds, kitchen, garden and poultry waste. Recycling and reuse of solid and liquid wastes.

UNIT III (13 hours)

Liquid waste: Sewageand effluents, effect of liquid waste on environmental components. Biological treatment of liquid wastes - aerobic and anaerobic treatment of sewage and effluents. Physical, chemical and biological treatment of liquid waste. Disposal of textile, radioactive, pharmaceutical, refinery, detergent and leather waste.

References:

1. Agrawal, K.C. 2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.

2. Diwakar Rao, P.L. 1990. Pollution control Hand book, Utility Publications Ltd., Secunderabad. India.
3. Hosetti, B.B. and Arvind Kumar.1998. Environmental Impact Assessment and Management, DayaPublishing House, Delhi.
4. John Arundel, Sewage and Industrial Effluent Treatment, Blackwell Science Publishers.
5. Metcalf and Eddy, Waste Water Engineering, McGraw-Hill International.
6. Schmitz, R.J.1996. Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.

IV SEMESTER

HARD CORE COURSES

ESH551 CONSERVATION OF BIODIVERSITY52 hrs.

Course Outcomes:
CO1 Explain the concept of biodiversity and its conservation.
CO2 Describe the policies that have been developed to conserve biodiversity.
CO3 Get the knowledge of biodiversity and causes for biodiversity depletion.
CO4 Understand different Acts for biodiversity conservation.

UNIT I (13 Hours)
Biodiversity – Definition, types - Genetic, Species, Ecosystem diversity; Alpha, Beta and Gamma diversity, values of Biodiversity – consumptive use value, optional values, productive use value, social value. Biowealth, endemism, significance of the endemism, hotspots of Biodiversity.

UNIT II (13 Hours)
Endangered flora and fauna of India. Red data book and IUCN categories. Endangered, Vulnerable and Rare species. Man - Wildlife conflicts. Ecological consequences of reduction in biodiversity. Biodiversity issues – Deforestation and its impact. Two paradigms of Biodiversity, Convention on Biological diversity (CBD), Man and Biosphere programme (MAB).

UNIT III (13 Hours)
Causes for depletion of biodiversity in India, Biodiversity in Karnataka. Conservation measures of biodiversity in Karnataka, Sacred grooves. Prospects and Perspectives of keystone species with special reference to Tiger.

UNIT IV (13 Hours)
Concept of conservation – objectives and management. Biosphere Reserves. Nilgiri Biosphere Reserve - Biosphere Reserves in India, *In situ* and *ex situ* conservation, Role of Zoos, National Parks and Sanctuaries in conservation, Biological Diversity Act of India.

References:
1. Agarwal, S.K. 2002. Biodiversity and Environment, APH Publishers, New Delhi.

2. Dadhich, L.K. and Sharma,A.P. 2002. Biodiversity – Strategies for Conservation, APH Publishing Corp., New Delhi.
3. Khan, T.I. and Dhari N. 1999. Global Biodiversity Conservation Measures, Pointer Publishers, Jaipur.
4. Krishnamurthy. K.V. 2003. An Advanced Text book on Biodiversity – Principles and Practice, Oxford and IBH publishing, New Delhi.
5. Nagore, A.P. 2000. Biological Diversity and International Environment Law.

SOFT CORE COURSES

ESS 552ENERGY AND GREEN TECHNOLOGIES 39 hrs.

Course Outcomes:
CO1 Introduce various sources of energy.
CO2 Explain green technology as alternate sources of energy.
CO3 Learn energy resources and their management methods.
CO4 Understand the principles and advances of green technology.

UNIT I (13 Hours)
Introduction:Renewable energy sources, non-renewable energy sources, non-conventional and inexhaustible energy resources. Geothermal energy, wind driven power station, tidal power plants, glacier power plants, solar energy, nuclear energy, natural radioactivity, nuclear power plant, fast breeder reactors, nuclear fusion, gober gas plant.

UNIT II (13 Hours)
Energy management – solar energy input conventional fuels – oil, coal, natural gas, uranium, risk of nuclear accidents, bio energy – biomass and biofuels, biogas- biogas technology, petroplants energy plantations and crops. Waste as renewable sources of energy- types of waste, classification based on chemical nature and physical state, composition of the waste, conversion of methane in to synthetic gas, factors effecting methane formation.

UNIT III (13 Hours)
Green Technology: Phytoremediation- Hyperaccumulators- biotic interactions, biofilm. Green chemistry– introduction- inception and evolution- importance of solvents- types of catalysts and their role- Biological alternatives- applications. Principles of green chemistry, advances in green chemistry.

References:
1. Agrawal, K.C.2001. Fundamentals of Environmental Biology, Nidhi Publishers, Bikaner, India.
2. Deka, M.M.2002. Joint Forest Management of Water Projects.
3. Dubey, R.C. Text book of Biotechnology
4. Gangstad, E.O. 2002. Environment Managements of Water Projects.
5. Khenshoo, T.N. Environment Concerns and Strategies.

6. Maitra, M.K.2002. Watershed Management; Project, Planning, Development and Implementation.
7. RajendraManeria, Environment Conservation and Planning.

ESS553 ENVIRONMENTAL POLLUTION AND MANAGEMENT 39hrs.

Course Outcomes:

CO1 Demonstrate various types of pollution and their impact on different environmental components.
CO2 Demonstrate various pollution mitigation measures.
CO3 Demonstrate the various forms of pollution and its impact on different components of environment.
CO4 Understand about biopollution.

UNIT I (13 Hours)

Thermal pollution- Sources, effects and control methods.Thermochemical and photochemical reactions in the atmosphere.Thermal extremes and their health impacts. Marine water pollution: Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system–coastal management.

UNIT II (13 Hours)

Indoor and outdoor air pollution:Sources, types, effects and control.Industrial air pollution-fugitive emission and source emission, preventive methods. Automobile pollution and mitigation measures.Soil pollution:Sources, physico-chemical and biological properties of soil, effects and control measures.Swachh Bharat Mission.

UNIT III (13 Hours)

Nuclear hazards: Sources, effects – nuclear accidents and ecological impacts, control measures. Light pollution: Definition, types, causes, measurement and prevention.Biopollution:Aeroallergens, biological components - pollen grains, fungi, effects, respiratory diseases and control methods.

References:

1. Aswathanarayana, U. Soil Resources & the Environment, Oxford & IBH publishing, New Delhi.
2. Dubey, R.C. and MaheshwariW.K., Text book of Microbiology, S.Chand and Co., New Delhi.
3. Meera Asthana and Astana D.K. 1990. Environmental pollution and Toxicology, Alka Printers.
4. Santra, S.C. Environmental Science, New Central Book Agency (Pvt.) Ltd., Kolkata.
5. Sharma, B.K. and Kaur. 1995. Environmental Chemistry,Goel Publishing House, Meerut.

6. Sharma, P.D.1994. Environmental Biology and Toxicology, Rastogi Publ.
7. Sharma, P.D. Ecology and Environment, Rostogi Publications, Meerut.

PRACTICAL COURSES

ESP554 CONSERVATION OF BIODIVERSITYLAB.

Course Outcomes:
CO1 Determine the diversity of species using different methods.
CO2 Study adaptive features in hydrophytes and xerophytes.
CO3 Determine various diversity indices.
CO4 Identify endangered species.

1. Determination of density of species using quadrat method.
2. Determination of suitability point of a vegetation.
3. Determination of frequency and relative frequency of species in a given area.
4. Determination of abundance of species in a given area.
5. Identification of endangered species of flora and fauna.
6. Economic potentialities of selected plants and animals.
7. Visit to National parks and sanctuaries.
8. Identification of ecological features of selected flora and fauna.
9. Study of adaptive features of hydrophytes.
10. Study of adaptive features of xerophytes.

ESP 555 ENERGY AND GREEN TECHNOLOGIES LAB.

Course Outcomes:
CO1 Study the working principles of various energy plants.
CO2 Describe the role of biomaterials in the removal of metals.
CO3 Identify energy plants.
CO4 Understand plants used for the production of alternate energy sources.
CO4 Assess metal adsorption by biomaterials.

1. Study and identification of energy plants.
2. Adsorption and removal of chromium using different biomaterial.
3. Adsorption and removal of iron using biomaterials.
4. Study of biofuel /green chemistry / petroleum energy plants characteristics.
5. To study the working principles of wind plant/ nuclear energy plant / Gobar gas plant/Glacier plant.

ESP 556 ENVIRONMENTAL POLLUTION AND MANAGEMENT LAB.

Course Outcomes:
CO1 Conduct experiments on water quality parameters.
CO2 Learn the principles of air pollution monitoring, radiation and noise pollution control instruments.
CO3 Gainthe knowledge of air, water and noise pollution and control through field visits.
CO4 Understand primary and secondary abatement methods.

1. Air pollution monitoring, devices, samplers.
2. Determination of salinity in water samples.
3. Study of primary and secondary abatement methods.
4. Detection of pathogenic bacteria in water.
5. Detection of pathogenic cyanobacteria in polluted waters.
6. Study on instruments related to measurement of radioactive compounds.
7. Noise pollution control instruments.
8. Practicals on pollution related issues.
9. Visits to factories, laboratories, industries like KIOCL, MCF, dairy industry.

PROJECT WORK
ESP557 Project work (Report/Dissertation)

Course Outcomes:
CO1 Experience the method of writing the dissertation and present the research data.
CO2 Build up the capacity and confidence to carry out a project independently.
CO3 Gain the knowledge of conducting research based study which will be motivating to go for higher study.
CO4 Able to get job opportunities in the field of research topic carried out in the project work.
