BHARATHIAR UNIVERSITY, COIMBATORE
M.Sc. ENVIRONMENTAL SCIENCES (UD)
SEMESTER WISE SYLLABUS AND SCHEME OF EXAMINATION (2018-2019)

			Duration	Internal	External	Total	Credit
SEMESTER I							
CORE 1	18ENVA13A	Environmental Chemistry	4	25	75	100	4
CORE 2	18ENVA13B	Environmental Pollution	4	25	75	100	4
CORE 3	18ENVA13C	Statistics and Research Methods in Environmental Management	4	25	75	100	4
CORE 4	18ENVA13D	Instrumental Methods of Analysis	4	25	75	100	4
ELECTIVE 1	18ENVA1EA	Environmental Health and Industrial Safety (or) Natural Resource Management	4	25	75	100	4
ADD-ON COURSE 1	18ENVA1AA	Ecotourism	2	12	38	50	2
SUPPORTIVE 1			2	12	38	50	2
SEMINAR			1				
LIBRARY			1				
PRACTICAL I	18ENVA13P1	Practical I	6	25	75	100	4
SEMESTER II							
CORE 5	18ENVA23A	Environmental Impact Assessment	4	25	75	100	4
CORE 6	18ENVA23B	Environmental Microbiology	4	25	75	100	4
CORE 7	18ENVA23C	Biodiversity and Conservation	4	25	75	100	4
CORE 8	18ENVA23D	Green Auditing	4	25	75	100	4
ELECTIVE II	18ENVA2EB	Natural Hazards and Disaster Management (or) Environmental Geosciences	4	25	75	100	4
ADD-ON COURSE II	18ENVA2AB	Vermicomposting	2	12	38	50	2
SEMINAR			1				
LIBRARY			1				
SUPPORTIVE II			2	12	38	50	2
PRACTICAL II	18ENVA23P1	Practical II	6	25	75	100	4
SEMESTER III							
CORE 9	18ENVA33A	Remote Sensing and GIS	4	25	75	100	4
CORE 10	18ENVA33B	Environmental Engineering	4	25	75	100	4

CORE 11	18ENVA33C	Environmental Law, Policy and Auditing	4	25	75	100	4
CORE 12	18ENVA33D	Environmental Toxicology	4	25	75	100	4
CORE 13	18ENVA33E	Waste Management and Bioremediation	4	25	75	100	4
ELECTIVE III	18ENVA3EC	Environmental Biotechnology (or) Environmental Management and Sustainable Development	4	25	75	100	4
ADD-ON COURSE III	18ENVA3AC	Environmental Genomics	2	12	38	50	2
SEMINAR			1				
LIBERARY			1				
SUPPORTIVE III			2	12	38	50	2
PRACTICAL III	18ENVA33P1	PRACTICAL III	6	25	75	100	4
SEMESTER IV							
	Project work and viva-voce examination					150	6
	Self – study paper : Social Issues and Environment (or) Climate Change					50	2
	Industrial visit and Viva-voce examination					50	2
	Summer project					50	2
	SWAYAM – MOOCs-Online 4 weeks Course*					50	2
		TOTAL				**2550**	**102**

SWAYAM – MOOCs-Online 4 weeks Course is mandatory and it should be completed within third semester*

SUPPORTIVE PAPERS OFFERED FOR OTHER DEPARTMENT STUDENTS:

SEMESTER	SUBJECT CODE	TITLE OF THE PAPER	Duration	Internal	External	Total	Credit
I	18ENVGS18	Ecotourism	2	12	38	50	2
II	18ENVGS53	Natural Disaster Management	2	12	38	50	2
III	18ENVGS03	Environmental Education and Awareness	2	12	38	50	2

Note :

1. Practical paper is offered as one single paper with a common code, encompassing all core papers for a given semester, for the University examination with 4 credits.
2. Equal number of experiments to be fixed for all papers.

Note: The revised syllabus for the following papers core/practical furnished below be followed and there is no change in the existing syllabi of remaining papers. Three core papers namely, Environmental Chemistry, Green Auditing & Environmental Microbiology are being offered in the Semester I, II & II, respectively. Core papers, Basics in Chemistry and Biology for Environmental Sciences (Sem. I) & Green Products (Sem. II) and an elective paper, Concepts of Industrial Ecology (Sem. II) have been removed. Only two optional papers for elective in semester I, II and III are being given, out of which the candidate can choose any one of following paper (I) Environmental Health and Industrial Safety (or) Natural Resource Management, (II) Natural Hazards and Disaster Management (or) Environmental Geosciences and (III) Environmental Biotechnology (or) Environmental Management and Sustainable Development. The following papers are being offered as Add-On Course for the Semester I (Ecotourism), II (Vermicomposting) and III (Environmental Genomics).

QUESTION PAPER PATTERN (2018-19)
CORE & ELECTIVE PAPERS

PRACTICAL COMPONENTS MAXIMUM MARKS - 100

INTERNAL MARKS:25

Major Practical	**10 Marks**
Minor Practical	**5 Marks**
Spotters (A,B,C,D and E)	**5x2= 10 Marks**

	Total=25Marks

EXTERNAL MARKS:75

Major/Minor Practical	**60 Marks**
Spotters (A,B,C,D and E)	**5x2= 10 Marks**
Record	**5 Marks**

	Total=75Marks

THEORY COMPONENTS;

CORE & ELECTIVE PAPERS –MAXIMUM MARKS-100

INTERNAL MARKS:25

Test	**15 Marks**
Assignment	**5 Marks**
Seminar	**5 Marks**

EXTERNAL MARKS:75

Question paper pattern

Time: 3.00 Hrs. **Marks: 75**

PART A

Answer ALL questions **(10 x 1 =10)**

Ten Multiple choice questions each carrying one mark

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

PART B

Answer any FIVE **(5 x 2 = 10)**

Seven questions out of which FIVE have to be answered

11.
12.
13.
14.
15.
16.

17.

PART C

Answer all Questions **(5 x 5 = 25)**

FIVE questions with Internal Choice

18. a or b
19. a or b
20. a or b
21. a or b
22. a or b

PART D

Answer any THREE **(3 x 10 = 30)**

Five questions out of which THREE have to be answered

23.
24.
25.
26.
27.

(Unit wise distribution of questions should be followed)

SUPPORTIVE, ADD-ON COURSE AND SELF STUDY PAPERS-MAXIMUM MARKS - 50

INTERNAL MARKS:12

Test	**6 Marks**
Assignment	**3 Marks**
Seminar	**3 Marks**

EXTERNAL MARKS:38

PART A

Time: 2.00 Hrs **Marks: 38**

Answer ALL questions **(6 x 1 =6)**

Six Multiple choice questions each carrying one mark

1.

2.

3.

4.

5.

6.

PART B

Answer any THREE **(3 x 2 = 6)**

Five questions out of which THREE have to be answered

7.

8.

9.

10

11.

PART C

Answer ALL Questions **(2 x 5 = 10)**

TWO questions with Internal Choice

12. a or b

13. a or b

PART D

Answer any TWO **(2 x 8 = 16)**

Three questions out of which TWO have to be answered

14.

15.

16.

(Unit wise distribution of questions should be followed)

SEMESTER I

CORE 1: 18ENVA 13A: ENVIRONMENTAL CHEMISTRY

Objectives: To enable the students to understand the fundamentals of various chemical process that form the core of important environmental problems and to apply the same in solving various environmental issues in polluted environments.

UNIT - I

Concept and scope of environmental chemistry;atomic structure, their properties, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis. redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells.

UNIT - II

Stochiometry, types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides.Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organicfunctional groups, polarity of the functional groups.Gasoline, antiknock compounds, lubricants and greases, biogas, PAH, PCBs, phenols, chlorofluorocarbons, pesticides,chemical fertilizers.

UNIT - III

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Laws of mass action and Applications, Le-Chatlier Braun principle. Principles of photochemistry, fluorescence, phosphorescence, photochemical and photosensitized reactions.Thermochemical and photochemical reactions in the atmosphere, Oxygen and ozone chemistry, Chemistry of air pollutants, greenhouse gases; Photochemical Smog, free radicals and ozone layer depletion, role of CFCs in ozone depletion.aerosols; chemistry of acid rain, reactions of NO_2 and SO_2.

UNIT - IV

First law of thermodynamics, enthalphy, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium, third law of thermodynamics, enzymes catalysis, Michaelis/ Menten equation, exothermic and endothermic reactions, spontaneous and nonspontaneous reactions.

UNIT - V

Chemistry of water, alkalinity and acidity of water, hardness of water, concept of DO., BOD., and COD. Heavy metals, metal solubility, complexation and chelation.Wastewater treatment: Primary, Secondary and tertiary treatments. Advanced water treatment techniques, redox potential.Organic compounds -hydrocarbons, functional groups, nucleophiles and electrophiles. Surface and interface chemistry - Adsorption, absorption, catalysis, colloids, surfactants, examples, types of adsorption, desorption. Synthetic Polymers: biological decomposition, polymer decay, ecological consideration. Inorganic and organic components of soil, anion and cation exchange reactions in soil, nitrogen pathways and NPK in soils.

COURSE OUTCOMES: On successful completion of the course**, s**tudents will be able to

CO 1: understand the fundamental concepts of chemistry - atoms, bonding a chemical molecules.

CO 2: understand the sources, classification and formation of chemical pollutants and their impact on environment.

CO 3: gain detailed knowledge about various physico-chemical parameters, chemical reactions

and removal/reduction of air, soil and water pollutants from the environment.

CO 4: students willbe able to design a field research on environmental problems for sustainable maintenance of the functional ecosystem.

REFERENCES

1. Fundamental Concepts of Environmental Chemistry,Sodhi, G.S. (2009),Alpha Science International Ltd.
2. Environmental Chemistry, (5^{th} Ed.), De, A. K. (2002),New Age International (P) Ltd.
3. Fundamentals of Environmental Chemistry, 3^{rd} Edition, Manahan, E. S. (2011). CRC Press.
4. Photochemistry &Spectroscopy, Simons, J. P. (1971), Wiley Interscience.
5. Fundamentals of Photochemistry, Rohatgi-Mukherjee, K. K.(2006), New Age International (P) Ltd.
6. Elements of Environmental Chemistry, Jadhav, H. V. (1992), Himalya Publication House.
7. Environmental Chemistry, Sharma, B. K. and H. Kaur, H. (1994), Goel Publishing House
8. Environmental Chemistry, Moore, J. W. and Moore, E. A. (1976), Academic Press Inc.
9. Environmental Chemistry A global perspective, (4^{th} Ed.),,VanLoon, G. W. and Duffy, S. J. (2017),Oxford University Press.
10. Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Wayne, R. P., (2000), Oxford University Press.
11. Basic Concepts of Environmental Chemistry (2nd edition), Connell, D.W. (2005), CRC Press.
12. Textbook of Environmental Chemistry,Pani, B. (2007), IK International Publishing House.
13. Elements of Environmental Chemistry (2nd edition). Hites, R.A.(2012), Wiley & Sons.
14. Standard Methods for the Examination of Water and Waste Water, (23thEd.), APHA, (2005), Washington, D.C.
15. Fundamentals of Soil Science, (8^{th} Ed.), Futh, H. D. (2016), Wiley India.
16. Lehninger Principles of Biochemistry, (7^{th} Ed.), Nelson, D. L and Cox, M.M. (2017).W.H. Freeman & Co.

CORE 2: 18 ENVA13B: ENVIRONMENTAL POLLUTION

Objectives: To educate the students on pollution of water, air and soil, impacts of pollution and control measures.

UNIT- I

Structure of the atmosphere, Sources and Classification of Air Pollutants.Transport andDiffusion of Pollutants. Plume behavior and stack dispersion, Reactions of hydroxyl radical withO_2, N_2, CO_2 and Oxides of Nitrogen, Sulphur and Carbon. Sinks of Air pollutants – Acid rain:Ozone depletion – Montreal protocol; Global warming – Kyoto protocol; Gaseous pollutioncontrol measures; photo chemical smog; Automobile pollution in India;Particulate matter pollution – PM 10 and PM 2.5 – Cleaner technologies – online monitoring ofpollution.

UNIT - II

Properties of water – water quality, DO, BOD, COD, acidity, alkalinity, salinity, hardness;drinking water quality standards; Water pollution; Classification of water pollutants, Groundwater pollution, Sources and sinks, Eutrophication. Purification of water by adsorption,flocculation, ion exchange and reverse osmosis methods.Alternatives of end of pipe treatments,online monitoring of industrial effluents – Marinepollution- sources & control.

UNIT - III

Soil pollution; Sources, sinks and broad classification, movement and sorption mechanisms oforganic and inorganic contaminants and their impacts on physio-chemical and biological properties of soil and plants, Sediment Pollution – Black carbon – Soil pollution controlmeasures – Physico-chemical and Biological methods.

UNIT – IV

Hazardous Solid Wastes – Hospital Wastes, Radioactive Wastes - Sources, Transport, Disposal.Municipal solid wastes - hazards, disposal and energy production- Case studies; Light pollutionand control measures; and Thermal pollution and control measures. Noise pollution – Sensing,Measurement,Abatement measures.

UNIT V

Industrial Disasters and Pollution - remedial measures – Case studies-Chemical Industries – Pesticide Industries, Bhopal Disaster, Chernobyl accident, Love canal Disaster, Oil Disasters – Exxon, British Petroleum- Gulf of Mexico; e-wastes, Impact and Remedial Measures.

COURSE OUTCOMES: On successful completion of the course,

CO 1: The students will be able to understand the Sources and Classification of Air/Soil/Water pollutants and their impact on environment.

CO2: Students will be able togain detailed knowledge about physico-chemical and biological control methods of various air/soil/water pollutants.

REFERENCES

1. Chemistry for Environmental Engineering and Science, Sawyer, C.N., Mc Carty P.L., and Parkin,G.F. (2003), Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2. A text book of environmental chemistry and pollution control, Dara, S.S.(1998), S. Chand &Company Ltd, New Delhi
3. An Introduction to Soils and Plant Growth, 5th Edition, Donalue, R. I., Miller, R. W. and Shiekluna, J. C. (1987), Prentice Hall of India.
4. Environmental Engineering, Howard S Peavy, H. S. (2003), Tata McGraw Hill Publishing Company Ltd., New Delhi.
5. Environmental Chemistry, De, A. K. (2001), New Age International Publishers, New Delhi.
6. Environmental Chemistry, Manahan,S. E. (2000), CRC Press, USA.

CORE 3: 18ENVA13C: STATISTICS AND RESEARCH METHODS IN ENVIRONMENTAL MANAGEMENT

Objectives: To impart understanding on the concepts of statistics and to improve the Computing knowledge of the statistical methods related to environment

UNIT - I

Fundamentals of Statistics (Basic concept) – Collection of Data – Classification and Tabulation – Diagrammatic Representation – Measures of Central Tendencies and Dispersion – Probability – Moments, Skewness and Kurtosis – Normal, Poisson and Binomial Distributions.

UNIT – II

Sampling Methods: Probability sampling, random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling.

UNIT – III

Tests of Significance – Mass and alternative hypothesis – error level of significance – Equal and Unequal Sampling - t, z, x2 test, Analysis of variance – One way ANOVA – Two way ANOVA – Regression and correlation - simple and multiple. Introduction to environmental system analysis, Approaches to development of models, models of population growth and interaction-various models.

UNIT – IV

Applications of Computer in Environmental Science and Management – Data Analysis using packages (SPSS): Editing, Data Tabulation, Descriptive statistics,Multivariate Analysis – Correlation – Regression –Cluster analysis – Factor Analysis -PCA, Graph Plotting, Computational databases and environmental management.

UNIT - V

Scientific documentation: Methods of literature collection, design, planning and execution of investigation, Preparation of scientific documents, general articles, research papers, review articles, editing of research papers, methods of citation, collection of literatures, including web based methods, bibliography and thesis writing. Presentation techniques, effective communication skill.

COURSE OUTCOMES: On successful completion of the course,

CO1: Students will be able to extract information and draw scientific inference from ecology and environment related data collected to solve environmental problems

CO2: The students will be able to analyse, model and quantify uncertainty

CO3: The students will be able to design and execute a well-planned field research.

REFERENCES

1. Business Mathematics and Statistics, Vittal, R.R. (1986), Murgham Publications.
2. Programming with C, Gottfried, B. S. (1996), Hill Publishing Co, New Delhi.
3. Statistical Methods, Gupta, S.P. (1996) Sultan Chand & Sons Publications, New Delhi.

4. Environmental Science Methods, Haynes, R. (1982), Chapman & Hall, London.
5. Fundamentals of Bio-Statistics, Khan, I.A. and Kanum, A. (1994),Ukaaz Publication, Hyderabad.
6. Quantitative Techniques, Kothari, C.R. (1996),Vikas Publishing Housing Pvt Ltd, Hyderabad.
7. Statistics for Advanced Level, Miller, J. (1989), Cambridge University Press.
8. Statistical Methods, Snedcor, G.W. and Cochran, W.G. (1982), Academic Press.
9. Statistics in Biology. Bliss, G. I. (1970),Vol. I and II,McGraw Hill Book Company, New Delhi.
10. Practical Statistics for Experimental Biologists. Wardlaw, A.C. (1985), Wiley Chichester.
11. Research Methods in Social Sciences. Sharma, B.A.V., Prasad, D. R. and Satyanarayana, P. (1989), Sterling Publishers Pvt. Ltd.
12. Research Methodology – Methods and Techniques. Kothari, C.R. (1989), Wiley Eastern, New Delhi.
13. Introduction to Research Methodology in Agricultural and Biological Sciences, Venkatasubramanian, V. (1999), New Century Book House (P) Ltd., Chennai

CORE 4: 18ENVA 13D: INSTRUMENTAL METHODS OF ANALYSIS

Objectives: To impart understanding on principles, instrumentation and applications of various instrumental methods in the analysis of chemicals responsible for the pollution of the environment

UNIT - I

Spectroscopic Techniques: Properties of EMR–Basic Principles, Instrumentation andapplications of: Ultraviolet – visible (UV-VIS) Spectroscopy, Infrared spectroscopy, FT-IR, Flame Spectrometry; Atomic Absorption spectroscopy (AAS) – Inductively Coupled Plasma Emission Mass Spectroscopy (ICP-MS), Mass spectrometry, Nuclear magnetic resonance spectroscopy (NMR), Electron paramagnetic resonance (EPR), Flourimetry – Chemiluminescence's Detector System, X-Ray Fluorescence, Microscopy, SEM, TEM.

UNIT - II

Chromatographic Techniques: Basic principles, Instrumentation and applications of Chromatography – paper, thin layer chromatography (TLC), Gel permeation chromatography, Ion exchange chromatography – High performance liquid chromatography (HPLC),Gas Chromatography(GC), Electrophoresis-SDS-PAGE, Agarose gel electrophoresis, 2D-Electrophoresis, PCR, Types of Centrifuge-high speed refrigerated centrifuge.

UNIT – III

Radiochemical analysis: Types of radiation – radioactive decay; Carbon dating; Radioactive labeling – Isotope dilution, Radiation detectors – Geiger Muller Counter, Scintillation counters; Application of isotopes in biological and environmental studies, Neutron activation analysis.

UNIT - IV

Electrochemical Techniques: Introduction to Techniques – Basic principles, Instrumentation and applications of Conductometry, Potentiometry – Ion selective meter – Voltammetry – Polarography, Coulometry.

UNIT - V

Turbidimetry, Nephelometry, Gravimetry, Elemental analyzer, TOC analyzer, Portable Gas Analysis – H_2S, CO_2, SO_2, O_3, HC, Particulate analysis, Stack monitoring, Meteorological equipments.

COURSE OUTCOMES: On successful completion of the course,

CO 1: The students will be able understand the basics of various complex instrumentation

CO 2: The students would have understood the application areas of various instruments viz- environmental samples, drugs, biological samples, food etc.,

CO 3: The students will be able to handle the various analytical instruments enabling them to perform various quantitative and qualitative analyses of environmental samples.

REFERENCES

1. Principles of Instrumental Analysis, Skoog, D. A., Holler, F. J. and Crouch, S. R. (2007). Thomson Brooks/Cole, Belmont, CA.
2. Vogel's Text Book of Quantitative Inorganic Analysis, Barnes, J.D. J., Denney, R.C., Jeffery,G.H. and Mendham, J. (1999), 6th Edition, Pearson Education Ltd., U.K.
3. Fundamentals of Analytical Chemistry, Skoog, D.A.and West, D.M.(2004), Thomson Asia Pvt Ltd, Singapore.
4. Instrumental Methods of Chemical Analysis, Ewing, G.W. (1985), 5th Edition, McGraw Hill, U.K.
5. Instrumental Methods of Chemical Analysis, Sharma, B.K. (2001), Goel Publishing House, Meerut., India.
6. Standard Methods for the Examination of Water and Wastewater, (1998), 23rd, Edition, APHA, Washington, D.C.
7. Environmental Monitoring and Instrumentation, Bucholtz, F. (1997), Optical Society of America,Washington D.C.
8. Environmental Sampling Analysis: A Practical Guide, Keith, L.H. (1991), 3rd Edition, Lewis Publication, Boca Raton, Florida.

ELECTIVE I- 18ENVA1EA: 1. ENVIRONMENTAL HEALTH AND INDUSTRIAL SAFETY

Objectives: To impart knowledge on various occupational health hazards and educate the students about the safety measures to be taken in the work place.

UNIT - I

Occupational Health –WHO concepts of environmental health, Hazards and Safety –Physical, Chemical and Biological hazards.Occupational Diseases and Occupationally induced illness - Prevention and Control. Health problems in different types of industries – construction, textile, steel and food processing, pharmaceutical, Occupational Health and Safety considerations in Wastewater Treatment Plants. Measures for Workers.Health Education Medical First-Aid and Management of Medical Emergencies. Epidemiological approaches. Ergonomics – Need, Task Analysis, Preventing Ergonomic Hazards, Ergonomics Programme. Definition and Role of Ergonomics in Designing Work Place - Work Environment - Effects of Light, Ventilation, Vibration, Noise and stress - Performance Evaluation of Man.

UNIT – II

Industrial Safety Management Techniques – Industrial Safety Standards.Industrial Accidents and Disasters - Frequency Rate, Prevention and Control.Dispersion of Radioactive material and release of Toxic and inflammable materials. Work Study - Method of Study and Measurement. Measurement of Skills. Safety - Cost of Expenses. Principles and Functions in Safety Management. Case Study - Preparation of report on safety and remedial measures followed in Industry.

UNIT- III

Hazards Exposure evaluation-Sampling techniques, Personal monitoring, Biological monitoring; Threshold Limit Values (TLV), STEL; List of Industries involving Hazardous process Occupational Hazards under the First Schedule of the Factories Act,1948; Permissible Limits of certain Chemical substances in work environment under the Second Schedule of the Factories Act,1948; Hazards Control : Elimination, Control , Substitution, Isolation, Personal Protective Equipment(PPE).

UNIT - IV

Hazards Control- Causes of Accident - Accident statistics - Accident Reporting system, Safety Audit, Accident prevention, Disaster Planning, Safety Committee, Case studies on Bhopal, Chernobyl and similar disasters - Control of Hazards Substitutions, Engineering control, Administrative control, Behaviour control, integrated control, Elimination, Control, Substitution, Isolation, Personal Protective Equipment (PPE), Databases of hazardous chemicals.

UNIT- V

Labour laws - Occupational Safety and Health Act and Health Administration, Right to know Laws- Indian Acts – Labour Act, Factories Act, OSHA. Parameters of safety – Factors affecting the conditions of occupational and Industrial safety – Concept of safety organization and Management - Safety Regulations - Supervisors and safety department in motivation.

COURSE OUTCOMES: On successful completion of the course,

CO 1: The students will be able to understand the various possible hazards in a working environment.

CO 2: The student will be able to identify potential workplace hazards and will design for mitigation by employing safety devices

CO 3: The student will be aware of environmentalsafety standards, certification, about safety auditing and management systems.

REFERENCES

1. Occupational Safety and Health for Technologists, Engineers and Managers, Goetsch, D.L. (1999), Prentice Hall.
2. Safety and Environmental Management, Della - Giustina, D.E. (1996), Van Nostrand Reinhold International Thomson Publishing Inc. New York.
3. Environmental Strategies–Hand Book, Kolluru, R. V. (1994), McGraw Hill Inc., New York.
4. A B C of Industrial Safety, Walsh, W. and Russell, L. (1984), Pitman Publishing Ltd., UnitedKingdom.
5. Environmental and Industrial Safety, Hommadi, A. H. (1989), I.B.B. Publication, New Delhi.

ELECTIVE I- 18ENVA1EA: 2. NATURAL RESOURCES MANAGEMENT

Objectives: To enrich the knowledge on natural resources and their significance and to know the strategies for sustainable management

UNIT- I

Natural resources: Concept and types of natural resources, 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.

UNIT- II

Land and Water Resource: soil types, profile and composition, degradation of land and soil-agricultural lands - Land use and land cover, impacts of land use on environment – man-induced landslides; wetland ecology & management.Major water resources- surface and ground water - distribution and supply- hydrological cycle, Causes of water resource depletion - Use and over use of water resources, water resource management - Ground water recharging, rain water harvesting; Watershed management Concept, and objectives, flood control-Dams; Wetlands: definition, importance and classification.

UNIT- III

Mineral and Energy Resources: Types, distribution and reserves of mineral resources, - use and exploitation - environmental effects of mining – case studies - Resource extraction, access and control system – Ecological, economic, and ethnological approach and their implications; integrated resource management strategies.

UNIT- IV

Forest and Energy resource: Types and extent of forests in India - deforestation and conservation strategies; Importance of natural areas - carbon sequestration; forest fragmentation, national forest policy; Biodiversity- conservation strategies, global biodiversity hotspots; threatened and endemic species-Developing and developed world strategies for forestry.

World energy demand – renewable, non-conventional, nuclear energy, tidal energy- alternate energy sources- solar and wind energy- Oil and natural gas, coal, biomass energy, geothermal energy, hydropower; Environmental implication of energy use.

UNIT- V

Management of Common International Resources: Ocean, climate, International fisheries and management commissions; Antarctica: the evolution of an international resource management regime – case studies – Resource management in mountain ecosystem – management of marine and coastal ecosystem .

COURSE OUTCOMES: On successful completion of the course, the students will be able to

CO 1: gain a thorough knowledge of natural resources, their distribution andfactors affecting their availability.

CO 2: understand how developmental activities will affect the natural resources of a nation.

CO 3: understand the importance of natural resources, the need to conserve them and can attempt for alternative energy sources.

CO 4: create awareness to incorporate best management plans in planning activities for nature conservation and sustainable environmental protection.

REFERENCES

1. Global Biodiversity: Status of the Earth's Living Resources, World conservation Monitoring Centre, Groombridge, B. (2010), UNEP, Cambridge.
2. The Environment, Raven, P.H. and Berg, L. R. (2011), 8th Edition, Wiley, UK.
3. Resource Ecology, Agarwal, S. K. (1993), Himanshu Publications. Delhi.
4. Ecology of Natural Resources, Ramade, F. (1984), John Wiley& Sons Ltd.
5. Fundamentals of Ecology, Odum, E. P. (1971), W. B. Saunders Co. USA.
6. Monitoring Sustainability: Indices and Techniques of Analysis, Ramachandran, N.(2000). Concept Publishing Company, New Delhi.
7. Coastal Ecology & Management, Ecology of Coastal Waters with implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303, Mann, K.H. (2000), Wiley-Blackwell.
8. Global Change and Natural Resource Management, Vitousek, P.M. (1994), Beyond global warming: Ecology and global change. Ecology 75, (7),1861-1876.
9. Environmental Biology, Agarwal, K. C.(2001), Nidhi Publication Ltd., Bikaner.
10. Environmental Encyclopedia,Cunningham, W.P., Cooper, T. H., Gorhani, E. and Hepworth, M.T. (2001), Jaico Publishing House.
11. Global Biodiversity Assessment, Heywood, V.H. and Watson, R.T. (1995), Cambridge University Press.
12. Introduction to Environmental Science, Anjaneyulu, Y. (2004), B S. Publications, Hyderabad
13. Environmental Science, Miller T.G. Jr. (1989), Wadsworth Publishing Co. (TB)
14. Essentials of Ecology, Townsend, C. R., Begon, M. and Harper, J. L. (2008), 3rd edition, Blackwell Science.

ADD-ON COURSE-18ENVA1AA: ECOTOURISM

Objectives: To teach the students about the importance of tourism and ecotourism activities along with resource conservation strategies

UNIT - I

Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and Non-Consumptive Tourism. Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism.

UNIT - II

Places of interests of Ecotourism – Ecocircuit of the Western Ghats – Infrastructural Facilities for Ecotourism – Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rain forest Ecotourism – Mountain Ecotourism – Polar, Islands and Coasts Ecotourism – Wilderness – Marine Ecosystem- Sanctuaries and National Parks - TQM of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers.

UNIT - III

Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research-Disasters and Ecotourism-Role of ethics in ecotourism - Advantages and Disadvantages of Ecotourism- Eco-branding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism, Ecotourism and Sustainable Development - Management Issues in Ecotourism, Ecotourism-based/related employment: Scope and areas of employment.

COURSE OUTCOMES: On successful completion of the course,

CO 1: Students will be able to understand the role of ecotourism for sustainable development

CO 2: Students will be able to use a business framework to plan and implement sustainable tourism

CO 3: Students can understand that the implementation of sustainable tourism for protecting the environment as well as consider the needs of local people.

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14. Ecotourism, Weaver, D. (2001). John Wiley and Sons, Milton.

SEMESTER II

CORE 5 – 18ENVA23A: ENVIRONMENTAL IMPACT ASSESSMENT

Objectives: To expose the students to the recent methods, programmes and projects, preparation of EA and EIA reports and institutional requirements of assessment of environmental impacts of policies and plans.

UNIT - I

Objectives – Basis for Environment Impact Assessment, Screening of Projects – Environmental Assessment Procedures – Writing the Environmental Assessment and Checklists, Concept and Significant Impact – Case Studies - Project Alternatives.

UNIT - II

EIA Methodologies – Adhoc Method – Checklist Methods – Matrix Methods – Network Methods, Uniqueness ratio, habitat evaluation system. The Environmental Impact Statement Process. – Preparing EIS – Environmental Management Plan (EMP).

UNIT - III

Procedure for reviewing impact analysis and structure- Prediction and Assessment of Impacts on natural Resources – Biota, Surface Waters, Ground Water, Air, Noise, Hazards, Historic and Cultural Resources, Transportation, Socio-economic relationships. Interlinking of rivers and River Basin Management.

UNIT - IV

Guidelines for environmental audit, Notification – 1994, 2006 and amendments. Public Participation, Regional and Sectoral Impact Assessment, Major limitations of Environmental Impact Assessment.Status of EIA in India – EIA regulations in India – TOR for hydropower projects.

UNIT - V

Case studies - Land Clearing Projects – Dam sites – EIA for Aquaculture, Steel, Mines, Hydel, Thermal, Nuclear, Oil and Gas based Power Plants – Highways projects – Industrial Projects.

COURSE OUTCOMES: On successful completion of the course,

CO 1: The students would have understood about the importance of EIA in a development project.

CO 2: The students will be able to analyse a developing project for their impacts on various environmental matrices by employing various methods.

CO 3: The students would have understood the importance of public participation in EIA process, thereby will be able to provide suggestions for mitigation of impacts.
CO 4: The students will be able to participate in EIA report preparation.

REFERENCES

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2. Environmental Impact Statements, Bregman, J. I. (1999), Lewis Publishers, London.
3. Environmental Assessment, Singleton R, Castle, P and Sort, D. (1999), Thomas Telford Publishing, London.
4. Effective Environmental Assessment, Eccleston, C. H. (2000), Lewis Publishers, London.
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6. A guide book for Integrated Ecological Assessments, Jensen,M. E. and Bourgeron, P. S. (2001), Springer-VerlagInc., New York.

CORE 6 – 17ENVA23B: ENVIRONMENTAL MICROBIOLOGY

Objectives:

- To provide a basic understanding on microbiology and its metabolisms relevant to environment
- To understandvarious microbiological concepts and identify the role of these microbes in environment.
- To provide in-depth knowledge of role of beneficial and pathogenic microorganismin environment.
- To provide knowledge of recent advancements and methods inthe analysis of microbial diversity.

UNIT- I

Introductory microbiology; Introduction to microorganisms: General characteristics, Classification of microorganisms, nutritional types, Scope of Environmental Microbiology; microbial growth and metabolism - carbohydrates, proteins, fat metabolisms and the role of enzymes. Respiration, aerobic and anaerobic-fermentation, glycolysis, Krebs cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, Role of microbes in human life and environment.

UNIT- II

Distribution of microorganisms in environment – Distribution / diversity of Microorganisms – Microflora in different aquatic environment (fresh, marine and other aquatic environment), Microflora in terrestrial environment – microbes in surface soil, Microbes in sub-surface soil; Air – outdoor and Indoor, aerosols, Adaptation of microorganisms to the air environment ; Extramural aeromicrobiology, intramural aeromicrobiology, bioaerosol control and bio safety in

Laboratory; Extreme Environment – archae bacteria, acidophilic, alkalophilic, thermophilic, barophilic and osmophilic and radiodurant microbes.

UNIT- III

Ecological relationships among the microorganisms; relationship among microbial population, interspecies microbial interactions, microbial interactions in a biofilm, Plant –Microbe interaction (Beneficial and pathogenic), animal –microbe interactions (Beneficial and pathogenic) Role of Microorganism in Biogeochemical cycles - Nitrogen, Carbon, Phosphorus, Sulphur Cycle, Microbial corrosions.

UNIT - IV

Indicator organisms in Environment- Standard criteria of indication, indication microbes in air water and soil (Bacteria, algae, bacteriophages and other organisms). Bio-indication of water quality (surface and ground water) – Coli forms - total coli forms, E-coli, Streptococcus, Clostridium, Concentration and detection of virus. Microbial pathogens and Parasites and their effects on Human, Animal and Plant health, Transmission of pathogens – Bacterial, Viral, Protozoan, and Helminths, Control of microorganisms.

UNIT -V

Understanding microbial diversity in the environment by culture-dependent approaches and their limitations, and by culture-independent molecular approaches (DNA heterogeneity by reannealing denatured environmental DNA, ARDRA, analysis of FAME profiles, measuring metabolic capabilities using BIOLOG, microtitre plates, using DNA probes and PCR primers, G+C analysis, slot-blot hybridization of community DNA, and fluorescent in situ hybridization of intact cells)

COURSE OUTCOMES: On successful completion of the course,

CO 1: The students at the end of the course will have a basic understanding on the environmental microbiology, diversity and their role.

CO2: The students would be able to understand and describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem.

CO3: Relate the role of micro-organisms in spread of human diseases and select the type of physical and chemical agents for microbial control.

CO4: To Understand the recent developments in identification of microbes from environment.

CO5: Select the most appropriate technique for detection of environmental microbes for their future research.

REFERENCES

1.Topics in Ecological and EnvironmentalMicrobiology, Schmidt, T. M. and Schaechter, M. (2012), 3rdedition, Academia Press,Elsevier.

2. Environmental Microbiology:Fundamentals and Applications: Microbial Ecology,Bertrand, J- C., Caumette, P.and Lebaron, P. (2015),Springer.

3. Textbook of Environmental Microbiology,Mohapatra, P. K. (2008), I.K. International (P)Ltd.

4. Environmental Microbiology, Pepper, I. L., Gerba, C. P. and Gentry, T. J. (2015), 3rdedition, Academia Press, Elsevier.
5. Environmental Microbiology, Uhrig, B.(2017), Lulu.com Publisher.
6. Environmental Microbiology, Mitchel, R.(2009),2nd edition, Wiley-Blackwell.
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8. Environmental Microbiology: Principles and Applications, Jjemba, P. K.(2004),Science Publishers Inc., Enfield.

CORE 7-18ENVA23C: BIODIVERSITY AND CONSERVATION

Objectives: To impart understanding on the occurrence and distribution of various flora and fauna, their existence and conservation

UNIT I -Scope and Constraints of Biodiversity Science

Biological Diversity: Species – Origin of new species, Description of new species, Community and ecosystem diversity, Genetic diversity- The Hardy-Weinberg law; genetically effective populations size, Gene flow-Genetic pollution and gene erosion, Systematics in Diversity – Environment and Genetic Variations – Biological Classification – Phylogenetic Relationship – Ecological Biodiversity –Species Concept – Biological and Phylogenic Concepts; Species Inventory – Biodiversity hot spots. IUCN categories– Red data book.Case Studies – Deciduous Forests - Desert Lizard communities – Marine and Coral Reef - Fish Communities -Island species — Western and Eastern Ghats – Himalayas

UNIT II -Species Diversity

Global Distribution of Species - Tropical species diversity – Diversity in terrestrial, marine and freshwater –Micro-organisms-lower and higher plants – lower and higher invertebrates and vertebrates; Species extinction and Endangered species; Monitoring indicatorspecies and habitats; Threats to biodiversity: Extinction – Past rate of Extinction – Human Caused Extinctions – Endemic species - Extinction rates - Man and animal conflicts.

UNIT III -Habitats and Ecosystem

History of ecosystem ecology, Human induced Ecosystem change, Urban Ecosystem Classification – Ecosystem mapping, tropical forests, grasslands, wetlands, coral reefs, mangroves; Habitat lass: Habitat destruction – Fragmentation and degradation – desertification – Habitat restoration;Invasive Species: their introduction pathways, biological impacts of invasive species on terrestrial and aquatic systems; Pollution: Impacts of Pesticide pollution, Water pollution and Air Pollution on biodiversity;Overexploitation: Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems

UNIT IV -Values of Biodiversity

Instrumental/Utilitarian value and their categories, Direct use value;Indirect/ Non-consumptive use value, Introduction to Ecological Economics; Monetizing the value of Biodiversity;Intrinsic Value;Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism and Religions; Intellectual Value; Economics of Ecosystem, Green Revolution, Food Plants, medicinal and ornamental plants, animal uses – livestock and fisheries.

UNIT V -Conservation and Management

National Legislation – Protection of Wild flora and Fauna -Protection of National Habitats - National and International Protected Areas – Current Practices in Conservation - in *situ* Conservation and *ex situ* Conservation of Threatened Species – Biodiversity Act 2002 – Patent Act – Agenda 21 – Forest protection Act-Forest conservation Act 1980-Multilateral Treaties – Biodiversity Conventions. Environmental ethics – Biodiversity – a Socio – Political Perspective; Community conserved Areas (CCAs) - Range sand significance of CCAs,

COURSE OUTCOMES: On successful completion of the course, the students will be able to understand

CO 1: the spectacular occurrence of the enormous number of species and different kind of ecosystems in the natural world.

CO 2: the interaction between the various species and environment and the impact of social development on biodiversity

CO 3: the values of biodiversity in serving mankind and the ecosystem, and the major threats to biodiversity due to human developmental activities.

CO 4: will gain knowledge about legislations regarding the conservation of biodiversity.

REFERENCES

1. Global Biodiversity – Status of the Earths Living Resources, Groombridge, B. (1992), Chapman & Hall, London.
2. Ecology of Natural Resources, Ramade, F. (1991), John Wiley and Sons Ltd.
3. Global Biodiversity and Strategy, WRI, IUCN, UNEP (1992).
4. Biodiversity, Science and Development, Younes, T and Castri, F. (1996),CAB International,,UK.
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6. Biodiversity Conservation – In Managed forest and Protected areas, Kotwal, P.C. and Banerjee, S. (2002),Agrobios, India.
7. Global Biodiversity, Sinha, R. K. (1997), INA Shree Publishers, Jaipur.
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9. Conservation of Biodiversity and Natural Resources. Singh, M.P., Singh B.S. andDey, S.S. (2004), Daya Publishing House, New Delhi.
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11. Global Biodiversity – Conservation Measure, Khan, T. I and Al-Ajmi, D. N. (1999), Pointer Publishers, Jaipur.
12. An Advanced Textbook on Biodiversity – Principles and Practice, Krishnamurthy, K.V.(2003), Oxford and IBH Publishing, New Delhi.
13. An advanced Text book on biodiversity,Krishnamurthy, K. V.(2003), Oxford and IBH Book Publishing Co Pvt Ltd., New Delhi.
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16. Curry, G.B. and. Humphries C.J. (2007), Biodiversity Databases Techniques, Politics, and Applications ,CRC Press, Taylor & Francis Group.
17. The conservation of Plant Biodiversity, Frankel, O. H., Brown,A.H.D.and Burdon, J.J. (1995), 1st edition, Cambridge University Press.
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26. Conservation of Plant Biodiversity, 1st edition, Cambridge University Press
27. General account on Biodiversity, Krishnamurthy, K.V.An advanced Text on Biodiversity : Principles and Practice. (2014), Oxford & IBH publiching Co. Pvt. Ltd. New Delhi
28. Megadiverse Countries; http:// geography. about.com/od/ physicalgeography /a/Megadiverse - Countries. htm accessed on 28.12.2014.
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30. procedures/ file_geobase_standards.pdf accessed on 31.12.2014.
31. Geodata standards http://www.tdwg.org/proceedings/article/view/48 accessed on 31.12.2014
32. Barcode Standards: barcoding.si.edu/pdf/dwg_data_standards-final.pdf accessed on 31.12.2014.
33. UNESCO http://en.wikipedia.org/wiki/Biosphere_reserves_of_India accessed on
34. 31.12.2014
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36. UNIT V: Biodiversity Economics, Legislation and Intellectual Property Rights (IPR):
37. Environmental and Forest Acts, TRIPS, UPCOV, Suigeneris systems, Plant Breeders
38. Conservation, Management and use of Agrobiodiversity naasindia.org/Policy% 20Papers /pp4.pdf
39. PPV & FRA http://www.plantauthority.in/ accessed on 31.12.2014
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CORE 8- 18ENVA23D: GREEN AUDITING

Objectives: To provide the students a broad understanding of environmental management systems (EMSs), and the increasing importance of corporate social responsibility and the use of standards for environmental management by companies.

UNIT – I

Green Auditing – Introduction, Scopes and Objectives, Types, Necessity, Process, Aspects (Environmental Audit, Energy Audit and Waste Audit), Green Audit Reporting, Advantages and Disadvantages of Green Auditing.

UNIT–II

Compliance of Environmental Laws - National Environmental laws, Rules and Regulations (General, Water, Air, Forest and Wildlife), Pollution Control Authorities (MOEF, CPCB, SPCB, NEAMA).

UNIT–III

Environmental Management System Standards – ISO 9001, ISO 14001, ISO 18001, ISO 27001, ISO 29001, Sustainable Managements – Green Technology, Eco Marks.

UNIT-IV

Green Accounting - Capitalizing, Examples, Sustainable Reporting, Global Reporting Initiative, EIA, Carbon Credit, Greenhouse Gas emissions; Kyoto Protocol.

UNIT-V

Carbon Sequestration – Sources and Sinks, Physical, Chemical and Biological processes, Carbon Footprint, Carbon Trading- energy foot printing; carbon foot printing; Carbon Diet; carbon credits.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

CO 1: describe specific environmental auditing process associated with the activities of an organization.

CO 2: understand the responsibility of corporate in environmental management

CO 3: assess critically the use and application of environmental auditing and management tools.

CO 4: calculate the carbon footprint of any organization and identify suitable mitigation strategies for carbon reduction solutions.

REFERENCES

1. Environmental Audit, Shrivastava, A. K. (2003), New Delhi, India.
2. Environmental Auditing, Humphery, N. and Hadley. M. (2000), Boca Raton, USA.
3. Green Accounting, Bartelmus, P. and Seifert, E. K. (2017), Taylor & Francis Limited.
4. Introduction to Carbon Capture and Sequestration, Smit, B., Reimer, J. A., Oldenburg, C. M. and Bourg, I. C. (2014), Imperial College Press, London.
5. Perspectives in Environmental Studies, Kaushik, A. and Kaushik C.P. (2014). 4th Edition, New Age International Publishers, New Delhi.
6. Carbon Sequestration for Climate Change Mitigation and Adaptation, Ussiri, D. A. N. Lal, R. (2017), Springer International Publishing.

ELECTIVE II - 18ENVA2EB: 1. NATURAL HAZARDS AND DISASTER MANAGEMENT

Objectives: To educate the students about the different types of natural hazards and understand approaches towards disaster mitigation and risk reduction.

UNIT – I

Natural Disasters –Educative – trends in climatology, meteorology and hydrology.Seismic activities. Changes in Coastal zone, coastal erosion, beach protection. Coastal erosion due to natural and manmade structures.

UNIT--II

Disasters – Nature and characteristics Cyclone – Tornadoes – Avalanches – Flood –Drought – Volcanic – Earthquakes – Fire – Landslides – Causes and effects - Impact on Environment Forecasting and Warning System – Disaster Profile of India.

UNIT - III

Disaster Management. Predisaster Planning-Toning of Disaster – prone areas – prioritization – regulations – protection measures during disaster and Post disaster. Relief Camp Organization – Survey and Assessment. Disaster Management Cycle – Vulnerability Analysis – Disaster Training – Legal Aspects – case studies for disasters and management. Technology for Disaster Management – Role of Information and communication technology, GPS, Remote sensing and Geographic Information system in Disaster Management.

UNIT - IV

Disaster Preparedness and Training. Community Preparedness in Natural Disasters- Role of information, education, communication and training- Roles and responsibilities of different national and international agencies and government - NGO, Armed forces, Paramilitary forces, Community based organizations (CBO) - Army Training for Disaster Reduction –Role of team and co-ordination -Training needs.

UNIT-V

Mitigation Strategies: Disaster Mitigation – emerging trends in disaster management - UN draft resolution on Strengthening of Coordination of Humanitarian Emergency Assistance, International Decade for Natural Disaster Reduction (IDNDR), Policy for disaster reduction, problems of financing and insurance. Training for emergency, Regulation/guidelines for disaster tolerance building structures.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

CO 1: differentiate the different types of disasters, analyse the causes and their potential impact on the natural and man-made environments.

CO 2: will be able to create awareness among the vulnerable population as a measure of disaster mitigation

CO 3: educate people about the importance of preparedness in vulnerable areas.

CO 4: will know about the various national and international agencies that play a major role in disaster management

CO 5: the knowledge gained will enable the students to volunteer themselves in disaster management programmes thus helping affected community.

REFERENCES

1. Natural Hazards, Edwards, B. (2005), Cambridge University Press, U.K.
2. Space Technology for Disaster management: A Remote Sensing & GIS Perspective ,

Roy, P.S. (2000), Indian Institute of Remote Sensing (NRSA), Dehradun.
3. Natural Disaster,Sharma, R.K. & Sharma, G. (2005), APH Publishing Corporation, New Delhi
4. www.GIS. Development.net
5. www.iirs.nrsa.org
6. http://quake.usgs.gov
7. Disaster Management: A disaster Manager's Handbook Carter, N.W. (1992), Asian Development Bank, Manila.
8. Earthquake : A Natural Disaster, Ashutosh, G. (1994), Ashok Publishing House. New Delhi.
9. Natural Hazards and Disaster Management -Vulnerability and Mitigation, R.B. Singh. R. B,(2006),Rawat Publications.
10. Early warning Systems for Natural Disaster Reduction, Zschau, J. and Kuppers, N. (2003), Springer-Verlag, Berlin Heidelberg.
11. A Manual on Disaster Management, Diwan, P. (2010), Pentagon Earth, New Delhi.

ELECTIVE II - 18ENVA2EB 2.ENVIRONMENTAL GEOSCIENCES

Objectives: To educate the students about Earth, Geochemistry, Mineral and Water resources of the environment

UNIT- I

The earth systems and Biosphere: Conservation of matter in various geospheres – lithosphere, hydrosphere, atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons. Ecosystems flow of energy and matter. Coexistence in communities-food webs., Earths'major ecosystems terrestrial and aquatic. General relationship between landscape, biomes and climate. Climates of India, Indian Monsoon, El Nino, Droughts. Tropical cyclones and Western Disturbances.

UNIT- II

Earth's Processes and Geological Hazards: Earths processes; concept of residence, time and rates of natural cycles. Catastrophic geological hazards.Study of floods, landslides, earthquakes, volcanism and avalanche.Prediction and perception of the hazards and adjustments to hazardous activities.

UNIT- III

Mineral Resources and Environment: Resources and Reserves, Minerals and Population. Oceans as new areas for exploration of mineral resources.Ocean ore and recycling of

resources.Environmental impact of exploitation, processing and smelting of minerals.

UNIT- IV

Water Resources and Environment: Global Water Balance. Ice sheets and fluctuations of sea levels. Origin and composition of seawater. Hydrological cycle. Factors influencing the surface water.Types of water.Resources of oceans.Ocean pollution by toxic wastes.Human use of surface and groundwaters.Groundwater pollution.

Land use Planning: The land use plan. Soil surveys in relation to land use planning. Methods of site selection and evaluation.

UNIT- V

Environmental Geochemistry: Concept of major, trace and REE. Classification of trace elements, Mobility of trace elements, Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health.Possible effects of imbalance of some trace elements. Diseases induced by human use of land.

COURSE OUTCOMES: On successful completion of the course, The students will be able to

CO 1: understand the earth's structure, natural resources and the environment.

CO 2: understand that Earth is a complex system of interacting rock, water, air and life and how these elements have shaped Earth's surface.

CO 3: identify the geologic features of the earth (minerals, rocks, structures, fossils, etc.) and use them to understand the geologic history of a region.

REFERENCES

1. Geoenvironment - An introduction, Aswathanarayana, U., (1995), Capital Books.
2. A text book of environment, Agrawal, K. M, Sikdar, P. K., and Deb, S. C., (2002), 1st Edition, Macmillan India.
3. Natural Hazard, Bryant, E. A. (1991), Cambridge University Press.
4. Geology and Society, Coates, D.R.(1985),Chapman &Hall,New York.
5. Environmental Geology, Keller, E.A.(1999), 8th editon, Pearson.
6. Groundwater assessment, development and management, Karanth, K. R., (1987), Tata McGraw Hill.
7. Engineering and General Geology, Singh, P.(1999), S. K. Kataria & Sons, New Delhi.
8. Environmental Geology-Indian Context,Valdiya, K. S. (1987), Tata McGraw Hill Publication. Co., Bombay.
9. Geology, Environment and Society, Valdiya, K. S. (2004), Universities Press.

ADD-ON COURSE-18ENVA2AB: VERMICOMPOSTING

Objectives: To enable the students to learn composting technology and to gain knowledge about solid waste management**.**

Unit -I

Earthworms **–-** Indigenous and Exotic species of earthworms – Life cycle of earthworms - ecological role in soil – economic importance – vermiculture technology - breeding techniques.

Unit- II

Introduction to vermicompost–definition and scope - vermicompost technology – substrates for vermicomposting – selection of worms – Environmental parameters for vermicomposting.

Unit -III

Vermicompost quality – NPK and micronutrients – application of vermicompost – vermiwash - organic farming – benefits of vermicomposting – marketing – creating demand by awareness and demonstration.

COURSE OUTCOMES: On successful completion of the course,

CO 1: Students will be able to construct their own compost farm

CO 2: Students will learn to minimize environmental pollution by recycling and reusing.

CO 3: Helps the student for self employment or to become an entrepreneur

REFERENCES

1. Earthworms: Their ecology and Relationship with Soils and Land Use, Lee, K.E. (1985), Academic Press, Sydney.
2. Verms&Vermitechnology, Kumar, A. (2016), A.P.H. Publishing Corporation, New Delhi.
3. Earthworm-vermiculture and vermin-composting, Bhatnagar, R. K. and Patla, R. K. (2007). Kalyani Publishers, New Delhi
4. Vermiculture Technology: Earthworms,Organic Wastes, and Environmental Management, Edwards, C.A, Arancon, N. Q. and Sherman, R. L. (2011), CRC Press, USA.
5. Biology of Earthworms, Karaca, A. (2011), Springer–Verlag, New York.

SEMESTER III
CORE 9-18ENVA33A: REMOTE SENSING AND GIS

Objective: To teach the principles and applications of spatial information technologies viz RS, GPS and GIS about the distribution of resources. To give hands-on training on the uses of GIS software in environmental studies

UNIT - I

Elements of photographic systems and computer applications. Land stat. IRS and other satellite systems- satellite data. Principles involved in thermal IR image and microwave image interpretation. Applications of different types of images in earth Sciences, Environmental Sciences, Archeology, Marine studies, Forestry, Soils, Hazard management etc.

UNIT - II

Concepts and foundations of remote sensing - History of remote sensing - Electro-magnetic energy – Properties and interaction with the earth.Atmospheric windows.Black, white and grey bodies, sources of EMR.Image interpretations. Aerial photo-classification based on attitude of camera lens, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects. Photo recognition elements, Different types of photographs.

UNIT - III

Introduction to Geographical Information Systems and GIS software, Fundamentals of GIS: Layers and features, Raster/Vector- Georeferencing and projection, Spatial data and GIS basics; Data attributes and spatial topology, Projection / Image registration, Digitization and data attributes -map data representation, GPS.

UNIT - IV

GIS Applications: Resources mapping, Inventory and monitoring natural resources, Land cover mapping, Wetland mapping – Applications to Agriculture - Water Management, Specific Applications - Infrastructure – Ground Water. GPS applications – Principles of Accuracy – Database Creation – Networking of Data.

UNIT - V

Remote sensing applications – Impact Assessment – Pollution Monitoring – Water – Air –Ocean Pollution – Land Degradation – Desertification – Industry – Mining – Ground Water Modeling – Damage Assessment – Coastal and Marine applications – Future Sensors – Satellite System – ENVISAT – MeghaTropiques – TRMM – EOS Missions – Integral Earth Observation Studies – Global Change-Case studies.

COURSE OUTCOMES: On successful completion of the course, the students will be able

CO 1: to learn how sensors collect spatial geographic data

CO 2: to generate geographical information by processing digital data by remote sensing and assess its environmental applications.

CO 3: to apply RS, GIS and GPS tools in various dimensions of the environment.

REFERENCE

1. Remote Sensing and image interpretation, Lillesand, T., Keifer, R. W. and Chipman, J. W. (2004), 5th edition, John Wiley and sons, NewYork.
2. Remote Sensing Techniques for Environmental Analysis, Estes J. E. and Senger, L.W. (1973), John Wiley and Sons, New York.
3. Remote Sensing of Environment, Lintz, J. and Simonett, D.S. (1976),Reading, Massachusetts,Addition – Wesley Publishing Co.
4. Geographic Information Systems – Spatial Modeling and Policy Evaluation, Fischer, M.M. and Nijkamp, P. (1993), Springer – Verlag.
5. Remote Sensing and GIS for Environmental Planning, Muralikrishna, I.V. (1995), Tata-McGraw Hill.
6. Environmental Monitoring: Applications of Remote Sensing and GIS, Singh, R. B. (1992), Geocartho International Centre, Honk Hong.
7. Environmental Remote Sensing from Regional and Global Scales, Foody, G. M. and Curran, P. J. (1994),1st edition, Wiley.
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CORE 10-17ENVA33B: ENVIRONMENTAL ENGINEERING

Objectives: To educate the students about concepts of designs of water distribution systems, sewer networks, working principles and design of various physical, chemical and biological treatment systems of water and waste water.

UNIT - I

Physico chemical and biological characteristics of waste water, Primary, Secondary and tertiary treatment of waste water-.Flow measurement-Hydraulics – Pressure- Hydrostatic Pressure, Pressure Head, Measurement of Pressure, Flow, Design of Pressure Pipes – Darcy – Weisbach Formula, Manning's Formula, Hazen – William's Formula – limiting velocities, Minimum and Maximum Test Pressure and Working Pressure in pipes – selection of pipe material – Pump types, Characteristic Curves – selection and determination of capacity.

UNIT - II

General layout of Water Treatment Plant. Flash Mixer – Design – Clariflocculator – parameters for design – Filtration - Rapid sand filter and Pressure filter and Disinfection -calculation of chlorine dosage, chlorine demand, and residual chlorine.

UNIT - III

Physical and Chemical Unit Operations and Applications – Design Parameters and Design of Primary and Secondary Settling Tanks – Activated Sludge Process – types and modifications – Design of Aeration Tanks– Diffusers and Mechanical Aerators. Trickling Filters and Design. Oxidation Ditch and Duncan Mara Systems (Waste Stabilization Ponds).

UNIT - IV

Sludge Processing and Disposal Methods – Design of Anaerobic Digester and Sludge Drying Bed – Reverse Osmosis – Ion Exchange – Incinerators and Multiple Evaporators.

UNIT - V

Air Pollution – Minimum Stack Height – Plume Rise, Ground Level Concentration of Pollutants. Design of Settling Chamber, Cyclones, Fabric filters and Electrostatic Precipitators.Wet Scrubber. Case studies: Distillery, Dyeing, Electroplating, Paper and Pulp, Steel, Tannery - Industrial Effluent Treatments.

COURSE OUTCOMES: On successful completion of the course, the students will be able to
CO 1: understand the engineering principles of water treatment
CO 2: understand the various parameters influencing water treatment
CO 3: attempt to design a water treatment method for real time effluents
CO 4: gain knowledge about environment protection and operation of pollution control devices

REFERENCES

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2. Water and Wastewater Technology, Hammer, M.J. and Hammer, Jr. M. J. (2001), Prentice Hall of India Pvt. Ltd., New Delhi.
3. Wastewater Engineering: Treatment and Reuse, Metcalf and Eddy. (2003), Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Handbook of Water and Wastewater Treatment Plant Operations, Spellman, F. R. (2003), Lewis Publishers, London.
5. Environmental Engineering, Peavy, H. S. (2003), Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. Environmental Engineering: A Design Approach, Sincero, A. P. and Sincero, G. A.(1999), Prentice-Hall of India Pvt. Ltd.,New Delhi.

CORE 11 – 18ENVA33C: ENVIRONMENTAL LAW, POLICY AND AUDITING

Objectives: To impart knowledge about environmental laws, auditing, regulations and policies of India and international perspectives

UNIT-I

History of Environmental policy – (Ancient India, Medieval India, British India, during post independent era, the seventies, eighties and nineties)- International environmental policy – environmental problems and their impact on international system, the instruments of international environmental policy – international law- soft law - (treaties, conventions and protocols) scientific cooperation - fund support, sanction, dispute settlement procedures, non state actors and international environmental policy - Transnational environmental policies – the Indus river basin, the Ganga – Brahmaputra river basin system

UNIT-II

International Environmental laws - Hazardous Wastes-Basal convention – Necessity for International Environmental Court - United Nations Environment Programme [UNEP] role on international environment laws. Land use policy for India – Urban planning.

Constitutional and legislative provisions in India : Environmental protection and fundamental rights, judicial remedies and procedures – Tort law, public nuisance, the writ jurisdiction, statutory remedies, public interest litigation, class action, freedom of information and the right to know.

UNIT-III

Indian Environmental legislation: The Water (prevention and control of pollution) Act of 1974, The Water Cess act of 1977, The Wildlife Act of 1972, The Air (prevention and control of pollution) act of 1981, The Public Liability Insurance act of 1991, The National Environment Tribunal Act, 1995, The National Environment Appellate Authority act, 1997, The Mines and Minerals act, 1957- The Indian Forest Act, 1927, The Forest (conservation) Act, 1968, The Atomic Energy Act, 1962, The Factories Act, 1948. The Environmental Protection Act, 1986, The forest conservation act 1980, The Wildlife Protection Act 1972 (2002 amendment), Plastics Waste management Rules 2015.

UNIT-IV

Environmental Auditing (EA) – organizations and the environment -Objectives and Scope – Types of EA – Objective based (Liability, management and functional audits); Client driven – Elements of audit process (What, who, why and how) – Environmental issues: Identification of problems.

UNIT- V

Benefits and costs of environmental audit – Contents of EA reports -Tools for EA (EMSs) – International standards for environment quality –ISO 14001, 19011 - EA in India – Gazette Notification, 1992- Case studies: South India Viscose rayon unit case.

COURSE OUTCOMES: On successful completion of the course,

CO 1: Students will be able to understand the key features of Environmental laws/acts and legal obligations of citizens to environmental related issues.

CO 2: Students will be able to apply key auditing tools and techniques.

CO 3: Students will be able to conduct on-site assessments and prepare audit reports.

REFERENCES

1. Environmental law in India ,Singh, G. (2005), McMillan, New Delhi.
2. Environmental law and policy in India, Diwan, S. andRosencrany, A. (2001), Oxford University Press, New Delhi.
3. Pollution Control Legislations, (1999), Vol. I and II, Tamil nadu Pollution Control Board, Chennai.
4. Environmental Management in Practice, Nath B., Hens, L., Compton, P. and Devuyst, D. (1998), Vol I, Routledge, London and New York.
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6. ISO 14004 – Environmental management systems: General guidelines on principles, systems and supporting techniques (ISO 14004: 1996 (E).
7. ISO 14001: Environmental management systems: Specification with guidance for use (ISO 14001: 1996b (E)), International organization for standardization – Switzerland.

CORE 12-18ENVA33D: ENVIORNMENTAL TOXICOLOGY

Objectives: To understand the occurrence and route of entry of various environmental toxicants and contaminants, their fate and impact in environment and on life of organisms.

UNIT – I

Toxicology – Definitions, Major classes of environmental toxicants, Origin and Nature of Toxicants in Environment. Basic Probit analysis, concepts – Toxicants – Toxicity, Acute, sub acute, chronic, dose effect, LD 50, LC 50 and response safe limits. Dose response relationship, graphs, concentration response relationship, Safe Limits.Biological, chemical Factors that influence.Influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals.

UNIT – II

Pest – Pesticides – Classification of pesticides – Pest surveillance, resistance, residual effects, toxic effects of insecticides on man and mammals. Metals- Toxicity, Properties, occurrence, Production, Industrial uses, Metabolism, Physiology, Toxicology, Prophylaxis and Therapy - Aluminium, arsenic, cadmium, chromium, lead and mercury. Mutagenesis and carcinogenesis - case studies.Emerging pollutants in environment-Pharmaceuticals and personal care products.

UNIT – III

Chlorinated xenobiotics in environment – Bioconcentrations – Volatilization – Biological and nonbiological degradations, Detoxification. Chlorinated organics in environment and their fate. Short chained chlorinated hydrocarbons – Toxicity – Ecotoxicological relevants and degradation. PCB – Dioxins levels, fate, toxicity and their global distribution. Toxaphene – occurrence and degradation. Environmental risk assessments- Biomonitoring - Bioindicators- Environmental specimen banking.

UNIT – IV

Bioaccumulation – Bioconcentration – Biomagnifications –mechanisms in biota – Significant influence, mechanisms and Kinetics of Bioconcentration. Cellular response to chemical stress – membrane process; intracellular fate of chemicals, cell receptors, cell injury and apoptosis. Long-term impact of chemicals in aquatic organisms, soil invertebrates and Avian species.

UNIT – V

Ecotoxic modes of action of chemicals: Biotransformation of xenobiotics – Molecular mode of action – Toxicity Testing Methods – Microbial, algal, invertebrates and alternative toxicity tests. Multimedia mass balance models – fugacity – nonfugacity models – applications of multimedia models.Future test strategies in Ecotoxicology – Legislative perspectives. Animal management in Toxicological Evaluation: Animal extrapolation; Animal ethics.

COURSE OUTCOMES: On successful completion of the course, the students would have

CO 1: gained knowledge on the various environmental toxicants – toxicants in food, drugs, pesticides PPCP's etc.,

CO 2: improved understanding about the negative effects of organic and inorganic toxicants on life of organisms and on environment.

CO 3: gained knowledge on the exposure routes of toxicants, toxicological test methods, and determination of toxic levels of contaminants.

CO 4: understood the importance of toxicological regulations and will be able to

explain the potential fate and effects of a contaminant in the environment.

CO 5: understood the importance of animal ethics to be followed in toxicological testing methods and option for alternative test methods.

REFERENCES

1. Introduction to Environmental Toxicology- Landis, W. G. and Yu, M. H. (2003),3rd edition,Lewis Publishers, CRC press , NY.
2. Ecotoxicology, Schuurmann, G. and Market, G. (1998), John Wiley & Sons,Inc
3. Hand book of Environmental Risk Assessment and Management, Callow, P. (1998), Blackwell Science, London.
4. Environmental Impact of Chemicals: Assessment and Control,Quint, M.D., Taylor, D., Purchase, R. (1996), The Royal Society of Chemistry, Cambridge.
5. Health and Environmental Risk Assessment, Ricci, P. and Rowe, M.D., (1985),Pergamon Press, New York.
6. Environmental Risks and Hazards, Cutter, S.L. (1994), Prenctice - Hall of India, New Delhi.
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8. Information Resources in Toxicology: Philip, W. et al, (2000), 3rd edition, Academic Press.
9. Casarett and Doull's Toxicology:The Basic Science of Poisons Companion Handbook, Klaassen, C. D. and Watkins, J. B. (2001), 6th Ed. McGraw-Hill, NY.
10. Environmental Toxicology and Chemistry, Crosby, D. G. (1998), Oxford University Press, NY.
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14. Environmental Toxicology-Biological and Health effects of Pollutants. Yu, M.-H.,Tsunado, H. and Tsunoda, M. (2011), 3rd edition, CRC Press.

CORE 13 – 18ENVA33E: WASTE MANAGEMENT AND BIOREMEDIATION

Objectives: To impart knowledge on the management of solid and liquid wastes frommunicipal and industrial sources and principles of remedial measures of recycling,reuse and recover from the wastes.

UNIT – I

Wastes– Classification and Quantification – Solid Waste Management and Disposal: Sourcesand Generation of Solid Waste – characterization, composition and classification. Hazardous Waste Management: Cyanides, Dioxins, Detergents, Plastics, Nylon and Paper. WasteMinimization approaches – Monitoring and Management strategies. Radioactive Waste: Sources, half-life of radioactive elements, modes of decay. Effects on Plants, Animal and Man. Low andHigh-level Radioactive Waste Management – Waste Minimization and Treatment, Radiationstandards.

UNIT – II

Recycling of Wastes – Types – sources – composition of waste – recycling of waste for Industrial, Agricultural and Domestic Purposes; Recycling of Metals, Reuse, recovery andreduction of paper and plastics; Recycling in Food Manufacturing, Beverages, Apparel, Leather,Paper, Pulp, Chemical and other industries; Fly Ash utilization. Waste Disposal Methods –incineration, pyrolysis, medical waste disposal strategies. Strategies for conversion ofbiodegradable waste into organic fertilizers and fuels. Composting, Vermicomposting and biomethanization.

UNIT – III

Microbial Activity in Soil, Lithosphere as Microbial habitat, Microorganisms in rock andminerals, Mineral soil and Organic soil. Physiological groups of prokaryotes, Geomicrobial transformations – Biodegradation of carbonates – Biomobilization of silicon, phosphate, nitrogen. Geomicrobiology of fossil fuel, methane, peat, coal and petroleum.

UNIT – IV

Principles of Bioremediation – Rapid growth and Metabolism- Genetic plasticity – Metabolicpathways for the degradation of xenobiotics– Microbial site characterization – Microbiological methodologies – Standard biotreatability protocols -Principles and mechanisms of biodeterioration -Microbial leaching of metal ores, microbial transformation of antibiotics and steroids-Phytoremediation and plant microbe interaction in organic and inorganic polluted soils - Genetic engineering approaches .

UNIT – V

Aerobic Bioremediation: Bioremediation of Surface Soils: Fate and transport of contaminants in the Vadose zone – Biodegradation in soil ecosystems – Types of soil treatment systems – Bioreactors. Subsurface Aerobic Bioremediation: in situ Bioremediation – in situ Bioventing –in situ treatments of Harbour Sediments and Lagoons. Bioremediation in fresh water and marinesystems: Bench and Pilot Scale studies – in situ Bioreactor treatment of sediments – in situtreatment in marine ecosystem. Anoxic/Anaerobic Bioremediation: Anoxic/Anaerobic Processes–Fermentation, Degradation of xenobiotics – Anoxic/Anaerobic bioremediation of hydrocarbons, Phenols, Chlorophenolic compounds, Polycyclic Aromatic Hydrocarbons (PAH),Heterocyclic Compounds, Cyanide, dyes, Radioactive wastes.

COURSE OUTCOMES: On successful completion of the course,

CO 1: The students at the end of the course will have a basic understanding on the management of solid and liquid wastes from municipal and industrial sources and principles of remedial measures of recycling, reuse and recover from the wastes.

CO 2: The students would be able to understand and describe the principle and mechanistic role of microbes in the degradation of various pollutants.

REFERENCES

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2. Bioremediation, Baker, K.H. and Herson, D.S. (1994), McGraw–Hill Inc, New York.
3. Biology of Microorganisms, VII Ed., Brock,T.D., Madigan,M.T. Martinko,J.M. and Parker, J. (1994),Prentice Hall, New Jercy.

4. Geomicrobiology, Ehrlich,H.L. (1996), Marcel Dekker Inc., New York.
5. Bioremediation – Principles, Eweis, J.B., Ergas, S.J, Change, D.P.Y and Schroeder, E.D. (1998), McGraw-Hill Inc.
6. Environmental Engineering, Kiely, G. (1998), Irwin/McGraw Hill International, U.K.
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9. Hazardous Wastes and Solid Wastes, Liu, D.H.F and Liptak,B.G.(2000), LewisPublishers, New York.
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13. Recycling of Crop, Animal and Human Waste in Agriculture, Tandon, H. L. S. (1995), Mc Graw Hill Publishing Co.
14. Biodegradation and Bioremediation, Alexander, A. (1999), Academic Press

ELECTIVE III -18ENVA3EC: 1. ENVIRONMENTAL BIOTECHNOLOGY

Objectives: To impart knowledge in molecular biotechnology and its applications in Environmental management

UNIT-I

Technology for Bioremediation- Recombinant DNA Technology, development of genetically engineered microorganisms (GEMs), Polymerase Chain Reaction (PCR) and development of gene probes for environmental remediation*:* Role of genetically engineered plants and microbes (GEMs) in *In-situ* and *Ex-situ* bioremediation. Suicide genes.Micro-electromechanical systems (MEMS), Genosensor technology.

UNIT-II

Xenobiotics and Biodegradation- Xenobiotics, biodegradation of Polychlorinated biphenyls (PCBs). Biodegradation of halogenated hydrocarbons; polycyclic aromatic hydrogen; Pesticides and Detergents.Biosorption of heavy metals, degradation of oil spills, plastic degradation by microbes.

Industrial Biotechnology- Fermentation Technology-submerged and solid state fermentation, advantages of SSF. Applications of Enzymes in bakery, detergents, textile, leather, pulp and paper manufacturing industries.

UNIT-III

Biotechnology for Resource Management- Bio-transformation of heavy metals ; Oil field microbiology; Improved oil recovery; Role of environmental biotechnology in resource management – Bioremediation – energy production - mineral and energy recovery,

Nanotechnology for control of pollution - Planning and management of bioremediation and environmental biotechnology processes

UNIT-IV

Forestry and Biotechnology- Forestry and Biotechnology: Reforestation through micro-propagation; Somaclonal variations; Induction of genetic variability and heriditability; Conservation of endangered species; Biotechnology in preservation of bio-diversity; In situ and ex situ conservation through gene banks. Phytoremediation - xenobiotics and bioaccumulation of metals using plants.

Agricultural biotechnology- Production ofbiofertilizers –Rhizobium, Azolla, Biopesticides-Bt insecticide.Advantages and applications of biofertilizers and biopesticides.

UNIT-V

Bioethics and Biosafety- Bioethics– Ethics of Genetically modified plants, animals and microbes, ethics in genetically modified food, stem cell research. Potential effect on Environment and Human health by transgenic plants-Risk assessment, regulation and containment - Human genome project - ICMR Ethical Guidelines for Biomedical Research on Human Subjects. Biosaftey guidelines and regulations - Intellectual Property Rights - Plant variety protection.

COURSE OUTCOMES: On successful completion of the course, the students would have understood

CO 1: the basic principles on degradation of persistent organic pollutants mainly by means of the biological approaches using degradation ability of microorganisms, fungi, and plants.

CO2: the importance of genetically engineered plants and microbes in environmental remediation

CO 3: the importance of genetically engineered organisms in forestry and agriculture

CO 4: importance to follow ethical guidelines in use of bioengineered plants and microbes.

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1. Environmental Biotechnology – Theory and Application, Evano, G. H. and Furlong, J. C.(2004), John Wiley and Sons, USA.
2. Environmental Microbiology – Theory and Application, Jjemba, P. K. (2004), Science Pub. Inc., USA.
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5. Basic Biotechnology, Ratledge, C. and Kristiansen, B. (2003), 2nd edition, Cambridge University Press.

ELECTIVE III - 18ENVA3EC: 2. ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT

Objectives: To impart an understanding of system approaches, tools of environmental management, management of ecosystem and; local and global environmental issues

UNIT - I

Concept and scope of Environmental Management, Environmental Management of Resources -- Water, forest, biological, mineral and agricultural; Environmental management of chemical, mining and manufacturing industries –petroleum, coal, cement, paper, fertilizer. Analysis and prediction of Environmental issues: Environmental Planning, Establishment of Health and Environmental standards, measuring Sustainable Development, Life Cycle Assessment, Material Flow Analysis, Environmental Auditing and Environmental Management Systems and Accounting for Eco-efficiency.

UNI T - II

Principles of Risk Assessment: Human Health Risk Assessments, Ecological Risk Assessment, Probabilistic Risk Assessments, Determination of acceptable risk based limits for Environmental chemicals and development of risk based remediation goals.

UNIT - III

The role of Risk Assessment in Environmental Management decisions: Evaluation of Human Health Risks Associated with airborne exposures to asbestos, a diagnostic human health risk assessment for a contaminated site problem and a risk based strategy for developing a corrective action, Response plan for petroleum – contaminated sites, Risk Management and Risk Communication.

UNIT - IV

Basic concepts of Environmental Economics, International Trade and its Environmental Integrity, Eco-labelling, responsible care, design for the Environment and full-cost accounting for municipal solid waste management, Waste lands and their reclamation, Desertification and its control. Soil erosion, Formation and reclamation of user, alkaline and saline soil, Terra Preta [black carbon] soil in Amazon forests for sustainability in soil; Biochars for energy production and as mitigation measures for global warming and soil rejuvenation.

UNIT - V

Environmental Education and Communication, Environmental Conflict Management, Sustainable development – concept, and growth of the idea, indicators of sustainability, Sustainability of Water Resources, Sustainable Management of Forests, Sustainability in Industry, Ecosystem Management: Coastal Environments, River and Inland Water Environments, Wetlands, Desert margins, Rural and Urban Environments. Current environmental issues in India – Case studies: Narmada Dam, There Dam, Almetti Dam.

COURSE OUTCOMES: On successful completion of the course, the students would have

CO 1: understood the importance of environmental planning in environmental management

CO 2: understood about the importance of various tools of Environmental Management Plans like life Cycle Assessment, material Analysis Environmental Impact and Risk Assessment, Environmental Audit etc.,

CO 3: knowledge to anticipate, identify and assess the environmental issues in various industrial sectors and in cooperation with federal, state, and local agencies and officials work for mitigation strategies on issues pertaining to environmental protection.

CO 4: gained awareness about use of ecofriendly products to promote sustainable development

REFERENCES

1. A Practical Guide to Understanding Management and Reviewing Environmental Risk Assessment Reports, Benjamin, S. L. and Bullock, D. A. (2001), Lewis Publishers, Washington D.C.
2. Hand Book of Environmental Risk Assessment and Management,Calow, P. (1998), Blackwell-Synergy, London.
3. Environmental Management in Pactice, Volume – I to III Instruments for Environmental Management, Nath, B., Hens,L., Compton, P. andDevuyst, D. (1998), Routledge,London and New York.
4. Risk based analysis for Environmental Managers, Frantzen, K.A. (2001), Lewis Publishers, Washington D.C.
5. Risk Assessment in Environmental Management, Kofi, A.-D.D. (1998), John Willey and Sons, New York.

ADD-ON COURSE III-18ENVA3AC: ENVIRONMENTAL GENOMICS

Objectives: To impart understanding on the basic concepts of environment-gene interaction and environmental genomics

UNIT-I

Basic and molecular Genetics- Mendalian genetics- Law of segregation, law of independent assortment and alleles.Basics of Environmental genetics, epigenetics and diversity.Environment induced genetic adaptation - Darwinian and molecular evolution. Molecular central dogma- DNA, RNA and protein.Chromosomes, transcription and translation.

UNIT-II

Environmental genomics- Concepts of gene–environment interaction.Environmental population genomics of flora and fauna.Hardy-Weinberg equilibrium.Sex, genes, and the environment. Metagenomics-concepts and methods. Microbial environmental genomics (MEG) – analysis of the diversity of different organism types (archaea, bacteria, fungi, protists and micro fauna). Concepts of environmental viral genomics.Environmental genomics methods - gene expression profiling (NGS), whole genome and chromosome mutation detection, and methods to assay genome diversity and polymorphisms within a particular environment.

Unit-III

GMO and Environmental impacts - Concepts of genetically modified organisms (GMO)– Genetically modified plant and animals.Plant and animal genome editing and its impact on environment (CRISPR gene editing).Crop biotechnology and the environmental impact of global agriculture.GM plants and its impact on pesticide use and carbon emissions.Existing GMO and its environmental impacts - Herbicide tolerance soybean,insect resistance corn, altered fatty acid composition canola, vitamin enrichment rice, virus resistance plum, vaccines tobacco, faster maturation fish-coho salmon.

COURSE OUTCOMES: On successful completion of the course,

CO 1: Students would have understood the basic concepts of environment-gene interactionand adaptation of organisms under various environmental exposures.

CO 2: Students would have understood the importance of genomics principles for

environmental protection would be unveiled.

REFERENCES

1. Principles of Genetics. Snustad, P. and Simmons, M. J. (2011), 6th edition, John Wiley & Sons
2. An Introduction to Ecological Genomics. van Straalen, N. M. and Roelofs, D. (2011), 2nd edition, Oxford University Press, UK.
2. Insight on Environmental Genomics, Faure, D. and Joly, D. (2016), 1st edition, Elsevier.
3. Genetically Modified Organisms in Agriculture, Nelson, G. (2001), 1st Edition, Elsevier.
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5. Principles and Applications of Environmental Biotechnology for a Sustainable Future, Lakhan, S. R. (2017), Springer, Singapore.
6. Environmental risk assessment of genetically modified organisms,Andow, D. A., Hillbeck, A.and Van Taut, N. (2008), CAB International, UK.

SUPPORTIVE PAPER I-18ENVGS18: ECOTOURISM

Objectives: To teach the students about the importance of tourism and ecotourism activities along with conservation of natural resources

UNIT - I

Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and Non-Consumptive Tourism. Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism.

UNIT - II

Places of interests of Ecotourism – Ecocircuit of the Western Ghats – Infrastructural Facilities for Ecotourism – Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rain forest Ecotourism – Mountain Ecotourism – Polar, Islands and Coasts Ecotourism – Wilderness – Marine Ecosystem- Sanctuaries and National Parks - TQM of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers.

UNIT - III

Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research-Disasters and Ecotourism-Role of ethics in ecotourism - Advantages and Disadvantages of Ecotourism- Eco-branding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism, Ecotourism and Sustainable Development - Management Issues in Ecotourism, Ecotourism-based/related employment: Scope and areas of employment.

COURSE OUTCOMES: On successful completion of the course,

CO 1: Students will be able to understand the role of ecotourism for sustainable development

CO 2: Students will be able to use a business framework to plan and implement sustainable tourism

CO 3: Students can understand that the implementation of sustainable tourism for protecting the environment as well as consider the needs of local people.

REFERENCES

1. The Encyclopedia of Ecotourism, Weaver, D. B. (2001), CABI Publishing, U.K.
2. Encyclopedia of Ecotourism, Volume I, II and III, Sinha, P.C. (2003), Anmol Publications (P) Ltd., New Delhi.
3. Ecotourism and sustainable Development, Mukherjee, N. (2008), Cybetech Publications, New Delhi.
4. Global Ecotourism, Chandra, P. (2003), Kaniskha Publishers, New Delhi.
5. Ecotourism. An Introduction, David, F. A. (2003), Routledge, London and New York.
6. Ecotourism Impacts, Potentials and Possibilities, Wearing, S. and Neil, J. (2009), 2nd edition, Butterworth &Heinemann, Amsterdam.
7. Case studies in ecotourism, Buckley, R. (2003),CABInternational, Cambridge.
8. Environmental impacts of ecotourism, Buckley, R. (2004), CABInternational,Oxfordshire.
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13. Ecotourism, Page, S.J. and Dowling, R.K. (2002), Prentice Hall,New York.
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SUPPORTIVE II-18ENVGS53: NATURAL DISASTER MANAGEMENT

Objectives: To impart knowledge on the management, disaster preparedness and training and mitigation strategies during the natural disasters.

UNIT - I

Natural Disasters – Nature and Extent and Educative – Disasters - Cyclone – Tornadoes – Avalanches – Flood –Drought – Volcanic – Earthquakes – Fire – Landslides. Forecasting and Warning System: Cyclone Disaster Education - Cyclone Safety – Earthquake – Avalanche – Safety and Flood Safety – Impact on Environment.

UNIT - II

Disaster Management.Predisaster Planning-Toning of Disaster – prone areas – prioritization – regulations – protection measures during disaster - Post disaster. Relief Camp Organization – Survey and Assessment. Disaster Management Cycle – Vulnerability Analysis – Warning system –Legal Aspects – case studies for disasters and management, Safety Measures – Disaster Management plans.

UNIT - III

Disaster Preparedness and Training. Community Preparedness in Natural Disasters- Roles and responsibilities of different national and international agencies and government - NGO, Armed forces, Paramilitary forces, Community based organizations (CBO) - Army Training for Disaster Reduction –Role of team and co-ordination -Training needs – Target Groups – Local Condition.

Mitigation Strategies: Disaster Mitigation –Training for emergency.

COURSE OUTCOMES: On successful completion of the course, the students will be able to

CO 1: differentiate the different types of disasters, analyse the causes and their potential impact on the natural and man-made environments.

CO 2: educate people about the importance of preparedness in vulnerable areas.

CO 3: will know about the various national and international agencies that play a major role in disaster management

CO 4: the knowledge gained will enable the students to volunteer themselves in disaster management programmes thus helping affected community.

REFERENCES

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2. www.GIS. Development.net
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12. Natural Disaster Reduction, Misra, G. K. and Mathur, G.C. (1993), Reliance Publishing House, New Delhi.

SUPPORTIVE III -18ENVGS03: ENVIRONMENTAL EDUCATION AND AWARENESS

Objectives: To impart understanding on the environmental education and environmental awareness

UNIT-I

Environmental Education- Concept, scope and importance of Environmental Education - Objectives of Environmental Education at secondary school level. Values and ethics related to environment - Approaches of Environmental Education - Salient features of environmental awareness through education: programs of environmental education for secondary school children - Programs of environmental education for attitude changes among the children.

UNIT II

Environmental Hazards -Causes and effects of environmental hazards, effect of human activities on environment - environmental pollution - global and local (Soil pollution, water

pollution, air pollution, noise pollution) - Green House effect –Ozone layer depletion –acid rain, pillar melting, rise of sea level and their implications - Mitigation efforts.

UNIT III

Sustainable Development and Environmental Awareness - Learning to live in harmony with nature - environmental education for development, conservation of soil, water, forests, wild life, energy resources, movement to save environment, eco-friendly technology - Alternate sources of energy - Waste management - Population and environment .

COURSE OUTCOMES: On successful completion of the course,

CO1: Students will be able to understand the role and importance of environmental education for school children.

CO2: Through obtained the environmental awareness knowledge, students will be able to understand the eco-friendly mitigation efforts to save the sustainable nature for future generation.

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5. Environmental Science, Purdom, P.W. and Anderson, S.H.(1983), Charles E. Merril Publishing Co.
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7. Environmental Biology, Sharma, P. D. (1993),Rastogiand Co. Meerut.
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9. The Handbook of Environmental Education, Palmer, J. and Philips, N. (1994), Routledge, London.

SEMESTE IV

SELF STUDY PAPER-1. SOCIAL ISSUES AND ENVIRONMENT

Objectives: To acquire the knowledge, values, attitudes, and practical skills to participate in a responsible and effective way in anticipating and solving social problems, and in the management of the quality of the environment.

UNIT - I

Human Population and the Environment - Population growth, variation among nations. Population explosion and environmental quality – Family Welfare Programme - Environment and human health - Human Rights to a clean environment - Role of Information Technology in Environment and human health - Case Studies

UNIT- II

From Unsustainable to Sustainable development - Urban problems related to energy – existing conventional energy sources – rate of depletion – alternate energy sources and its sustainable use – India's clean energy goals 2012-2022 – significance of energy audit – recent initiatives of renewable energy by Govt. of India. Water scarcity and importance of water - water conservation - rain water harvesting - watershed management – causes and effects of water crisis – World Water Council & UNDP initiatives.

UNIT- III

Consumerism and waste products - e-pollution and their management – plastic and biomedical waste - management – Impacts of plastic and biomedical waste on environment –public awareness – Urbanisation and pollution – challenging issues - vehicular, solid waste, water, noise pollution – Issues involved in enforcement of environmental legislation

REFERENCES

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15. An Invitation to Environmental Sociology, Bell, M. M. (2012), 4th edition, Pine Forge Press, SAGE, London.

SELF STUDY PAPER- 2. CLIMATE CHANGE

Objectives: To study the changes under various climate change scenarios and to analyse consequential impacts on water resources in particular on changes in snow and glacier melting and changed spatio-temporal monsoon patterns, biodiversity, agriculture and energy.

UNIT-I

Climate change – concept of climate change - Human Impacts on climate- greenhouse gas emissions, sea level rise - Global warming, greenhouse effect, global and regional trends in green house gas emissions - role of oceans and forests as carbon sinks, ozone depletion- stratospheric ozone shield and Ozone hole – Impact of Climate Change on weather and climatic patterns, ice caps, glaciers, agriculture, vegetation, biodiversity, sea level, tourism and their implications.

UNIT-II

Climate change - Adaptation and Mitigation strategies - renewable energy, green building, energy efficiency and reducing consumption - low carbon economy - international adaptation initiatives and programs - Integrated mitigation for development and planning through low emission development strategies - Climate Change and sustainable development

UNIT-III

International agreements and protocols. The role of UN Collaborative Programme on Reducing Emissions from vehicles - United Nation Framework Convention on climate change (UNFCCC) -Key provisions of the UNFCCC, its structure, and different party groups under the convention - Annex I, Annex II and Non-Annex I countries. The Kyoto protocol and its associated bodies. Overview of Conference of Parties (CoP). Main climate change negotiations evolved over the past years and highlights of some key issues relevant to future climate change regime.

REFERENCES

1. Climate Change and Biodiversity: Perspectives and Mitigation Strategies-Ranade, P. S. (2008), ICFAI University press.
2. Environmental Science: Earth as a Living Planet, Botkin, D. B. and Keller, E. A. (2007), 6th edition, John Wiley &Sons, USA.
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12. Global Environmental Challenges –Transitions to a Sustainable World, Speth, J. C.

(2004), Orient Blackswan, New Delhi.

PRACTICAL I – 18ENVA13P1

ENVIORNMENTAL CHEMISTRY, ENVIRONMENTAL POLLUTION AND INSTRUMENTAL METHODS OF ANALYSIS

1. Spectrophotometric Methods of Estimation: Fluoride, Nitrate, Phosphate, Chromate [Cr^{6+}], Hg, Pb, Cd, three pesticides, phenol.
2. Flame photometric analysis of Na, K, and Ca.
3. Sampling and analysis of SO_2, CO_2, NOX, HC
4. Determination of
   (i) SPM in ambient air by high volume sampler, (ii) water soluble suspended matter
   (iii) Water insoluble suspended matter and (iv) organic suspended matter.
5. Study on the effect of selected air pollutants on some plants
6. An air quality survey report of an area
7. Detection and estimation of noise pollution.
8. Water quality analysis: Determinations of DO, BOD, COD, TKN, TDS, TSS, turbidity, conductivity, alkalinity, acidity, nitrate, chloride, total hardness - Instrumental and wet chemical methods of analysis.
9. Estimation of sulphate by turbidimetry.
10. Physical, Chemical and Biological properties of soil: Collection, particle size analysis (silt and clay), Soil profile, water holding capacity, density, porosity, pH, conductivity, NPK, TOC.

STATISTICS AND RESEARCH METHODS IN ENVIRONMENTAL MANAGEMENT

1. Collection of Data: Primary data – Secondary data – Classification and Tabulation – Diagrammatic Representation
2. Data Analysis using software: SPSS, R and Excel stat: Editing, Data Tabulation,
3. Analysis: Descriptive statistics – Correlation – Regression – Factor analysis – Cluster analysis – Principal Component Analysis (PCA), Graph Plotting - One way ANOVA – Two way ANOVA
4. Environmental chemicals related databases and uses.

PRACTICAL II – 18ENVA23P1

ENVIRONMENTAL MICROBIOLOGY

1. Preparation of culture media.
2. Isolation of microbes from soil.
3. Isolation of microbes from water.

4. Sampling of Airborne Microorganisms.
5. Culturing and Identification of Microorganisms.
6. Staining of bacteria.
7. Membrane Filter Technique
8. Measurement of growth of microorganisms.
9. Pollutant removal using microbes from industrial effluent.
10. Bacteriological analysis of wastewater (Coliforms, *E. coli*, *Streptococcus*) – MPN
11. Detection of Anaerobic bacteria (*Clostridium* sp.)

BIODIVERSITY AND CONSERVATION

1. Plankton community study: Phytoplankton and Zooplankton: Species identification - Diversity – density – abundance – distribution– Primary productivity
2. Aquatic insect community study: Species identification - Diversity – density – abundance – distribution
3. Fish community study: Species identification - Diversity – density – abundance – distribution
4. Amphibians community study: Species identification - Diversity – density – abundance – distribution
5. Reptiles community study: Species identification - Diversity – density – abundance – distribution
6. Bird community study: Species identification - Diversity – density – abundance – distribution
7. Mammals community study: Species identification - Diversity – density – abundance – distribution
8. Vegetation studies: Line, quadrates and belt transect methods– Species identification - Diversity – density – abundance – distribution
9. Grassland community study: Species identification - Diversity – density – abundance – distribution
10. Taxonomic identification of plants and animals using morphological and molecular techniques.

PRACTICAL III – 18ENVA33P1

REMOTE SENSING & GEOGRAPHICAL INFORMATION

1. Importing Aerial/ Satellite image in ERDAS
2. Georeferencing and Image/Map Projection in ERDAS
3. Supervised and Unsupervised classification

GEOGRAPHICAL INFORMATION SYSTEM

I. Visual Interpretation

1. Map reading (survey of India Topo sheet)
2. Marginal Information and Extra Marginal Information
3. Relief and Cultural Features

II. Digital Interpretation

1. Importing Aerial/Satellite Imagery and Scanned Raster Image

2. Georeferencing and Co-Ordinate System
3. Map Projection (Type of Map Projection)
4. Digitization and Editing
5. Topology Creation
6. Proximity Analysis (Buffer, Distance Measures)
7. Interpolation Analysis (Kriging, IdwEtc)
8. Density Analysis (Point, Line Etc.)
9. Surface analysis: Tin Creation – Aspect – Slope - Hill Shade - View Shed - Cut and Till

ENVIRONMENTAL ENGINEERING

1. Jar test Experiments –Optimization of coagulant, pH and dose
2. Determination of residual chlorine
3. Determination of total dissolved solids / suspended solids
4. Determination of volatile suspended solids
5. Biotreatment of textile / dairy / paper industrial effluent
6. Calculation and designing of Sedimentation / Aeration tank
7. Calculation and designing of Activated Sludge Processes
8. Calculation and designing of Trickling Filter
9. Calculation and designing of Disinfection Process
10. Calculation and Designing of Sanitary Landfills
11. Calculation and Designing of Cyclones / Settling chamber / Electrostatic precipitator

WASTE MANAGEMENT AND BIOREMEDIATION

1. Studying the effect of temperature/pH/salinity on microbial growth.
2. Isolation of Metal resistant Bacteria and effect of heavy metals on microbial growth
3. Isolation and characterization of hydrocarbon tolerating/degrading microbes from polluted environment
4. Assessment of P solubilisation/ammonification potential of microbes
5. Assessment of the effects of pollutants on soil enzyme activity
6. Enzyme production using agro waste (Protease / cellulase / lipase)
7. Effect of pH/temperature on enzymes (Protease / cellulase / lipase) production
8. Production of biogas from different organic waste materials
9. Exercises on estimation, composition and segregation of solid waste
10. SCP production using waste water
11. Embryonic toxicity assessment using developing chick embryo