RANI CHANNAMMA UNIVERSITY,

Vidyasangama, PB-NH-4, Bhutaramanahatti,BELAGAVI – 591 156

PROPOSED SYLLABUS

M.Sc. Environmental Science

Choice Based Credit System (CBCS) Semester Scheme

I, II, III & IV SEMESTER

(Effective from the Academic Year 2022-23)

P.G. Department of Environmental Science

Rani Channamma University and G.S.Sc College, Belagavi

Rani Channamma University

PG. DEPARTMENT OF ENVIRONMENTAL SCIENCE

M. Sc. Environmental Science

PROGRAMME OUTCOMES (PO'S)

The post graduates are able to

1) Acquire in–depth knowledge and integrate with existing knowledge to sensitize the people about global and local environmental issues.
2) Develop an ability to identify, critically analyze, formulate and solve environmental problems using basic principles of nature conservation.
3) Get acquainted with environmental and social impacts of any developmental activity.
4) An ability to design a system and process to meet desired needs of society within realistic limitations such as health, safety, security and environmental considerations.
5) An ability to design and conduct experiments, interpret data, and provide well informed conclusions.
6) Communicate effectively socio-economic problems related to environment by appropriate documentations and presentations.
7) Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8) Apply ethical principles and commit to professional ethics and responsibilities and follow the norms of the any surrounding practice.

PROGRAM SPECIFIC OUTCOMES (PSO's):

I: Professional skills -Ability to monitor the present status of environmental parameters through monitoring for design and development of new concept or technology.

II: Industrial Skills- Successfully tackle with the industrial pollution problems through appropriate technology and tools.

III: Environmental and Social values within individual -Inclusion of environmental and social values within the individual's life.

IV: Problem solving approach: Identify, formulate, review literature and analyze complex environmental problems and suggest suitable solutions reaching substantiated conclusions using first principles of natural science.

V: Successful development of Career and Entrepreneurship -To prepare the students with broad environmental perspective and become a successful in career and entrepreneurship.

VI: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding of the limitations.

Syllabus – M.Sc. Environmental Science

Semester I

M.Sc. Part I Sem. I Course Code	Paper No. Title of the Course	Instruction Hrs./ Week	Duration of Exam (hrs.)	Marks Term end Exam	Marks Internal Assessment	Credits
	Compulsory Courses					
1.1	Introduction to Environmental Science	4	3	80	20	4
1.2	Environmental Chemistry	4	3	80	20	4
1.3	Environmental Geoscience & Climatology	4	3	80	20	4
1.4	Environmental Biology and Conservation	4	3	80	20	4
1.5	Practical 1- based on 1.2-1.3	4	4	80	20	4
1.6	Practical 2 - based on 1.4	4	4	80	20	4

Semester II

M.Sc. Part I Sem. II Course Code	Paper No. Title of the Course	Instruction Hrs./ Week	Duration of Exam (hrs.)	Marks Term end Exam	Marks Internal Assessment	Credits
	Compulsory Courses					
2.1	Environmental Biotechnology and Microbiology	4	3	80	20	4
2.2	Environmental Engineering	4	3	80	20	4
2.3	Environmental Pollution	4	3	80	20	4
	Open Elective Course					
2.4	Environment & sustainable development	4	3	80	20	4
	Compulsory Courses					
Practical 2.5	Practical 3- based on 2.1- 2.2	4	4	80	20	4
Practical 2.6	Practical 4- based on 2.3	4	4	80	20	4

Syllabus – M.Sc. Environmental Science

Semester III

M.Sc. Part II Sem. III Course code	Paper No. Title of the Course	Instruction Hrs./ Week	Duration of Exam (hrs.)	Marks Term end Exam	Marks Internal Assessment	Credits
	Compulsory Courses					
3.1	Solid and Hazardous Waste Management	4	3	80	20	4
3.2	Natural Resource Management & sustainable development	4	3	80	20	4
3.3	Research Methodology & Statistics	4	3	80	20	4
	Open Elective Course					
3.4	Climate change and environment	4	3	80	20	4
	Compulsory Courses					
Practical 3.5	Practical 5- based on 3.1	4	4	80	20	4
Practical 3.6	Practical 6 – based on 3.2 -3.3	4	4	80	20	4

Semester IV

M.Sc. Part II Sem. IV Course code	Paper No. Title of the Course	Instruction Hrs./ Week	Duration of Exam (hrs.)	Marks Term end Exam	Marks Internal Assessment	Credits
	Compulsory Courses					
4.1	Environmental Law & Policy	4	3	80	20	4
4.2	Environmental Planning & Management	4	3	80	20	4
4.3	Environmental Toxicology & occupational health hazards	4	3	80	20	4
4.4	Nanotechnology & Environment	4	3	80	20	4
Practical 4.5	Practical7- based on 4.2 – 4.3	4	4	80	20	4
4.6	Project / Dissertation	4		80	20	4

Total Course credits = 96

Open Elective Subjects for PG Departments (OEC)

1. School of Classical Kannada Studies- 1 Kannada Kadambarigalu
2. School of Classical Kannada Studies -2 Kannada Sannakategalu
3. English - English for Employability
4. Marathi -Marathi Katha Wangmaya (Short Stories)
5. Criminology and Criminal Justice Introduction to Forensic Science
6. Commerce - 1. Fundamentals of Business
7. Commerce 2. Basics of Income Tax
8. Education Strategies of Teaching
9. Education- Diet and Nutrition
10. History- History of Social Transformation Movements in India (Ancient and Medieval)
11. Business Administration -Entrepreneurship Development and Project Management
12. Computer Science (M.C.A) - 1. Big Data Analytics
13. Computer Science (M.C.A) -2. Internet Concepts and Web Designing
14. Computer Science (M.C.A) -3. Management Information Systems
15. Computer Science (M.Sc)-1. Computer Fundamentals
16. Computer Science (M.Sc)-2. Graph Theory
17. Geography-1. Physical Geography
18. Geography -2. Disaster Management
19. Mathematics -1. Set Theory (Arts and Commerce stream)
20. Mathematics - 2. Integral Transforms (Science stream)
21. Chemistry- Chemistry for Everyday Life
22. Physics - Modern Physics
23. Library and Information Science- Information Sources and Services
24. Economics - Indian Economy
25. Political Science- Human Rights: Theory and Practice
26. MSW - Management of Non-Governmental Organizations
27. Sociology - Indian Society: Continuity and Change
28. Journalism and Mass Communication - Introduction to Print Media
29. Botany - Medicinal Plants
30. Zoology - Economic Zoology
31. Environment & sustainable development

Question Paper Pattern

Question paper pattern to be adopted for theory exam.

There will be three sections in a question paper of each theory course for the semester end examination. (Part A, Part B, Part C).

Part A consists of concept-based questions. There shall be 12 questions carrying 2 marks each. Students should answer any 10 questions out of 12 questions.

Part B consists of 7 questions carrying 5 marks each. Students should answer any 4 questions out of 7 questions.

Part C consists of questions which are descriptive. There shall be 4 questions (with internal choice) carrying 10 marks each.

Question paper pattern

Part A	(10 X 2 Marks)	20 Marks
Part B	(4 X 5 Marks)	20 Marks
Part C	(4 X 10 Marks)	40 Marks
Total		80 Marks

The project work shall carry 100 marks (IA-20; Dissertation – 50; Viva-voce – 30 marks)

1.1 - Introduction to Environmental Science

Credits- 4 Teaching hrs/week = 4 hrs

Unit -1

a) Introduction to Environmental Science: (13 hrs)

Meaning, scope and interdisciplinary nature of Environmental Science, principles background and scope of environmental science, Environmental Science and technology, Media and people, decision making and applications of Environmental Science.

b) Environmental ethics:

Nature and origin of environmental ethics, ecological consciousness, western and Eastern views, philosophy of environment, Environment, community and equity, Integrating ethical values and knowledge, self centered development and environment.

Unit- 2 Global and national environmental issues: (13 hrs)

Greenhouse effect, Acid rain, Global Warming, Ozone depletion, Climate change, Carbon Sequestration, Clean Development Mechanism, Carbon credits, Carbon footprint, Deforestation, Biodiversity loss, Desertification**.**

Unit -3 Human impact on environment and its consequences (13 hrs)

Hunting and gathering, agriculture societies, Human history Rise and Fall of civilisations, Age of colonisation, industrial societies, impact of cultural change on environment, population explosion, degradation of natural resources, pollution of air, water and soil, urbanization, industrialization, food security, public Health, energy crises.

Unit- 4 Concept of carrying capacity (13 hrs)

Biotic and abiotic components of environment, concept of sustainability and carrying capacity, tragedy of commons, human population and food, water and energy security, present status of environment and future scenarios.

References:

1. Environmental Science - Arms Karen
2. Principles of Environmental Science-Watt, K. E. F. (1973) McGraw-Hill Book Company.
3. Environmental Science –Noble, B .J. Kormandy, E.J.(1981),The way world works, Prentice-Hall Inc., N .J.
4. Environmental Science-Turk A. , Turk J. Wittes J.T. and Wittes, R.E.
5. Environmental Issues: Measuring, Analyzing, Evaluating, Abel, Daniel C. McConnell, Robert L. Abel, Daniel C. Edi. 2 Prentice Hall Publication
6. Botkin Daniel. B and Edward. A. Keller, Environment Science – Earth as a living Planet, JohnWiley and Sons, 2005.
7. Miller, G., Spoolman, S., 2007. Environmental Science: Problems, Connections and Solutions.Cengage Learning.

1.2 - Environmental Chemistry

Credits- 4 Teaching hrs/week = 4 hrs

Unit – 1 - **Concept and scope of Environmental Chemistry (13 hrs)**

a) Concept and scope of Environmental Chemistry, Chemistry of environmental segments - lithosphere, hydrosphere, atmosphere.

b) Basic concepts of Environmental Chemistry:
Gibb's energy; chemical potential; chemical equilibrium; acid – base reaction; solubility product; the carbonate system; unsaturated and saturated hydrocarbons, radionuclide's

Unit -2 - Chemistry of Air, Water and Soil (13 hrs)

a) Chemistry of Air: Classification of elements in air; composition of air; chemical speciation; particles ions and radicals in the atmosphere; chemical processes for formation of inorganic and organic particulate matter; thermochemical and photochemical reactions in the atmosphere, Oxygen and ozone chemistry; chemistry of air pollutants; photochemical smog.

b) Chemistry of water and soil:
Chemistry of water, structure of water molecule, water quality parameters, solubility of gases in water, carbonate system,
Chemistry of soil, Soil profile, Inorganic and organic components of soil, Chemical factors affecting the soil quality, adsorption of contaminants in soil, Effect of modern agro-technology on quality of soil.

Unit – 3 (13 hrs)

a) Chemistry of Organic and Inorganic chemicals in the Environment
Organic chemicals in the environment, soaps, detergents, polymers, drugs, dyes, oil and grease, Inorganic chemicals in the environment, Inorganic gaseous pollutants, Particulate matter, trace leave toxic metals, Inorganic pesticides, Persistent organic pesticides and fertilizers.

b) Environmental monitoring and sample analysis
Sampling of air and water pollutants, Monitoring techniques and methodology, pH, Dissolved Oxygen (DO), Chemical oxygen demand (COD), Biological Oxygen Demand (BOD), Speculation of metals, monitoring and analysis of CO, NOx, CO2, SOx, pesticide residue, phenols and petrochemicals.

Unit – 4 Instruments used in environmental monitoring (13 hrs)

Theory; principle; working and applications of following sampling instruments: pH meter; EC meter; DO meter; Nephlometer, Colorimeter; Atomic Absorption Spectroscopy (AAS), Flame photometry, X-ray Fluorescence, UV-Visible spectrophotometer, IR Spectroscopy, High performance liquid chromatography (HPLC), Gas chromatography (GC), NMR etc.

References:

1. Environmental Chemistry by B. K. Sharma S. H. Kaur Goel Publishing House, Meerut
2. Anil Kumar De, 2003. Environmental Chemistry, New Age International Limited Publishers, 5th edition.
3. Toxic Chemicals, health and the Environment, Lave, L.B and Upton, A.C. 1987. The Hopkins Press Ltd., London.
4. Vogel's Textbook of quantitative Chemical analysis, 5th Edition-J. H. Basett, J. Nendham and Denny, R.C.
5. Instrumental Methods of analysis – Chatwal and Anand
6. Chemistry for Environmental Engineering, C. N. Sawyer and P L Mc Carty, McGraw Hill Kogakusha ltd., 1990.
7. Fundamentals of Analytical Chemistry, 1982.Hobert H. Willard D.L. Merrit and J. R. J. A. Dean.
8. Spiro G and William M. Stigliani, 2002. Chemistry of the Environment, Thomas, Hall of India Pvt. Ltd, 2nd edition.
9. Yadav L., Singh J., Srivastava J., 2014. Advanced practical's of chemistry Pragati Prakashan

1.3 - Environmental Geoscience & Climatology

Credits- 4 Teaching hrs/week = 4 hrs

Unit – 1 (13 hrs)

a) The universe, solar system and origin of earth- Brief introduction to universe, physical characteristics of planets, brief description of – comets, asteroid, meteors, origin of earth.

b) evolution of biosphere & Earth processes

Origin and evolution of life, Theories of evolution, Chemical evolution, prokaryotic and eukaryotic cellular evolution, Evolution of organelles and genetic basis for evolution,

Earth's Processes – Endogenic and Exogenic processes: Earthquakes, Tsunami and Volcanism. Geological agents: River, Wind, Glaciers and Ocean action. Floods, landslides, cyclone and avalanche, Concepts of major, trace and REE, Classification of trace elements, Mobility of trace elements, Bio Geochemical cycles(C,N,O,P)

Unit – 2 (13 hrs)

a) Atmosphere, structure, composition and dynamics

The vertical structure of atmosphere, composition of earth's atmosphere, thermal stratification, the ionosphere, D.E.F. and G regions, energy transfer near earth's surface, insolation, terrestrial radiation and heat balance of the earth.

b) Climate, weather, measurement of climatic parameters

Concept of Weather, Climate, Meteorology and Climatology, Elements of Weather, Measurement of premise – Temperature, Air pressure, Turbulence, Wind, Rain, Humidity and Radiation. Wind systems of the world, El Nino, Monsoon phenomenon and its role in Indian subcontinent.

Unit – 3 (13 hrs)

a) Lithosphere - Structure, Formation and processes of change

Structure and composition of lithosphere, Primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere. Magma generation and formation of igneous and metamorphic rocks. Plate tectonics- sea floor spreading, mountain building, composition of soil, soil formation: physical, chemical, biological weathering, soil profile, properties of soil: physical, chemical and biological, soil erosion.

b) Hydrosphere, Composition and circulation of surface and ground waters

Global water balance, types of water, Physicochemical characteristics and composition of sea water, Rain water, River water, Ground water, Hydrological cycle

Unit –4- GIS, Remote sensing & Applications (13 hrs)

Scope, Concept of Remote Sensing and GIS, GIS for Environmental Planning and Management: Surface and Ground water, Watershed, Marine resources, Coastal zones, Wild life Ecology, Mining and Quarrying; Agriculture and rangeland management and applications; Land use Planning, Earthquakes and flood mapping assessment.

References:

1. Ecology and Environment, P. D. Sharma, Ashish publications, 1994.
2. .Ground water Hydrology by D..K..Todd John Wiley and Sons.
3. Ground water contamination (Transport and remediation) by Philp Bedient, Hanadi.
4. S. Rifai and Charles. Publishers: Prentice Hall.
5. Environmental Hydrology by Andy. D. Ward and William J..Elliot, Lewis
6. Environmental Geography, Valdia ,K..S(1987)
7. Environmental Geography, Savindra Singh
8. Environmental Geology,Keller E.A. and Turk and Turk
9. Introduction to weather and climate-Trewartha
10. Physical Geography - S. Strahler, John Wiley and Sons,

1.4 - Environmental Biology and Conservation

Credits- 4 Teaching hrs/week = 4 hrs

Unit – 1 Ecology **(13 hrs)**

Definition of ecology and sub divisions, Relation to other sciences, Relevance to civilization, levels of organization, hierarchy, Cake and other ecological models, Concept of ecosystem, its structure and function, cybernetic nature and stability of Ecosystem, Energy in ecological systems, concept of productivity, food chains, food web and trophic levels, ecological pyramids, Concept of habitat, niche and guild, concept of ecotone and edge effect, succession, natural selection, Concept of Gaia hypothesis.

Limiting factors and their tolerance- Liebig's law of minimum, Shelford's law of tolerance, limiting factors - temperature, radiation, and water, micronutrients etc.

Unit – 2 – Population & System ecology **(10 hrs)**

a) Population and community ecology- Basic concepts of population ecology, population dynamics, growth curves, characteristics of population: natality, mortality, fecundity, density, age distribution, relationships among organisms, population explosion, Community types and community composition.

b) System ecology and ecosystem modelling

Basic concepts of system ecology, Ecosystem modelling, compartmental system approach, Experimental components approach, simulation, System analysis.

Unit – 3 - Biomes of the world: (15 hrs)

Bio-geographical realms, Classification of biomes – Tundra, Taiga, Grassland, Desert, Evergreen and deciduous forests, Tropical rain forests and their characteristics, flora and fauna; Classification of Aquatic Habitats – Fresh water pond, Wetlands, Rivers – their characteristics, flora and fauna; Marine Habitats – Pelagic, Benthic, Inter-tidal Estuarine; Mangroves ecosystem, flora and fauna of India. Biogeography of ecosystems in India.

Concept of Bioindicators, Bio-indicators as plants, animals, Ecosystem services and ecosystem dynamics Ecosystem services, Ecosystem functioning and ecosystem services provided by different ecosystems at present – provisioning services, regulating services, habitat or supporting services, cultural services

Unit – 4 Biodiversity & Conservation **(14 hrs)**

Biodiversity as life support system for man, types of biodiversity, ecosystem, species and genetic, Values of biodiversity, Indian ethos of wildlife conservation, Hotspots of Biodiversity, Causes for loss of biodiversity, measurement of biodiversity; IUCN criteria, Red list,

Criteria for conservation, Approaches to conservation, Design criteria(habitat constituents, reserve design, reserve shape and size, population size, need for buffers, wildlife corridors, landscape connectivity, administrative, political and economic considerations), Methods of

biodiversity conservation – in situ conservation (sanctuaries, national parks and biosphere reserve); ex situ conservation (zoo, botanical gardens; gene/germ plasma banks), Convention on Biological Diversity (CBD), Biodiversity conservation efforts in the country.

References :

1. Ecology - E.P. Odum, 1983, Holt-Saunders International Edition
2. Concepts of Ecology. E. J. Kormondey, 1984. Indian reprint 1991 Prentice-Hall of India.
3. Ecology and Environment, P. D. Sharma, Ashish publications, 1994.
4. Alfred J. R.B, A.K.Das and A.K.Sanyal, Ecosystems of India, ZSI, 2001.
5. Banarjee A., 2010, Footprints in the forest, Winrock International India.
6. Botkin Daniel. B and Edward. A. Keller, Environment Science – Earth as a living Planet, John Wiley and Sons, 2005.
7. Carabias Julia and Kishore Rao, Capacity Needs to Manage Protected Areas, The Nature Conservancy, 2003.
8. Champion S,. Seth S, (2005). Revised survey of forest types of India. Nataraj Publishers, New Delhi.
9. Gopal, R., 2011. Fundamentals of Wildlife Management. Natraj Publishers, New Delhi.
10. Grimmett R., Inskipp C. and Inskipp T. (2001) Pocket Guide to the Birds of the Indian Subcontinent, Oxford University Press, Oxford.
11. Groom M.J., MeffeG.K. and Carroll C.R. (2006) Principles of Conservation Biology (3rd edition), Sinauer Associates, Sunderland
12. Hunter Malcom. Jr, Maintaining Biodiversity in Forest Ecosystems, Cambridge University Press, 1999.
13. J. B. Lal, 1992, Forest ecology, Natraj publishers.
14. Kamaljit S. B., et. Al., 2011, Conservation Biology, Universities Press.
15. Keddy Paul. A, Wetland Ecology – Principles and Conservation, Cambridge University Press, 2000.
16. Menon, V., 2014. Indian mammals: a field guide. Hachette India.
17. Sawarkar, V.B., 2005. A guide to planning wildlife management in protected areas & managed landscapes. Natraj Publishers.
18. Sharma, B.D., Karthikeyan, S., Singh, N.P., Flora of Maharashtra State. Botanical Survey of India.
19. Slootweg R., Rajvanshi A., Mathur V., Kolhoff A., 2009. Biodiversity in Environmental Assessment: Enhancing Ecosystem Services for Human Well-Being. Cambridge University Press.
20. Sutherland, William J. 2006. Ecological Census Techniques: A Handbook. Cambridge University Press.
21. Townsend Colin. R, John. L. Harper and Michael Begon, Essentials of Ecology, Blackwell Science, 2000.
22. Alexander, M. Management Planning for Nature Conservation: a Theoretical Basis & Practical Guide. Springer, 2008.

1.5 - Practical 1- based on 1.2 & 1.3 (Env. Chemistry & Geosciences)

PRACTICALS : based on 1.2

1. Determination of pH and Conductivity of different water and soil samples
2. Determination of calcium and magnesium by EDTA complex metric method
3. Determination of Carbonates and Bicarbonates in water samples
4. Determination of Chloride in water sample
5. Estimation of Iodine value of given oil sample
6. Determination of ferrous iron by permanganate method
7. Determination of Saponification value of oil
8. Determination of manganese from water.

PRACTICALS : based on 1.3

1. Identification of Minerals and Rocks.
   A) Physical properties & chemical composition of various rocks and economic minerals,
   B) Hand specimen study of Igneous, sedimentary & metamorphic rocks.
2. Classification of soils, sediment their texture, mineralogy
3. Basics of mapping - Interpretation of Topo sheets
4. Survey of a given area using GPS survey method
5. Google earth, Q GIS
6. Image interpretation of land use/water, vegetation and lithology
7. Study of geological /contour/drainage pattern maps

1.6 - Practical 2 - based 1.4 (Env. Biology)

1. Identification of Common birds
2. Vegetation analysis using quadrats and analysis in excel (Density, frequency, abundance)
3. Vegetation analysis using line transects and analysis in excel
4. Vegetation analysis by using belt transect and analysis in excel
5. Assessment of Bird diversity (Transact & point count)
6. Assessing mammal diversity (camera trapping & sign survey)
7. Calculation of diversity index
8. Study of forest ecosystem (assessment for forest structure, measurement of GBH, canopy estimation, vegetation analysis)
9. Study of grassland ecosystem (grassland vegetation analysis).
10. Study of River /wetland ecosystem (Vegetation mapping, wetland bird analysis)

2.1 - Environmental Biotechnology and Microbiology

Credits- 4 Teaching hrs/week = 4 hrs

Unit -1 - Role of biotechnology in environmental science (13 hrs)

Introduction to biotechnology, concept of environmental biotechnology, public perception of biotechnology. Applications of some important technologies- Genetic engineering, Genetic concept in environment management, Concept of bio-safety, Fate of GEM'S in the environment, Role of biotechnology in conservation of species.

Unit- 2 Environmental Microbiology (13 hrs)

Prokaryotes, classification of microbes, microbial communities in nature interaction within microbial communities with man, animals and plants, dispersal of microorganisms in different environments, pure culture concept, techniques, preservation and maintenance of microbial culture.

Water microbiology: Waterborne diseases, role of microorganism in treatment of wastewater.

Air microbiology: Aerobiology; allergy; role of microorganism in airborne diseases, Classification and enumeration of microbes in air, dust droplet and droplet nuclei.

Soil microbiology : important microbes for soil fertility, biodegradation; soil borne diseases, Role of microbes in soil reclamation.

Unit -3 (13 hrs)

a) Use of biotechnology in innovative practices - Concept of bio-leaching, methods of bioleaching, microorganisms involved, advantages and disadvantages of bioleaching. Concept of bio-absorption, limitations of bio absorption. Concept of bioremediation, microorganisms involved, bioremediation processes and technologies, landfill technologies. Cell immobilization as a tool in waste treatment, Techniques of cell immobilization, Advantages of cell immobilization, Environmental applications of immobilized cells.

b) Use of different technologies

Aerobic Vs anaerobic degradation, testing of biodegradability, Bio-oxidation of phenolic compounds, Bio-degradation of specific hazardous wastes, biodegradation of hydrocarbons.

Unit 4 (13 hrs)

a) Biotechnology in agro-industry and forestry

Plant biotechnology, Biological control, Organic farming, Bio-fertilizers - types and production technology, Fermentation technology, Tissue culture, Animal biotechnology, Applications of biotechnology in forestry, Concept of biofuel, advantages, production. Animal Biotechnology and its application, Vermi-technology.

b) Microbial degradation of chemical pesticides, mechanism of degradation of chemical pesticides and herbicides, concept and types of bio-pesticides and their significance.

Application of biotechnology in wastewater treatment - Tanning industry, Distilleries, Dairies, Dye industries, Pulp and paper industry, sugar industry.

References

1. Introduction to Environmental Biotechnology, A. K. Chatterji, Prentice Hall of India Pvt. Ltd, New Delhi
2. Environmental Biotechnology-Basic Concepts and Applications Indu Shekhar, Thakur, I.K. International Pvt. Ltd. New Delhi.
3. Environmental Biotechnology S.K. Agawal, APH Publishing Corp., New Delhi.
4. Elements of Biotechnology, P. K. Gupta, Rastogi Publishing House, New Delhi.
5. Environmental Biotechnology, Jogdand S.N., Himalaya Publishing House, New Delhi.
6. Biotechnology, B.D. Singh, Kalyani Publishers , New Delhi
7. Molecular Biotechnology- Principles and Applications of Recombinant DNA, Glick and Pasternak. Panima Publishing Corporation, New Delhi
8. A Text Book of Biotechnology, R.C. Dubey, S. Chand and Company Ltd., New Delhi.

2.2 - Environmental Engineering

Credits- 4 Teaching hrs/week = 4 hrs

Unit -1 Water & Waste water Treatments (14 hrs)

Water treatment : Objectives; Physical, chemical and biological properties of water, drinking water Quality standards in India.

Aeration, Sedimentation,Coagulation and flocculation, chemical dosing, jar test; Filtration: mechanism, types of filters(Gravity, pressure, sand filter, dual media filter etc); backwashing. Disinfection: UV, Chlorination, Ozonation. Water softening, Reverse osmosis. Taste, colour and odour removal methods. Activated carbon method, iron and manganese removal, fluoridation and defluoridation

Primary treatments-principle, flow measurement, screening, grit removal, skimming tank, equalization; sedimentation Secondary treatments- principle, coagulation, flocculation, filtration, chemical precipitation, membrane filtration, activated sludge process, aerobic lagoons, oxidation ponds, septic tank, imhoff tank; trickling filter, rotating biological contactors, Up flow anaerobic sludge blanket (UASB), sludge drying bed, Tertiary treatment - activated carbon,

Unit – 2 Design and functioning of treatment plants (13 hrs)

Methods of water treatment, Concept of water treatment plant (WTP), Sewage treatment plant (STP), Effluent treatment plant (ETP), Common Effluent treatment plant (CETP) design aspects of major units in treatment plants and their functions.

Unit – 3 Air & Noise pollution control (13 hrs)

a) Air pollution control technologies

Meteorology and plume Dispersion, laws governing behavior of air pollutants, thermodynamics of major air pollutants, Ambient air quality monitoring, Stack monitoring; Particulate matter control equipment's- Settling chamber, Cyclones, Fabric filter, Electrostatic precipitator, Wet scrubber, Control of gaseous pollutants absorption, adsorption and combustion recovery system, Principle, design and working of catalytic converters.

b) Noise pollution control technologies:

Noise monitoring, noise monitoring devices, ear muffs, silencers, noise absorbers, antinoise device; Noise control methods

Unit – 4 (13 hrs)

a) Municipal, Industrial and biomedical solid wastes and their treatment :

Need of solid waste treatment, dry and wet waste treatments recovery and recycling of metals, disposal methods for medical, industrial and biomedical wastes, Different methods of disposal and management of solid wastes; conversion of solid waste into energy / manure.

b) Innovative techniques for prevention and control of Pollution

Solar detoxification process, Carbon adsorption, Adsorption media filters, Micro screening and other low cost treatment methods, Removal of chromium, phenol, mercury, nitrogen etc. from industrial effluents.

References:

1. Waste water engineering, Met Calf and Eddy, INC, Tata Mc Graw Hill
2. Indian Standard for Drinking Water, BSI, New Delhi.
3. Environmental Pollution Control, C.S.Rao, Wiley Eastern Ltd.,1993
4. Air Pollution Control and Engineering, De Nevers, Mc Graw Hills, 1993.
5. Fundamentals of Air Pollution, Samuel, J.W., 1971, Addison Wesley Publishing
6. Fundamentals of Environmental Pollution, Krishnan Khannan, S. Chand and Company Ltd.,1994.
7. Noise Pollution, Vandana Pandey, Meerut Publishers,1995.

2.3 - Environmental Pollution

Credits- 4 Teaching hrs/week = 4 hrs

Unit – 1 Air & Noise pollution (13 hrs)

a) Air pollution -natural and anthropogenic sources, Classification of air pollutants, Meteorological aspects of air pollution, types– indoor air pollution, vehicular pollution, industrial pollution; air pollution episodes and disasters, Effects of air pollution on human health, animals, plants, material and climate, Formation of fog and smog, acid rain, Air quality standards, Monitoring of air pollution, Air quality index.

b) Noise Pollution - Concept of noise, Sources, Measurement of noise, Equivalent sound pressure level (Leq), Noise pollution level (NPL), Sound exposure level (SEL), Traffic noise index (TNI), Day-Night level (DNL), Monitoring of noise pollution, Noise exposure levels and standards, Physiological and psychological effects of noise; control of noise.

Unit – 2 Water Pollution (12 hrs)

Principal forms of water pollution, sources of water pollution, Water pollution monitoring,, Sampling and physicochemical and bacteriological analysis of water, water quality parameters, Eutrophication, Oil pollution, Ocean pollution-sources of pollution, oil spills, plastics & micro fibres, effects, control.

Ground water pollution - sources of pollution, effects, control, Water quality standards, consequences of water pollution and control. Water quality index.

Unit – 3 Solid waste & Radiation (14 hrs)

a) Solid Waste Pollution - Concept and types of solid waste, Effects of solid wastes on environment, Classification of waste–Domestic , Industrial , Municipal, Hospital, Nuclear, Agriculture, Waste minimization technologies, Disposal in landfills, operation of sanitary landfills; leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation.

Hazardous wastes: Definition, sources and characteristics: Hazardous waste categorization, generation, collection, transport, treatment and disposal. Legislation on management and handling of municipal solid wastes and hazardous wastes.

b) Radiation Pollution - Types, sources- natural and manmade, fuel processing and radioactive waste, Units of radiations, Measurement and detection of radiation intensity, effects of radioactive pollution, radioactive fallout; control of radiation pollution, Nuclear reactor safety.

Unit – 4 – Soil & Thermal pollution (13 hrs)

a) Soil Pollution - Definition; causes of soil pollution; major soil pollutants;, analysis of soil key parameters, soil acidity, saline and alkaline soil, causes of soil salinity, Chemical and metallic pollution in agricultural soil, Mining and soil pollution, physicochemical and biological methods of soil reclamation

b) Thermal pollution: Definition; sources of thermal pollution; effects of thermal pollution; Control of thermal pollution.

References:

1. Environmental Pollution Control, C.S. Rao, Wiley Eastern Ltd.,1993
2. Air Pollution Control and Engineering, De Nevers, Mc Graw Hills, 1993
3. Fundamentals of Environmental Pollution, Krishnan Khannan, S.Chand and Company Ltd., 1994.
4. Environmental Chemistry, A. K .De.,New Age Intl. pub Co, New Delhi, 1990.
5. Environmental Pollution Anlysis- Khopkar

2.4 OEC - Environment & sustainable development

Credits- 4 Teaching hrs/week = 4 hrs

Unit -1

a) Introduction to Environmental Science: (13 hrs)

Meaning, scope and interdisciplinary nature of Environmental Science, Environmental Science and technology, Media and people, decision making and applications of Environmental Science.

b) Environmental ethics:

Nature and origin of environmental ethics, ecological consciousness, western and Eastern views, philosophy of environment, Environment, community and equity, Integrating ethical values and knowledge, self centered development and environment.

Unit- 2 Global and national environmental issues: (12 hrs)

Greenhouse effect, Acid rain, Global Warming, Ozone depletion, Climate change, Carbon Sequestration, Clean Development Mechanism, Carbon credits, Carbon footprint, Deforestation, Biodiversity loss, Desertification**.**

Unit -3 Human impact on environment and its consequences (13 hrs)

Hunting and gathering, agriculture societies, Human history Rise and Fall of civilisations, Age of colonisation, industrial societies, impact of cultural change on environment, population explosion, degradation of natural resources, pollution of air, water and soil, urbanization, industrialization, food security, public Health, energy crises, present status of environment and future scenarios.

Unit – 4 (14 HOURS)

Sustainable Development – scope & definition, parameters of sustainability, Concept of eco-development Vs growth, Concept of eco-development, Integrating economic and ecological principles, definition of physical, economic and ecological growth, cost benefit ratios, development processes and growth, Integrated approach to environment and development, Western Ghats eco-development plan, developmental models for hilly area, river basins lands, growth centres. environmental education and awareness.

References –

1. Environmental Science - Arms Karen
2. Principles of Environmental Science-Watt, K. E. F. (1973) McGraw-Hill Book Company.
3. Environmental Science –Noble, B .J. Kormandy, E.J.(1981),The way world works, Prentice-Hall Inc., N .J.
4. Environmental Science-Turk A. , Turk J. Wittes J.T. and Wittes, R.E.
5. Environmental Issues: Measuring, Analyzing, Evaluating, Abel, Daniel C. McConnell, Robert L. Abel, Daniel C. Edi. 2 Prentice Hall Publication
6. Botkin Daniel. B and Edward. A. Keller, Environment Science – Earth as a living Planet, JohnWiley and Sons, 2005.
7. Miller, G., Spoolman, S., 2007. Environmental Science: Problems, Connections and Solutions.Cengage Learning.
8. V. P. Agrawal. (1968). Forests in India: Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi.
9. Sitram Rao. Introduction to Social Forestry, Oxford and IBH Pub. Co. Pvt. Ltd.
10. Anand S. Bal. (2005). An Introduction to Environmental Management, Himalaya Publishing House.
11. Prabhakar V.K. Energy Resources and Environment, Anmol Publisher
12. Rai G.D. Non Conventional Energy Sources, Khanna Publication, New Delhi.
13. Kothari D.B and Singal K.C. (2011). Renewable Energy Sources and Emerging Technologies: PHI Learning Pvt. Ltd. New Delhi.
14. Satyanaraya, Sitre S.R, Zade S.B, Meshram P.U. A Textbook of Environmental Studies: Allied Publisher.
15. Oliver S. Owen. (1980). Natural resources conservation – An Ecological approach, 3rd edition, Macmillan publishing Co. Inc. New York.
16. Daniel D. Chiras. (1994). Environmental Science. 4th edition.
17. Sapru R.K. (1987). Environment Management in India. Vol. I & II. Ashish Pub. House.
18. Agarwal and Rana S.V.S. (1985). Environment & Natural resources, society of Biosciences.
19. Sharma V.K. (1985). Water resources planning and management, Himalaya Pub. House.
20. Francois Ramade 1984.Ecology of Natural Resources. John Wiley & Sons Ltd.
21. Harris, J.M. 2006. Environmental and Natural Resource Economics: A Contemporary Approach, 2nd edition. Houghton Mifflin.
22. Coastal Ecology & Management, Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303.
23. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
24. Agarwal, K.C., 2001. Environmental Biology, Nidhi Publication Ltd. Bikaner.
25. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001,Environmental Encyclopedia, Jaico Publishing House.
26. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press.
27. Miller T.G.Jr. Environmental Science, Wadsworth Publishing Co. (TB)
28. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science.
29. Barber, E. 1989. Economics: Natural Resources Scarcity and Development. Earthscan.
30. Kamaljit S. B., et. Al., 2011, Conservation Biology, Universities Press.

Practical 2.5 - Practical 3 - 2.1- 2.2

PRACTICALS : based on 2.1

1. Methods of collection preservation for microbiological studies
2. Serial dilution of soil and water
3. Preparation of different types of microbial culture media
4. Study of microorganisms in air
5. Study the morphology of the organisms by monochrome/negative/gram staining
6. Study of isolation of bacteria by Streak plate/Spread Plate/ Pour Plate method.
7. Isolation, enumeration and identification of microorganisms in soil samples
6. Estimation of Nygaard's algal indices in a given water sample

PRACTICALS : Based on 2.2

1. Determination of DO in water
2. Determination of BOD
3. Determination of COD
4. Estimation of hardness
5. Estimation of Total dissolved solids and Total suspended solids & Total Solids
6. Determination of turbidity and optimum alum dose by jar test.
7. Determination of fluorides in given water sample.
8. Determination of chlorine demand and residual chlorine for potable water.
9. Determination of phosphates in water / wastewater sample.
10. Determination of sulphates in water / wastewater sample.
11. MPN techniques for coli form analysis

Practical 2.6 – Practical 4 –Based on 2.3

1. Determination of Organic carbon in soil
2. Determination of Nitrite/Nitrate/Total nitrogen/Ammonia nitrogen in water and soil samples.
3. Determination of sodium and potassium by flame photometry
4. Determination of pesticides by Gas chromatographic method.
5. Estimation of Suspended Particulate Matter (SPM) and Respirable Particulate Matter(RPM) using high volume sampler.(PM10 and PM2.5)
6. Estimation of SOx and NOx in ambient air (including sampling).
7. Monitoring of wind speed and wind direction using anemometer and construction of windrose.
8. Measurement of ambient noise in different environments by sound level meter (SLM)
9. Determination of Sludge Volume Index and Mixed Liquor Suspended Solids.
10. Basic radioactive measurement procedures/ Radiation estimation using dosimeter

Visit to water / wastewater treatment plants /Air sampling station
Field visit to assess air and noise pollution.

3.1- Solid and Hazardous Waste Management

Credits- 4 Teaching hrs/week = 4 hrs

UNIT-I : Solid Waste – (12 Hrs)

Introduction, sources, characteristics, composition, classification, waste generated per capita-Global scenario. Solid Waste – collection, handling, Storage, segregation-transportation and disposal methods-sanitary land fills and types (Site Selection, Site Investigation and Site Characterization), composting, anaerobic digestion, biogas, incineration, types of incineration, pyrolysis.

UNIT-II : Solid Waste Management: (14 Hrs)

Introduction, 4R's concept; preparation of fuel cakes, waste minimization program, typical material recovery facility operation (TMRF), Reuse and recycling of paper, glass, rubber. Plastic waste status in India, effect of plastic wastes on environment, management of plastic waste, Bio-medical Waste Management- Generation and Characterization, Types, Collection and storage quantity, segregation, treatment and disposal; Biomedical waste management in developed countries and in India- legal aspects;

Indian Scenario and Legislative Control.

UNIT-III : Hazardous waste (12 Hrs)

Introduction, Definition, Classification, Identification, characteristics, resource conservation and recovery act, listed hazardous waste, listing criteria. Classification of hazardous waste and handling of hazardous solid wastes. Collection, Storage, Transportation, Hazardous Waste Testing in Terms of Toxicity. E-waste, composition, sources, collection, disposal.

Radioactive wastes- sources, pollution, types of radioactive waste and its control and management.

Unit 4: Hazardous Waste management (14 Hrs)

Physico-Chemical, Biological and Thermal Destruction of Hazardous Wastes, Containment Technologies, Secured Landfill, Land Farming, Bioremediation, Biodegradation of Recalcitrant, Xenobiotics Treatment; Guidelines for safe disposable of Hazardous Wastes at different places-institutions, industries, Leachate Management Waste Minimization, Recycle and Reuse of Hazardous Waste.

Hazardous Waste disposable: Type of disposable methods deep underground storage, deep well injection, Incinerator and other latest methods; E-waste management in global & national scenario, Recycling and disposal strategies.

REFERENCES :

1. Botkin, D. and E. K. Future, 1995. Environmental Science – Earth as a living planet
2. Sindhu, P. S. 2004. Environmental chemistry. New Age Int. Publishers
3. Wright R. T. and B. J. Nebel. 2002. Environmental science – towards sustainable future. Prentice Hall India Pvt. Ltd. New Delhi
4. Abbasi, S. A. and E. Ramasami, 1996. Biotechnological methods of pollution control.
5. Cunningham, W. P. and M. A. Cunningham, 2003. Principles of Environmental Science. Tata McGraw Hill Publ. New Delhi
6. Trivedi, P. R. and G. Raj. 1992. Solid waste pollution. Akshadeep Publishing House, New Delhi
7. Bhoyar, R. V., S. K. Titus, A. D. Bluide and P. Kanna, 1996. Municipal and Industrial Soild waste management in India. J. IAEM, 23: 53-64
8. Brumer, R. Calvin, 1993. Hazardous waste incineration, McGraw Hills, Singapore
9. Shah, K. L. 2000. Basics of solid and hazardous waste management technology, Prentice Hall, New Jersey
10. Pfeffers, J. T. 1992. Solid waste management engineering. Prentice Hall, New Jersey
11. Reinhardt, P. A and J. G. Gordon, 1991. Infectious and medical Waste management, Lewis Publ. NYK
12. Hazardous Wastes and Solid Wastes- Lie, D.H.F. and Liptak, B.G. (2000), Lewis publishers, New York.
13. Solid Waste management in Developing countries – Indian National Scientific documentation center- Bhide and Sundaresan, New Delhi. (2000)
14. Solid waste management- George Tehobanaglous- Milary Theiren and Samuel A vigil, Integrated, Mc Graw Hill Inc, (1993).
15. WHO Manual on solid waste management
16. CPHEEO Manual on solid waste management
17. Hazardous Waste Management, II Ed, La Grega, M.D., Buckingham, P.L. and Evans J.C., Mc Graw Hill Inc., (2001)
18. Bioremediation, Baker, K.M. and Herson, B.S, Mc. Grqw-Hill Inc., (1994)
19. Bioremediation- Principles, Eweis, J.B.Ergas S.J.Change, D.P.Y and Schroeder, E.D. Graw Hill Inc.,(1998)

3.2- Natural Resource Management & sustainable development

Credits- 4 Teaching hrs/week = 4 hrs

Unit – 1 **(13 Hrs)**

Introduction to natural resources - Classification, current status of natural resources and their reserves. types of resources, Abiotic resources- minerals, fossil fuels, water, soil, Biotic resources - Wild animals, fisheries, domesticated animals, plants.

Soil as resource, Soil conservation practices, wasteland reclamation.

Mineral resource : important minerals; mineral exploitation; use of minerals; environmental problems due to mining; reclamation of mining areas;

Energy resources : conventional energy resources (fossil fuels, biomass), nonconventional energy resources (wind energy, solar energy) energy use patter; environmental problems due to energy use.

Unit – 2 **(13 Hrs)**

Various aspects of Natural Resource Management - Livelihoods and Natural Resources, Natural Resource Economics, Society, Ethics and Participatory Development, Conflicts management - land, biodiversity, water. The role of communication in natural resource management; Facilitating discussions with multiple stakeholders, multiple perspectives; Conflict management; Policy negotiation; Collaborative planning. Ecological restoration.

Unit – 3 **(13 Hrs)**

a) Conservation - Management of Watershed & wetlands

Concept, objectives, planning and measures; Land use planning for watershed management; Rain Water harvesting and recycling; flood control and watershed management; Socioeconomic aspects of watershed management. Classification, values & present status of wetlands in India, RAMSAR convention ,conservation of wetlands,

b) Management of - Forest resources, Wildlife conservation and management, Urban forestry, Biodiversity and landscape, Climate change and carbon trading, Agro-ecosystems and Agro forestry, Environmental modelling, Eco-tourism, Access and benefit sharing of bioresources.

Unit – 4 **(13 HOURS)**

Sustainable Development – scope & definition, parameters of sustainability, Concept of eco-development Vs growth, Concept of eco-development, Integrating economic and ecological principles, definition of physical, economic and ecological growth, cost benefit ratios, development processes and growth, Integrated approach to environment and development, Western Ghats eco-development plan, developmental models for hilly area, river basins lands, growth centres. environmental education and awareness,

References

1. V. P. Agrawal. (1968). Forests in India: Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi.
2. Sitram Rao. Introduction to Social Forestry, Oxford and IBH Pub. Co. Pvt. Ltd.
3. Anand S. Bal. (2005). An Introduction to Environmental Management, Himalaya Publishing House.
4. Prabhakar V.K. Energy Resources and Environment, Anmol Publisher
5. Biomas Energy and Environment: H.R. Ravindranath, Oxford University Press,New York. 1995.
6. Rai G.D. Non Conventional Energy Sources, Khanna Publication, New Delhi.
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9. Oliver S. Owen. (1980). Natural resources conservation – An Ecological approach, 3rd edition, Macmillan publishing Co. Inc. New York.
10. Daniel D. Chiras. (1994). Environmental Science. 4th edition.
11. Sapru R.K. (1987). Environment Management in India. Vol. I & II. Ashish Pub. House.
12. The state of India's Environment, The second citizen's report (1984-85). Center for science and environment. New Delhi.
13. Agarwal and Rana S.V.S. (1985). Environment & Natural resources, society of Biosciences.
14. Sharma V.K. (1985). Water resources planning and management, Himalaya Pub. House.
15. Maheshwar Dayal. (1992). Renewable energy. Konark publishers Pvt. Ltd.
16. Francois Ramade 1984.Ecology of Natural Resources. John Wiley & Sons Ltd.
17. Harris, J.M. 2006. Environmental and Natural Resource Economics: A Contemporary Approach, 2nd edition. Houghton Mifflin.
18. Coastal Ecology & Management, Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303.
19. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
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21. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001,Environmental Encyclopedia, Jaico Publishing House.
22. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press.
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24. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science.
25. Barber, E. 1989. Economics: Natural Resources Scarcity and Development. Earthscan.
26. Kamaljit S. B., et. Al., 2011, Conservation Biology, Universities Press.

3.3 - Research Methodology & Statistics

Credits- 4 Teaching hrs/week = 4 hrs

UNIT I

(14HOURS)

Foundations of Research: Meaning, Objectives, Motivation, Utility, types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Planning the research Selecting a topic, research question – problem definition, hypothesis, objectives, research design, Data gathering – primary and secondary. Literature Review, Methodology of literature review, sources – books and journals, electronic databases, government and industry, internet; searching on keywords, Writing a literature review, Referencing – systems, referencing websites, citations,use of software.

UNIT II

(12HOURS)

Documentation and presentation of data, Analysis and interpretation of data, Quantitative Analysis, Quantitative Analysis, manuscript preparation.

Interpretation of Data and Paper Writing – Layout of a Research Paper, finding appropriate Journals, Impact factor of Journals, When and where to publish? Research ethics, permits, Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Abstract writing, Data sharing, Social media, popular writing.

UNIT III **(13HOURS)**

Biostatistics: Terms and Terminologies, Sampling Vs Population; Types of sampling; Variables and derived variables, Concept of Frequency and Distribution - Binomial distribution, Normal distribution, Data in Ecology and Environment Sciences and its types, Organization of data, Representation of data – tabular and graphic.

UNIT IV **(13HOURS)**

Simple random and stratified random sampling, sampling distribution, standard deviations of sample statistic, hypothesis critical region, errors.

Measures of Central tendencies (Mean, mode, median,) Standard deviation, Dispersion and Variability. The variance and coefficient of variation, coefficient of Correlation and regression, ANOVA, Chi square test for goodness of fit and independence. Test of significance - t – test, Z test, Non- Parametric Test

References

1. An Introduction to Biometry- Mungikar, A. M. (1997), Saraswati Printing Press Aurangabad.
2. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
3. Methods in Experimental Biology.-Ralph, R. (1975).Blakie, London
4. Plant Tissue Culture: Theory and Practice, a Revised Edition by S.S. Bhojwani and M.K. Razdan.
5. Research Methodology For Biological Sciences (01 Edition, 2013)- Gurumani, N. (2013), MJP Publishers
6. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
7. Bio-statistic : A Foundation for analysis in the health sciences : Wayne W – Daniel John Wiley and sons Inc
8. Survival models and data analysis : Elandt – Johnson and Johnson, John Wiley and sons Inc.
9. Statistical Method for the analysis of Biomedical data : Wool son John Wiley and Sons Inc.
10. Statistical Methods for Environmental and Agricultural Sciences A – Reza Horseman CRC Press Boca Raton Network
11. Text book of Environmental Engineering : P. Venugopala Rao, Prentice – Hall of India Pvt. Ltd. Delhi
12. Computer Fundamental : P. K. Sinha BPB Publications New Delhi
13. Digital Computer fundamentals : Thomas C. Bastee, Mc Graw Hall international book Company Tollyo.
14. Mathematical models in Biology and Medicine : J. N. Kapur Affiliated Eastwest Press Pvt. Ltd., Bangalore

OEC - 3.4: CLIMATE CHANGE AND ENVIRONMENT

Credits - 4 Hours of Instruction 4 hrs/week

Unit 1: Climate Change: 12 hrs

Origin and evolution of the earth's atmosphere. Overview of key concepts – weather and climate; Atmospheric Chemistry; Climatic variability - temperature, rainfall, wind speed & direction. El-Niño, La Nino and their impacts. Effect of various anthropogenic activities on earth's atmosphere. Changing climate.

Unit 2: Greenhouse Effect: 14 hrs

Global warming and greenhouse effect – major greenhouse gases, sources and sinks of greenhouse gases; monitoring greenhouse gases; Urban Heat Islands; Ozone layer depletion, issues and Advance research to protect the Ozone layer and consequences; sea level rise and its impact; Heat and cold waves; global dimming; Implications of Climate Change, monitoring and assessment; climate change models.

Unit 3: Climate change and policy frameworks – 12 hrs

History of international climate change policies. United Nation Framework Convention on climate change (UNFCCC) – Key provisions of the UNFCCC, its structure. The Kyoto protocol and its associated bodies. Overview of Conference of Parties (CoP). Main climate change negotiations evolved over the past years and highlights some key issues relevant for a future climate change regime.

Unit 4: Climate change adaptation and mitigation: 14 hrs

The concept of climate change adaptation; Linkage between climate change adaptation and development. International adaptation initiatives and programs. strategies for environmental education, Definitions of mitigation and present an overview of emissions levels and mitigation targets per country. Integrate mitigation into development planning through low emission development strategies. International mechanisms created to assist countries in planning and implementing mitigation actions. Climate Change and Sustainable Development.

Reference Books:

1. Abhishek Tiwary and Jerem Colls, 2010. Air Pollution: Measurement, Modelling and Mitigation. III Edition, Routledge Publication.

2. Dey.A.K. 2005. Environmental Chemistry, V Ed., New Age International Publishers. M.Sc Environmental Science, Bangalore University Syllabus 34

3. Donald Ahrens.C. 2008. Essentials of Meteorology: An Invitation to the Atmosphere. Cengage Learning publication.

4. Frederick K. Lutgens, Edward J. Tarbuck. 1995. The atmosphere: an introduction to meteorology. Prentice Hall publication.

5. IPCC. 2006. Guidelines for National Greenhouse gas Inventories. Published by the Institute for Global Environmental Strategies (IGES), Hayama, Japan on behalf of the IPCC.

6. John E. Oliver, John J. Hidore. 2002. Climatology: An Atmospheric Science, Second Edition. Prentice Hall publication.

7. John T. Hardy. 2003. Climate Change: Causes, Effects and Solution. John Wiley & Sons publications.

8. Jonathan I. Lunine, Cynthia J. Lunin. 1999. Earth: Evolution of a Habitable World. Cambridge University Press. Great Britain.

9. Nicholas Stern. 2008. The Economics of Climate Change: The Stern Review. Cambridge University Press. Great Britain.

10. Pal Arya.S. 1998. Air Pollution Meteorology and Dispersion. Oxford University Press.

11. Agarwal K.M, Sikdar P.K. and Deb S.C. 2002. A text book of Environment – MacMiller India Ltd., Calcutta

12. Tyler Miller Jr. Living in the Environment – Principles, Connections and Solutions.

13. Botkin D.B. 1989. Changing the Global Environment, Academic Press, San Diago.

14. Howard J. Critchfield. (1983). General Climatology (Fourth Edition), Phi Learning Pvt Ltd.

15. Mark Maslin. 2013. Climate - a very short introduction, Oxford University Press.

16. Roger G. Barry and Richard J. Chorley. 2007. Atmosphere, weather and Climate, 8th Edition, Routledge Publishers.

17. Oliver. 2002. Climatology: An Atmospheric Science, 1st Edition, Pearson Publishers.

18. Mark Maslin. 2008. Global Warming, 2nd Edition, Oxford University Press Publishers -New Delhi.

19. Manoj Singh. 2012. Climatology: Sonali Publications Publisher.

3.5 - Practical 5 - Based on 3.1

PRACTICALS :

1. Characterization of solid waste from different sources.
2. Designing of Biogas plants / secured sanitary land fills.
3. To study methods of management of biomedical waste.
4. Characterization of (TCLP) toxicity characteristic leaching test procedure hazardous waste from different sources.
5. Field trip to municipal solid waste/zero waste management sites/ Biomedical waste plant.
6. Determination of inorganic phosphate in leachate samples.
7. Determination of total nitrogen in leachate
8. Determination of TSS/TDS in leachate sample.

3.6 - Practical 6 - based on 3.2 and 3.3

Practical's based on 3.2

1. Conducting Participatory Rural Appraisal (structured interview technique)
2. Analysing interview data (quantitative & qualitative method)
3. Conducting informal interviews
4. Participatory mapping.
5. Conducting Participatory Rural Appraisal using matrix scoring.
6. Conducting Participatory Rural Appraisal using seasonality calendar.
7. Bioacoustics – recording and analysis
8. Field visit – Study of watershed, Forest Management, Community managed projects.

Practical's based on 3.3

1. Graphical representation of data and calculation of different types of mean based on different types of data
2. Calculation of mode and median based on different types of data by different methods.
3. Calculation of standard deviation, coefficient of variation and coefficient of correlation
4. Calculation of t-test and Z-test
5. Calculation of Chi-square test
6. Solve examples based on one-way ANOVA
7. Solve examples base on two-way ANOVA
8. Calculation of Simple Regression and Regression Coefficient
9. Calculation Standard error and significance test

4.1- Environmental Law & Policy

Credits- 4 Teaching hrs/week = 4 hrs

Unit – 1 **(13 Hrs)**

a) International Environmental Policies Agreements and Treaties

Nature of Environmental Policies, Stockholm Conference (1972), Rio Conference (UNCED, 1992), merits of the Conference Agenda 21. Difference between agreement and treaty, Johannesburg treaty, GAAT and Environment, CITES, Montreal Protocol, Kyoto Protocol and COP under UNFCC.

b) Constitutional provisions for Environmental Protection

Article 14, 15, 19, 21, 32, 39, 47, Article 48(A), Art. 49 fundamental duties of citizen, Art. 51A (g) directive principles of state policy, Art. 243, 243(G) and (W), Art. 246, 248 Writ provisions for the protection of environment.

Unit – 2 **(13 Hrs)**

a) National Environmental Legislation

The Water (Prevention and Control of Pollution) Act, 1974.
The Air (Prevention and Control of Pollution) Act, 1981.
The Environment (Protection) Act, 1986 , Sec. 12 of Mining Act, 1952.
Public Liability Insurance Act, 1991.
Noise Pollution Control Rules, 2002

b) National Legislation on Forest, Wildlife etc.

The Forest (conservation) Act, 1980, The Wildlife (Protection) Act, 1972,
The Biodiversity (Protection) Act, 2002

Unit – 3 **(13 Hrs)**

a) Waste Management Rules: Plastic Waste Management Rules 2016, e-waste (Management) Rules, 2016, Bio-Medical Waste Management Rules, 2016, Construction and Demolition Waste Management Rules, 2016, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, Solid Waste Management Rules, 2016.

b) National Policy on Environment : National Forest Policy, National Water Policy, National Energy Policy, CPCB and SPCB and their role.

Unit – 4 **(13 Hrs)**

a) Environmental Legislation related to CRZ and PIL- Concept and need of Public Interest Litigation, jurisdiction of High Courts and Supreme Court, Need of CRZ rules for regulation the activities in coastal zone.

b) IPR, and patenting -Introduction and the need for intellectual property right (IPR) , patents - rules and regulations, trademarks, Trade secrets, industrial designs, new plant varieties, geographical indications, Benefits from IPR, Problems of IPR.

Reference

1. Mohanty S. K., Environment and Pollution Law Manual, Universal Law Publishing Vompany ltd., 3rd edition, 2002.
2. Environment and Pollution Laws, Law Publishers, 2000.
3. Leelakrishnan P, Environmental Law in India, Butterworths, 2000.
4. Singh Kuldip, Environmental Jurisprudence, Modern Law House, 2nd edition 2002.
5. ChoudhuriS.K, Environmental Legislations in India, Oxford and IBH Publishing 1996.
6. Pollution Control Acts, Rules and Notifications, Pollution Control Law Series – Volume – I, Central Pollution Control Board, 1992.
7. Conserving Life – Implications of Biodiversity conservations for India, Kalpavriksh, 1994.
8. Convention of Biological Diversity, World Wide Fund for Nature India 1992.
9. Singh Kuldeep, Handbook of Environment, Forest and Wildlife Protection Laws in IndiaNatraj Publishers, 1998.
10. The Environment (Protection) Act and Rules 1986, Law Publishers.
11. Traffic Bulletin, Traffic International.
12. Vanguri Kishore, Environmental Laws in India – A guide, C.P.R. Environmental Education Centre, Madras, 1994.
13. The Water (Prevention and Control of Pollution) Act, 1974 and Rules 1975, Akalank Publications, 1999.
14. The Air (Prevention and Control of Pollution) Act, 1981 Akalank Publication 1999.
15. The Indian Forest Act, 1927 along with Forest (Conservation) Act 1980, Indira Gandhi National Forest Academy, Natraj Publishers 2002.
16. The Wildlife (Protection) Act 1972, Natraj Publishers, 1994.
17. Understanding Biodiversity Law Module, Center of Environmental Education Research and Advocacy (CEERA)
18. Trivedy R.K., Handbook of Environmental Law, Acts, Guidelines, Compliances and Standards, Volume Environment Media, 1996.
19. Nair Manju, The Montreal Protocol – in the Indian Context, Centre for Environmental Law, WWF India, 1996.
20. Environmental Legislation in India – A guide for Industry and Business, Environment Management Division, Confederation of Indian Industry, 1999.

4.2- Environmental Planning & Management

Credits- 4 Teaching hrs/week = 4 hrs

Unit -1 Environmental Impact Assessment: (13 Hrs)

a) Introduction of Environmental Impact Assessment process, objectives of EIA, Terminology, and Hierarchy in EIA, Historical Review of EIA, and concepts of EIA, Basic data collection for EIA.

b) Legislation and Procedures: National Environmental Policy Act and Implementation, EIA legislative requirements and administrative procedures in India/Indian States, EIA notification 2006 and its amendments.

Unit -2 (13 Hrs)

a) Techniques and Methodology of EIA:
Description of the environmental setting, Environmental Impact Assessment techniques-Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, system diagram technique, Environmental risk assessment, baseline data collection for EIA.

b) Public Participation, Prediction and impacts and case studies of EIA: Public Participation in environmental decision making, regulatory requirement, techniques, Preparation and writing of EIA report Prediction and Assessment of Impacts on Air, Water, Noise, Biological, Cultural and socio-economic Environment. Case studies of EIA for various Industries and developmental projects of road/dams and housing etc.

Unit -3 Environmental Audit: (12 Hrs)

a) Environmental Audit: Definition of Environment Audit and its importance for industries. Types of audits, General audit methodology and basic structure of audit, Elements of an audit process and its importance.

b) Types of Audits: Definitions of Signatory, a. Consumption Audit, b. Pollution audit, c. Hazardous audit, d. Solid waste audit, e. Disposal audit, f. Cost audit, g. Investment audit, h. Voluntary social audit and socio-economic surveys, Social Impact Assessment (SIA).

Unit -4 (14 Hrs)

a) Environmental Management system:
EMS benefits and costs , benefits to an industry, ISO 14000-Background, the ISO 14000 series, business and standards, voluntary standards and GATT/WTO, ISO 14001 & elements of EMS-environmental policy, planning, implementation and operation checking & correction action and management review, OSHAS – 18000.

b) Life Cycle Assessment :Components of LCA, measuring environmental impact (lifecycle stages of product, boundaries, functional unit, issues at each life-cycle stage, benefits of LCA), strategic framework for LCA and LCA-a tool for sustainability-Case study.
Environmental entrepreneurship

References:

1. Environmental Impact Assessment, Canter, L.W., 1977, McGraw Hills, New York.
2. Environmental Impact Assessment, Peter Wathern , Unwin Hywin, London
3. Environmental Impact Assessment, P. R. Triwedi, APH Publishing Corporation, New Delhi
4. A Handbook of EIA, V.S. Kulkarni, S.N. Kaul and R. K. Trivedi, Scientific Publication (India).
5. Bathwal R.R. (1988) Environmental Impact Assessment, New Age, International
6. Baumgartner Ruedi, 2004. The search for sustainable livelihood system sage Publications.
7. Biswas A.K, 1987. Environmental Impact Assessment, Tycooly International.
8. Canter L.W. (1996) Environmental Impact Assessment, 2nd Edn. New York, McGraw Hill.
9. Dale R. (2004) Evaluating Development Programme and Project, Second Edition, Sage Publication.
10. Desh Bandhu, 1981. Environment management, Indian environment Society.
11. Eccleston, Charles H., 2011. Environmental Impact Assessment : A Guide to Best Professional Practices, CRC Press.
12. Environmental Impact Assessment, Selected reading, Wildlife Institute of India, 1991.
13. Kulkarni and Ramchandra, 2006. Environment Management, Capital Publishing Company,
14. Lee N. and Kirkpatrick C. (Eds) (2000) Integrated Appraisal and Sustainable Development in a Developing World, Cheltenham, Edward Elgar.
15. Natarajan Banerjee, 1985. Environment impact assessment and control measures adopted in Neyvelli lignite project, N.L.C Printing Press. Publishers.
16. Shukla and Shrivastav, 2000. Concepts in environmental impact analysis, Common wealth Publication.
17. SINAR MAS pulp and paper (India), Ltd. Engineering Projects Pvt, Ltd. February, 1997
18. Trivedi, 2004. Environmental Impact Assessment, A P H Publishing Corporation.
19. Tyler Miller, 2017, Environmental Science: Working With The Earth.
20. Vanclay F. and Bronstein D.A. (1995) Environmental and Social Impact Assessment, Wiley Publishers.

4.3 - Environmental Toxicology & occupational health hazards Credits- 4

Teaching hrs/week = 4 hrs

UNIT –I : **(13 Hrs)**

Definition, classification, Sources of toxicants in environment, Evaluation of toxicity, Bioassay, factors affecting toxicity, mutagenesis, spermatogenesis, carcinogens, hallucinogens, phyto-toxins, animal toxins. mechanism of toxicity and receptor mediated events, acute and chronic toxicity. Introduction to eco-toxicology, Principles of toxicology, Types of toxic substances - degradable and non-degradable; Influence of ecological factors on the effects of toxicity.

UNIT – II : **(13 Hrs)**

Toxic substances in the environment, their sources and entry routes, Effects of heavy metals and pesticides, Eco-system influence on the fate and transport of toxicants; Transport of toxicants by air and water;Bioaccumulation and Biomagnifications of toxic materials in food chain, Toxicology of major pesticides-Environmental impacts of pesticides, biotransformation, biomonitoring, programs and parameters of biomonitoring, Basic concepts of Environmental forensics.

UNIT – III : **(14 Hrs)**

Occupational health hazards - Stress, man, machine and environment, Ergonomics - Introduction, Definition, Objectives, Advantages, Occupational physiology and hazards of working environment, Occupational diseases, Personal Protective Equipment's, Respiratory personal protective devices, Non respiratory personal protective devices: Head protection, Ear protection, Hand protection , Foot protection, Body protection.

Sanitation and public health, hygiene and human health, concept of social and public health, sanitation, practices and related problems, case studies.

Unit 4 - **(12 Hrs)**

Industrial Safety - Planning for safety, Definition, purpose, nature, scope. safety. Policy formulation and effective planning for safety. Organization structure and safety department, Safety Management Information System, Sources of information on Safety , Health, and Environment. Compilation, Introduction to national & international SHE Management Systems, Total Quality Management and its application to SHE, occupational Health & safety appraisal system 18001 and 15001

References:

1. Environmental Sanitation, Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc.
2. Toxic Chemicals, health and the Environment, Lave, L.B and Upton, A.C. 1987. The HopkinsPress Ltd., London.
3. Basic Environmental Toxicology, Lorris G. Cockerham and Barbara S. Shane,CRC Press.
4. Introduction to Environmental Toxicology Wayne G.Landi Ming-Ho Yu.
5. Patty's Industrial Hygiene and Toxicology, Ed.by Lewis J.Cralley, Lester V. Cralley, James S. Bus.
6. Hazardous waste management - Charles A. Wentz, 2nd Edition, 1995, Mc Graw Hill International
7. Integrated Solid waste management - George Tchobanoglous, Hilary and Samuel A. Vigil
8. Standard handbook of hazardous waste treatment and disposal - Harry M. Freeman, Mc Graw Hill 1997.
9. Environmental Sanitation, Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc.
10. Toxicology- The Basic Science of Poisons, Louis J Casarette, John Doull. Mc Millan Publishing Co. Inc. New York.
11. Modern Toxicology, Gupta , Salunkhe, Metropolitian Book Co. Pvt. Ltd.
12. Anderson, D and D.M.Conning. 1990. Experimental Toxicology: The Basic issues. Royal society of Chemistry, London.
13. Dhaliwal, G.S. 1993. Pesticides: Their Ecological Impact in Developing Countries. Commonwealth Publishers, New Delhi.
14. Guithinier Perry. (1980). Introduction to Environmental Toxicology, Elsevier.
15. Moriarty, F. 1999. Ecotoxicology, 3rd ed. Elsevier Pub.
16. Peter Calow, 1993. Handbook of ecotoxicology, Blackwell Science, London.
17. Timbrell, J. 2003. Principles of Biochemical toxicology, CRC Press.
18. Environmental Sanitation, Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc.
19. Toxic Chemicals, health and the Environment, Lave, L.B and Upton, A.C. 1987. The Hopkins Press Ltd., London.
20. Basic Environmental Toxicology, Lorris G. Cockerham and Barbara S. Shane, CRC Press.

4.4 - Nanotechnology & Environment

Credits- 4 Teaching hrs/week = 4 hrs

Unit -1: (14 Hrs)

Nanoscale Materials: Introduction; Definitions; Classification: Origin, Composition and Structure, Free versus Fixed Nanoparticles; Properties: Overview, Effect of Increased Surface Area, Influence of Quantum Effects, Influence of Quantum Effects; Types of Nanomaterials and Applications: Carbon, Inorganic Nanotubes, Metals, Metal Oxides, Clays, Quantum Dots, Dendrimers.

Unit 2: (12 Hrs)

Preparation of Nano-Materials: Introduction; Methods of synthesis; physical-mechanical and vapour; chemical-colloids, chemical reactions, Sol-gel techniques and biological-Green synthesis; Flame synthesis; Solid state combustion; Solution combustion synthesis; Catalyst-types and Characterization of Catalyst.

Unit-3: **(13 Hrs)**

Analysis of Nanoparticles: Nanoparticle Imaging: Size, Shape, and Chemical Composition-Electron Microscopy, Scanning Probe Microscopy (SPM); Compositional Analysis: Single Particle Mass Spectrometer, Particle-Induced X-Ray Emission (PIXE); Surface Area: Product Characterization and Air Monitoring-Epiphaniometer, Aerosol Diffusion Charger; Size Distribution: Electrostatic Classifiers, Real-Time Inertial Impactor: Cascade Impactors, Electrical Low Pressure Impactor (ELPI), Dynamic Light Scattering (DLS).

Unit-4: **(13 Hrs)**

Environmental Remediation: Nano-remediation- Concepts of fullerene, carbon nanotubes, nanoparticles for environmental conservation, Carbon adsorption, Adsorption media filters, Micro screening and other low cost treatment methods.

Sustainable Nanotechnology: Application of nanotechnology in industrial ecology, environmental and health impacts of nano materials, exposure to nano particles-biological damage, threat posed by nano materials to humans; Nano materials in future - implications.

References:

1. Nanotechnology and the environment, by Robert V. Neumann, Nova Science Publishers, Inc. New York, 2010.
2. Nanotechnology: Consequences for Human Health and the Environment by R.E. Hester and R.M. Harrison, RSC publication, 2007
3. Nanotechnology and the environment by Kathleen Sellers, Christopher Mackay, Lynn L. Bergeson, Stephen R. Clough, Marilyn Hoyt, Julie Chen, Kim Henry, Jane Hamblen, CRC Press, New York, 2009
4. Nanotechnology for Environmental Remediation: by Sung Hee Joo, I. Francis Cheng, spinger Publications, 2006.
5. Nanoscience and Nanotechnology: Environmental and Health Impacts: by Vicki H. Grassian, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008
6. Nanotechnology- Toxicological Issues and Environmental Safety: by P.P. Simeonova, N. Opopol, M.I. Luster, Spinger Publications, 2006
7. Green Nanotechnology: Solutions for Sustainability and Energy in the Built Environment: by Geoffrey B. Smith Claes G. Granqvist, CRC Press, New York, 2011.
8. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
9. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.
10. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
11. Nanotechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.
12. Handbook of Nanofabrication. Edited by Gary Wiederrcht. Elsevier, 2010.
13. Nanoporous materials: Advance techniques for characterization, Modeling and Processing. Edited by Nick Kanello Poulos. CRC press, 2011.
14. Inorganic Nanoparticles: Synthesis, Application and Perspectives. Edited by Claudia Altavilla and Enrico Ciliberto. CRC Press, 2011.
15. Nanostructured conductive polymers. Edited by Ali Eftekhari. Wiley, 2010.
16. Adsorption and diffusion in nanoporous material by Rolando M.A. Raque Malherbe. CRC press, 2007.
17. Introduction to Nanoscience by Gabor L. Hornyak, Joydeep Dutta, Harry F. Tibbals, Anil K. Rao. CRC Press, 2008.

4.5 - Practical 7- based on 4.2, and 4.3

1. Determination of solid food adulteration.
2. Methods of prevention of food poisoning.
3. Determination of liquid food adulteration.
4. Estimation of LC50 value in mosquito larvae.
5. Spot test for the detection of nitrate/nitrite poisoning.
6. Determination of toxic chemicals in different samples.
7. Safety devices in industries
8. Survey and documentation of occupational diseases and causes in given areas
9. Respiration disorder in industrial workers.
10. Occupational health hazards in agricultural workers.

4.6 - - Project work / Dissertation