

BHARATHIAR UNIVERSITY : COIMBATORE 641046
M.PHIL. / Ph.D. – (FT/PT) - ENVIRONMENTAL SCIENCES

PART – I SYLLABUS
(effective from the academic year 2017–18 onwards)

Paper-I : Research Methodology

Paper-II : Principles of Environmental Science

Paper-III : Special Paper

1. Advanced Waste Management
 2. Environmental Health
 3. Remote Sensing and Geographic Information System (GIS)
 4. Environmental Mutagenesis
 5. Water Pollution and Management
 6. Ecotoxicology and Risk Assessment
 7. Oxidation Techniques for Water Management
 8. Environmental Microbiology and Bioremediation
 9. Systematics, Biodiversity and Aquatic cology
 10. Bioresource Technology
 11. Environmental Ecology
 12. Environmental Phytotechnology
-

BHARATHIAR UNIVERSITY, COIMBATORE-641 046.
DEPARTMENT OF ENVIRONMENTAL SCIENCES

M.Phil.- Part-I : Paper : I

PAPER – I : RESEARCH METHODOLOGY

UNIT – I

Fixative and Fixation, Dehydration, Embedding, Sectioning, Mounting and Staining procedures with reference to Carbohydrates, Lipids, Proteins, Nucleic acids, DNA extraction and amplification. Preparation of samples for electron microscopy.

Principles and applications of Autoradiography, Microscopy (TEM, SEM, Fluorescence and Stereomicroscopes), Ocular and Stage micrometer, Camera Lucida, Scintillation counter, Radioactive isotopes.

UNIT – II

Principles and Applications:

Centrifuges, pH meter, Conductivity meter, Ion meter and Ion selective electrodes, Spectrophotometer (UV-Visible double beam), Atomic Absorption Spectrophotometer (Flame, graphite furnace and ICP), Flame photometry and Fluorimetry, Ambient and Stack Monitoring, Noise meter.

UNIT – III

Principles and Applications:

Electrophoresis (SDS and PAGE, Isoelectro focusing, Immuno electrophoresis), Chromatography (TLC, HPLC and GC), Osmometry, Respirometer, Electrodes for measurement of partial pressure / concentration of gases, Aminoacid analyzer, ELISA. Estimation of Carbohydrates, Proteins, Lipids, Nucleic acids (RNA and DNA). PCR and gel documentation.

UNIT – IV

Estimation of animals and plant population of aquatic and terrestrial ecosystem, Primary production in lake ecosystem, Population ecology, Population dynamics, Toxicity testing.

Sampling methods and estimation of total viable heterotrophic bacteria in water, soil and animals. Faecal indicator bacteria in sewage.

UNIT – V

Introduction to Environmental System analysis- Basic elements and tools of statistical analysis – Probability, sampling measurement and distribution of attributes – Approaches to development of models – Test of significance – Analysis of variance –

one way ANOVA – two way ANOVA – Regression and correlation – linear simple and multiple regression models.

Methods of literature collection, design, planning and execution of investigation – preparation of research articles, review papers for journals, research thesis writing.

REFERENCE :

1. Experimental Microbial Ecology. Aranson, S. (1970), Academic Press. New York and London.
2. Statistics in Biology. Bliss, G.I. (1970). Mc Graw Hill Book Company, Vol. I and II. New Delhi.
3. Laboratory Experiments in Microbiology. Case, C.L. and Johnson, T.R. (1984). The Benjamin / Cummings Publishing Co., London.
4. Environmental Instrumentation. Fritschen, L.J and Gay, L.W (1979). Springer-Verlag, New York.
5. Analytical Biochemistry. Holme, D.L. and Peck, H. (1983), Longman, London.
6. Animal Tissue Techniques. 4th Ed. Humason. G.L. (1979), W.H. Freeman and Co., Sanfrancisco.
7. Hawk's Physiological Chemistry. 14th Ed., Oser, B. L. (1965), Tata Mc Graw – Hill Co., New Delhi.
8. Methods of Protein and Nucleic Acid Research. Osterman. A. (1984), Springer – Verlag, New York.
9. An Introduction to Practical Biochemistry. Plumber. D.T. (1971), Tata Mc Graw – Hill Co., New Delhi.
10. Laboratory Instrumentation. 3rd Ed., Robert Hicks, M. Haven, C.M., Schenken, R.J. and Mc Whorter ,C.A (1987), J. B. Lippincott Company, Philadelphia.
11. Manometric Techniques, Umbriet. W.W. et al., (1968), Burgess Publishing Co., Minneapolis.
12. Practical Statistics for Experimental Biologists. Wardlaw. A.C. (1985), Wiley, Chichester.
13. Limnological Analysis. Wetzel., R.G. and Linkens, G.E. (1979), Saunders, Philadelphia.
14. Research Methods in Social Sciences. Sharma, B.A.V., Ravindra Prasad, D. and Satyanarayana, P (1989), Sterling Publishers Pvt. Ltd.
15. Research Methodology – Methods and Techniques. Kothari, C.R., (1989), Wiley Eastern, New Delhi.
16. Introduction to Research Methodology in Agricultural and Biological Sciences, V.Venkatasubramanian (1999), New Century Book House (P) Ltd., Chennai.

PAPER II – PRINCIPLES OF ENVIRONMENTAL SCIENCE

UNIT – I

Natural Resources: Mineral resources – resources and reserves, minerals and population. Ocean as new areas for exploration of mineral resources. Ocean ore and recycling of resources. Environmental impact of exploitation. Processing and smelting of minerals.

Water Resources: global Water balance, Ice sheets and fluctuations of sea levels, Origin and composition of sea water. Hydrological cycle. Factors influencing the surface water, Types of water. Resource of Oceans. Ocean pollution by toxic wastes. Human use of surface and ground water. Ground water pollution – case studies.

Biodiversity: conservation, Intellectual Property Rights and Environment, Impact of genetically modified microbes, plants and animals.

UNIT II

Remote sensing and GIS: Principles of Remote sensing and its application to Environmental Sciences. Application of GIS in Environmental Management

UNIT III

Solid wastes; Sources and generation of solid wastes, their characteristics, classification. Different methods of disposal and management of solid wastes (Hospital and hazardous wastes). Recycling of waste material. Waste minimization technologies. Hazardous waste management and Handling rules 1989. Natural hazards and mitigation and Management - case studies.

Marine: Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine systems – coastal management.

UNIT IV

Environmental Impact Assessment (EIA): Introduction to environmental impact analysis. Environmental impact statement and environmental management plan. EIA guidelines 1994. Notification of Government of India. Impact Assessment Methodologies. Generalized approach to impact analysis. Procedure for receiving environmental impact analysis and statement. Guidelines for Environmental audit. Introduction to environmental planning. Base line information and predictions (land, water atmosphere, energy, etc). Restoration and rehabilitation technologies. Landuse policy for India. Resource management, Disaster Management, and natural risk analysis. Environmental Risk Assessment, Environmental Management systems - ISO 14001, Sustainable Managements - Green Technology, International Trade Agreements and Implications on Environment.

UNIT V

Regulations and Laws: Environmental Protection Acts in India, 1986 and Rules 1986 – Water (Prevention and Control of Pollution) Act, 1974, as amended up to 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981, as amended by Amendment Act 1987 and Rule 1982, Motor Vehicle Act 1988. Wildlife Protection Act, 1972, amended 1991. Forest Conservation Act, 1980, Indian Forest Act 1982. Scheme of labeling of environmental friendly products (Ecomark). Public Liability Insurance Act, 1991 and Rules 1991. Green courts, International Treaties, International movements on Environment.

REFERENCE :

1. Environmental Pollution. Dix. H.M. (1981), Willey, Chichester.
2. Principles of Environmental Sciences and Technology. Jorgansen, S.E. and Johnson, I. (1981), Elsevier, Amsterdam.
3. Chemical Contamination in the Human Environment. Lippmann, M. and Schlessger, R.B. (1979), Oxford, New York.
4. Environmental Sciences. Purdom, P.W. and Anderson, S.H (1983). Columbus, Merrill.
5. The Animal and the Environment. Verberg F.J. and Vennebergm, W.B. (1970), Holt. R. Inchart and Wonston, New York.
6. Ecology, Impact Assessment and Environmental Planning. Wastman, W.E. (1985), Wiley Interscience, New York.
7. Pollution Control Legislations – Environmental Laws, Vol.I and Vol.II. (1999) Tamilnadu Pollution Control Board, Chennai.

Paper-III

1. ADVANCED WASTE MANAGEMENT

(Adsorption, Catalysis & Oxidation Processes)

UNIT – 1

Removal and recovery of heavy metals (Cr, Cd, Ni, Cu, Hg, As, Zn, Pb) by conventional methods –hydroxide, carbonate and sulphide precipitations, chemical reduction, ferrite coprecipitation, cementation, xanthate process, solvent extraction, membrane process, electrodeposition, ion exchange - Adsorption methods – conventional and nonconventional adsorbents – Agricultural / industrial solid wastes, biosorbents –live and dead biomass.

UNIT – II

Removal and recovery of anions(CN^- , F^- , NO_3^- , PO_4^{3-}), dyes, phenols, pesticides, surfactants- chemical oxidation - adsorption processes by conventional and nonconventional adsorbents – Biosorbents –Live and dead biomass.

UNIT – III

Adsorptive removal of toxic gases (CO , NO_x , SO_x , H_2S and Hydrocarbons) - conventional and nonconventional adsorbents – catalytic decomposition; Desulphurization methods – Regenerative and nonregenerative alkaline processes – Adsorption by liquids.

UNIT –IV

Advanced oxidation processes for organics removal – Photocatalysis – Mineralization of pesticides, phenols, dyes and surfactants – Analysis of pollutants and adsorbents by advanced methods –HPLC, GC. –Mechanisms of mineralization, SEM,XRD, FT-IR.

UNIT-V

Preparation of adsorbents – activated carbon, modified biomass by physical and chemical methods and Characterization of adsorbents –surface area, pH_{zpc} , porosity, surface groups - Determination; Kinetics of adsorption– Adsorption rate equation, Isotherms - Langmuir, Freundlich, B.E.T, D.R- Factors affecting adsorption - pH, adsorbate concentration, adsorbent particle size, adsorbent concentration, temperature, presence of other species - Mechanisms of adsorption of metal ions, anions, organics- dyes, phenols, pesticides, and surfactants – Electrostatic attraction / repulsion model, ion exchange model, James-Healy model, Chemisorption

REFERENCE :

1. Redmud Analysis and Utilization. R. S. Thakur and Das,S.N., Wiley Eastern, New Delhi, (1994) ; Chapters 4 and 5- Adsorbents and Catalysts; pages 201-250.
 2. Biosorbents for Metal Ions. Wase,J and Forster, C., Taylor & Francis, London, (1997).
 3. Encyclopedia of Environmental Pollution and Control. Vol .1. Trivedi,R.K., Enviromedia, Karad, (1995); pages: 30-49; 119-131 and 297-336.
 4. Advances in Environmental Sciences. Iyer,C.S.P., Educational Publishers, New Delhi, (1997) , pages: 347-437.
 5. Surveys in Industrial Wastewater Treatment, Vol. 3 - Manufacturing and Chemical Industries. Chapter 1: Kiff,R.J - General Inorganic Effluents. Barnes,D., Forster,C.F., and Hruley,S.E., Longman Scientific & Technical, New York, (1987) , pages 1-20.
-

2. ENVIRONMENTAL HEALTH

Unit –I

Environmental Microbiology: Normal flora in the human body, Normal flora in the skin, conjunctiva, respiratory alimentary and urinary tract, Bacteriology of water, milk-detection of coliform bacteria and *E. coli*, detection of fecal streptococci, bacteriological examination of milk-viable count, test for coliform bacteria, methylene blue reduction test, phosphatase and turbidity test, staining techniques-gram staining, acid fast staining, optical and electron microscope, sterilization techniques-Physical agents, sunlight, dry heat, incineration, moist heat, autoclaving.

Unit-II

Impact of Environment in Health care System: Sources of water supply, sanitary well, water pollution, water related diseases, purification of water-slow sand filter and rapid sand filter and their comparison, water quality criteria and standard, rain water harvesting, chlorination/disinfection of water, action of chlorine-principles of chlorination, method of chlorination, break point chlorination-orthotoludine test-disinfection of well, heat-effect of heat stress-preventive measures and global warming, disposal of wastes solid wastes, storage collection and methods of disposal- dumping, tipping or sanitary land, incineration-composting manual pits-burial method, excreta disposal, extent of problem in India-methods of excreta disposal, bore hole latrine, water seal latrine, RCA latrine.

Unit-III

Occupational Health: ergonomics, occupational diseases, pneumoconiosis-antracosis, silicosis, bagassosis, byssinosis, asbestosis, lead poisoning, occupational cancer-skin cancer, lung cancer, bladder cancer and leukaemia, occupational dermatitis, legislative act in occupational health factory act 1948, employees state insurance act 1948-scope, administration, finance benefits to employee-medical benefit, sickness benefit, maternity benefit, disablement benefit, dependants benefit, funeral expenses, rehabilitation, benefits to employer, Rajiv Gandhi shramik kalyan yojna.

Unit-IV

Biomedical Waste Management: definition, classification of health care waste, sources of health care waste, health care waste generation, hazards of health care waste, treatment and disposal, incineration-types, inertization, biomedical waste management-categories and colour coding.

Unit-V

Killer Communicable Diseases in India: Tuberculosis-problem statement-world and India, natural history of tuberculosis-agent, host and social Factors, tuberculin test, mantoux test, mode of transmission, incubation period, control of tuberculosis-case finding, collection of sputum samples, slide reporting, sputum culture, directly observed treatment short course(DOTS), chemotherapy, management of patients who interrupt treatment, childhood tuberculosis, BCG vaccination, chemoprophylaxis, rehabilitation, surveillance, role of hospitals, drug resistance-multidrug and extensively drug resistant tuberculosis, National tuberculosis programme, revised national tuberculosis programme,

STOP TB strategy, tuberculosis and HIV- epidemiological impact, diagnosis of tuberculosis in people with HIV, the future, HIV-problem statement-world and India, epidemiological features-agent and host factors, mode of transmission-sexual transmission, blood contact, mother to child transmission, incubation period, clinical manifestations, diagnosis of AIDS-Clinical diagnosis, laboratory diagnosis-western blot, ELISA, control of AIDS-prevention, antiretroviral treatment, post exposure prophylaxis, specific prophylaxis, primary health care, National AIDS control programme.

REFERENCES

1. Principles and Practice of Medicine-(Davidson's), Colledge, N. R., Walker, B. R., and Ralston, S. H (Eds.), 21st Edition, Churchill Livingstone Elsevier, UK, 2010.
2. Parks Textbook of Preventive and Social Medicine, Park, K (Ed.), 19th Edition, M/S Banarasidas Bhanot, Jabalpur, India, 2007.
3. Ananthanarayan and Paniker's Textbook of Microbiology, Panikar, C. K. J (Ed.), 7th Edition, Orient Longman Private Ltd, Chennai, India, 2005.

3. REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM(GIS)

UNIT I:

REMOTE SENSING: Concepts and Fundamentals of Remote Sensing. Energy – Sources, Radiation, Interaction with Atmosphere and Earth Surface. Data Acquisition, Interpretation and Reference Data. Sensors, Radar Development and Side Looking Radar System. Remote Sensing Data Sources and Periodicals.

UNIT II:

IMAGE PROCESSING: Image, Rectification, Restoration, Enhancement and Manipulation Technics. Digital Image Classification (Supervised and Unsupervised). Post Classification – Smoothing – Hardware and Software for Image Processing.

UNIT III:

GEOGRAPHIC INFORMATION SYSTEM: GIS – Introduction – Defition – Terminology – Essential Components and Fundamental Operations of GIS. Data Structure – Data Management – Data Manipulation and Analysis. Mapping Concept and Projection Sytem.

UNIT IV:

DATA ANALYSIS AND SPATIAL MODELLING: Database definition, data retrieval, Map overlay operations, Cartographic modelling – using natural language commands. Linking command sequences into cartographic models. Advantages and Disadvantages; Errors, classification – Multivariate analysis and classification; Spatial Interpolation.

UNIT V:

ENVIRONMENTAL APPLICATION OF GIS: Land Resources, Municipal GIS, Water Resources and Hazardous Management. Global Positioning System (GPS).

REFERENCE:

1. Remote Sensing and Image Interpretation, IV Ed, Thomas M Lillesand and Ralf W.Kiefer, John Wiley Sons, New York.
2. Introduction to Geographic Information Systems, Kang-tsung Chang, (2002) Tata McGraw Hill Publishing Company Limited, New Delhi.
3. Principles of Geographic Information Systems, Nitin Kumar Tripathi,
4. Geographic Information Systems, Jeffery Star, (1990)John Estes Prentice Hall
5. Fundamentals of Geographic Information Systems, Demers, (1995)
6. Remote Sensing Principles and Interpretation, III Ed, Floyd F Sabins, W.H.Freeman and Company, New York.
7. Introductory Remote Sensing: Digital Image Processing and Applications, Paul J Gibson and Clare H Power, (2000) Routledge Publishers, London.
8. Remote Sensing and its Applications, Narayan,L.R.A, (1999) United Press, Hyderabad.
9. Principles of Geographical Information System for Land Resources Assessment, Burrough,P.A, (1986) Oxford Science Publications.

4. ENVIRONMENTAL MUTAGENESIS

UNIT I

General Principles of Mutagenicity, Testing and Regulatory Control of Environmental Chemicals. Monitoring of Chemical Mutagens in the environment – genetic effects of environmental agents. Mutations – spontaneous and induced somatic and Germ Cell Mutations and their significance. Molecular basis of mutations induced by physical and chemical agents.

UNIT II

Methods of evaluation of mutagens – microbial test procedures to detect mutagens (*Salmonella*, *Neurospora* and Yeast). *Drosophila* – various assay procedures to determine genotoxicity. Mammalian system – Mice – Micronucleus test, dominant lethal test. Sperm abnormality assay, chromosomal aberrations in Meiotic cells. Mammalian cell cultures – lymphocytes, fibroblast, CHO cells. Sisterchromatid exchanges and chromosomal aberrations a comparison. The need for both *in vitro* and *in vivo* systems in mutagenicity screening. Site directed mutagenesis. DNA amplification and applications.

UNIT III

Biochemical approaches to detect gene mutations in human population – approaches for detecting germinal mutations. Biochemical markers – their use in assessing risk for genotoxic exposures. Interrelationship between mutagenesis, carcinogenesis and teratogenesis.

UNIT IV

Repair of DNA damage – importance and methods, Antimutagens – modification of the process of mutagenesis: Mutagenesis and plasmids – mechanism of plasmid mediated effects of mutagenesis.

UNIT V

Epidemiological approach to evaluate genetic hazards: Occupational Epidemiology and Reproduction – Monitoring for genetic disease in the new born: Transplacental genotoxic agents – Methods for their detection.

REFERENCE:

01. Genetic Damage in Man, Caused by Environmental Agents. Berg.K (1979) Academic Press.
 02. Principles of Genetic Toxicology. Brusick.D (1980), Plenum Press.
 03. Evaluation of Mutagenic and Carcinogenic Potential of Environmental Agents. (1982). Environmental Mutagen Society of India, Bombay.
 04. Chemical Mutagens – Principles and Methods for their Detection. Hollaender. A, and Serres.F.J., Volume 1-10, Plenum Press.
 05. Cytogenetic Assays of Environmental Agents. Hsu, T.C (1982) , Oxford and IBH, New Delhi.
 06. Handbook of Mutagenicity Test Procedures. Kilbey, B.J., Lehgator,M., Nichols, W and Ramel, C (1984) Elsevier.
 07. Carcinogens and Mutagens in Environment. Stich,H.F.(1982) CRC Press Inc.
 - 08.Environmental Mutagens and Carcinogens. Sugimura,T., Kondo, S and Takebe,H (1982) , Alan, R., Liss Inc.,
 - 09.Chemical Mutagenesis in Mammals and Man. Voge, F and Rohroborn, G (1970), Springer – Verlag, Berlin.
 - 10.Mutagenic Effects of Environmental Contaminants. Sutton, H.E., Bareis, M.I, Academic Press.
 11. Comparative Chemical Mutagenesis. Deserres, F.J., and Shelbu, M.D., (1981), Plenum Press.
 12. Environmental Health Criteria No.27 and 47. I.P.C.S, (1985) Published by WHO
-

5. WATER POLLUTION AND MANAGEMENT

UNIT I

Water quality standards – sampling, preservation techniques for water and waste water, Basic Principles and their significance with special reference to colour, turbidity alkalinity, acidity, chemical coagulation, hardness, water softening, BOD, COD, Nitrogen, Phosphate and Sulphate.

UNIT II

Source and classification of water pollution – water pollution: Organic, inorganic, sediments, radionuclides and heavy metals, biochemical effects of Arsenic, Cadmium, Lead, Chromium, Nickel, Mercury, Selenium, Cyanides and Pesticides.

UNIT III

Pre Primary methods of waste water treatment: Screening and communiting: flow equalization – coagulation – sedimentation – floatation, Granular medium filtration. Basic principles of biological treatment kinetics of biological growth – suspended culture system – sludge characteristics – sludge thickening, sludge digestion and disposal.

UNIT IV

Advance treatment methods - Removal of nitrogen, phosphate, Removal of dissolved inorganic by oxidation and adsorption. Removal of dissolved inorganic and heavy metals by adsorption, chemical precipitation, electro dialysis, and ion exchange and reverse osmosis. Removal of phenols. Flow diagram for sewage and industrial wastewater treatment.

UNIT V

Wastewater reuse and disinfection process: Need for Water reuse- Public health and environmental issues in water reuse – Risk assessment for water reuse – issues involved with storage of reclaimed water – Planning for waste water reclamation. Waste water disinfection – disinfectants – disinfection methods – mechanism – Factors influencing the action of disinfectants – chlorine – chlorine demand – ozone – other chemical disinfectants – UV radiation – Byproduct formation - Environmental impacts.

REFERENCE:

01. Chemistry of Environmental Engineerig. Sawyer,C.N and Mc Carty,F.C (1978),
Mc Graw - Hill.
02. Aquatic Chemistry. W.Sium and Morgan,J.J., (1972). Wiley Interscience.
3. Standard Methods for the Examination of Water and Waste Water. APHA, New York (1968).

4. Basic Environmental Toxicology. Nathanson, A (1984). John Wiley and Son. Inc. New York.
 05. Environmental Engineering. Aveavy et al. (1983). Mc Graw Hill, New York.
 06. Water Pollution Management. Varsheney, K.V (1982). Wiley Eastern.
 7. Environmental Chemistry. Stanley E Mohan (1984). Books/Cole Pub.Co., California.
 08. Environmental Chemistry. A. De (1987). Winston Publishing Ltd., New Delhi.
 9. Pollution Control in Process Industries. Mahajan,S.P (1985). Tata Mc Graw Hill, New Delhi.
 10. Waste Water Engineering, Treatment and Disposal. Met Calf & Eddy Inc. (1987). Mc Graw Hill.
 11. Waste Water Engineering, Treatment and Reuse. George Tchobanoglous, Franklin L Burton and H.David Stensel (2003), Tata McGraw - Hill Publishing Co Ltd., New Delhi.
-

6. ECOTOXICOLOGY AND RISK ASSESSMENT

UNIT I

Introduction and Scope of Toxicology: History – Disciplines of toxicology, Importance and significance. General classification of environmental contaminants – air, water and soil. Common Terminologies; Contaminant, Pollutant, Risk, Cumulative and Additive toxicity. Synergism, Antagonism, Fate, Half-life, Depuration. Metabolites, Threshold concentration. Dose, Response, Acute, Chronic, Lethal Dose and Lethal Concentration.

UNIT II:

Factors Affecting Toxicity of Environmental Contaminant: Dose – response relationship, curves, routes of exposure – physical and chemical factors.

Study of Specific Environmental Contaminants: Heavy metals – Pesticides – organochlorine, Organophosphate and Carbamates . PAH, PCBs, PBDEs, PBDFs, Dioxins and Furans. Classification, source, routes of exposure, effects and fate with special reference to fish and birds.

UNIT III:

Toxicity Mechanism and Detoxification: Biotransformation of contaminants – conjugation and hydrolysis, transformation reactions. Translocation of contaminants- absorption, distribution and excretion. Detoxification mechanisms – Metallothionein, Glutathione, MFO.

UNIT IV:

Bioconcentration, Bioaccumulation and Biomagnification of Toxicants, Biomarkers and Bioindicators – Terminology, Criteria and Processes.

UNIT V:

Hazard and safety evaluation: Usage pattern, Environmental and health effects, Decision making, Monitoring, Surveillance and follow-up. Restrictions on use. Teratogenicity, Carcinogenicity, Genotoxicity and Mutagenicity. Environmental guidelines – FAO/WHO, ISI for aquatic wildlife toxicology.

REFERENCE:

1. Fundamentals of Aquatic Toxicology. Rand G M (1995) Taylor and Francis, London.
 2. Ecotoxicology – Ecological Fundamentals; Chemicals exposure and Biological Effects. (1998) Gerrit Schuurmann and Bernd Markert – Wiley, New York.
 3. Behavioural Ecotoxicology. (1994) Dioacomo Dell’Omo – John Wiley and Sons, U.K
 4. Handbook of Ecotoxicology. (1994) Peter Calow – Blackwell Scientific Publications, London.
 5. Experimental Toxicology - The Basic Principles. (1990) – Edited by Diana Anderson and DM Conning – The Royal Society of Chemistry, Cambridge.
 6. Bio markers for Agrochemicals and Toxic substances - Applications and Risk Assessment. (1996) – Jerry N Blancalo, Robert N Brown, Curtis C Dary and Mahmoud Abbas Saleh – American Chemical Society, Washington.
 7. Wildlife Toxicology , Tony J Peterle, (1991) Van Nostrand Reinhold, New York.
 8. Handbook of Toxicology – Edited by David J Hoffman, Barnettt A Rattner, G Alien Burton Jr, and Hohn Cairns Jr. (2003) Lewis Publishers, Boca Raton.
-

7 . OXIDATION TECHNIQUES FOR WATER MANAGEMENT

UNIT I

Fundamental aspects of Ozone – Chemistry – Molecular Ozone Reactivity – Decomposition of Ozone- Oxidation of Synthetic Organic Chemicals – Reactions with Aquatic Humic Substances - Toxicity – Principles and Limitations of Toxicological Testing – Short-Term Bioassay for Carcinogenic/Mutagenic By-products - Theoretical aspects of Ozone Analysis – Interferences affecting Dissolved Ozone Measurements – Ozone Measurements in the Aqueous Phase (Ozone Residual) – Gas-phase Measurements - Ozone Generation – By Corona Discharge – Alternative Methods - Ozone Gas Transfer – Solubility of Ozone in Water – Contacting of Ozone with water.

UNIT II

Engineering Aspects – Treatability Studies – Feed Gas Preparation – Ozone Generation – Design of Contact Chamber and Diffusion Systems – Instrumentation and Control Systems – Ozone Destruction Systems – Corrosion considerations and Ozone Resistant Materials – Performance Evaluation.

UNIT III

Advanced Oxidation Process; Ultra-Violet Radiation, Hydrogen Peroxide – Titanium Oxides - Photo catalysis - Chlorination – Analysis of the products by UV-Visible Spectroscopy, FTIR, AAS, HPLC, GC-MS – Mechanisms of Mineralization.

UNIT IV

Fundamentals of Electrochemistry; Basic concepts - Galvanic Cells - Standard Potentials - The Nernst Equation - Reference Electrodes - Indicator Electrodes - Ion selective Electrodes - Polarography in Chemical Analysis - Cyclic Voltammetry.

UNIT V

Electrochemical Techniques; Types of Electrodes, Preparation of Electrodes - Electro Oxidation – Titanium Electrodes – Graphite Electrodes – Triple Oxide coated Electrodes – Boron Doped Diamond Electrodes – Evolution of chlorine, oxygen and ozone during electrolysis, Mechanisms of oxidation of organic compounds by chlrorine, oxygen and ozone. Electro Coagulation – Iron Electrodes – Aluminum Electrodes – Kinetics and Mechanisms of the Reactions.

REFERENCE :

1. Ozone in Water Treatment Application and Engineering. Bruno Langlias, D.A. Reckhow and D.R. Brink, (1997) Lewis Publishers, USA.
2. Ozone and its Reactions with Organic Compounds. S.D. Razumovskii and G.E. Zaikov,(1984) Elsevier science publishers, The Netherlands.
3. Quantitative Chemical Analysis. Daniel C. Harris, W.H. (1995) Freeman and Company, New York.
4. Handbook of Analytical Instruments. R.S. Khandpur, (2000) Tata McGraw-Hill Publishing Company Limited, New Delhi.

8. ENVIRONMENTAL MICROBIOLOGY AND BIOREMEDIATION

UNIT I

Structure, Function and Classification of bacteria, fungi, and virus. Distribution and composition of microorganisms in soil, water and air. Nutrition of bacteria, Influence of environmental factors on the growth and activity of bacteria – Microbial interactions with plants, animals – Beneficial and pathogenic microbes.

UNIT II

Microbial enzymes – uses enzyme immobilization techniques – Microbial toxins – Microbial antibiotics – Biofertilizers – Biopesticides – Significance of Bioindicator – Faecal indicator bacteria – Sewage and drinking water treatment – process and steps – Water borne diseases, detection and control – Spoilage of vegetables, dairy products and meat, control of spoilage.

UNIT III

Bacterial genome, Arrangement of genes on the chromosomes, Mutations, Mutagens, Isolation of mutants - Bacterial transformation - Conjugation, transduction – Plasmids - Recombinant DNA technology, Genetically Engineered Microorganisms – Drug resistance.

UNIT IV

Principles of bioremediation – Bioremediation techniques – Factors affecting bioremediation - Bioremediation of pesticide and organic contaminant in soil and water – Microbially induced corrosion – Biofouling – Microbes in mineral recovery – Microbial site characterization – Biodegradation potential of microbes – Bioprocess design and optimization.

UNIT V

Aerobic bioremediation – Bioremediation of surface soil – biodegradation in soil ecosystems – Bioreactors – *in situ* bioremediation – Biostimulation – Bioaugmentation – Bioventing – Bioremediation in fresh water and marine ecosystems – Bench scale and Pilot studies – *in situ* bioreactor treatment of sediments and sludge – Anaerobic bioremediation – Factors influencing aerobic and anaerobic bio remediation.

REFERENCE :

1. Microbiology – An Introduction. 6th ed., Tortora, G. J., Funke, B.R and Case, C.E (1998). Addition Wesley Longman. Inc.
2. Techniques in Microbial Ecology. Burlage, R.S., R. Atlas, D. Stahl, G. Geesey and G. Sayler, (1998). Oxford University Press.
3. Biology of Microorganisms. 6th ed., VII Ed., Brock, T.D. and Madigan, M. T Martinko, J.M and Parker, J (1994), Prentice Hall, New Jersey.

4. Bioremediation. Baker, K.H. and Herson, D.S., (1994) Mc Graw Hill Inc.
5. Bioremediation–Principles. Eweis, J.B., Ergas,S.J, Change, D.P.Y and Schroeder, E.D (1998) Mc Graw Hill Inc.
6. Microbial Degradation of Xenobiotics and Recalcitrant Compounds. Leisinger,T., Cook, A.M Hutter, R and Nuesch,J (1981) Academic Press, London.

9. SYSTEMATICS, BIODIVERSITY AND AQUATIC ECOLOGY

Unit I: Fish Habitat

Aquatic habitat inventory: Stream order – Classification, Habitat profile Habitat structure – Macro habitat - micro habitat – Substrate type – Habitat type – Velocity – Instream cover, Riparian Profile: Riparian zone, bank vegetation, land use, agricultural practices - forestry operations,

Unit II: Ecology and Biology of Fishes

Ecology: Fish profile – Type, size, community structure, Distribution – Distribution of fishes – distribution pattern - endemism – Habitat preference – Food and feeding ecology, breeding ecology

Unit III: Systematics and Evolution

Biogeography of Indian fresh water Fishes, Taxonomy - Collection – preservation – identification – cataloging, Classification of fishes – World classification – Indian Classification, Evolution and phylogeny of fishes.

Unit IV: Fish Genetics

Genetic Variations: Morphological, Genetic variation in natural Population Fish genomics –Gene mapping –Physical maps –Genetic maps –Genetic distance - Basics of DNA finger printing –Molecular markers – RFLP, RAPD-AFLP- Fish phylogeny using molecular data - Profiling methods in fisheries science-*Danio rerio* - Model organism of genomic studies

Unit V: Fish conservation

Conservation: In situ conservation – ex situ conservation, Conservation status - IUCN, Habitat restoration - Managing Riparian Land – Stream bank Stability - Riparian Widths -Water Quality - In-Stream Life - Riparian Habitat for Wildlife - Managing Stock - Managing Woody Debris in Rivers - Planning for River Restoration - River Flows and Blue-green Algae.

References

1. Jhingran, A.G. (1983) Fish and Fisheries of India. Hindustan Publishing Corporation, India, New Delhi, 727 pp.
2. John Liu (2007) Aquaculture Genome Technologies. Blackwell Publishing Ltd, Australia 528 pp.
3. Odd- Ivar Lekang (2007) Aquaculture Engineering. Blackwell Publishing Ltd, Australia, 352 pp.
4. Beaumont, A. R., K. Hoare (2003) Biotechnology and Genetics in Fisheries and Aquaculture. Blackwell Publishing Ltd, Australia, 157pp
5. Rehm,H.(2006) Protein Biochemistry and Proteomics, AcademicPress,MA,USA,236 pp.
6. Andres Moja and Enrique Font (2004) Evolution from Molecules to Ecosystem, Oxford University Press, New Delhi, 333 pp.
7. Ray Wu, Grossman, L. Moldave, K., ed., (2006) Recombinant DNA Technology Methodology. Academic Press, MA, USA, 760 pp.
8. Ranga.M.M, Q.J.Shammi 2003, Fish Biotechnology. Agrobios,Jodhpur,India, 258pp.

10. BIORESOURCE TECHNOLOGY

Unit -I

Importance of Bioresources and Biodiversity: Focal components and problems. Biodiversity: Genetic diversity, species diversity and ecosystem diversity. Value of Bioresources: Direct and indirect values, ethical values. Agrobiodiversity: Biodiversity in farming. Natural and wild resources of economically/industrially important plants. Difference between crop plants and wild species. Biodiversity and food security. Plant species richness and diversity. Wetlands-importance, productivity, habitats, nutrient cycling. Ecologically relevant resource: Keystone species, pollinators, natural predators.

Unit-II

Threats to Bioresources: Habitat loss and fragmentation, disturbance and pollution. Introduction to exotic species. IUCN categorized endangered, threatened and vulnerable species. Biodiversity hot spots – Eastern, Western Ghats, Himalayas. Biodiversity in tropical region. Global environmental changes. Red data book and related documentation. Biodiversity Bill Act 2002. Intellectual property rights and bioresources. Bioresources genetically modified organisms-promise and danger. Emerging avenues and careers in the field of biodiversity, Bioresources and Biotechnology.

Unit-III

Conservation Strategies: Conservation: Ecological and evolutionary perspective. Conservation of biodiversity. Conservation and sustainable use of Bioresources – In-situ, Ex-situ, seed bank, tissue culture repositories, centers of diversity of crop plants. Bioresources conservation through genetic resources and biological approaches. Conservation of cultivated plants: Static conservation, Germplasm collections. Conservation of biodiversity in Indian scenario and future strategies. Energy sources: conventional and non-conventional energy sources. Conservation and management of non-renewable resources and renewable resources, Biofuel crops -Introduction, bioresources and bioenergy prospectus.

Unit -IV

Biomolecules of Edible Plant Sources: Sources and functional properties of nutrient molecules – Carbohydrates, proteins, lipids, vitamins and minerals. Antinutritional factors: Enzyme inhibitors, lectins, saponins, tannins, phytate, cyanogenic glucosides/cyanogens, toxic non-protein amino acids, glucosinolates, antivitamin, allergens, oxalic acid, gossypol, nitrate and nitrite.

Unit- V

Plant Bioresources and Utility Prospectus: Introduction to underutilized and new crops: legumes, grains, fruits and vegetables; processing, preservation and products; Biofunctional and health effects of functional ingredients: Resistant starch, Dietary fiber, Natural food antioxidants in vegetables, grains, fruits, non-alcoholic beverages. Probiotics and prebiotics. Nutraceuticals: Historical and technological aspects, sources and potentiality in health and disease prevention. Role of natural and synthetic bioactive molecules. Climate changes and food security-Global perspectives.

References :

1. Bioresources and Gene pool Conservation (2004). M. P. Singh and S. Dey, Daya Publishing House, New Delhi.
2. Conservation of Biodiversity and Natural Resources (2004). M. P. Singh, B. S. Singh and S. Dey, Daya Publishing House, New Delhi.
3. The Conservation of Plant Biodiversity (1998). O. H. Frankel, A. H. D. Brown and J. J. Burdon, Cambridge University Press, UK.
4. A Handbook of Bioenergy Crops (2008). V.N. M. Devi, G. S. Vijaylakshmi and P. N. Prasad, Agrobios, Jodhpur, India.
5. Biofuels for Transport-Global Potential and Implications for sustainable energy and Agriculture (2008). Ethscan, World Watch Institute, VA, USA.
6. Bio-Fuel Plants: Cultivation Practices & Seed Bank (2007). S. K. Mehla, Pointer Publishers, Jaipur, India.
7. Foods -Facts and Principles (2005). S. Manay and M. Shdaksharaswamy, IInd Edition. New Age International Pvt Ltd, New Delhi, India.
8. Handbook of Nutraceuticals and Functional Foods (2006). R.E.C. Wildman (Ed.), CRC Press, Florida, USA.
9. Prebiotics in Food Safety and Human Health (2005). I. Goktepe, V. K. Juneia and Mohamed Ahmedna (Eds.), CRC Press, Florida, USA.
10. Functional Foods and Biotechnology (2006). K. Shetty, G. Paliyath, A. Pometto and R.E. Levin (Eds.), CRC Press, Florida, USA.
11. Toxic constituents of Plant Foodstuffs (1980). I. E. Liener, IInd Edition. Academic Press, New York, USA.
12. Toxic substance in crop plants (1991). J. P. F. DMello, C. M. Duffs and J. H. Duffs (Eds.), Royal Society of Chemistry, USA.
13. Plant non protein Amino and Imino Acids – Biological, biochemical and toxicological properties (1982). G. A. Rosenthal, Academic Press, New York, USA.
14. Food antioxidants – Technological, Toxicological and Health Perspectives (1996). D. L. Madhavi, S. S. Deshpande and D. K. Salunkhe (Eds). Marcel Dekker, Inc., New York, USA.
15. Post Harvest Biotechnology of food legumes (1985). D. K. Salunkhe, S. S. Kadam and J. K. Chavan, CRC Press, Florida, USA.
16. Food and feed from legumes and oil seeds (1996). E. Nwokolo and J. Smartt (Eds.), Chapman and Hall, London, UK.

11. ENVIRONMENTAL ECOLOGY

UNIT I

Concepts in Ecology

Ecology-Definition, Scope and History of Ecology, Fundamental Concepts, Conservation Ethics, Gaia Hypothesis, Ecological Footprint, Environment-Elements of Environment, Interaction of Environmental Elements, Natural Resources-Forest, Water, Mineral, Food, Energy, Ecosystems- Major Types, Structure, Function, Ecological Succession.

UNIT II

Biodiversity and Conservation

Levels of Biodiversity, Habitat, Niche, Biome, Biogeography, Global and National level Biodiversity, Mega-diversity Nation, Hotspots of Biodiversity, Species Diversity, Density, Mortality, Age Distribution, Population Dispersal, Threats and Conservation of Biodiversity, Human Animal Conflicts.

UNIT III

Environmental Factors and Species Interactions

Concept of Limiting Factors, Law of Minimum, Law of Tolerance, Physical Environment as Limiting Factor, Temperature, Rainfall, Light, Radiation, Humidity, Fire, Atmospheric Gases, Edaphic Factors, Biotic Environmental Factors, Species Interactions, Prey-Predation Relations, Insect Plant Interactions, Defensive Ecology.

UNIT IV

Ecological Sampling Methods and Statistical Analysis

Plot Sampling, Transect Sampling, Point-Quarter Sampling, Terrestrial Invertebrate Sampling, Capture-Recapture Sampling, Terrestrial Vertebrate Sampling, Diversity Index, Frequency, Species-Area Curve, Poisson Distribution.

UNIT V

Global Environmental Problems

Global Warming, Greenhouse Effect, Greenhouse Gases, Effects of Global Warming, Global Climate Change, IPCC, Carbon Sequestration, Carbon Sinks, Ocean Acidification, Ozone Depletion, Deforestation and Loss of Biodiversity, Over Exploitation, Brownfield, Soil Erosion, Water Crisis, Spread of New Diseases, Conservation Medicine.

REFERENCES

01. Essentials of Ecology and Environmental Science, Rana, S.V.S. (2005), 2nd Edition, Prentice Hall of India, New Delhi.
02. Field and Laboratory Methods for General Ecology, Brower, J., Zar, J. and von Ende, C. (1990), 3rd Edition, Wm. C. Brown Publishers, Dubuque, IA, USA.
03. Perspectives in Environmental Studies, Kaushik, A. and Kaushik C.P. (2014), 4th Edition, New Age International Publishers, New Delhi.
04. Environmental Biology, Sharma, P.D. (1999), 2nd Edition, National Press, Meerut.
05. Research methods for the biosciences, Holmes, D., Moody, P. and Dine, D. (2006), Oxford University Press, New York.

12. ENVIRONMENTAL PHYTOTECNOLOGY

UNIT I

Soil pollution; chemical and bacteriological sampling and analysis of soil quality, Organic Pollutants and Inorganic Pollutants: Sources and on terrestrial and aquatic environments – Soil quality parameters; industrial waste, effluents and heavy metals and their interactions with soil components; site remediation techniques – physical, chemical and biological methods.

UNIT II

Ecorestoration principles and approaches, rehabilitation of salt-affected and water-logged lands, Riparian zone restoration, Phytoremediation, Decontamination of industrially polluted sites by rhizofiltration, phytoextraction, phytostabilisation and phytotransformation; ecorestoration of mined areas, Mechanism of phytoremediation, Factors influencing Phytoremediation, Uptake and Translocation, Enzymatic Transformation, translocation factor (TF), bioconcentration factor (BCF); Future of Phytoremediation. Transgenic plants for phytoremediation, Green belts

UNIT III

Microbial association with plants - Phyllosphere, Rhizosphere, endosphere, Mycorrhizae, nitrogen fixing organism – Beneficial and harmful interactions – phosphate solubilizers – siderophore producers, Plant growth promoting bacteria - Biology of nitrogen fixation – The Rhizosphere Ecology. Analysis of plant associated microbial diversity; Selective plating, Direct viable counts, Community physiological profiling, FAME, G+C content analysis, DNA Microarrays, DGGE, T-RFLP, Pyrosequencing

UNIT IV

Abiotic stress tolerance in plants- role of Phytochelatins, metallothioneins, polyamines, and amino acids. Plant and microbe interaction in polluted environment; Microbe assisted phytoremediation; Microbial mediated environmental stress tolerance in plants; heavy metals, drought, temperature, salinity stress in plants.

UNIT V

Macrophyte based waste- water treatment systems, Algal effluent treatment systems and their limitations, General Character of Wetlands, Technology description – history and applications, Introduction to ecology and wetland water quality processes, Pollutant reduction performance overview. Reed bed technology.

REFERENCES

1. Phyto: Principles and Resources for Site Remediation and Landscape Design, Kate Kennen & Niall Kirkwood (2015)
2. Phytoremediation: Transformation and Control of Contaminants, Steven C. McCutcheon & Jerald L. Schnoor (2003)
3. “Ecological Engineering - An Introduction to Ecotechnology”, Mitsch, J.W. and Jorgensen, S.E., John Wiley & Sons, New York. 2009.

4. D.T. Tsao. (2003) *Phytoremediation (Advances in Biochemical Engineering Biotechnology)*. 151 edition, Springer
5. Todd A. Anderson. (1994) *Bioremediation through Rhizosphere Technology*. 15t edition, An American Chemical Society Publication
6. Mackova, Martina; Dowling, David; Macek, Tomas. (2006) *Phytoremediation and Rhizoremediation*. Springer
7. *Microbial diversity, Form and Function in Prokaryotes* ; OladeleOgunseitan, Blackwell publishing, 350 Main Street, Malden, MA 02148-5020, USA
8. *Phytoremediation: Role of Aquatic Plants in Environmental Clean-Up*: Dhir, Bhupinder; Springer