



**DEPARTMENT OF PG STUDIES & RESEARCH IN
ENVIRONMENTAL SCIENCE**

Biosciences Complex, Jnana Sahyadri, Shankaraghatta 577 451

**Ph.D. Course work in Environmental Science
Syllabus & Model question paper**

March 2020

Ph. D course structure and scheme

Course and Title	Contact hrs/week	Credits	Maximum marks		Total marks	Examination Hrs
			Continuous assessment	Course end examination		
Course-I: Research & Publication Ethics and Research Methodology	4	4	25	75	100	3
Course-II: Cognate Subject- Environmental Science	4	4	25	75	100	3
Course – III: Field of Specialization	4	4	25	75	100	3
Comprehensive Viva-voce Examinaiton	-	2	-	50	50	-
Total	12	14	75	275	350	-

Note: Paper I and II are common to all research students; Paper III is the field of specialization

Details of Paper III

Name of the guide	Field of Specialization
Prof. S. V. Krishnamurthy	Ecotoxicology
Prof. J. Narayana	Environmental pollution and health hazards
Dr. Yogendra, K	Environmental Chemistry and Pollution
Dr. Hina Kousar	Environmental Pollution, Biotechnology, Bio and Phytoremediation
Dr. S. H. Basavarajappa	Water Pollution, Wastewater Treatment & Techniques
Dr. Nagaraj parisara*	Biodiversity and Natural Resource Conservation

* Sahyadri Science College, Shimoga

Syllabus – Ph.D Course work in Environmental Science

Paper-I: RESEARCH & PUBLICATION ETHICS AND RESEARCH METHODOLOGY — 48 hrs (Compulsory for all Ph.D students)

(Instructors: Dr. S. V. Krishnamurthy, Dr. J. Narayana, Dr. Yogendra, K. Dr. Hina Kouser,
Dr. S. H. Basavarajappa)

PART-A: RESEARCH & PUBLICATION ETHICS

- Unit-1: **PHILOSOPHY AND ETHICS:** Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and reactions. - 3 hrs
- Unit -2: **SCIENTIFIC CONDUCT:** Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data. - 5 hrs
- Unit -3: **PUBLICATION ETHICS:** Definition, introduction and importance; Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behavior and *vice versa*, types; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals - 7 hrs
- Unit- 4: **PRACTICAL COMPONENTS: 1. OPEN ACCESS PUBLISHING-** Open access publications and initiatives; SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU; Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. **2. PUBLICATION MISCONDUCT** -Group Discussions -Subject specific ethical issues, FFP, authorship; Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad; **SOFTWARE TOOLS** -Use of plagiarism software like Turnitin, Urkund and other open source software tools. **3. DATABASES AND RESEARCH METRICS-** Databases Indexing data bases; Citation databases: Web of Science, Scopus, etc. **RESEARCH METRICS:** Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics - 15 hrs

PART- B: RESEARCH METHODOLOGY

- Unit 5: **RESEARCH** – Definition, Importance and Meaning of research, Types of Research, Characteristics of research, Steps in research, Identification, Selection and formulation of research problem, Research questions, Research design, Formulation of Hypothesis,

Review of Literature. Sampling- Sampling theory, techniques, types of sampling, sample size, sampling steps, Errors- sampling and non-sampling. Merits and limitations of sampling. General methods of sampling Components of air, water, soil and biological/ecological materials. - 9 hrs

Unit – 6: **DATA AND DATA ANALYSIS IN RESEARCH**, primary and secondary data, processing and presentation of data, Relevance, limitations and cautions. Statistics in Research –Descriptive statistical tests, Measure of Central tendency, Dispersion, Skewness and Kurtosis. Hypothesis and Hypothesis testing, Standard Error, parametric and non-parametric tests. Applications of Chi-Square Test, ANOVAs, and ‘t’ test. Graphical Presentation of data - 9 hrs

References and Suggested Readings:

1. Charls, J. Krebs (1999). Ecological Methodology, 2nd Ed. Addison Wesley Longman, N.Y.
2. Clouthier, S. G. (2003) Plagiarism erodes scientific integrity. Science, 301 (5631), 311-312.
3. Ford, E. D (2006). Scientific methods for Ecological Research. Cambridge Univ. Press. Pp 564
4. George D. G and J. A. Swan. (1990). The Science of Scientific Writing, American Scientist, 78: 550-558.
5. GORE Surveys handbooks – Sampling Air, Soil, and Water. W L Gore and Associates, USA.
6. Hexham, I (2005). Academic Plagiarism Defined. Academic Press, NY
7. Janice M. Mueller (2006). Introduction to patent Law. Amazon Book Company
8. McJohn (2006). Copyright-Examples and expansions.
9. Patton, Michael Quinn. (1987). How to Use Qualitative Methods in Evaluation. Thousand Oaks, CA: Sage.
10. Hoshmand, R. A (2006). Design of Experiments for Agriculture and the Natural Sciences, CRC Press.
11. Snedecor, W and G. Cochran, 1967. Statistical Methods. Oxford and IBH Publishing Co. Calcutta
12. Tischeler, M.E.(2004) Scientific Writing Booklet, Arizona University Press.

Ph.D. in Environmental Science – **COURSE WORK**
Paper-II: Cognate Subject: ENVIRONMENTAL SCIENCES — 48 hrs
(Compulsory for all Ph.D Students)

(Instructors: Dr. S. V. Krishnamurthy, Dr. J. Narayana, Dr. Yogendra, K. Dr. Hina Kouser and Dr S.H. Basavarajappa)

Unit 1 Understanding our Environment: Objectives; Earth as a marvelous Planet; Need of Environmental Science. Modern Environmentalism; Global Concerns; Current Environmental Conditions; Causes of Environmental Degradation; Human Dimensions of Environmental Science. — 4 hrs

Unit 2 Principles of Ecology: Matter, Energy, and Life: Principles of Matter and Energy; Thermodynamics and Energy Transfers. The Building Blocks of Earth and Life; Atoms, Molecules, and Compounds, Chemical Reactions, Acids and Bases, Organic Compounds. Cells: The Fundamental Units of Life. The Miracle of Water - Sunlight: Energy for Life: Energy and Matter in the Environment; Food Chains, Food Webs, and Trophic Levels, Ecological Pyramids, Biogeochemical Cycles and Life Processes. Biogeochemical Cycles: Hydrologic Cycle, Carbon Cycle, Nitrogen Cycle, Phosphorus Cycle, Sulfur Cycle. — 8 hrs

Unit 3 Environmental Health and Toxicology: Objectives. Types of Environmental Health Hazards, Infectious Organisms, Morbidity and Quality of Life, Emergent Diseases and Environmental Change, Emerging Ecological Diseases, Antibiotic and Pesticide Resistance. Toxic Chemicals: Endocrine Hormone Disrupters. Movement, Distribution, and Fate of Toxins, Bioaccumulation and Biomagnification, Chemical Interactions. Measuring Toxicity, Animal Testing; Toxicity Ratings, Detection Limits, Risk Assessment and Acceptance — 8 hrs

Unit 4 Air: Climate and Pollution: The Atmosphere and Climate; Energy and the "Greenhouse Effect"; Convection and Atmospheric Pressure; Ocean Currents; Seasonal Winds and Monsoons; Climate Change. Human-Caused Global Climate Change; Climate Skeptics. Sources of Greenhouse Gases, Current Evidence of Climate Change; International Climate Negotiations. Controlling Greenhouse Emissions. Climate and Air Pollution- Major Kinds of Pollutants, Sources and Problems of major Pollutants, Indoor Air Pollution, Interactions Between Climate Processes and Air Pollution, Urban Climates. Effects of Air Pollution-Human Health, Air Pollution Control — 6 hrs

Unit 5 Water: Resources and Pollution: Water Resources - Major Water Compartments - Groundwater - Rivers, Lakes, and Wetlands -The Atmospheric water. Water Availability

and Use- Freshwater Shortages- Depleting Groundwater. Water Pollution: Point and Nonpoint Source Pollution, Biological Pollution, Infectious Agents, organic and Inorganic Pollutants. Sediment and Thermal Pollution. Groundwater Pollution. Ocean Pollution. Pollution Control; Nonpoint Sources and Land Management, Sewage Treatment-Remediation, Water Legislations. — 6 hrs

Unit 6. Energy: Energy Sources and Uses; Current Energy Sources, Per Capita Consumption. Fossil Fuels- Coal; Oil; Oil Shales and Tar Sands; Natural Gas. Nuclear Power -Nuclear Wastes. Solar Energy, Passive Solar Heat, Active Solar Heat, High-Temperature Solar Energy, Photovoltaic Energy, Transporting and Storing Electrical Energy, Promoting Renewable Energy, Fuel Cells. Biomass- Fuelwood Crisis, Dung and Methane as Fuels, Alcohol from Biomass. Energy from the Earth's Forces-Hydropower, Wind Energy, Geothermal, Tidal, and Wave Energy, Energy Conservation — 6 hrs

Chapter 7 Solid and Hazardous Waste: Garbage: The Science of Trash, Waste, Waste-Disposal Methods- Open Dumps; Ocean Dumping; Landfills; Exporting Waste, Incineration and Resource Recovery, Recycling, Composting, Energy from Waste. Reuse, Producing Less Waste. Hazardous and Toxic Wastes, Hazardous-Waste Disposal, Options for Hazardous-Waste Management, Investigating Our Environment Bioremediation — 6 hrs

Chapter 8 Sustainability and Human Development: Importance of Sustainable Development, Classical Economics, Neoclassical Economics, Ecological Economics, Scarcity and Limits to Growth. Cost-Benefit Analysis and Natural Resource Accounting. Accounting for Nonmonetary Resources. Green Business and Green Design-Design for the Environment. Investigating our Environment Urban Ecology. — 4 hrs

Suggested Reading:

1. Botkin D B and Keller E A. 2011. Environmental Science- Earth as a living Planet. John Wiley & Sons.
2. Masters, G. M. 2007. Introduction to Environmental Engineering and Science. Pearson Education
3. Miller, G. T and Spoolman, S. E. 2010. Environmental Science. Cengage learning, Tokyo
4. Spiro, T. G., Purvis-Roberts, K and Stigliani, W.M. 2017. Chemistry of the Environment. Viva Publisher. New Delhi
5. William P. Cunningham, 2004. Principles of Environmental Science. McGraw-Hill Higher Education,

Ph.D. in Environmental Science – COURSE WORK

Paper-III: Specialization: ECOTOXICOLOGY — 48 hrs

(Guide: Prof. S.V. Krishnamurthy)

Unit 1: Ecotoxicology: Introduction, Objectives and definitions; origins of ecotoxicology. Pollutants and foreign substances in ecosystem and environment of organisms. — 4 hrs

Unit 2: Basic Ecological Problems of Ecotoxicology: Levels of organization of biological system; Individuals, populations, biocoenoses, ecosystems; extrapolation from one level to another; structure and function. — 4 hrs

Unit 3: General Aspects of Fate and Effects of chemicals: Media and compartments-classification of environment by media and compartment—Ecosystem types: terrestrial, aquatic—functional classification from the point of chemicals. Entry pathways of chemicals. Exposure: Environmental fate, sinks – water: soil: sediment compartments: Bound residues of chemicals. Bioavailability: uptake-Effects: types of effects. Genetic variability of effects. — 6 hrs

Unit 4: Pesticides and Environmental Chemicals: Pesticides-definition, description and classification- classification based on target organism, active ingredients, formulations. Pesticide market and application quantities. Action of pesticides on biomolecule, organism and ecosystem. Other environmental chemicals: natural and foreign substances; hazardous and non hazardous. — 6 hrs

Unit 5: Measurement of hazard potential: Parameter characteristics-physico-chemical-fate parameters-effect parameter and toxicological parameters. Assessment and measurement end points used in ecotoxicology. Physico-chemical parameters- ionization, Henry's Law constant, vapour pressure, water solubility, soil/water partition coefficient, Octonol water coefficient, Oxidation rate, Direct photolysis rate, Aqueous photolysis reaction quantum yield, molar absorptivity, hydrolysis rate, biotransformation rate. Fate parameter-Persistence and mobility. Effect Parameters- Acute and chronic; mortality, sub lethal. Biological parameters at the level of individuals (toxicological parameters)- Direct damaging effect (key measurement effect in laboratory tests- eg. mortality, growth, reproduction, development, morphological effect, biochemical or physiological effect, behavioral change, teratology, mutagenicity, carcinogenicity). Statistical evaluation-Determination of LC or EC values. — 10 hrs

Unit 6. Parameters on bioaccumulation- biological parameters at system level, population biocoenoses level. Biomonitoring: reaction indicator, accumulation indicator, biomarkers and bioassay. — 6 hrs

Unit 7. Levels of investigations in ecotoxicology: Tiered test programme: Laboratory (individual & population), semi field (population and biocoenoses) and field (populations, biocoenoses and ecosystem). Extrapolation of test results- sources of ecological uncertainty. —6 hrs

Unit 8. Test methods for chemicals: On environmental fate-adsorption/desorption, degradation, metabolism. Semi field level test-model ecosystem segment (microcosm), ecosystem segment in the field (mesocosm). Field level- models and designs. Surveys, surveillance and monitoring systems. Consideration for field studies, extrapolations of result- spatio-temporal variability. — 6 hrs

References:

1. Rombke, J and Moltmann, JF. 2005. Applied ecotoxicology. Lewis Publishers, NY.
2. Newmann, MC and Clements W. H. 2007. Ecotoxicology – a Comprehensive treatment. CRC Press. London
3. Newmann, MC. 2009. Fundamentals of Ecotoxicology, CRC Press, NY
4. Jorgenson, E. 2010. Ecotoxicology. Elsevier.
5. Klaassen, C.D and Watkins III J.B. 2010. Essentials of Toxicology, 2nd Ed. McGraw Hill. New York.

Ph.D. in Environmental Science – COURSE WORK

Paper III: Specialization: ENVIRONMENTAL POLLUTION AND HEALTH HAZARDS—48 hrs

(Guide: Prof. J. Narayana)

Part – A Environmental Pollution

Unit-1: Introduction- Sources of Pollution, Point and Non-point sources. Industrial Pollution, Agriculture pollution. Prevention and Control. Impact of Industrial Pollution on Environment. Nature of Pollution; air, water, solid wastes, hazardous wastes. Environmental regulations on air & water. Disposal of solid and hazardous waste. 6 hrs

Unit- 2: Method of water pollution control- primary and secondary treatment, solids processing, Final disposal, tertiary methods. Solid and Hazardous waste disposal, sanitary land fills, Resource recovery, Hazardous waste treatment, Disposal, Bioremediation. 6 hrs

Unit-3: Pollution control in Iron and Steel plant, Cement and paper & pulp industry. Impact of Environment regulations. Environmental Quality, Cost benefit analysis. 6 hrs

Unit-4: Water treatment and Distribution: Introduction to treatment, Unit Processes- Preliminary screening, Storage, Aeration, Chemical pre-treatment, Coagulation, Sedimentation, Filtration, Disinfection, Fluoridation, Advanced water treatment, Sludge production and disposal. Water distribution 6 hrs

Unit-5: Drinking water contamination: Introduction, Problems arising from resources- Taste and odour, Iron and manganese, Nitrate, Organic compounds. 2 hrs

Unit-6: Nature of wastewater: Composition of wastewater, Sewage Collection, Industrial and agricultural wastewater, Introduction to wastewater treatment: Requirements of treatment, Basic unit processes-screens, Grit separation, Other preliminary processes, Storm water, Primary sedimentation (primary treatment), Biological (secondary) treatment, Secondary sedimentation, Tertiary treatment, sludge treatment, pre-treatment of industrial wastewaters. -6hrs

Part –II Occupational Health and Safety

Unit -7: Introduction to Occupational health in Industry; History of occupational health. Occupational diseases- Lung diseases, Lung function test, Industrial dermatitis, occupational Eye diseases, occupational cancer. Chemical hazards in industry. dangerous properties of chemicals, dust, fumes, mist, physical hazards Noise, vibration, Heat 'X' ray –UV & IR. Prevention and control measures. - 8 hrs

Unit-8 Industrial hygiene: Concept of threshold limit values, Harmful agents and their mode of entry into the body and effect. Workplace monitoring. Sampling of dust, vapours and gases. Noise measurement. Industrial hygiene control methods Dilution/ventilation. Personal hygiene and health awareness. 8 hrs

References:

1. Nicholas P.Cheremisinoff. Handbook of Pollution prevention practices.
2. Thomas E.Higgins- Pollution prevention hand book.
3. Lawrence K Wong. Handbook of Industrial and hazardous waste treatment.
4. European Environmental Agency. Research study on Environment and health.
5. National safety council – Chicago Fundamentals of Industrial hygiene.
6. Industrial Medicine – David F Tver.
7. Environment and Health Management Madelyn Giraffa.
8. ILO Encyclopedia on occupational health and safety.
9. Industrial toxicology. Cassert Doulls. USA.
10. Dan Peterson. Techniques of Safety Management.
11. Simonds and Grimaldi-Safety Management.
12. Dr.N.K. Tarafdar- Chemical Safety and occupational health.
13. W.Hammar-Occupational Safety Health and Environment Management.
14. Factories Act and Rules.
15. National Fire Protection Association USA. Handbook on Fire protection.
16. N.F. Gray, Water Technology-An introduction for environmental scientists and engineers, 2ndedn, Elsevier Science & Technology Books, Dublin, 2005.
17. NG Wun Jern, Industrial Wastewater Treatment, ICP, London, 2006.
18. John De Zuane, P.E. Handbook of drinking water quality, 2ndedn, John Willey & Sons, Inc.Newyark, 1997.
19. Kathleen Hartnett White, R. B. “Ralph” Marquez, Larry R. Soward, Glenn Shankle, A Guide to Freshwater Ecology, Texas Commission on Environmental Quality, 2005
20. Arcadio P. Sincero. Gregoria A. Sincero, Physical–Chemical Treatment of Water and Wastewater, IWA, Washington, 2002

Ph.D. in Environmental Science – **COURSE WORK**
Paper III: Specialization: ECOLOGY & SUSTAINABLE ENVIRONMENTAL
MANAGEMENT—48 hrs

(Guide: Prof. J. Narayana)

Unit- 1: Ecology: Definition, Scope, Structure and function of ecosystem. Types of ecosystem- Aquatic and terrestrial ecosystems.

Unit -2: Biodiversity: Definition, genetic, species, and landscape diversity. Values of biodiversity. Biodiversity hotspots; threats to biodiversity and biodiversity depletion, conservation of biodiversity. Role of biodiversity in ecosystem functioning.

Unit-3: Traditional knowledge and conservation: Traditional ecological knowledge (TEK)-definition, history. Conservation practices associated with traditional practices- sacred crone, sacred landscape, sacred species, TEK and sustainable development, human dimensions of biodiversity and sustainable development.

Unit -4: Sustainable environmental management: Sustainable agricultural, Organic waste and agricultural residue management-composting, types of composting, vermicomposting, organic agriculture, organic farming, soil nutrients and quality management. Bio-pesticides, traditional agro ecosystem-advantages and disadvantages.

Unit 5: Natural Resources: Soil, water and biological resources- classification, characteristics. Sustainable resource utilization. Resource management- Waste resource utilization techniques, palatalization, bio-pellets, bio-plate making, mulching, baling mulching materials and innovative skills for utilization of waste materials. Sustainable management of waste resources, Value analysis and cost effect of waste management.

Unit – 6: Waste Management: Definition, classification, waste as a resource. Domestic and industrial waste treatment. Components of domestic waste, industrial waste, small scale sewage and industrial waste treatment, large scale waste water treatment, land applications, sludge management.

References:

- 1) Deshubandu 2008, “Environmental Education for sustainable development, published by Indian environmental society.
- 2) Vishwanath, 2015, Environmental Engineering, Sapna book house publ.
- 3) J.L. Chopman and M.J. Reiss 1995, Ecology, Principles and application.
- 4) Ashok kumar 2012, Aquatic ecosystem practices prateeksha publication.
- 5) Aloke 2008, Environmental Science and Engineering Universal press India pvt ltd.

Ph.D. in Environmental Science – COURSE WORK

PAPER-III: Area of specialization: **ENVIRONMENTAL CHEMISTRY AND POLLUTION** —48Hrs.

(Guide: Dr. Yogendra, K)

Unit 1: Environmental pollutants; Chemistry and quantitative aspects of environmentally important cycles (C, N, O, P, S) in the context of the atmosphere, hydrosphere, and lithosphere pollution. Major environmental issues; acid rain, sewage treatment, ozone destruction, anthropogenic climate change, air pollution, and eutrophication. Pollutants of soil, water and air origin; Influence of Pollutants on environmental and human health; Human population pressures and pollution dynamics: Relationships between pollutant exposure and toxicity, and toxic response; Linkages to risk assessment of likelihood between pollutants and environmental diseases. Metals and Elements in the Environment: fate-persistence-transport and accumulation. Overview of types and sources of toxic metals in the environment, Essential metals and their potential for toxicity. -----12 Hrs.

Unit 2: Chemistry of environmental contaminants: Basic chemical parameters of relevance for persistence and transport of chemicals in the environment. Overview of chemicals reactions in relations to their physical- chemical characteristics (Eg: dyes, pesticides, heavy metals). -----8 Hrs.

Unit 3: Surface Chemistry: Introduction; treatment for environmental contamination, relevance of surface chemistry for contamination treatment; **Adsorption** – Physical and chemical adsorption. Colloids – Preparation and general properties. Catalysis: Homogeneous and heterogeneous, structure of catalyst. Photocatalysis. ----- 8 Hrs

Unit 4: Photochemistry: Principles of Photochemistry: properties of light: absorption of light: Semiconductors, photocatalysts and nanoparticles- applications in environmental science. ----8 Hrs

Unit 5: Test and Treatment, and analysis methods: Principles of the instrumental techniques –Colorimetry, TEM, SEM, ICP, XRF and XRD methods. Analysis of Factors/Cluster/Spatial Analysis and Dispersion Pattern ---12 Hrs

1. Environmental Chemistry, A.K. De, Fifth Edition, 2003, *New Age International Publishers, New Delhi*.
2. Environmental Chemistry, J.W. Moore and E.A. Moore, 1976, *Academic Press, Science*.

3. Instrumental Methods of Chemical Analysis, Dr. B. K. Sharma, *Krishna Prakashan*,
4. Environmental Chemistry, Samir K. Banerji, 2004, *PHI Learning Pvt. Ltd.*
5. A Text Book Of Environmental Chemistry & Pollution Control, S. S. Dara, *S. Chand & Company Limited*, 2006
6. Friis, Robert H. *Essentials of Environmental Health*. Jones and Bartlett, Inc., Sudbury, MA.

Ph.D. in Environmental Science – **COURSE WORK****PAPER-III: Area of specialization: ENVIRONMENTAL POLLUTION AND BIOTECHNOLOGY -48 hrs**

(Guide: Dr. Hina kousar)

Unit 1: Concept of environmental pollution; origin of pollution; classification and nature of environmental pollutants; major sources; impacts of environmental pollution at local, regional and global level. -4hrs

Unit 2: Air Pollution: Scales of air pollution problems, the philosophy of air pollution control; meteorology of air pollution; effects of air pollution on human health, welfare, vegetation, animals, materials and structure; ambient air pollutant analysis and measurement; bio indicators; aero microbiological studies. -6hrs

Unit 3: Water Pollution: Types, sources and classification of water pollution; basic process of water treatment, disposal and recycling; water pollution and risk analysis; water pollution in transboundary regions; risk identification, risk quantification, risk assessment of environmental water quality; analysis of water: surface water, ground water; water quality standards; bacteriological examination of water. -8hrs

Unit 4: Soil pollution: Types and sources; sampling methods; specifications for disposal of sewage & effluent on land for irrigation & ground water recharge; methodology of wastewater disposal on land; impact of usage of land due to solid waste disposal, both municipal & industrial solid wastes (fly ash from thermal power station, lime sludge from pulp & paper mills etc); disposal of hazardous solid waste (heavy metals, toxic organic compounds) on land & its impact on soil; deterioration of soil due to mining activities. Solid-waste Pollution: Types and sources; classification of solid-waste (Domestic, Industrial, Municipal, Hospital, Nuclear, Agriculture); transfer and transport; recycle, reuse, recovery; conversion of solid wastes energy / manure; disposal methods. -10 hrs

Unit 5: Thermal and radioactive pollution: Impact of thermal pollution on environment (air, water, soil); standards and control of thermal pollution. Case studies pertaining to thermal power plants. Sources of radioactivity in environment; distribution of manmade radioactive elements; fate and movement of radioactivity in environment; mechanism and biological effects of radiations; control of radioactive pollution. -8 hrs

Unit 6: Heavy metal pollution: Accumulation and concentration of heavy metals; biosorption; microbial interactions with metal pollutants; heavy metal uptake by plants and micro organisms. -4hrs

Unit 7: Bioremediation: *In situ* and *Ex situ* bioremediation; microbial systems of bioremediation; phytoremediation; constraints and priorities of bioremediation; environmental applications of bioremediation. -4hrs

Unit 8: Xenobiotics: Persistence and biomagnifications of xenobiotic molecules; Microbial interactions with xenobiotics; Use of microbes and plants in biodegradation.

-4hrs

References:

1. S V S Rana, 2006, Environmental pollution ,health and toxicology, 1st edition ,Narosa publishing house Pvt .Ltd,New Delhi
2. A.K.De.,2005, Environmental Chemistry, 5th Ed Newage Publ.Pvt Ltd New Delhi
3. Rao M N, H V N., 2004,Air pollution , 1st Edition Tata McGraw-Hill publishing company limited, New-Delhi
4. Noll, K. E., 2004. Adsorption Technology for Air and Water Pollution Control, Atlas Books and Periodicals, Delhi.
5. Litch, W., 2004. Air pollution control engineering 2nd Ed. Basic calculations for particulate collection. Atlas Books and Periodicals, Delhi.
6. Dop, H. V., 2004. Air pollution modeling and its application. Atlas Books and Periodicals, Delhi.
7. Willam P .Cunnigham and Mary Ann Cunnigham , 2003 ,Principles of Environmental Science,Second edition, Tata McGraw-Hill publishing company limited New-Delhi
8. M.N.V. Prasad, Kazimierz Strzalka., 2002,Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants, Kluwer Academic Publishers, Dordrecht Hardbound.
9. Bruce Rittman, Perry L. McCarty., 2000,Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, New Delhi
10. Milton Wainwright.,1999An Introduction to Environmental Biotechnology, Kluwer Academic Publishers, Boston. Hardbound,
11. K.G. Mukerji, B.P. Chamola, Rajeev K. Upadhyay, 1999, Biotechnological Approaches in Biocontrol of Plant Pathogens, Kluwer Academic/Plenum Publishers. Hardbound.
12. Martin Alexander, 1999, Biodegradation and Bioremediation, 2nd edition, Academic Press.

Ph.D. in Environmental Science – **COURSE WORK**
PAPER-III: Area of specialization: BIO AND PHYTOREMEDIATION – 48 hrs
(Guide: Dr. Hina Kousar)

Unit 1: Fundamentals of Environmental Microbiology; Taxonomy of Microorganisms: Bacteria, Algae, Fungi, Protozoa and their environmental significance. – 8 hrs

Unit 2: Bioreactors: Aerobic biological treatment-Activated sludge process, Rotating biological contactors, Biological filters; Anaerobic biological treatment-Contact digesters, Packed column reactors; Membrane bioreactors. - 10 hrs

Unit 3: Bioremediation for soil and water: Microbial systems for heavy metal accumulation, biosorption; pesticides and microorganisms. Municipal and industrial wastewater treatment. Ex-Situ and In-Situ bioremediation techniques. -12 hrs

Unit 4: Plants for Environmental Restoration: Identification, selection and utilization of plants to promote soil and water conservation and quality; Phytoextraction, Rhizofiltration. Phytostabilization, Phytodegradation and Phytovolatilization . -10 hrs

Unit 5: Phytoremediation of metals and inorganic contaminants: Recovery of heavy metals from soil. Treatment of municipal and industrial wastewater; Advantages and limitations of Bioremediation and Phytoremediation. - 8 hrs

References

1. Atlas Ronald and Bartha Richard. Microorganisms and some novel pollution problems in microbial ecology. Addison Wesley Co . 2011.
2. Carroll L. Ombre. Phytoremediation of Hydrocarbon Contaminated Soils. Taylor & Francis Group. 1999.
3. Jogdand.S.N.Environmental Biotechnology. Himalaya Publishing House.2003.
4. Prescott, L. M., Harley, P., and Klein, D. A., Microbiology, Second Edition, W. C. Brown Publishers, Dubuque, Iowa, 1993.
5. Rittmann, B.E., and McCarty, P.L. Environmental Biotechnology: Principles and Applications. McGraw Hill, 2001.
6. P.C. Trivedi. Phytoremediation & Environmental Biotechnology, 1st Edition, Pointer Publishers, 2009.

Ph.D. in Environmental Science – **COURSE WORK**
 Paper III: Specialization: **WATER POLLUTION, WASTEWATER TREATMENT AND
 TECHNIQUES – 48 hrs.**
(Guide: Dr. Basavarajappa S.H, Assistant Professor)

Unit – 1 Introduction: Water Pollution: Sources of water pollution; Point and non-point sources; Municipal, Industrial, Agricultural, Mining, Littering, Oil spillage and other sources. Effect of water pollution: Biotic and abiotic, Ecosystem level. Water pollution control management. Different methods and techniques for control: Design of treatment plant; ETP, STP, Soak pit, Lagoon and land discharge. - 8 hrs

Unit – 2 Water Quality: Importance of Water quality; characteristics of domestic, potable, and irrigation water. Water quality criteria: WHO, BIS and other standards. Physical, chemical and Biological Parameter of water, Water quality requirement- Potable water standards, Wastewater Effluent standards for irrigation and industries, Water quality indices. -8 hrs

Unit- 3 Water System and Water treatment: Sources of water in earth ecosystem. Chemical composition of water; resident time of chemicals in water. Water Treatment: Domestic water treatment; Settling, Oxidation, flocculation, filtration, pH adjustment, disinfection. Methods and techniques associated with potable water treatment: filters- types and applications. Distillation, Electrodialysis, reverse Osmosis, Ion exchange, Millipore filter and ultra-filtration. Treatments for pathogens, toxic compounds, toxic heavy metals. -10 Hrs

Unit 4: Tertiary and Advanced treatment: For colloidal organic matter; Phosphate, Nitrate, Iron, Dissolved inorganic ions. Water softening process. Taste, colour and odor removal. Fluoridation, Demineralization. Disinfections – Methods of disinfections in sewage treated water. - 6 hrs

Unit- 5 Wastewater treatment techniques: Characteristics of Wastewater; physical, chemical and biological characteristics. Treatment methods: Primary treatment; Screening & Grit chambers sedimentation and flocculation, equalization, neutralization. Secondary treatment – Aerobic and Anaerobic decomposition of wastewater, Activated Sludge process, Oxidation pond, Trickling Filters, Aerated lagoons, Tertiary treatment- Soak pit. Lagoon and land discharge, sludge drying bed. - 10 hrs

Unit-6 Microbial degradation of Wastes: Microbial diversity, Microbial digestion, waste as a media for microbial activity; organic matter- POM and DOM. Degradation of waste- biochemical process. Aquatic Biomass, Eutrophication. Microbial degradation of

biomass. Methods for identification of microbes and microbial treatment techniques- Serial dilution of water, Microbial- isolation, Characterization, identification of strains. Bioremediation-Its role in Environmental management, Treatment of solid and liquid industrial wastes. - 6 hrs

References:

1. Goel P.K, 1999, Advances in industrial Wastewater treatment, Techno Science Publications.
2. Hammer M.J, 1986, Water and wastewater Technology, John Willey.
3. Weber, W.J, 1983, Physicochemical process for water quality control, John Wiley and sons, New York.
4. Fair, G.M. Geyer T.C and Okun 1984, Water and Wastewater Engineering, John Wiley and sons, Strauss.
5. Metcalf and Eddy, 2005, Wastewater treatment process, Academic press, New York.
6. Patrick K. Jjemba, 2004, Environmental Microbiology Principles and Applications. Enfield NH USA by Science publishers.
7. Baily, R.A., Clark, H.M., Ferris, J.P., Krause, S. and Strong, R. L., 2005. Chemistry of the Environment. Academic Press. California, USA.

Paper-III: Specialization: Biodiversity & Natural Resource Conservation - 48 hrs
(Guide: Dr.Nagaraj parisara, Asst. Professor, Sahyadri Science College)

Unit 1: Introduction to Biodiversity: Biodiversity and its Types, Conservation of Biodiversity: in-situ conservation and ex-situ conservation, conservation of biodiversity and its ecological and economic importance, Global initiatives to conserve biodiversity. Biodiversity hot spots and global distribution. -8 hrs

Unit 2: Natural Resources: Distribution of natural resources, types and importance. Forest resources-types, social forestry and agro forestry. Water resources-fresh water and marine water. Rainwater harvest and importance. Energy resources-renewable and nonrenewable. Mineral resource –Importance, overexploitation and its impact. -8hrs

Unit 3: Threats to Biodiversity: Habitat loss, urbanization, overexploitation, hunting and poaching, man-wildlife conflicts, pollution: (soil. Water, air) Sources of pollution, Agrochemicals, pollution by industrial effluents and solid wastes, pollution due to urban activities, Effects of pollution on flora and fauna. and Control measures, Eutrophication and its Effects. -8hrs

Unit 4: Conservation of Biodiversity: Environment management and sustainable development: concepts, waste land reclamation, resettlement and rehabilitation. Forest management: Afforestation, Social Forestry, Agroforestry Reforestation, watershed management. Organic farming: Definition of organic farming and methods of organic farming advantages and disadvantages of organic farming, organic farming and its role in conservation of biodiversity. -8hrs

Unit 5: Biodiversity conservation acts: Environment protection act, biodiversity act, forest conservation act, wild life protection act, air pollution control and prevention act and water pollution control and prevention act,. National regulatory agencies for protection of biodiversity and natural resources. -8 hrs

Unit 6: Environmental Biotechnology and conservation of natural resources: Green chemistry and clean technology: Introduction, Importance of green chemistry in conservation of environment. Biotechnology and its application in Environment, Bio control Agents, Solid and Biomedical Waste Management. Bioremediation. Significance of refuse, reduce, reuse, repurpose and recycle. -8hrs

References:

1. Environmental Science- S. C. Santra, New Central Book Agency Private limited, London.
2. Methods and practice in Biodiversity conservation. David L Hawksworth. Springer publisher.
3. Environmental Biotechnology by Lawrence K wang. Springer.
4. Biodiversity conservation indigenous knowledge and practices. Martemjen, Notion press publisher.
5. Environmental management, Geotsch E I and Davis S.B.
6. Environmental impact analysis- A new dimention in decision making, Jain R.R., Stanley G.S.(1977)

7. Milton Wainwright, 1999 An Introduction to Environmental Biotechnology, Kluwer Academic publishers, Boston. Hardbound.
8. K.G. Mukerji, B.P. Chamola, Rajeev K. Upadhyay, 1999, Biotechnological Approaches in Biocontrol of plant pathogens, Kluwer Academic plenum publishers, Hardbound.
9. Environmental chemistry and Pollution Control by Dara and Mishra. S Chand Publications.
10. Organic farming-global perspectives and methods. Sharath Chandra, Unni MR and Sabu Thomas. Elsevier publications.

Department of PG Studies and Research in Environmental Science
Ph.D. in Environmental Science – COURSE WORK EXAMINATION
Model Question paper (for paper I, II and III)

Paper Code and title: _____

Time: 3 Hours

Max. Marks: 75

Note: Answer questions from all the three sections

SECTION – A

Answer any SEVEN of the following (Short Answer Type) 7 X 2 = 14

(Should be covered all units of the syllabus)

1. Moral Philosophy (Example- One or two words for each questions)
2. Research Integrity
3. COPE
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.

SECTION – B

Answer any FIVE of the following (Medium Answer Type) 5 X 5 = 25

(Should be covered all units of the syllabus)

10. What is redundant publication? What are the important characters of such publications? (Example)
- 11.
- 12.
- 13.
- 14.
- 15.

SECTION – C

Answer any THREE of the following (Medium Answer Type) 3 X 12 = 36

(Should be covered all units of the syllabus)

16. Describe process involved in selection and formulation of a research problem (Example)
- 17.
- 18.
- 19.
- 20.