Maharaja Surajmal Brij UniversityBharatpur

Syllabus

M.Sc. Environmental Studies

2024-26 (I & II Semester)

Dr. Farbat Singh
Asstt. Registrar
Acad.I

(Ms. Ajita Mishra)

M.Sc. Environmental Studies (Session 2024-26)

Semester: First

Curriculum Structure									
Session 2024-25									
Name of Programme: M.Sc. Environmental Studies									
Year: First							Semester: I		
Sr. No.	Subject Code	Course Title	Credi	Contact hours per week			Weightage (%)		
				L	T	P	CWS	MTE	ETE
Discipline Specific Core (DSC)									
1.	ENV 701	Fundamentals of Ecology	4	4	0	0	10	20	70
2.	ENV 702	Environmental Chemistry	4	4	0	0	10	20	70
3.	ENV 703	Natural resources and their conservation	4	4	0	0	10	20	70
4.	ENV 711	General Practical Lab (Based on ENV 701, ENV 702 & ENV 703)	6	0	0	12	45	-	105
Discipline Specific Elective (DSE)									
5.	ENV A01	Environmental Instrumentation	4	4	0	0	10	20	70
OR									
6.	ENV A02	Biodiversity Conservation	4	4	0	0	10	20	70
7.	ENV A11	Elective Practical Lab (ENV A01 or ENV A02)	2	0	0	4	15	-	35
Value Added Course (VAC)									
8.			2	0	0	2	05	10	35

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M.Sc. Environmental Studies (Session 2024-26)

Semester: Second

Curriculum Structure									
Session 2024-25									
Name of Programme : M.Sc. Environmental Studies									
Year: First							Semester: II		
Sr. No.	Subject Code	Course Title	Credit	Contact hours per week			Weightage (%)		
				L	T	P	CWS	MTE	ETE
Discipline Specific Core (DSC)									
1.	ENV 801	Environmental Biotechnology	4	4	0	0	10	20	70
2.	ENV 802	Environmental Pollution & Control	4	4	0	0	10	20	70
3.	ENV 803	Research Methodology	4	4	0	0	10	20	70
4.	ENV 811	General Practical Lab (Based on ENV 801, ENV 802 & ENV 803)	6	0	0	12	45	-	105
Discipline Specific Elective (DSE)									
5.	ENVB01	Environmental Policy & Law	4	4	0	0	10	20	70
OR									
6.	ENVB02	Environmental Management & Impact Assessment	4	4	0	0	10	20	70
7.	ENVB12	Elective Practical Lab (ENV B01 or ENV B02)	2	0	0	4	15	-	35
Value Added Course (VAC)									
8.			2	0	0	2	05	10	35

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1. SCHEME OF EXAMINATION (2024-2025, 2025-2026)

1. Each theory paper shall carry 100 (70 for End term exam + 30 for Internal/midterm exam) marks. The Paper will be of 3 hours duration. Part "A" of theory paper shall contain 10 Short Answer Questions of 10 marks based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry one mark for the correct answer.
2. Part "B" of paper will consist of four questions with internal choice selecting one question from each unit (except in case where a different scheme is specified in the syllabus) of 15 marks each.

2. Course Structure:

The details of the courses with code, title and the credits assigned are as givenbelow.
Abbreviations Used .

Course Category

DSC: Discipline Specific Core

DSE: Discipline Specific Elective

VAC: Value added course

SEM/INT/DIS: Seminar/ Internship/Dissertation

CWS: Class work (It would include attendance, assignments, class test/quiz test, ppt,play, learn by fun activities etc.)

MTE: Mid Term Exam

ETE: End Term Exam

Contact Hours

L: Lecture

T: Tutorial

P: Practical

S: Self Study

The medium of instruction and examination shall be English only

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Syllabus M.Sc. Environmental Studies

Semester-I

ENV 701: Fundamentals of Ecology **Max. Marks -100**

Course title: Fundamentals of Ecology

Course objective: To provide an understanding of the impacts of various environmental factors on the living being and vice versa.

Learning outcomes:

- It will give knowledge of the environmental factors affecting animals and plants.
- A sense of energy flow and nutrient cycling in the environment.
- A sense of the application of the population ecology.

Unit-I: Introduction to Ecology

Definition, subdivision and scope, Basic concepts in ecology, Autecology and Synecology, Level of organization in Ecology, Environmental heterogenicity, Applied ecology, Environmental complexes, Interaction of ecological factors,

Unit-II: Ecological Factors

Light, temperature, precipitation (rainfall), humidity. Atmosphere: gases and wind, atmospheric gases, wind factor and fire factor, topographic and edaphic factors. Different environmental laws and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors). Biotic community, Interdependence in a community and community metabolism, Community ecology: structure, composition and development of community, species diversity in communities, Ecotones, Concept of edge effect, Ecological niche, Gause's Principle.

Unit-III: Ecosystem

Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and Food web, Concepts of productivity and standing crops, Ecological Pyramids-types, Ecological succession, Ecological indicators, Ecological efficiencies, Biogeochemical cycles in ecosystems.

Unit-IV: Population Ecology

Population characteristics; density, natality, mortality, biotic potential, survivorship curves, age distribution, growth curves and models, r & k selection. Population interaction, Prey-Predator Relationship, Ecological Model.

REFERENCES

1. Cunningham W P, Cunningham M A (2008) Principles of Environment Science. Enquiry and Applications. 5th Edition. Tata McGraw Hill, New Delhi
2. Dash M C, Dash S P (2009) Fundamentals of Ecology. 3rd McGraw Hill Education.

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3. Odum E P (2017) Fundamentals of Ecology, 5th Edition, Cengage Learning Publication
4. Raven P H, Berg L R, Hassenzahl D M (2018) Environment. 10th Edition. John Wiley & Sons., USA
5. Sharma P D (2017) Ecology & Environment, 13th Edition, Rastogi Publications, Meerut
6. Singh J S, Singh S P, Gupta S R (2008) Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India
7. Smith (2014) Elements of Ecology. 8th edition, Pearson Education India
8. Santra S C (2010) Fundamentals of Ecology and Environmental Biology. New Central Book Agency
9. Juniper T (2019) The Ecology Book: Big Ideas Simply Explained. DK

ENV 702: Environmental Chemistry — Max. Marks -100

Course title: Environmental Chemistry

Course objective: To understand the chemistry that governs natural and polluted environments by utilizing and building on the tools acquired in general chemistry, chemical kinetics, and thermodynamics. The chemistry of species in the atmosphere, hydrosphere, lithosphere, and their interactions will be examined. Additionally, concepts of ecotoxicology will be introduced.

Learning outcomes:

- A sense of water chemistry and various physical properties involving in the chemical processes.
- A sense of the atmospheric chemistry and processes involved in the troposphere.
- Knowledge of soil properties and toxicological compound emerging into the environment.

Course content:

Unit-I: Chemistry of Water and Aquatic System

Stoichiometry, Gibb's energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, the solubility of gases in water. The carbonate system; Chemistry of water, Properties of water and their significance, types, sources and consequences of water pollution, Physicochemical and bacteriological sampling and analysis of water quality. Redox potential, alkalinity, acidity, calcium and other metals in water, organic pollutants in sewage, soaps, oil and detergents, radio nuclide in water

Unit-II: Atmospheric Chemistry

Particles, ions and radicals in the atmosphere. Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Oxygen and ozone chemistry. Chemistry of air pollutants, Photochemical smog. Methods of monitoring and control of air pollution- SO_2, NOx, CO, SPM. Effects of pollutants on human beings, plants, animals and materials. Air Quality Standards

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Unit-III: Soil and Sediment Geochemistry

Inorganic and organic components of soil, Weathering of rocks, rock-forming minerals, Soil properties, acid-base and ion-exchange reaction in soil, Macro and micronutrients in soil, Nitrogen pathways and NPK in soil.

Unit-IV: Toxic Chemicals in the Environment

Organic compounds: Hydrocarbons, Chemistry of hydrocarbons, phenols, chlorofluorocarbons, pesticides, chemical fertilizers, environmental effects, effects on macro and microorganisms. Gasoline lubricants and greases, Pesticides: Classification, degradation, analysis, pollution due to pesticides and heavy metals, Principles of green chemistry.

REFERENCES

1. De A K (2016) Environmental Chemistry, 8th Edition, Wiley Eastern Ltd, New Delhi
2. Field F W, Haines P J (2000) Environmental Analytical Chemistry, Blackwell Science Ltd. USA
3. Karikalan V L (2002) Environmental Engineering. Dhanpati Rai & Co. (P) Ltd., Delhi
4. Manahan S E (2009) Environmental Chemistry. CRC Press; 9th edition Lewis Publishers, Chelsea, Michigan
5. O' Neill P (1998) Environmental Chemistry. 3rd edition., CRC Press
6. Rao C S (2018) Environmental Pollution Control Engineering. Third edition, New Age International Publishers
7. Kaur H (2016) Environmental Chemistry. Pragati Prakashan-Meerut
8. Sodhi G S (2008) Fundamental concepts of Environmental Chemistry, Narosa Publishing House, New Delhi

ENV 703: Natural Resource Conservation and Management **Max. Marks -100**

Course title: Natural Resource Conservation and Management

Course objective: To create awareness among the students about the natural resources, their status, importance and need of preservation.

Learning outcomes:

- It will be helpful for students to understand different types of natural resources and their status in the present context.
- The understanding of issues concerning different natural resources will be helpful to find scientific solution based on participatory approach.
- To achieve their sustainable use as well as proper management.
- Participate in sustainable development

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Course content:

Unit-I: Natural Resources: An Introduction

Natural Resources: Concept and Classification of Natural Resources; Factors influencing resource availability, distribution and uses; Mineral Resources: Mineral Resources and Reserve; Mineral exploration and exploitation, Environmental impacts of mineral extraction; Oceanic Minerals: Exploration prospective and Impacts

Unit-II: Physical Resources

Soil Resource: Soil Characteristics and Classification; Soil Development, Soil Profile; Degradation of Soil: Soil Erosion, Desertification and Salinization; Soil and Land Management: Soil Conservation and Management Strategies; Water Resources: Water Composition and Quality: Rainwater, Rivers, Lakes, Groundwater, Seawater; Impacts of Exploitation of Surface & Ground Water, Environmental Issues of Water Resource Projects; Rainwater Harvesting and Ground Water Recharge.

Unit-III: Energy Resources

Fossil Fuels: Classification, Composition, Characteristics of Coal, Petroleum and Natural Gas; Renewable Energy Resources: Overview and Principal of generation and Environmental Implications of renewable Energy: Hydropower, Tidal Energy, Ocean Thermal Energy Conversion (OTEC), Wind Energy, Geothermal Energy, Solar Energy (Solar Collector, Photo-voltaic Modules, Solar Ponds), Nuclear Energy (Fusion & Fission), Bioenergy; Energy use pattern in India and the World.

Unit-IV: Forest Resources

Forest Resources: Classification and Forest Types in India; Importance, Use and Over Exploitation; Human Interaction with Forests: Causes and Effects of Deforestation; Purposes and Techniques of Forest Management; Urban Forestry

REFERENCES

1. Boyle G (2012) Renewable Energy: Power for a Sustainable Future. 3rd ed. Oxford: Oxford University Press and Open University
2. Chiras D, Reganold J (2014) Natural Resource Conservation – Management for Sustainable Future. 10th ed. Pearson Education
3. Freeman A (2001) Measures of value and Resources: Resources for the Future. Washington DC
4. Ginley D, Cahen, D (2011) Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press
5. Grebner D L, Bettinger P, Siry J P (2012) Introduction to Forestry and Natural Resources. Academic Press
6. Khan B (2017) Non-conventional energy resources. Tata McGraw-Hill Education.
7. Khan I (2019) Forest Governance and Sustainable Resource Management. SAGE Publications. India.
8. Pal S K (2020) Textbook of Soil Science. India: CBS PUB & DIST Pvt Limited India
9. Rai G D (2013) Non-conventional Sources of Energy. Khanna Publishers

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10. Tiwari G, Ghosal M (2005) Renewable Energy Resources: Basic Principles and Application. Narosa Publishing House
11. Twidell J, Weir T (2015) Renewable Energy Resources. Routledge

ENV 711: Core Lab based on theory papers

Practical Based on ENV 701:

1. Quantitative characterization of plant community.
2. Evaluation of species diversity indices in a given plant community.
3. Determination of Important Value Index (IVI) of trees in Forest Ecosystem.
4. Estimation of primary productivity by harvest method
5. Industrial Ecology survey: Questionnaire/Interview/ Discussion.

Practical Based on ENV 702:

1. Preparation of laboratory solutions.
2. Analysis of relative humidity in air.
3. Analysis of hardness in water sample.
4. Analysis of turbidity in water samples.
5. Analysis of soil texture.
6. Analysis of water holding capacity in the soil.
7. Analysis of soil pH.

Practical Based on ENV 703:

1. Remote sensing and GIS - Applications of GPS, Image interpretation. Digitization and data generation.
2. Survey for sustainability in rural areas.
3. Determination of selected elements in mineral and ores.
4. Soil texture analysis.
5. Physicochemical characterization of water samples.

Elective-I

ENV A01: Environmental Instrumentation

Course title: Instrumental Techniques for Environmental Analysis

Course objectives: To provide a fundamental understanding of the design, operational principles and practical applications of modern instrumental methods employed in chemical analysis of environmental samples.

Learning outcomes:

- Students will be able to use adequate equipment and determine the state of pollution in the environment
- They will be able to correctly perform sampling and prepare the samples
- To adequately use instrumental methods of chemical analysis and interpret the results.

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Course content:

Unit-I: Basics of Analytical Approach

Defining of Problem and Designing of Analytical Method; Sampling: Types and Methods for Solid, Liquid and Gaseous Matrix; Sample Storage; Sample Preparation; Measurement and Assessing of Data; Method Validation and Documentation; Titrimetry; Gravimetry; Colourimetry

Unit-II: Spectroscopic Analytical Techniques

Spectrophotometry (UV-Visible Spectrophotometry, Atomic Absorption Spectrophotometry, Flame Photometry); Plasma Emission Spectroscopy (Induced Coupled Plasma Mass Spectrometer, Induced Coupled Plasma Atomic Emission Spectroscopy); Fourier-Transform Infrared Spectroscopy; Nuclear Magnetic Resonance Spectroscopy; X-Ray Spectroscopy (X-Ray Fluorescence, X-Ray Diffraction); Nephalometry and Turbidimetry

Unit-III: Chromatographic Techniques

Chromatographic Techniques (Paper Chromatography, Thin Layer Chromatography, Gas Liquid Chromatography, High Pressure Liquid Chromatography, Ion-exchange Chromatography); Electrophoresis

Unit-IV: Microscopy Techniques

Optical Microscopy (Brightfield, Darkfield, Phase Contrast, Fluorescence, Confocal); Electron Microscopy (Scanning and Transmission Electron Microscopy); Flow Cytometry

REFERENCES

1. Baird R B, Eaton A D, Rice E W (2017) Standards Methods for the examination of water and Waste water. 23rd ed., American Water Works Association, (AWWA, WEF and APHA)
2. Barbooti M (2015) Environmental Applications of Instrumental Chemical Analysis. Apple Academic Press, New York
3. Down D R, Lehr H J (2004) Environmental Instrumentation and Analysis Handbook. Wiley-Interscience
4. Horvai G, Pungor E (2020) A Practical Guide to Instrumental Analysis. 7th ed. United States: CRC Press
5. Khopkar S M (2008) Basic Concepts of Analytical Chemistry. New Age International Pvt Ltd Publishers, New Delhi
6. Robinson J W, Frame E M S, Frame G M (2014) Undergraduate instrumental analysis. 7th ed. CRC Press, New York
7. Rouessac F, Rouessac A (2013) Chemical Analysis: Modern Instrumentation Methods and Techniques. Germany, Wiley
8. Willard H H, Merritt L L, Deen J A, Settle F A (2004) Instrumental Methods of Analysis. 7th ed. CBS Publishers and Distributers, New Delhi

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Elective-II

ENV A02 : Biodiversity Conservation

Course title: Biodiversity Conservation

Course objective: To aware the students about the biological diversity, its importance, status and need of worldwide efforts in its preservation.

Learning outcomes:

- It will be helpful for students to understand the species diversity and associated issues.
- They will be able to understand the threat at biodiversity, causal factors and mitigation measures.
- The students will get the knowledge about trends of biological diversity and conservation strategies and thereafter be able to create awareness for its preservation and development.

Course content:

Unit-I: Introduction

Concepts and components of biodiversity, types of diversity (Microbial, Plant, Soil, Agro- biodiversity), Importance of biodiversity: aesthetic, cultural and ecosystem services, biodiversity informatics, biodiversity values, biodiversity indices, biodiversity losses, Human population growth implications on biodiversity.

Unit-II: Strategies for Biodiversity Conservation

In-situ conservation: sanctuaries, biospheres reserves, national parks, preservation plots. Ex-situ conservation: captive breeding, botanical gardens, zoos, aquaria, homestead garden, herbarium; In- vitro conservation of plant tissue culture: Gene bank, pollen bank, spore bank, DNA bank. Wildlife corridors, Resource partitioning, Pressure of firewood collection, non-wood forest produce collection, livestock grazing and fire on protected area and habitat management. National and international programmes for biodiversity conservation.

Unit-III: Megadiversity Zones and Biodiversity Hotspots

Concepts, distribution and importance of megadiversity zones, Biogeographic regions Biodiversity hotspots, National and global red data lists, Categories of species and their management, Restoration of biodiversity, Acceleration of ecological succession, Reintroduction of biota. Methods for inventorying and monitoring biodiversity trends, Habitat evaluation, IPRs and protection: Patent protection, TRIPs, Biopiracy and Bioprospecting.

Unit-IV: Planning and Implementation of Conservation Programmes

Indigenous knowledge, biodiversity and sustainable development, Sacred groves. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, IUCN, UNEP, WCPA, TRAFFIC in wildlife protection. Institutions and their role in conservation: Zoos, Natural history museums & collections, Zoological survey of India, Botanical survey of India, Forest research Institute, Survey of India. People and conservation. Role of NGOs in conservation.

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REFERENCES

1. Botkin D, Edward K (2007) Environmental Science: Earth as a Living Planet.6th ed. John Wiley & Sons, New York .
2. Gibbs J, Malcolm L, Sterling J (2008) Problem-Solving in Conservation Biology and Wildlife Management. 2nd ed. Wiley-Blackwell
3. Laladhas K, Oommen V, Nilayangode P (2018) Biodiversity for Sustainable Development. Springer International Publishing, pp 79-86
4. Matthews T, Triantis K, Whittaker R (2021) The Species–Area Relationship: Theory and Application (Ecology, Biodiversity and Conservation). Cambridge: Cambridge University Press
5. Odum E P, Barrett W, (2005) Fundamentals of Ecology. 5th ed. Cengage Learning.
6. Raven P, Berg L, Hassenzahl D (2008) Environment. 6th ed. John Wiley & Sons., USA
7. Sharma P D (2017) Ecology and Environment. 13th ed. Rastogi Publications
8. Sondhi S (2012) Protected Animals of India. The Energy and Resources Institute, TERI
9. Thangadurai D, Ching G, Jeyabalan S, Islam S (2019) Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management. United States: Apple Academic Press

ENV A11 : Elective Lab based on theory papers

Practical based on ENVA01

1. Determination of heavy metals in environment sample by spectrophotometer/AAS.
2. Determination of organic contaminants in environmental sample UV-visible spectrophotometer/HPLC/ Gas chromatography.
3. Preparation of acids and alkali of particular material (specify).
4. F-test, t- test and chi square test and correlation of given data set
5. Demonstration of instruments for analysis of environment samples.

Practical based on ENVA02

1. Indicate Biosphere Reserve, Hot spots, Wildlife Sanctuaries, Parks on map of India.
2. Invent erization of medicinal/ indigenous/ rare/endangered plant species of Rajasthan
3. Preparation of acids and alkali of particular material (specify).
4. Determination of primary metabolites (protein & carbohydrates) in plant sample.
5. Determination of secondary metabolites (phenol & ascorbic acid) in plant Sample.

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Syllabus M.Sc. Environmental Studies

Semester-II

ENV 801: Environmental Biotechnology **Max. Marks -100**

Course title: Environmental Biotechnology

Course objective: To provide basic understanding of the role of biotechnology in the field of environment

Learning outcomes:

- Explain the technologies, tools and techniques in the field of environmental biotechnology.
- To know about the role of microorganisms as biotechnological agents.
- Knowledge about the basic terminology of molecular biology and genetics.
- Study of bioreactors for environmental applications.

Course content:

Unit-I: Basic Techniques in Genetic Engineering

Brief account of the structure and functions of DNA and RNA, Recombinant DNA Technology: Enzymes (restriction endonucleases, DNA ligase, exonucleases and DNA polymerases), cloning vectors. Gene identification and isolation; genomic library, cDNA library, environmental genomics/metagenomics. Introduction of genes into new hosts using plasmid and phage vector. Gene transfer methods in bacteria and plants.

Unit-II: Biogeotechnology and Waste Gas Treatment

Xenobiotics compound: persistence and biomagnification. Bioleaching of metals: characteristics of commercially important microbes, mechanisms of bioleaching and current biomining processes. Biobeneficiation of gold ores. Biodesulfurization of coal. Biological treatment of waste gas (polluted air), Genetically Modified Organism (GMOs) and their impact on the environment.

Unit-III: Fermentation Technology

Bioreactor: basics, types and application. Use of natural and genetically engineered microorganisms from extreme environment like thermophiles, alkalophiles, acidophiles and halophiles in industrial applications. Production of enzymes like cellulase, proteases, and amylases for acetic acid production, Production of renewable and alternative sources of energy: bio-hydrogen, biodiesel and bioethanol.

Unit-IV: Biofertilizers and Biopesticides

Nitrogen fixation mechanism (biochemistry of nitrogenase, genetics of nitrogen fixation and regulation of nif genes expression), Bio-fertilizers: types, benefits, application and future prospects, Biopesticides: concept, categories, development and utilization in pest management. Bioremediation: concept, types of bioremediation technology, application of bioremediation in agricultural and industrial waste treatment.

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REFERENCES

1. Alexander M (1999) Biodegradation and Bioremediation, 2nd edition, Academic Press
2. Brown T A (2012) Gene Cloning and DNA Analysis: An Introduction 6th Edition, Wiley
3. Fulekar M H (2010) Environmental Biotechnology - Theory and Application. CRC Press. Science Publisher, USA
4. Gupta P K (2010) Elements of Biotechnology. 2nd edition. Rastogi Publications
5. Jordening H, Winter J (2005) Environmental Biotechnology: Concepts and Applications. 1st Edition. Wiley-VCH Verlag GmbH, Germany
6. Manahan S E (1997) Environmental Science and Technology. Boca Raton. FL: Lewis Publishers, New York
7. Purohit S S, Mathur S K (1994) Fundamentals of Biotechnology, Agro Botanical Publishers, New Delhi India
8. Rittman B, McCarty P L (2000) Environmental Biotechnology: Principles and Applications. 2nd Edition. Tata McGraw-Hill, USA
9. Thakur I S (2006) Environmental Biotechnology: Basic Concepts and Applications. I. K International Publishing House Pvt Ltd

ENV 802 : Environmental Pollution & Control **Max. Marks -100**

Course title: Environmental Pollution and Control

Course objective: To get knowledge about the technologies available to control the pollution which has been emerged to the environment already by various human activities.

Learning outcomes:

- A sense of the technologies and methods available to control the water pollution
- A sense about the methods and technologies which have been used until now for the control and purification of the polluted air.
- Knowledge about the noise pollution abatement and soil pollution control

Course content:

Unit-I: Water Pollution

Primary treatment methods – screening, grit removal, primary sedimentation, secondary treatment methods, Activated sludge process, Trickling filters, Rotating biological contactors, Oxidation ponds and Lagoons. Advanced wastewater treatment, removal of nutrients and solids. Wastewater reuse and sludge disposal.

Unit-II: Air Pollution

Control methods for particulates-gravitational settling chambers, Centrifugal Collectors, Wet Collectors, Fabric filters, electrostatic precipitators. Control methods for gaseous pollutants- adsorption, absorption, condensation, combustion. Air pollutants Sampling, Major air pollutants in India.

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Unit-III: Noise Pollution

Basics of sound, Sound propagation, Measurement of noise and indices, Effect of meteorological parameters on noise propagation. Noise control and abatement measures, Noise exposure levels and standards, Impact of noise on human health.

Unit-IV: Soil Pollution

Soil Pollution control. Phytoremediation process: Phytostimulation, Phytostabilization, Phytoextraction, Phytovolatilization, Phytodegradation, Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers. The land-use plan, soil surveys in relation to land use planning, methods of site selection and evaluation.

REFERENCES

1. Bell L H, Bell D H (1993) Industrial Noise Control: Fundamentals and Applications, Second Edition (Mechanical Engineering) 2nd Edition Marcel Dekker, Inc; New York
2. De A K (2016) Environmental Chemistry,. 8th Edition, Wiley Eastern Ltd, New Delhi
3. Gilbert M (2007) An Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi
4. Kannan K (1994) Fundamentals of Environmental Pollution, S. Chand & Company Ltd., Ramnagar, New Delhi
5. Manahan S E (2000) Fundamentals of Environmental Chemistry, Boca Raton: CRC Press
6. Metcalf E (1995) Waste Water Engineering: Tata Mc-Graw Hill Publishers, 3rd Edition
7. Rao C S (2001) Environmental Pollution Control Engineering, New Age International Publication, New Delhi
8. Trivedi R K, Goel P K (1995) An Introduction to Air Pollution, Techno Science Publications, Jaipur

ENV 803 : Research Methodology **Max. Marks -100**

Course title: Research Methodology

Course objective: To provide basic knowledge of methods to pursue research, learn mathematics, set theory and helps in understanding of the software that supports the mathematical research.

Course Learning Outcomes:

- After completion of this course, students will be able to
- Understand mathematics more efficiently and clearly.
- Understand how to write a basic mathematics article.
- Make students analyze a given fact or concept and how to reach a concept.
- Make students curious enough to read the most recent trends in mathematics.
- Understand the basic ideas of how to write an algorithm and related ideas. Understand the effective use of open-source software to write mathematical articles.

Unit-I: Nature of Scientific Inquiry

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Nature of Scientific Inquiry - Scientific Methods - Induction, Deduction Hypothesis and Theory and their Interpretation -Nature and Scope of Social Research for Multi-Disciplinary Inter-Disciplinary Approach in Commerce. Planning of Research-Selection of a Problem for Research-Sample design Census and Sample Surveys- Sampling Techniques- Sample size.

Unit –II: Research Design

Research Design- Important Aspects of Research Design. Methods of Data Collection-Sources of data Use of secondary data- Methods of collecting primary data- Observation- Interviews- Questionnaires and Schedules.

Unit –III: Processing and Analysis of Data

Processing and Analysis of Data- Processing Operations- Types of Analysis- Presentation and Interpretation of Data-Editing, Classification and Tabulation, Interpretation. Preparation of a Report-Types of Report- Research Report- Format- Principles of Writing Reports- Documentation- Footnotes and Bibliography

Unit –IV: Quantitative Tools

Quantitative Tools- Measures of Central Tendency- Dispersion- Measures of Correlation- Simple and Multiple Correlation-testing of Hypothesis-Tests based on t-P, Z, and Chi square, Time Series Analysis, Trend Measurement, Moving Averages.

Suggested Reading:

1. Srivastava, S.C. (1990) Foundation of Social Research and Economics Techniques, Himalaya Publishing House.
2. Sharma H.D. and Mukherji S.P. (1992) Research Methods in Economics and Business, New York:The Macmillan Company.
3. Gerber R. and Verdoom, P.J. (1992) Research Methods in Economics and Business, New York, The Macmillan Company.
4. Krishna swami O.R. (1993) Methodology of Research in Social Sciences, Himalaya Publishing House.
5. Menden HYall and Varacity: Reinmuth J.E. (1982) Statistics for Management and Economics (2nd Edition).
6. Courtis J.K.(ed.) (1980) Research and Methodology in Accounting & Financial Management.

ENV 811: Core Lab based on theory papers

Practical Based on ENV 801:

1. Screening of microorganisms from contaminated site.
2. Screening of plant species growing at contaminated areas.
3. Estimation of proline and assay of peroxidase activity in plants growing in polluted sites.

Practical Based on ENV 802:

1. Estimation of Gaseous pollutant (SOx, NOx, and Ozone) in ambient air.
2. Physicochemical Characterization of Industrial Effluents.
3. Determination of particulate matter in (SPM, RSPM) in ambient air.
4. Measurement of Noise level in Industrial and Residential area.

Practical Based on ENV 803:

1. Experiments based on chemical calculations.
2. Hands on training in Computer application
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

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Elective-I

ENV B01: Environmental Policy & Law

Course title: Environmental Policy and Law

Course objective: To acquaint the students with the environmental issues and the measures taken for its protection along with the norms prevailing at international and national level.

Learning outcomes:

- Students will be able to get basic knowledge of the environment, pollution and various principles.
- Students will be able to get knowledge about constitutional provisions for the protection of the environment.
- Students will get knowledge about the Environment (protection) Act, powers of central government and state government to make laws and Environment Tribunals.

Course contents:

Unit-I: Introduction to Environmental Legislations

Environment protection: Issues and Problems; International and National efforts for Environment Protection; General Principles in Environmental Law: Precautionary Principle; Polluter Pays Principle; Sustainable Development, Constitutional provisions of Constitution of India regarding Environment (Article 48A, 51A(g) and 253).

Unit-II: National & Global Environmental Initiatives

International Initiatives towards Environmental Protection: Stockholm Conference, Earth Summit, World Summit on Sustainable Development, Rio+20, Ramsar Convention, Vienna Convention, Montreal Protocol, Kyoto Protocol; Sustainable Development Goals; Eco-mark scheme, Creation of UNEP and its role, UNFCCC, Convention on Climate Change, CoPs, CDM, Convention on Conservation of Antarctic Marine Living Resource.

Unit-III: Environmental Laws & Legislations

The Water (Preventions and Control of Pollution) Act, 1974; National Water Policy, 2002; Air (Prevention and Control of Pollution) Act, 1981; Environmental (Protection) Act, 1986; National

Environmental Policy, 2006; Motor Vehicle Act, 1988 (Environmental Aspects Only); Public Liability Insurance Act, 1991; Coastal Regulation Zone (CRZ) Notification, 1991; Noise Pollution (Regulation and Control) Rules, 2000

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Unit-IV: Legislation Related to Biodiversity

National Forest Policy, 1988; Wildlife Protection Act, 1972 and Amendments; Forest Conservation Act, 1980; Indian Forest Act, Revised 1982; Biological Diversity Act, 2002;

REFERENCES

1. Deshai B (1994) Environmental Law of India, Lencern Book, New Delhi
2. Divan S, Rosencranz A (2002) Environmental Law and Policy in India: Cases, Material & Statutes. Oxford Publishers. ISBN: 978-0195661736
3. Ghosh S (2019) Indian Environmental Law: Key Concepts and Principles. The Orient Blackswan. ISBN: 978-9352875795
4. Leelakrishnan P (2019) Environmental law in India (5th ed, LexisNexis), ISBN: 9789386515872
5. Mehta C S (1991) Environmental Protection and the Law, Ashish Publishing House, New Delhi.
6. Nath B, Hens L, Compton P, Devuyst D (1998) Environmental Management in Practice, Vol I, Routledge, London and New York
7. Singh G (2005) Environmental law in India, Mc Millan Publishers. ISBN: 978-1403924902
8. Upadhyay S, Upadhyay V (2002) Hand Book on Environmental Law- Forest Laws,Wildlife Laws and the Environment. Lexis Nexis- Butterworths Publishers. ISBN: 978-8187162544

Elective-II

ENV B02: Environmental Management and Impact Assessment

Course title: Environmental Management and Impact Assessment

Course objectives: Understating the environmental laws, acts, standard for environmental compliance. Understating the EIA and its methodologies for Industries and Regulators.

Learning outcomes:

- Understand critical theories of environmental impact assessment
- Be able to critique environmental impact statements effectively
- Be able to apply knowledge to Indian situations/cases

Course content:

Unit-I: Introduction to EIA and Environmental Planning

Origin aims and needs of EIA, EIA guidelines 1994, EIA notification and amendments; Environmental Impact Assessment (EIA) as a tool in environmental management, EMS and QMS, ISO 14000 Series, Corporate Social Responsibility (CSR) 26000. Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies. Concept and strategies of sustainable development, Environmental priorities in India and Sustainable Development.

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Unit-II: EIA Methodology

Types of Projects requiring Environmental Clearance, Types of EIA, Project screening, Scoping, Base-line study, Impact identification, Prediction and assessment of impacts, Mitigation measures. Public participation, Review and decision making, Generic structure of EIA Document, Composition of Expert Appraisal Committee (EAC), State Level Expert Appraisal Committee (SEAC), Life Cycle Assessment (LCA) in EIA: principles and practical implications for industrial projects, Benefits and future of EIA.

Unit-III: Environmental Audit

Introduction, Concepts, Steps, Methodology and Types of Environmental audit, . Environmental Auditing: Procedure, quantitative methods of environmental auditing (Leopold Matrix method and Battelle method) Cost-Benefit analysis, National Environmental Policies and guidelines for environmental audit in India Main areas covered by the auditor in the case of environment audit in an Industrial unit, Environmental impact statement (EIS).

Unit-IV: Case Studies

Environmental Impact Assessment of major developmental projects– river valley projects, mining projects, thermal power plants, transport (rail, road highway), oil refineries and petrochemicals. Prediction and assessment of impacts on the biological, cultural and socio- economic environments.

REFERENCES

1. Barthwal R R (2012) Environmental Impact Assessment. New Age International Private Limited
2. Glasson J, Therivel R, Chadwick A (2012) Introduction to Environmental Impact Assessment. London: Routledge
3. Guinee J B (2002) Handbook on Life Cycle Assessment: Operational Guide to ISO Standards. Springer
4. Jain R K, Urban L V, Stacey G S, Balbach H E, Webb M D (2001) Environmental Assessment. New York: Mc Graw-Hill Inc
5. Kulkarni V S, Kaul S N, Trivedi R K A (2002) Handbook of Environmental Impact Assessment. Scientific Publishers
6. Musaida M M, Charles M, Edison M, Nita S (2020) Environmental Impact Assessments and Mitigation. United States: CRC Press
7. Reddy M A (2010) Textbook of Environmental Science & Technology. BS Publications
8. Singh P P, Sharma S (2004) Environment and Pollution Education. Deep and Deep Publication Pvt. Ltd, New Delhi

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ENV B12: Elective Lab based on theory papers

Practical based on ENVB02

1. Recording of Meteorological Parameters (Atmospheric pressure, rainfall, ambient temperature, wind speed and direction, Wind Chill and temperature, humidity and dew point-any two)
2. Heavy Metals Analysis Using Atomic Absorption Spectrophotometer
3. Soil Samples Collection and Analysis- (Sampling and Collection of soil sample, Determination of physical and chemical properties of soil: CEC, pH, moisture content, Soil water holding capacity, organic matter content, Nitrogen, Phosphate phosphorus, Calcium Carbonate content)
4. Field Visits and Data Collection - (Make Field visits to river/lake and/or wastewater treatment plants, measurement of noise form industrial, residential and commercial zones within the university premises).

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