Scheme of Teaching and Examination for M. Sc. Environmental Science (CBCS) As per NEP 2020

Structure and Credit Distribution of PG Degree Program for Two years

Choice Based Credit System (Semester Pattern)

With Effect from 2023-2024

M. Sc. ENVIRONMENTAL SCIENCE Semester I												
Course Category	Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
							Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
			Theory	Practical	Total			SEE	CIE		Theory	Practical
DSC	MES1T01	Paper 1: Environmental Chemistry	4	-	4	4	3	80	20	100	40	-
DSC	MES1T02	Paper 2: Environmental Microbiology and Biotechnology	4	-	4	4	3	80	20	100	40	-
DSE	MES1T03	Paper 3: Electives (Choose any one) (a) Ecotechnology for Sustainable Development (b) Environmental Management	4	-	4	4	3	80	20	100	40	-
RM	MES1T04	Paper 4: Research Methodology	4	-	4	4	3	80	20	100	40	-
DSC	MES1P01	Practical 1: Environmental Chemistry	-	6	6	3	3-8*	50	50	100	-	50
DSC	MES1P02	Practical 2: Environmental Microbiology and Biotechnology (Including Research Methodology)	-	6	6	3	3-8*	50	50	100	-	50
		TOTAL	**16**	**12**	**28**	**22**	--	**420**	**180**	**600**	**160**	**100**

CIE = Continuous Internal Evaluation and SEE = Semester End Examination

M. Sc. ENVIRONMENTAL SCIENCE Semester II													
Course Category	Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme						
			Theory	Practical	Total		Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
								SEE	CIE		Theory	Practical
DSC	MES2T05	Paper 5: Industrial Safety, Hygiene and Occupational Health	4	-	4	4	3	80	20	100	40	-
DSC	MES2T06	Paper 6: Analytical Techniques for Environmental Monitoring	4	-	4	4	3	80	20	100	40	-
DSE	MES2T07	Paper 7: Electives (Choose any one) (a) Environmental Impact Assessment and Environmental Audit (b) Water Supply and Resources	4	-	4	4	3	80	20	100	40	-
OJT	MES2P03	Practical 3: On Job Training/ Field Project	-	8	8	4	3-8*	50	50	100	-	50
DSC	MES2P04	Practical 4: Industrial Safety, Hygiene and Occupational Health	-	6	6	3	3-8*	50	50	100	-	50
DSC	MES2P05	Practical 5: Analytical Techniques for Environmental Monitoring	-	6	6	3	3-8*	50	50	100	-	50
		TOTAL	**12**	**20**	**32**	**22**	-	**390**	**210**	**600**	**120**	**150**

CIE = Continuous Internal Evaluation and SEE = Semester End Examination

M. Sc. ENVIRONMENTAL SCIENCE Semester III												
Course Category	Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
							Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
			Theory	Practical	Total			SEE	CIE		Theory	Practical
DSC	MES3T08	Paper 8: Physicochemical Treatment of Water and Waste Water Treatment	4	-	4	4	3	80	20	100	40	-
DSC	MES3T09	Paper 9: Biological Process in Waste Water Treatment	4	-	4	4	3	80	20	100	40	-
DSC	MES3T10	Paper 10: Advanced Waste Water Treatment	4	-	4	4	3	80	20	100	40	-
DSE	MES3T11	Paper 11: Elective (Choose any one) (a) Environmental Conservation and Sustainable Development (b) Disaster Management	4	-	4	4	3	80	20	100	40	-
DSE	MES3P06	Practical 6: Based on Elective subject	-	4	4	2	3-8*	50	50	100	-	50
RP	MES3P07	Research Project (RP)	-	8	8	4	3-8*	50	50	100	-	50
		TOTAL	**16**	**12**	**28**	**22**	-	**420**	**180**	**600**	**160**	**100**

CIE = Continuous Internal Evaluation and SEE = Semester End Examination

M. Sc. ENVIRONMENTAL SCIENCE Semester IV													
Course Category	Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme						
			Theory	Practical	Total		Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
								SEE	CIE		Theory	Practical
DSC	MES 4T12	Paper 12: Advanced Pollution Control Technology	4	-	4	4	3	80	20	100	40	-
DSC	MES 4T13	Paper 13: Climate Change and its consequences	4	-	4	4	3	80	20	100	40	-
DSC	MES 4T14	Paper 14: Remote Sensing, GIS and Computer Applications	4	-	4	4	3	80	20	100	40	-
DSE	MES 4T15	Paper 15: Elective (Choose any one) (a) Biomedical and Hazardous Waste Management (b) Environmental Geosciences	4	-	4	4	3	80	20	100	40	-
RP	MES 4P08	Research Project (RP)	-	12	12	6	3-8*	100	100	200	-	100
		TOTAL	**16**	**12**	**28**	**22**	-	**420**	**180**	**600**	**160**	**100**

CIE = Continuous Internal Evaluation and SEE = Semester End Examination

(Dr. S. L. Pal)

Basket for ELECTIVE (DSE) Category Courses (Environmental Science)

Semester	Course Category	Name of Course	Course Code
I	Elective 1	A. Eco-technology for Sustainable Development	MES1T03
		B. Environmental Management	
II	Elective 2	A. Environmental Impact Assessment and Environmental Audit	MES2T07
		B. Water Supply and Resources	
III	Elective 3	A. .Environmental Conservation and Sustainable Development	MES3T11
		B. Disaster Management	
IV	Elective 4	A. Biomedical and Hazardous Waste Management	MES4T15
		B. Environmental Geoscience	

Abbreviations:

DSC: Discipline Specific Course, **DSE**: Discipline Specific Elective **SEE:** Semester End Examination, **CIE:** Continuous Internal Evaluation, **OJT:** On the Job Training (Internship/Apprenticeship), **FP:** Field Project, **RM:** Research Methodology, **RP**: Research Project

EVALUATION AND DISTRIBUTION OF MARKS

(1) Continuous Internal Evaluation (CIE): Twenty (20) marks

a. Mid-Semester Examination: Maximum Marks 20, Duration of Examination: One Hour, Pattern of Question Paper: Multiple Choice Questions, Mode of examination: Online or offline.

b. Overall Participation: Maximum 20 Marks (Such as, Attendance in theory classes, seminar,assignment, quiz, participation in field tours, conferences, workshops, and the general behaviour in the department.)

Note: Total Marks of CIE will be 40 (i.e., 20+20). A candidate must have to secure minimum 50% marks (i.e., 20 out of 40 marks). Failing so, he/she shall not be allowed to appear in End Semester Examination.

(2) Semester End Examination (SEE)

a. Theory Paper: Maximum Marks: 80 (Eighty), Duration of Examination-Three Hours, The paper will be set so as to cover all units/sections of the syllabus as below:

Type of questions	Total Number of questions with Marks	No. of questions tobe	Marks for EachQuestion	Total maximum marks
• Short answer questions • Long answer questions	**4 + 1 = 5** one long question from each unit (16 marks each) or two short questions fromeach unit (8+8=16 markseach) + one short question on each unit (4 marks each)	**5**	**16**	**80**

3) General Scheme for Distribution of Marks in Practical Examination in Environmental Science

Marks: 100 [SEE: 50 Marks] [CIE: 50 Marks]

a) **Continuous Internal Evaluation (CIE): Fifty (50) marks:** Attendance in practical classes, seminar, assignment, quiz, participation in field tours, conferences, workshops, and the general behaviour in the department

Note: Total Marks of CIE will be 50 marks. A candidate must have to secure minimum 50% marks (i.e., 25 out of 50 marks). Failing so, he/she shall not be allowed to appear in End SemesterExamination

b) **Semester End Examination (SEE):** Time: 5-6 h (Two days Examination

Exercise-1	15 Marks	- Evaluated jointly by Internal and External Examiner
Exercise-2	15 Marks	- Evaluated jointly by Internal and External Examiner
Record	10 Marks	- Evaluated by Internal
Viva-Voce	10 Marks	- Evaluated by External
Total	**50 Marks**	

4) General Scheme for Distribution of Marks in Project Examination in Environmental Science

The project work will carry total 100 marks and will be evaluated by both external and internal examiners in the Department. The examiners will evaluate the project work considering the coverage of subject matter, presentation, literature etc.

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M.Sc. Semester-I Paper-I Environmental Chemistry

Unit-I: **Fundamental of Chemistry:** Classification of elements, normality, mole concept, molarity, molality, measurement of temperature, volume, density, viscosity and their uses.

Basic Concept from Quantitative Chemistry: pH and buffer solution, colorimetry, Beer's Lamberts Law, principle of colloidal chemistry, emulsion, carbonate and bicarbonate system, saturated and unsaturated hydrocarbon.

Physical Chemistry: Gibbs energy, chemical potential, types of chemical reaction, stoichiometry, principle of oxidation and reduction, adsorption and absorption.

Unit-II: **Basic Concept of Environmental Chemistry:** Basic concept, scope, definition and importance of environmental chemistry.

Aquatic Chemistry: Structure of water, water balance, solubility product, solubility of gases in water such as oxygen, nitrogen, CO2, H2S. Composition of ocean water, characteristic of world ocean structure like pH, temperature, density, balance of dissolved material in ocean.

Green Chemistry: Green chemistry for sustainable future, basic principles, importance and their significance, application of green chemistry, biopolymer.

Unit-III: **Soil Chemistry:** Introduction of soil chemistry, composition of soil, soil profile, soil formation, physico- chemical properties of soil, soil reactions (cation, anion, exchange phenomenon)

Classification of Soil and their Characteristics: Major nutrients of soil, bio fertilizers and their types, humus formation, nature and properties of humus, clay- humus complex, significance of C:N ratio

Soil Pollution: Definition and sources, consequences and control measures. Land use planning, soil survey in relation to land use planning, bioremediation and restoration of contaminated soil, soil erosion, and reclamation of degraded land, desertification and its control measures.

Unit-IV: **Industrial Chemistry:** Classification of industries based on environmental impacts, criteria for selection of site for establishment of industry, problem of sustenance and the chemical industry.

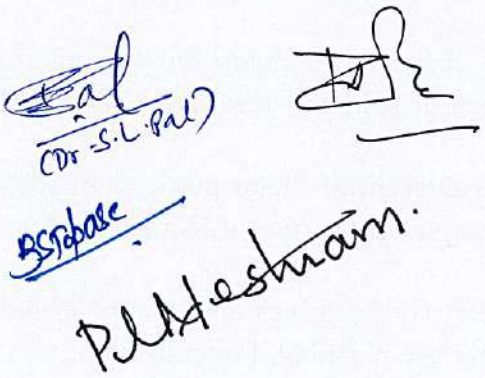
Characteristics of Industrial Wastes: Types of Industrial waste, characterization and treatment of industrial waste with respect to paper and pulp, tannery, textile, dairy, sugar, fertilizers, pharmaceutical.

Toxic Impurities in Industrial Effluent: Protection of surface waters from pollution with industrial waste, waste of industrial units and their purification.

(Dr. S.L. Pal) BSS/DSC Pldestmam.

Books for Reference:

1. Environmental Chemistry : B.K. Sharma and H. Kaur (Goel Publishing House, Meerut)
2. Industrial Chemistry : B. K. Sharma (Goel Publishing House, Meerut)
3. A Text book of Environmental Chemistry and Pollution Control : S. S. Dara (S. Chand)
4. Elements of Environmental Chemistry : H. V. Jadhav (Himalaya Publishing House) 1992
5. Global Environmental Chemistry : Parashar, Sharma, Mitra (Narosa Publishing House, New Delhi)
6. Environmental Chemistry : Samir K Banerji (Practice Hall New Delhi)
7. Environmental Chemistry with Green Chemistry by Asim K Das Book and Allied (P) LTD, Kolkata
8. Environmental Chemistry : A. K. Dey (Wiley Eastern Ltd) 1987
9. Environmental Chemistry : J. W. Moore and F. A. Moore (Academic Press, New Delhi)
10. Water Pollution and disposal of waste water on land U. N. Mahida (Tata Mc – Grew Hill Publishing Company, New Delhi)
11. Principles of Ecology : P. S. Verma, V. K. Agarwal (S. Chand and Co. New Delhi) Ecology and Environment : P. D. Sharma (Rastogi Publication, Meerut)



Paper- II: Environmental Microbiology and Biotechnology

Unit I: **Introduction to Microbiology:** Introduction, Scope, Branches of Microbiology, Importance of Environmental Microbiology, Environmental Aspects of Infectious Diseases (Water Borne Diseases).

Classification and Structure of Microorganisms: Structure of Microorganisms-Fungi, Bacteria, Virus, Microbial Diversity, Microbial quality of air, water and soil.

Microbial Nutrition: Basic nutritional requirement, Nutritional types of bacteria, Types of Culture media (selective, differential, enriched, synthetic and non-synthetic).

Unit II: **Isolation of pure culture by various methods:** Streak Plate Method, Spread Plate Method and Pour Plate method (Standard Plate Count)

Microbial Control and Preservation: Control by physical and chemical method, Sterilization and disinfection., Maintenance and Preservation of Microbial Culture, Culture Collection Centre.

Microbial Methods: Methods for detection of Coliform in water, Most Probable Number(MPN), Multiple Tube Dilution Technique (MTDT), Membrane Filtration Technique (MFT).

Unit III: **Applied Environmental Microbiology:** Bioremediation and its role in Environmental Management, control of insect and pest by microorganism. role of microbes in sewage treatment (Trickling filter, Activated sludge process and Oxidation pond process).

Environmental Microbiology in Sustainable Development: Plant growth Rhizobacteria and their metabolite, mechanism of action for biotic and abiotic stress management, biological nitrogen fixation, assimilation and transport, physiological aspects of nitrogen fixation.

Bio-fertilizers: Description and characteristics of bio-fertilizers, sources of nitrogen - Rhizobium, Azobacter, Azospirillum, Blue green algae, Azolla. Phosphate solubilizing microorganisms-Mycorrhizae, Psuodomonas, Bio-fertilizer production technology, Importance of bio-fertilizers.

Unit IV: **Environmental Biotechnology:** Introduction, basics of environmental biotechnology, definition and scope of biotechnology, biotechnological approach to control environmental pollution - In-situ and Ex-situ bioremediation, phyto-remediation (metal phyto-remediation, organic phyto-remediation), microbes used in pollution mitigation.

Bioinformatics: Biological data acquisition, the form of biological information, biological information and database, retrieval methods for DNA sequence, protein sequence and protein structure information.

Environmental Biotechnology and Sustainability: Bio-control agents- bio-pesticides, bio-insecticide, mushroom cultivation and vermiculture. Bioethics and Biosafety.

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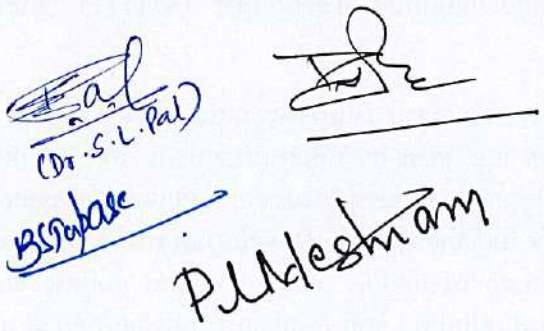
Books for Reference:

1. General microbiology Volume I &II : C. B. Powar& H. F. Daginawala (Himalaya Publishing House, Mumbai), 2002
2. Fundamental principles of Bacteriology (TMH Edition): A. J. Salle, (Tata McGraw-Hill Company Limited, New Delhi), 1974
3. Microbiology : P. D. Sharma (Rastogi Publication Meerut)
4. Microbiology: Pelizer, Reid & Chan (Tata McGraw-Hill Publishing Company Limited, New Delhi).
5. Hand book of Microbiology: Yu. S. Krivashein(Mir Publishers Moscow)
6. Microbiology for Environmental Engineering : M. C. Kinnery (Tata McGraw-Hill Publishing Company Limited, New Delhi).
7. Applied Microbiology: Vimta Kale & Kishore Bhusari (Himalaya Publishing House, Mumbai).
8. Soil Microbiology: Martin Alexander, Wiley Eastern Limited, 1981
9. Environmental Biotechnology: S. N. Jogdand, Himalaya Publishing House, Mumbai (2006).
10. A Textbook of Biotechnology: R. C. Dubey, S. Chand & Company, New Delhi (2002)



Elective-I
Eco-technology for Sustainable Development

Unit-I: Introduction to Eco-technology

Eco-technology: Definition, Principles and Concept of Eco-technology, applications of Ecotechnology. Eco-friendly technology for rural environment: concept & definition, characteristic features of eco-friendly technologies developed for rural people.

Ecofriendly schemes for rural areas: Solar cells, solar cooker, solar heaters, smokeless chulas, Biogas stoves, community biogas plant.

Ecofriendly schemes for urban areas: Green infrastructure, green road, urban forest, Eco-town concept, e-vehicle

Unit-II: Sanitation– Phyto sanitation and Green Inhibitors

Meaning, concept and importance of SPS, in reference to WTO-SPS agreement, important Phyto sanitation technologies- HBPST,TDC, SPS committee, the ten commandments of SPS agreement of WTO.

Green inhibitors: Factors pertaining to metal samples, inhibitors in use, cooling systems, processing with acid solutions, corrosion, problems in oil industry, corrosion inhibition in the mining industry, atmospheric corrosion inhibition mechanisms.

Standardized Environmental testing, Hybrid coating & corrosion inhibitors, Environmental green inhibitors, Industrial application of corrosion inhibition.

Unit-III: Climate Change Mitigation and Carbon Sequestration

Carbon related definitions: C-pool, C-stock, C-Flux, C-sink, C-source, and sequestration/uptake.

Clean Development Mechanism (CDM): A brief understanding of the Clean Development Mechanism (CDM)to combat climate change, developing carbon market for combating climate change, benefits of CDM projects.

C-sequestration: Development of C-sequestration projects their modalities and procedures- reducing emissions from degradation and deforestation (REDD and REDD+), International efforts in combating global warming & climate change. A brief understanding of UNFCCC (Kyoto protocol) NATCOM, IPCC, CBD, UNCCD, world heritage conventions, UN forum on forests etc.

Unit-IV: Restoration Ecology & Remediation Technology

Restoration Ecology: Definitions, aims and objectives, principles, concept & strategies (long term vs short term), physical, chemical and biological restoration, role of ecological principles in restoration, holistic approach in restoration.

Eco-restoration Technologies: Greenness improvement & planting technologies, bamboo forest maintenance, biotopes, recycled water technology, soil & ground water contamination survey and cleaning technologies.

Bioremediation Technology: Land treatment, surface soil contaminant remediation: Case studies, slurry bioreactor, bio-remediation of metals.

Books for Reference:

1. Faegri, K. Vanderpifl (1976). The Principles of Pollination Ecology. 3rd Edition Pergamon Press, NY
2. Burroughs (2007). Climate Change: A multi-disciplinary approach, 2nd Edition, Cambridge, New York university press ISBN 9780521690331.
3. Cunningham. Principles of Environmental Science.
4. Green Corrosion Inhibitors by V. S. Sastri.
5. Bhatia S.C. (2002) Hand Book of Industrial Pollution & control CBS Publishers, New Delhi.
6. JO Smith Pete Smith., Introduction to Environmental Modelling 1St Edition Oxford University, Press.
7. Chatterji AK, (2005) Introduction to Environmental Biotechnology, Prentice Hall of India Private Limited. New Delhi

ELECTIVE-II
Environmental Management

Unit I: **Concept of Environmental Management:** Environment Management, fundamentals & goals. Need for Environmental Management, Systems and approach. Environmental Risk Management

Standards: International and National; Eco-mark, Environmental accounts and auditing, Green funding and taxes.

Environmental planning, Micro & Macro planning, rural & urban planning: Need for environmental planning, Levels of planning-Micro & Macro Planning, National and regional Planning, Basic difference in rural and urban planning, Demographic consideration, Dynamic, Available resource planning.

Unit II **Sustainable Development:** Principles and Scope of sustainability, Strategies for promoting sustainable development and consumption, Current issues and areas of debate in relation to sustainable development, carrying capacity based planning processes.

Sustainable development control and model: Environmental sustainability, Energy security, Water security, Food security and Social security.

Sustainable Energy Resources: Renewable energy for sustainable development. Natural resources and sustainable development. International efforts for conservation of resources, Sustainable Development Goals (SDGs)

Unit III: **Global Environmental Initiatives:** The Agenda 21 of Earth Summit, Major International Organizations and Agencies Involved in Environmental Management. Stockholm Conference on Human Environment1972, Montreal Protocol, 1987, Ramsar Convention on Wetlands (1971), Convention on Biodiversity (1992), Kyoto Protocol, 1997, Paris Agreement, Under 2 Coalition, Race to Zero, Fridays for Future.

National Environmental Initiatives: National Action Plan on Climate Change, State Action Plan on Climate Change, National Air Quality Monitoring Program, National Clean Air Program- Non Attainment Cities of India, Indian Rivers interlinking Projects.

Green Sustainable Initialise: Pillars of Green Plan, Green Initiatives in India, Watershed Management (Need of Watershed Management), Integrated and Multi-disciplinary Approach, Water Budget, Watershed Development Committees.

Unit IV: **Way Forward 2050:** Environment& Climate Literacy, Reduced inequalities, Access of Clean Water & Sanitation, Swachh Bharat Abhiyan, Clean & Affordable Energy-Limitations & Challenges, Urban Forests, Green Buildings.

NGO/Corporate Participation: Role of NGO in achieving SDGs and Commitment made in Paris Agreement, Bridge between Development & Environment, Corporate Social Responsibilities, Allocation of Budget for Environmental commitments and duties, Nature based solutions & Sustainability, Policy Statement.

Role of Policy & Decision Makers: Commitment to the cause, fund allocation for innovation in green & clean technology, technology transfer, Special Incentives, Role in generating awareness, ensuring implementation of stipulated emission/ discharge norms, Case Studies – Changes in policies & Acts towards sustainable development.

Books for Reference:

1. Environmental Management: Ajith Sankar R.N, Oxford University Press.
2. Introduction to Environmental Management :Mary K. Theodore, Louis Theodore , CRC Press
3. Environment Management : Vijay Kulkarni, T.V Ramachandra, Karnataka Environment Research Foundation.
4. Fundamentals of Remote Sensing: George Joseph, Universities Press Hyderabad, 2005
5. Remote Sensing and GIS :M. Anji Reddy, BS Publications, Hyderabad, 2008
6. Remote Sensing Techniques in Agriculture :D. D. Sahu, R. M. Solanki, Agrobios India, Jodhpur, 2008
7. GIS Basics :Shahab Fazal, New Age International Publishers, New Delhi, 2008
8. Geographical Information Systems :Anil K. Jamwal, Jnanda Prakashan, New Delhi, 2008
9. Environmental Science : S. C. Santra, New Central Book Agency, Kolkata, 2005
10. Global Environmental Issues : Frances Harris, John Wiley & Sons, Ltd.

Semester- I: Research Methodology

Unit I: **Basics of Research Methodology:**

Introduction to Research: Nature and Scope, Problem Formulation and Statement of Research Objectives, Research- - Purpose, Characteristics and Types of Research.

Research Process & Research Designs: Exploratory, Descriptive and causal Research designs, Quantitative and qualitative research.

Formulation of Hypotheses: Types of Hypotheses - Methods of testing Hypotheses - Research plan and its components - Methods of Research (Survey, Observation, case study, experimental, historical and comparative methods).

Unit-II: **Sampling, Data Collection and Analysis Techniques**

Basics of Data sampling: Concepts of Statistical Population and Sample, Sampling Frame, Sampling Error, Sample Size. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample. Practical considerations in sampling and sample size

Literature Survey & Data Collection: Importance of literature survey, sources of information, assessment of quality of journals and articles- information through internet, Qualitative and Quantitative Research, Concept of measurement, causality, generalization, replication. Merging the two approaches.

Research Design: Meaning of research design, need of research design, different research designs, basic principles of research design, developing a research plan, design of experimental setup- use of standards and codes.

Unit-III: **Statistical Aspects**

Collection, classification and tabulation of data: Preparation of one-way and frequency tables. Diagrammatic and graphical representation of data (data bar, pie and histograms, frequency polygons), frequency curves and cumulative curves.

Measures of central tendency and dispersion: mean. median, mode, range, standard deviation and standard error, coefficient of variation, skewness, kurtosis confidence limits and confidence intervals and normal distribution curve, Analysis of variance one way and two-way classification.

Accuracy, errors and Probability: Classification, Minimisation of errors, Rejection of data. Student-t test and chi-square tests, Correlation and Regression, regression lines and their use. Probability: Exclusive and independent events, addition and multiplication theorems.

Unit-IV: **Perspectives of Intellectual Property Rights (IPR's):**

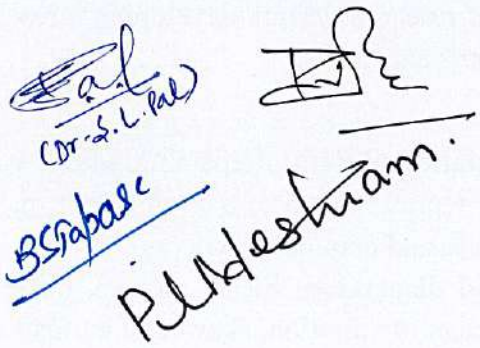
Definition & concept of IPR, types of intellectual property: industrial property, artistic and literary property, Sui Generis system, need of intellectual property, rationale for protection of IPR.

Patents: TRIPS, Definition, kinds of invention protection by patent- patentable and non-patentable inventions, patent filing process in India.

Trademarks: Definition, types, functions, and registration process of trademarks. Copyright: Fundamentals covered under copyright law, registration procedure for copyright, right to reproduction, right to perform the work publicly, copyright ownership issues. Academic integrity or Plagiarism: An intellectual theft

Books for References:

1. Fundamentals of IP for Engineers. K Bansal & P Bansal.
2. Intellectual Property Right- unleashing the knowledge economy. Prabuddha Ganguly, Tata McGraw Hill Publishing Company Ltd.
3. WIPO: Intellectual Property Handbook: Policy, Law and Use (web resource)
4. Fulekar, M. H. and Bhawana Pathak "Bioinstrumentation" I K International Publication, New Delhi, 2013.
5. Willard. H., Merritt, L., Dean, D.A. and Settle F.A., 'Instrumental Methods of, 7th edition, Wordsworth, New York, 1998.
6. Galen. W. Ewing, 'Instrumental Methods of Chemical Analysis 5th edition, McGraw Hill, New York., 1995.
7. Roger Reeve, Introduction to Environmental Analysis, John Wiley & SonsLtd,2002
8. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
9. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press
10. Research Methodology – C.R. Kothari



Semester-I Practical-I Environmental Chemistry

1. Laboratory concepts: Rules and regulation, preparation of standard solutions.
2. Weighing capacity and sensitivity of balance-care and use of balance.
3. Water sampling and storage techniques.
4. Examination of water quality with respect to following parameters
   i) pH, Conductivity, Density, Viscosity, Turbidity and Colour.
   ii) Acidity, Alkalinity, Hardness, Total Dissolved Solids (TDS), Dissolved Oxygen (DO).
5. Study of Adsorption of colour on Activated Charcoal and verification of Freundlich's Adsorption Isotherm.
6. Determination of Iron 1:10, O- Phenanthroline method.
7. Physical properties of soil: Porosity, water holding capacity, electrical conductivity and infiltration rate.
8. Physical properties of Fly ash.

Semester-I: Practical-II Environmental Microbiology and Biotechnology

1. Study of Laboratory Equipment and Instruments.
2. Microscopy a) Use of compound microscope b) Calibration of microscope.
3. Preparation and sterilization of microbial media.
4. Isolation of bacteria from soil ,water and air.
5. Determination of Standard Plate Count of given water sample.
6. Determination of Coli form count by MTDT and MPN technique
7. Staining techniques : a) Monochrome staining b) Gram staining.
8. Membrane Filters Technique (MFT) for coliform.
9. Estimation of total viable count in water and soil sample.
10. Determination of Rhizobium in soil sample.
11. Collection of affected leaves from roadside plantation and its comparison with reference plants.

Visit:

1. Visit to Dairy/ Sugar/ Distilleries Industry.
2. National Environmental Engineering Research Institute (NEERI), Nagpur
3. Rajiv Gandhi Biotechnology Center, Nagpur

At least one field visit is mandatory for all students, who need to submit the visit report within fifteen days of visit certified by HOD. The said visit report needs to be submitted at the time of Annual Practical Examination

Case Studies:

1. India's Commitment in Paris Agreement and Present Status
2. Role of green technology in India.
3. Plastic Waste Management – Urban Scenario

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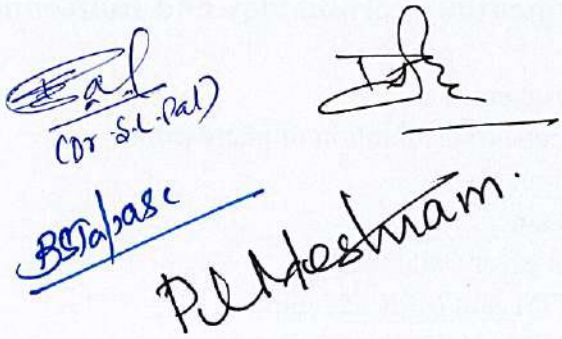
Students need to submit at least one case study duly certified by HOD and to be submitted at the time of Annual Practical Examination.

Distribution of Marks:

Long Experiment (One)	:	30 Marks
Short Experiments (Two)	:	30 Marks
Viva-Voice	:	10 Marks
Practical Records	:	10 Marks
Visit Report	:	10 Marks
Case Studies	:	10 Marks

Total Marks	**:**	**100 Marks**



M.Sc. (Semester II)

Paper- I: Industrial Safety, Hygiene and Occupational Health

Unit-1: **Industrial Hygiene:** Definition, scope, significance and applications. Occupational environmental stresses Physical stresses (Noise, vibration, illumination, ventilation, heat stresses), Chemical stresses (Toxic chemicals, hazardous chemicals) benefits of Industrial Hygiene.

Airborne Chemicals: Dust or aerosols (respirable and non-respirable, inhalable and total dust), gases, fumes, vapours, mist and smoke, Flammable chemical, explosive chemicals. etc. Inhalation and ingestion risks.

Toxicology: Concept of threshold limiting values(TLV), concentration, Time Weighted Averages (TWAs), Short Term Exposure Limits (STELs), Minimal National Standards (MINAS), International and national regulatory agencies like ACGIH.

Unit II: **Industrial Work Environment:** Identification of contaminants. Sampling strategies: monitoring methods / protocol on procedures. Sampling of airborne contaminants, viz dust, gases, fumes, vapours, mists etc in work place environment and analysis methods for quantification – Instrumental and manual methods.

Occupational Diseases: Pneumoconiosis, Silicosis, Asbestosis, Bagassosis, Byssiniosis. Work environment control measures: Substitution, isolation, ventilation, local exhaust system and engineering control methods.

Housekeeping and maintenance: Modification of the processes and operation. Process and product specific control measures. Report writing.

Unit III: **Introduction to Safety, Health and Hazards**

Importance of safety, health and environment: Industrial noise and noise control, Control Methods of industrial hygiene, Local Exhaust Ventilation, Wet method, Personal hygiene, housekeeping and maintenance, Introduction to OSHAS 18001 and OSHA.

Risk and hazards assessment: Understanding of risk and hazards, Hazards and operational Studies (HAZOP),On-site and Off-site emergency plan, Safety audit in chemical industry, risk assessment techniques, Accidents and unusual occurrences investigation, reporting, Hazards analysis techniques and measurement.

Hygiene of work environments: Occupational Health Standards, Toxic substances , Industrial process & safety measures, identify the tools to measure heat, noise and illumination inside the work-site, awareness of PPE equipments.

Unit IV: **Occupational Health and Environment Safety Management**

Occupational Health and Environment: Safety Management System, ILO (International Labour Standards on Occupational Safety) and EPA (Environmental Protection Agency) Standards. The scope and nature of occupational health and safety.

Chemical Hazard: Introduction to chemical hazards, Route of entry to human system, recognition, evaluation and control of basic hazards, concepts of dose response relationship, bio-chemical action of toxic substances.

Legislative measures in Industry: Factories Act, 1948, the factories rules, Functions of safety management., Air Pollution (Prevention and control) Act, 1981, Water Pollution (Prevention and Control) Act, 1974, Public Liability Insurance Act 1991, Coastal Regulation Zone (CRZ), Safety Audits: Internal and External Audits.

Books and References:

1. Industrial Hygiene & Chemical Safety - M.H. Fulekar: I. International Publishing House, New Delhi.
2. Industrial Hygiene Reference and Study Guide- Allan K. Fleeger, Dean Lillquist, AIHA, 01-May-2006.
3. Personal Protective Equipment -Guide to Ports/Dock Workers - M.H. Fulekar : Government of India's Publication.
4. Fundamentals of Industrial Hygiene-Barbara A. Plog, Patricia J. Quinlanational Safety Council Press, 2002.
5. Occupational safety management and engineering, Willie Hammer, Dennis Price, Prentice Hall, 2001.
6. Industrial Safety and Health Management, C. Ray Asfahl, David W. Rieske, Prentice Hall, 31-Jul-2009.
7. Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn, Government Institutes, 16-Aug-2010 .
8. Handbook of occupational safety and health, Louis J. DiBerardinis, John Wiley, 1999.
9. Occupational Hygiene. Blackwell Science, Harrington, J.M. & K. Gardiner. 1995, Oxford.
10. Sardar Patel University, University of Mumbai.

Paper -II: Analytical Techniques for Environmental Monitoring

Unit-I: **Chromatography:** Introduction, Definition, theory of chromatographic separation, stationary and mobile phases, classification of chromatographic separations, Rf value

Major Types of Chromatography: Principles, working and applications of Gas Chromatography (GC). High Performance Liquid Chromatography (HPLC) working and application, advantages of Gas Chromatography coupled with Mass Spectrometry (GC-MS).

Liquid Chromatography: Choice of solvents and stationary phases- characteristics of various stationary phases in chromatography, Thin Layer Chromatography and Paper Chromatography.

Unit-II: **Absorption Spectrophotometry:** Principle, working and applications of various instruments like UV-Visible Spectrophotometer, Infra-red (IR) Spectrophotometer, Nuclear Magnetic Resonance (NMR),

Estimation of Various Elements: Atomic Absorption Spectrophotometer (AAS), Flame Photometer,

Instrumental Analysis: Conductivity meter, Nephelometer/Turbidity meter, pH meter. working and applications.

Unit-III: **Electro Chemical Techniques:** Introduction, types of Electro-chemical technique, principle, instrumentation and application of Polarography in environmental chemical analysis

Aniodic Stripping Voltametry: Aniodic Stripping Voltametry with its application in environmental measurements, Speciation of heavy metals like Copper, Cadmium, Mercury, Nickel and Arsenic in natural water system.

Ion Selective Electrodes: Basic principles, classification of electrodes, measurement methods, Instrumentation and application in the analysis of fluorides, nitrates, cyanides, ammonia, sulfides. Redox potential measurement and its significance in environmental monitoring.

Unit-IV: **Modern Instrumental Techniques:** Radiochemical analysis, Inductively Coupled Plasma Spectroscopy (ICP), Aerosol Time of Flight Mass Spectrophotometry (ATOMFS).

Mass Spectrometer: Atomic Mass Spectrometer, Molecular Mass Spectrometry, Mass Spectrometric Applications in environmental analysis.

Analysis of Environmental Samples: Neutron activation analysis, X-ray diffraction, Isotope dilution analysis.

Books for Reference:

1. Instrumental Methods of Environmental Analysis: Karan Sareen, (Sarup and Sons Publishers, New Delhi), 2001
2. Instrumental Methods of Chemical Analysis: B. K. Sharma, Goel Publishing House, Meerut (1996).
3. Standard Methods for the Examination of Water and Waste Water: (APHA, AWWA & WPCF), 1985
4. Instrumental Methods and Chemical Analysis: H. Kaur, PragatiPrakashan, Meerut (2009).
5. Instrumental Analysis: Shoog Holler (Harcourt Asia Publishers Ltd., New Delhi), 1952
6. Instrumental Methods of Chemical Analysis: Chatwal and Anand (Himalaya Publishing House, New Delhi), 1994
7. Instrumental Analysis: GurdeepChatwal (Himalaya Publishing House, New Delhi), 2000
8. Instrumental Methods: V. B. Borade (Nirali Prakashan, Mumbai)
9. Instrumental Analysis for Science and Technology: W. Ferren (Agrobios India, Jodhpur)
10. Photo chemistry & Spectroscopy: J.P. Simmons Wiley 1971

Elective-I:
Environmental Impact Assessment and Environmental Audit

Unit-I: **Environmental Impact Assessment:** Definition, Basic Concepts and Evolution of EIA, Principles of EIA, Need for EIA, Elements of EIA.

Nature of Impacts: Primary, Secondary, Tertiary, Short Term, Long Term, Reversible and Irreversible Impacts with respect to Air, Noise, Water, Land, Biological and Socio-Economic Elements.

Case Studies: Case Studies of EIA, challenges faced, mitigation suggested, Project specific Environmental Management Plan.

Unit-II: **EIA Procedure:** Screening and Scoping in EIA, Impact Assessment; Mitigation, Impact Management, EIA Report, Review & Licensing, Monitoring.

Methodologies of EIA: Adhoc method, Checklist, Matrices, Overlays, Impact Identification Networks, Battelle Environmental Evaluation System, Computer Aided EIA, Role of Mathematical Models in EIA, Cost Benefit Analysis, Strategic Environmental Impact Assessment (SEA), Procedure, Benefits.

Legislation of EIA: Notification of EIA in India and it's modification Role of Statutory Agencies in EIA Clearance. EIA guideline for development project, Public Hearing.

Unit- III: **Environmental Audit:** Concept of Environmental Audit, Definition, Objective, Types of Environmental Audit, Benefits of Environmental Audit.

Procedural Requirements of Conducting EA: Pre-Audit, on-Site Audit and Post Audit Activities, Scope for audit : Water Audit, Raw' Materials Audit and Energy Audit, Health and Safety Audit, Reuse and Conservation of Water and Energy, Waste Minimization.

ECO- Audit: Importance in Environmental Management, Concept of ISO 9000. Concept & Scope ISO 14000, it's application in Environmental Management, Merits and Demerits.

Unit- IV: **Environmental Legislation:** Need of Environmental Legislation, The Water Prevention and Control of Pollution Act 1974, The Air Prevention and Control of Pollution Act 1981,The Environmental Protection Act 1986

Forest & Wild Life: The Wild Life (Protection) Act 1972, The Wild life Protection Rules 1995 The Forest Conservation Act 1980, The Forest, Conservations Rules 1981, Biological Diversity Act- 2002, The Maharashtra (Urban Areas) Protection & Preservation of Tree Act 1975 & Amendments 2021.

Other Important Acts: Salient Features of Coastal Zone Regulations (CZR) Notification, The Noise Pollution (Regulation and Control) Rules, 2000;Public Liability Insurance Act- 1991, National Green Tribunal Act- 2010.

Books for Reference:

1. Environmental Impact Assessment: Principles and Procedures, John Wileyand Sons, New York.
2. Environmental Impact Assessment: A.K. Shrivastav, APH Publishing, Corporation, New Delhi.
3. Environmental Impact Assessment: S.A.Abbasi, D.S.Arya, Discovery Publishing House, New Delhi.
4. Environmental Pollution Control: Neelima Rajvidya and Dilipkumar Markandey, APH Publishing Corporation, New Delhi, 2005
5. Environment Problems and Solutions: D.K.Asthana and Meera Asthana, S.Chand& Co. Ltd. New Delhi.
6. An Introduction to Environmental Management: Dr.AnandS.Bal, Himalaya Publishing House, New Delhi.
7. Environmental Impact Analysis Handbook: John G.R. and David C.Wooten, McGraw Hill Publications, 1987
8. Encyclopedia of Ecology and Environment: Environmental Impact Assessment Vol.7: Trivedi P.R., Indian Institute of Ecology and Environment, New Delhi, 1999
9. Environmental Law and Policy in India: Divan S and Rosencraz A, Oxford University Press, New Delhi,2001
10. Environmental Laws of India :An Introduction: CPR Environmental Education Centre, Chennai, 2001.

Elective- II:
Water Supply and Resources

Unit- I: **Sources of Water Supply:** Availability of water on earth, sources of water, types of water sources, surface water , ground water,(streams, lakes, rivers, ponds, impounded reservoirs, stored rainwater well water).

Water Supply Scheme: Importance and necessity of water supply scheme, essential of water supply scheme.

Suitability of Water: Suitability of surface water with regard to quality and quantity, suitability of ground water with regard to quality and quantity, reservoir storage capacity.

Unit-II: **Surface and Ground Water Quality:** Infiltration, porosity, water bearing stratum, groundwater flow, groundwater yield, permeability, groundwater velocity, springs, infiltration galleries, porous pipe galleries', parameters of organic content of water quality (DO and BOD).

Classification of Wells: Dug wells or percolation well, yield & types of wells, tube wells, specific capacity of a well, infiltration well, artesian well, yield of a artesian well, yield of an infiltration gallery.

Transformation and Transport Process in Water Body: Oxygen transfer by inter-phase, turbulence mixing in river, water quality in lakes, rivers and in groundwater.

Unit- III: **Quantity and Quality of Water:** Types of demand, factor affecting rate of demand, variations in rate of demand, measurement of water quantity, effects of variation on design.

Demand and Quality of Water: Water requirements for buildings other than residences, estimating population, factors affecting estimated population, meaning of pure and potable water, impurities in water.

Analysis of Water: Analysis of water, physical tests, chemical test, bacteriological tests, maintenance for purity of water, precaution and preservation, water borne diseases, suitability of water for trade purposes, water for swimming pool, drinking water standards,

Unit- IV: **Distribution of Water:** Method of distribution system, requirement of distribution of water and their merits and demerits

Maintenance of Water System: System of supplying water, types of service reservoir, different layout for distribution of water, design and maintenance of distribution system, wastage of water, water waste tests, maintenance of distribution system, analysis of pipe network.

Types of Valves: Detection and prevention of leakages, rectification, types of valves, fire hydrants, water meters.

(Dr. S.L. Pal)

Books for References:

1. Instrumental Methods of Analysis: Willered Meritand Dean CBS Publication, New Delhi.
2. Wastewater Treatment for Pollution Control: Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi.
3. Water Supply & Sanitary Engineering: G.S.Birdie.
4. Text book of Water Supply & Sanitary Engineering: S.K.Husain.
5. Water Supply & Sanitary Engineering: R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.
6. Wastewater Treatment: M.N.Rao, A.K.Datta, IBH Publishing Company, New Delhi.
7. A Textbook of Sanitary Engineering: Vinayak Gharpure, Engineering Book Publishing Company, Pune.
8. Water Pollution: V.P.Kudesia, Pragati Prakashan, Meerut.
9. Environmental Problems and Solution: D.K.Asthana, S.Chand and Company, New Delhi.
10. A Text book of Environment: K.M.Agarwal and P.K. Sikdar, Macmillon India Ltd, Nagpur

Semester –II: Practical-I

Practical- I:Analytical Techniques:

1. Separation of amino acid by Thin Layer Chromatography.
2. Detection of metal ions by Paper Chromatography
3. Study of principles components of UV-Visible Spectrophotometer .
4. Analysis of sulphate by Spectrophotometer.
5. Analysis of phosphate by Spectrophotometer.
6. Analysis of nitrate by Spectrophotometer.
7. Analysis of Phenol by Spectrophotometer.
8. Determination of Sulphide in raw water.
9. Estimation of Sodium, Potassium, Calcium and Lithium by Flame photo meter.
10. Demonstration of AAS for trace and heavy metal analysis.
11. Demonstration of HPLC and GC for pesticide analysis.

Semester –II: Practical-II

Practical- II: Industrial Safety, Hygiene and Occupational Health:

1. Estimation of oil and grease from Industrial water sample.
2. Determination of Suspended Particulate Matter (SPM) and RSPM in ambient air by using High Volume Sampler.
3. Determination of SOx concentration in ambient air by using High Volume Sampler.
4. Determination of NOx concentration in ambient air by using High Volume Sampler.
5. Measurement of noise pollution by Noise Meter in silent, residential, commercial, and industrial zone and comparison with standards.
6. Preparation and interpretation of wind roses
7. Estimation of Chemical Oxygen Demands (COD) of Industrial Waste Water.
8. Determination of settable particles by Dust fall jar method.
9. Estimation of Biochemical Oxygen Demands (BOD) of Industrial waste water.
10. Bioassay test with fish/snail and determination of LC50 value using pollutants/heavy metals.
11. Determination of Air Pollution Index(API) from Industrial area.
12. Determination of Water Quality Index (WQI) from Industrial area.
13. To neutralize the given sample using NaOH/HCl / CaCO3.
14. Determination of CO from the atmosphere by volumetric method in a workplace Environment.

Visit:

1. Industrial Visit.
2. National Environmental Engineering Research Institute (NEERI), Nagpur.
3. Visit to ISO Implemented Laboratory/Industry.
4. Visit to Fire Safety Department

At least one field visit is mandatory for all students, who need to submit the visit report within fifteen days of visit certified by HOD. The said visit report needs to be submitted at the time of Annual Practical Examination

Case Studies:

1. Development v/s Environment.
2. Operations and Impact of any one NGO of Nagpur City.
3. Role of PPE and NRPE.

Students need to submit at least one case study duly certified by HOD and to be submitted at the time of Annual Practical Examination.

Distribution of Marks:

Long Experiment (One)	:	30 Marks
Short Experiments (Two)	:	30 Marks
Viva-Voice	:	10 Marks
Practical Records	:	10 Marks
Visit Report	:	10 Marks
Case Studies	:	10 Marks

Total Marks	**:**	**100 Marks**