INSTITUTE OF SCIENCE, NAGPUR.

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF ENVIRONMENTAL SCIENCE

Syllabus

Master of Science (M.Sc.) Semester Pattern

Environmental Science

(EVS/PG/2021/01)

Approved by BoS, Environmental Science in the First Meeting conducted on dated 20.12.2021, Page. No. 1-91

(To be Implemented from 2021-2022)

M.Sc. (Semester Pattern) Syllabus
Semester wise Name of Papers
Subject - Environmental Science
PG Program and Paper Code

Semester	Paper	Name of the Paper	Paper Code
I	I	Environmental Chemistry	**MESFS11**
	II	Atmospheric Science	**MESFS12**
	III	Environmental Biology, Microbiology and Biotechnology	**MESFS13**
	IV	Climate Change and It's Consequences	**MESFS14**
	Practical – I : Laboratory Course	Environmental Chemistry and Atmospheric Science	**MESFS15**
	Practical – II : Laboratory Course	Environmental Biology and Climate Change and it's Consequences	**MESFS16**
	Seminar - I	**Seminar**	**MESFS1SM**
II	**I**	Environmental Ecosystem and Biodiversity	**MESFS21**
	II	Natural Resources Management	**MESFS22**
	III	Environmental Sampling and Research Methodology	**MESFS23**
	IV	Analytical Techniques for Environmental Monitoring	**MESFS24**
	Practical – I : Laboratory Course	Environmental Ecosystem and Management and Natural Resources Management	**MESFS25**
	Practical – II : Laboratory Course	Industrial Chemistry and Analytical Techniques	**MESFS26**
	Seminar - II	**Seminar**	**MESFS2SM**

III	I	Physico- Chemical Treatment of Water & Waste Water	**MESSS31**
	II	Biological Process in Wastewater Treatment	**MESSS32**
	III	**ELECTIVE-I** Water and Water Treatment **OR** **ELECTIVE-II** Water Supply and Resources	**MESSS33** **MESSS34**
	IV	**FOUNDATIONI** Fundamentals of Environmental Science- I **OR** Advance Water & Waste Water Treatment	**MESSS35** **MESSS36**
	Practical – I : Laboratory Course	Physico-chemical treatment of water and waste water and Biological process in waste water Treatment	**MESSS37**
	Practical – II : Laboratory Course	**ELECTIVE-I** Water & Water Treatment **OR** **ELECTIVE-II** Water Supply and Resources	**MESSS38** **MESSS39**
	Seminar - III	**Seminar**	**MESSS3SM**
IV	I	Air and Noise Pollution Control Technology	**MESSS41**
	II	Solid and Hazardous Waste Management	**MESSS42**
	III	**ELECTIVE-I** Environmental Impact Assessment and Legislation **OR** **ELECTIVE-II** Environmental Management	**MESSS43** **MESSS44**
	IV	**FOUNDATION-II** Fundamentals of Environmental Science- II OR Core (Subject Centric) –II Disaster Management	**MESSS45** **MESSS46**
	Practical – I : Laboratory Course	Air and Noise Pollution Control Technologies and Solid and Hazardous Waste Management and EIA & Legislation	**MESSS47**
	Practical – II : Laboratory Course	**Project Work**	**MESSS48**
	Seminar - IV	**Seminar**	**MESSS4SM**

Ex. MESFS11 : M -M.Sc, ES-Environmental Science, F-First Year, S1- Semester-1, 1- Subject Paper-1

MESFS1SM : M -M.Sc, ES-Environmental Science, F-First Year, S1- Semester-1, SM- Seminar

PG Program Structure

Marking Scheme of Syllabus

Faculty of Science B.Sc. Semester-I to VI (Environmental Science)

Semester	Paper	Total Periods / Week	Marks		Total Marks	Total Marks
			Theory / Practical/Project	Internal		
I to VI	**I**	04	80	20	100	625
	II	04	80	20	100	
	III	04	80	20	100	
	IV	04	80	20	100	
	Practical-I	08	100	-	100	
	Practical-II	08	100	-	100	
	Seminar	02	-	25	25	

Scheme of Teaching and Examination under Choice Based Credit Systems for M.Sc. Environmental Science

M.Sc. Environmental Science: Semester - I

Code	Theory / Practical	Teaching Scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
		Theory	Pract.	Total			External Marks	Internal Assessment		Theory	Pract.
MESFS11	**Paper I :** Environmental Chemistry	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS12	**Paper-II :** Atmospheric Science	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS13	**Paper-III :** Environmental Biology, Microbiology and Biotechnology	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS14	**Paper-IV :** Climate Change and It's Consequences	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS15	**Practical – I** Environmental Chemistry and Atmospheric Science	**--**	**8**	**8**	**4**	**3-8**	**100**	**--**	**100**	**--**	**40**
MESFS16	**Practical – II** Environmental Biology and Climate Change and it's Consequences	**--**	**8**	**8**	**4**	**3-8**	**100**	**--**	**100**	**--**	**40**
MESFS1SM	**Seminar - I**	**2**	**--**	**2**	**1**	**--**	**--**	**25**	**25**	**10**	**--**
	Total	**18**	**16**	**34**	**25**	**--**	**520**	**105**	**625**	**170**	**80**

M.Sc. Environmental Science: Semester - II											
Code	**Theory / Practical**	**Teaching Scheme (Hours / Week)**			**Credits**	**Examination Scheme**					
						Duration in hrs.	**Max. Marks**		**Total Marks**	**Minimum Passing Marks**	
		Theory	**Pract.**	**Total**			**External Marks**	**Internal Assessment**		**Theory**	**Pract.**
MESFS21	**Paper I :** Environmental Ecosystem and Biodiversity	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS22	**Paper-II :** Natural Resources Management	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS23	**Paper-III :** Environmental Sampling and Research Methodology	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS24	**Paper-IV :** Analytical Techniques for Environmental Monitoring	**4**	**--**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	**--**
MESFS25	**Practical – I** Environmental Ecosystem and Management and Natural Resources Management	**--**	**8**	**8**	**4**	**3-8**	**100**	**--**	**100**	**--**	**40**
MESFS26	**Practical – II** Industrial Chemistry and Analytical Techniques	**--**	**8**	**8**	**4**	**3-8**	**100**	**--**	**100**	**--**	**40**
MESFS2SM	**Seminar - II**	**2**	**--**	**2**	**1**	**--**	**--**	**25**	**25**	**10**	**--**
	Total	**18**	**16**	**34**	**25**	**--**	**520**	**105**	**625**	**170**	**80**

M.Sc. Environmental Science: Semester - III												
Code	Theory / Practical	Teaching Scheme (Hours / Week)			Credits	Examination Scheme						
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks		
		Theory	Pract.	Total			External Marks	Internal Assessment		Theory	Pract.	
MESSS31	**Paper I :** Physico- Chemical Treatment of Water & Waste Water	4	--	4	4	3	80	20	100	40	--	
MESSS32	**Paper-II :** Biological Process in Wastewater Treatment	4	--	4	4	3	80	20	100	40	--	
MESSS33 MESSS34	**Paper-III :** **ELECTIVE-I** Water and Water Treatment **OR** **ELECTIVE-II** Water Supply and Resources	4	--	4	4	3	80	20	100	40	--	
MESSS35 MESSS36	**Paper-IV : FOUNDATIONI** Fundamentals of Environmental Science- I **OR** Advance Water & Waste Water Treatment	4	--	4	4	3	80	20	100	40	--	
MESSS37	**Practical – I** Physico-chemical treatment of water and waste water and Biological process in waste water Treatment	--	8	8	4	3-8	100	--	100	--	40	
MESSS38 MESSS39	**Practical – II** **ELECTIVE-I** Water & Water Treatment **OR** **ELECTIVE-II** Water Supply and Resources	--	8	8	4	3-8	100	--	100	--	40	
MESSS3SM	**Seminar - III**	2	--	2	1	--	--	25	25	10	--	
	Total	18	16	34	25	--	520	105	625	170	80	

M.Sc. Environmental Science: Semester - IV												
Code	Theory / Practical	Teaching Scheme (Hours / Week)			Credits	Examination Scheme						
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
		Theory	Pract.	Total			External Marks	Internal Assessment		Theory	Pract.
MESSS41	**Paper I :** Air and Noise Pollution Control Technology	4	--	4	4	3	80	20	100	40	--
MESSS42	**Paper-II :** Solid and Hazardous Waste Management	4	--	4	4	3	80	20	100	40	--
MESSS43 MESSS44	**Paper-III :** **ELECTIVE-I** Environmental Impact Assessment and Legislation **OR** **ELECTIVE-II** Environmental Management	4	--	4	4	3	80	20	100	40	--
MESSS45 MESSS46	**Paper-IV : FOUNDATION-II** Fundamentals of Environmental Science- II OR Core (Subject Centric) –II Disaster Management	4	--	4	4	3	80	20	100	40	--
MESSS47	**Practical – I** Air and Noise Pollution Control Technologies and Solid and Hazardous Waste Management and EIA & Legislation	--	8	8	4	3-8	100	--	100	--	40
MESSS48	**Project Work**	--	8	8	4	3-8	100	--	100	--	40
MESSS4SM	**Seminar - IV**	2	--	2	1	--	--	25	25	10	--
	Total	18	16	34	25	--	520	105	625	170	80

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - I

MESFS11: PAPER- I (Environmental Chemistry)

OBJECTIVES:

To make Students:

1. Explain Fundamental of Chemistry, Basic Concept from Quantitative Chemistry and Physical Chemistry
2. Learn Basic Concept of Environmental Chemistry, Aquatic Chemistry and Green Chemistry
3. Understand Soil Chemistry, Classification of Soil and their Characteristics, Soil Pollution
4. Recognize Industrial Chemistry, Characteristics of Industrial Wastes, Toxic Impurities in Industrial Effluent

OUTCOMES:

Students shall be able to:

1. Interpret and utilize Fundamental of Chemistry, Basic Concept from Quantitative Chemistry and Physical Chemistry
2. Elucidate Basic Concept of Environmental Chemistry, Aquatic Chemistry and Green Chemistry
3. Expound Soil Chemistry, Classification of Soil and their Characteristics, Soil Pollution
4. Apply Industrial Chemistry, Characteristics of Industrial Wastes, Toxic Impurities in Industrial Effluent

Unit-I: **(15 Hrs)**

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

B. 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.

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

Unit-II: **(15 Hrs)**

A. Basic Concept of Environmental Chemistry: Basic concept, definition, importance of environmental chemistry.

B. 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.

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

Unit-III: **(15 Hrs)**

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

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

C. 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, reclamation of degraded land, desertification and its control measures.

Unit-IV: **(15 Hrs)**

A. 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.

B. 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.

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

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 Publioshing 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*)

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - I

MESFS12: PAPER- II (Atmospheric Science)

OBJECTIVES:

To make Students:

1. Explain Fundamentals of Atmospheric Science, Atmospheric Radiation, Application of Atmospheric Radiation
2. Understand Climatology, Hydrological Cycle- Process and importance, Cloud Physics
3. Discern Meteorology-Primary and Secondary meteorological parameters and their measurement, Air Masses and Fronts, Meteorology and Pollution
4. Recognize Ocean Science- Physical characteristics of the ocean, Water Mass Characteristics, Geostrophic Flow in Ocean

OUTCOMES:

Students shall be able to:

1. Interpret Fundamentals of Atmospheric Science, Atmospheric Radiation, Application of Atmospheric Radiation
2. Utilize Climatology, Hydrological Cycle- Process and importance, Cloud Physics
3. Analyze Meteorology-Primary and Secondary meteorological parameters and their measurement, Air Masses and Fronts, Meteorology and Pollution
4. Expound Ocean Science- Physical characteristics of the ocean, Water Mass Characteristics, Geostrophic Flow in Ocean

Unit-I: **(15 Hrs)**

A. Fundamentals of Atmospheric Science: Composition, change in atmospheric composition, structure and evolution of atmosphere, stratospheric ozone formation, segments of environment, modern views regarding the structure of the atmosphere.

B. Atmospheric Radiation: Solar spectrum, Earth radiation balance, ions and radicals in the atmosphere. temperature inversion and lapse rate.

C. Application of Atmospheric Radiation: Atmospheric radiation and earth's climate, energy balance, gradients.

Unit-II: **(15 Hrs)**

A. Climatology: Definition and scope, aims and objectives of climatology, Insolation-factors affecting the distribution of insolation. Atmospheric depletion of solar radiation, process of heat energy transfer- radiation, conduction and convection.

B. Hydrological Cycle: Process and importance, evaporation, condensation, forms of condensation (Dew, frost, fog and mist). Precipitation – formation and types, precipitation measurement.

C. Cloud Physics: Clouds, drops and snowflakes, formation of cloud drop, Koehler Theory, Curvature Effect, Kelvin Effect. Cloud formation, classification of clouds and role of clouds in weather forecasting.

Unit-III: **(15 Hrs)**

A. Meteorology: Definition and scope, aims and objectives of meteorology. Primary meteorological parameters and their measurement—temperature, wind direction and wind speed. Secondary meteorological parameters and their measurement-humidity, relative humidity, absolute humidity, pressure and solar radiation. collection and analysis of wind data, wind roses, plotting of wind roses and pollution roses. effects of meteorological parameters on air pollution.

B. Air Masses and Fronts: Air masses, source, region, classification , frontal weather - types of fronts, mid latitude cyclones and polar-Front theory, cyclonic and anti-cyclonic formation, divergence and convergence, severe weather And societal consequences – Thunderstorms, Lightning, Tornadoes, Hurricanes

C. Meteorology and Pollution: Co-relation of meteorology and pollution, Delhi SMOG – meteorological impact, SMOG threat to other cities of India, SMOG towers – operations and effectiveness, need to change in policy to combat urban SMOG. Case Studies.

Unit-IV: **(15 Hrs)**

A. Ocean Science: Physical characteristics of the ocean: ocean basins, temperature, salinity, density and oxygen characteristics, vertical profile of temperature and salinity in the major oceans.

B. Water Mass Characteristics: Formation and classification of water mass. T-S diagram, mixing processes in the oceans, upwelling and down welling processes, oceanic heat, salt and momentum budgets, thermohaline circulation and the oceanic conveyor belt.

C. Geostrophic Flow in Ocean - Ocean currents, equatorial current systems; wind driven ocean circulation, wind driven coastal currents. Ocean waves and their generation and

propagation; wave spectrum, storm surges and tsunamis, tides and tide generating forces, currents induced by wind, Oceanic Kelvin and Rossby waves, Indian ocean dipole, Madden-Julian oscillation (MJO),El-nino, La-nino and Southern Oscillation (ENSO)

Books for Reference

1. General Meteorology: H. R. Byers, Tata McGraw Hill Publications, New Delhi
2. Climatology: Fundamentals and Applications: *Mater J. R.*
3. Climatology: Selected Applications: *Henry D. Foth*
4. Introduction to weather and climate: *Trewartha*
5. The Atmosphere: An Introduction to Meteorology: *Fedrik K. Lutgen, E. J. Tarbuck*
6. General Meteorology: *H. R. Byers (Tata Mc Grew – Hill Publications, New Delhi)*
7. Meteorology: *Dr. S.R. Gadekar, Agromate Publishers, Nagpur 2000*
8. Environmental Analysis: M.M. Saxena, Agrobotanical Publisher, Bikaner 1994
9. Climatology: D.S. Lal, Shraddha Pustak Bhavan Alahabad, 2001
10. Atmosphere, Weather and Climate: K. Sidddhartha, Kisalaya Publication Pvt. Ltd 2000
11. The Great SMOG of India : Siddharth Singh, Penguin Viking Publication
12. Fundamental of Atmospheric Science : John A Dutton, Penn State College of Earth and Mineral Sciences

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - I

MESFS13: PAPER- III (Environmental Biology, Microbiology and Biotechnology)

OBJECTIVES:

To make Students:

1. Learn Ecology- subdivision and modern branches of ecology, Population Ecology its types and Characteristic, Population growth curve(S and J) shaped curve and Community Ecology
2. Distinguish Environmental Toxicology, Chemical Toxicology, Plastic Waste Management and Toxicology
3. Understand Introduction to Environmental Microbiology, Microbial Methods, Environmental Biotechnology
4. Discern Environmental Biotechnology for Environmental Protection, Bioinformatics and Genome Analysis

OUTCOMES:

Students shall be able to:

1. Interpret Ecology- subdivision and modern branches of ecology, Population Ecology its types and Characteristic, Population growth curve(S and J) shaped curve and Community Ecology
2. Utilize Environmental Toxicology, Chemical Toxicology, Plastic Waste Management and Toxicology
3. Elucidate Introduction to Environmental Microbiology, Microbial Methods, Environmental Biotechnology
4. Reveal Environmental Biotechnology for Environmental Protection, Bioinformatics and Genome Analysis

Unit-I: **(15 Hrs)**

A. Ecology: Definition, subdivision and modern branches of ecology, scope of ecology. Application and significance of ecology to human beings, Biotic Factor: Interspecific relationship, Positive**:** Mutualism (symbiosis), commensalism, proto-cooperation, Negative: Parasitism, predation, competition, Antibiosis.

B. Population Ecology: Definition and types, Characteristic of population: Natality, Mortality , Population density, Population dispersal and dispersion, Population fluctuation, Population growth curve(S and J) shaped curve, Biotic potential ,
Environmental resistance, Concept of carrying capacity.

C. Community Ecology: Definition, characteristic of community, community structure, Ecological dominants and indicators, Ecotone and edge effect, Ecological equivalents, Ecological niche (definition and types) Major and minor communities, Ecotypes and its significance.

Unit-II: (15 Hrs)

A. Environmental Toxicology: Definition and principle, Dose – Effect and Dose- Response Relationship, Factors Influencing Toxicity, Biotransformation and Bio concentration, Degradable and Non Degradable Toxic Substances, Biomagnifications, Bio-assays, Aquatic Toxicity Test, Statistical Test, Statistical concept of LD50.

B. Chemical Toxicology: Toxic chemical in the environment (air, water, and soil), Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead and Mercury. Biochemical effects of pesticides and cyanides: carcinogens, mutagens and tetrogens.

C. Plastic Waste Management and Toxicology: Insecticides Amendment Rules 2017, Pollutants generated due to burning of solid waste and plastic, Plastic Waste Management Rules 2016, Plastic Toxicology – effects on ocean and marine as well as terrestrial species, E-waste toxicology- effect on environment.

Unit-III: (15 Hrs)

A. Introduction to Environmental Microbiology: Introduction, scope, structure of microorganisms-fungi, bacteria, virus, classification of microorganisms, role of microbes in sewage (Trickling Filter, Activated sludge Process and Oxidation Pond Process).

B. Microbial Methods: Types of culture, sterilization and disinfection, techniques used of enrichment of culture, method of pure culture, preparation, maintenance, and preservation of microbial culture.

C. Environmental Biotechnology: Introduction, basic of environmental biotechnology, scope of biotechnology, biotechnological approach of environmental pollution.

Unit-IV: **(15 Hrs)**

A. Environmental Biotechnology for Environmental Protection: Scope of biotechnology in pollution control, In-situ and Ex-situ bioremediation, phytoremediation- metal phytoremediation, organic phytoremediation, microbes used in pollution mitigation.

B. Bioinformatics: Biological Data Acquisition: the form of biological information, Retrieval methods for DNA sequence, Protein sequence and protein structure information; Databases – Format and Annotation : Conventions for database indexing and specification of search terms, Common sequence file formats, Annotated sequence databases - Primary sequence databases, Protein sequence and structure databases

C. Genome Analysis: Whole genome analysis, Genome annotation and gene prediction, Basic principles of comparative genomics, Biodiversity informatics, metagenomics. Open source bio-informatics tools and web services.

Books for Reference

1. Fundamentals of Ecology: *Eugene P. Odum, (Natraj Publishers, Dehradun.)*
2. Environmental Biology: *P. D. sharma (Rastogi Publications, Meerut)*
3. Ecology and Environment: *P. D. sharma (Rastogi Publications, Meerut)*
4. Environmental Biology: *M. P. Arora (Himalaya Publishing House, New Delhi)*
5. Toxicology – Principles and Methods: *M. A. Subramanian, MJP, Publishers,Chennai,2004*
6. Environmental Biology:Principles of Ecology: P.S. Verma (S. Chand Ltd,2000)
7. General microbiology Volume I andII :*C. B. Powarand H. F. Daginawala (Himalaya publishing House, Mumbai), 2002*
8. Microbiology :*P. D. Sharma (Rastogi publication Meerut*)
9. Microbiology for Environmental Engineering :*M. C. Kinnery (Tata McGraw-Hill Publishing Company Limited, New Delhi).*
10. Applied Microbiology: *Vimta Kale and Kishore Bhusari (Himalaya Publishing House, Mumbai)*
11. Environmental Biotechnology: *S. N. Jogdand, Himalaya Publishing House, Mumbai (2006).*
12. A Textbook of Biotechnology: *R. C. Dubey, S. Chand and Company, New Delhi (2002).*
13. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
14. Bioinformatics Databases: Design, Implementation, and Usage (Chapman and Hall/ CRC)

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - I

MESFS14: PAPER- IV (Climate Change and It's Consequences)

OBJECTIVES:

To make Students:

1. Learn Fundamentals of Climate Change, Climate Change Impact, Economics of Climate Change
2. Understand International Scenario, Basic Group Countries, Paris Agreement and India's commitment in Paris agreement
3. Distinguish Climate Change Adaptation, Consequences of Climate Change, Climate Change Mitigations, Computer modeling for future projections
4. Discern Planning Process of Climate Change, National Action Plan on Climate Change (NAPCC), Clean Air Initiatives, Air Quality Index

OUTCOMES:

Students shall be able to:

1. Explain Fundamentals of Climate Change, Climate Change Impact, Economics of Climate Change
2. Elucidate International Scenario, Basic Group Countries, Paris Agreement and India's commitment in Paris agreement
3. Reveal Climate Change Adaptation, Consequences of Climate Change, Climate Change Mitigations, Computer modeling for future projections
4. Expound Planning Process of Climate Change, National Action Plan on Climate Change (NAPCC), Clean Air Initiatives, Air Quality Index

Unit-I: **(15 Hrs)**

A. Fundamentals of Climate Change : Introduction of the basics of climate change , Key concepts such as climate, weather and the greenhouse gas effect, human contribution to climate change, spectrum of scientific opinion, Greenhouse gases and their main sources, diminishing carbon sink, carbon sequestration.

B. Climate Change Impact: Observed changes in the climate since the industrial revolution, Future trends and impacts of climate change on surface temperature, precipitation, ocean pH, sea-level and Arctic sea-ice extent,

C. Economics of Climate Change: Effect of climate change in global and Indian economy, climate damages, mitigation cost

Unit-II: **(15 Hrs)**

A. International Scenario : Overview of international legal and policy framework to address climate change, brief history of International climate change negotiations, United Nations Framework Convention on Climate Change (UNFCCC) and its key provisions, Organizational structure and different party groups under the convention.

B. Basic Group Countries: Formation of basic Group- back ground and way forward, concerns of BASIC countries, Gains and losses of Kyoto Protocol.

C. Paris Agreement- Aims and objectives, associated bodies, Key commitments by Parties, Key issues under negotiation, India's commitment in Paris agreement and status so far, Case studies of meetings of Conference of Parties (COP), SDG's and India's take on meeting the SDG's.

Unit-III: **(15 Hrs)**

A. Climate Change Adaptation: Basic concept of climate change adaptation, measuring vulnerability, adaptation solutions and planned response.

B. Consequences of Climate Change: Consequences on key sectors, adaptation measures for various vulnerable sectors, linkages between climate change adaptation and development, important international adaptation initiatives and programmes.

C. Climate Change Mitigations: Aims and objectives, Political context to greenhouse gas emissions, integration of mitigation into development planning, international mechanisms for planning and implementing mitigation actions, Computer modeling for future projections, India's policy structure related to GHG mitigations.

Unit-IV: **(15 Hrs)**

A. Planning Process of Climate Change : Introduction to planning processes for climate change, overview of different dimensions and entry points for climate change planning, roles of national and sectorial, sub-national institutions in climate change planning, methodology for preparing a low-emission climate resilient development strategy, international initiatives to support climate change planning, key emitters, strategies to bring down emissions, mitigation targets per country.

B. National Action Plan on Climate Change (NAPCC): Aims and objectives, principles, national solar mission, mission on sustainable habitat, sustaining the Himalayan eco-system,

water mission, managing climate change agenda, current carbon dioxide emission status, Introductions of labelling program for appliances.

C. Clean Air Initiatives: Non-attainment cities of India, Air Quality Index, GHG mitigation in power generation, supercritical technologies, integrated gasification combined cycle (IGCC), natural gas-based power plants, efficient transmission and distribution.

Books for Reference

1. Atlas of Our Changing Environment – United Nations Environment Programme-2005
2. Earth: Making a Life on a Tough New Planet -Bill McKibben-2010
3. Our Choice: A Plan to Solve the Climate Crisis-Al Gore-2009
4. Surviving the Century: Facing Climate Chaos and Other Global Challenges-HerbertGirardet-2007
5. Climate Code Red: The Case for Emergency Action-David Spratt and Philip Sutton-2008
6. Climate Change: Meeting the Challenge – K R Gupta – 2010
7. The Climate Solution: India's Climate Change Crisis and What We Can Do About It-Mridula Ramesh – 2018
8. The Great Derangement: Climate Change and the Unthinkable-Amitav Ghosh - 2018
9. Climate Change in India: Sulagna Chattopadhyay – 2013
10. National Action Plan on Climate Change, Govt of India
11. Climate Changed: A Personal Journey Through the Science-Philippe Squarzoni-2014

MESFS15: LABORATORY COURSE

Practical-I : Environmental Chemistry and Atmospheric Science

OBJECTIVES:

To make Students:

1. Understand Laboratory concepts: Rules and regulation, preparation of standard solutions
2. Distinguish Weighing capacity and sensitivity of balance-care and use of balance
3. Understand Water sampling and storage techniques
4. Discern Examination of water quality: pH, Conductivity, Density, Viscosity, Turbidity and Colour, Acidity, Alkalinity, Hardness, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD)
5. Recognize Physical properties of soil: textured and particle size distribution (sand, silt and clay) Porosity, water holding capacity, electrical conductivity and infiltration rate.
6. Learn Determination of wind velocity, relative humidity in air

OUTCOMES:

Students shall be able to:

1. Interpret Laboratory concepts: Rules and regulation, prepare standard solutions
2. Utilize knowledge of Water sampling and storage techniques
3. Carry-out Examination of water quality: pH, Conductivity, Density, Viscosity, Turbidity and Colour, Acidity, Alkalinity, Hardness, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD)
4. Estimate Physical properties of soil: textured and particle size distribution (sand, silt and clay) Porosity, water holding capacity, electrical conductivity and infiltration rate.
5. Inspect and Determine of wind velocity, relative humidity in air

Practical-I : Environmental Chemistry and Atmospheric Science

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
   - **a**. pH, Conductivity, Density, Viscosity, Turbidity and Colour.
   - **b**. Acidity, Alkalinity, Hardness, Total Dissolved Solids (TDS), Dissolved Oxygen (DO) and Chemical Oxygen Demand (COD).

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: Determination of textured and particle size distribution (sand, silt and clay) Porosity, water holding capacity, electrical conductivity and infiltration rate.
8. Meteorology of air pollution:

a) Determination of wind velocity and direction by Anemometer.

b) Determination of relative humidity by Psychrometer.

9. Determination of Oil and Grease by Partition Gravimetric method.
10. Determination of Sulfide in raw water.
11. Physical properties of Fly ash.

MESFS16: LABORATORY COURSE

Practical-II : Environmental Biology and Climate Change and it's Consequences

OBJECTIVES:

To make Students:

1. Learn concept of Microscopy a) Use of compound microscopy b) Calibration of microscopy
2. Distinguish Staining techniques: Monochrome staining and Gram staining
3. Understand Estimation of primary productivity by Light and Dark bottle method
4. Explain lakes ecosystem with special reference to their conservation and management
5. Recognize Isolation of bacteria from soil water and air
6. Describe Collection and handling of water sample for bacterial analysis: Standard plate count at $37^{o}C$, Coli form count by MID and MPN technique, MF techniques for coli forms
7. Estimation of total viable count in water and soil sample
8. Acquire knowledge of Bioassay test with fish/snail
9. Discern the Identification and enumeration of phytoplankton and Zooplankton in water body

OUTCOMES:

Students shall be able to:

1. Interpret concept of Microscopy a) Use of compound microscopy b) Calibration of microscopy
2. Utilize the knowledge of lakes ecosystem with special reference to their conservation and management
3. Carry-out Isolation of bacteria from soil, water and air
4. Explain Collection and handling of water sample for bacterial analysis: Standard plate count at $37^{o}C$, Coli form count by MTD/MPN technique, MF techniques for coli forms
5. Estimate total viable count in water and soil sample
6. Elucidate Bioassay test with fish/snail
7. Reveal and Identify enumeration of phytoplankton and Zooplankton in water body

Practical-II : Environmental Biology and Climate Change and it's Consequences

1. Microscopy a) Use of compound microscopy b) Calibration of microscopy.
2. Staining techniques : a) Monochrome staining b) Gram staining.
3. Estimation of primary productivity by Light and Dark bottle method.
    a. Study of macrophytes lake
    b. Effects of light/pollutants on photosynthetic activity
4. Analysis of lakes ecosystem with special reference to their conservation and management.
5. Isolation of bacteria from soil water and air.
6. Determination of Rhizobium in soil sample.
7. Collection and handling of water sample for bacterial analysis with respect to
    a. Standard plate count at 37^{o}C.
    b. Coli form count by MTD/MPN technique.
    c. MF techniques for coli forms.
8. Estimation of total viable count in water and soil sample.
9. Preparation and sterilization of microbial media.
10. Membrane Filters Technique (MFT) for coliform.
11. Bioassay test with fish/snail and determination of LC50 value using pollutants/heavy metals.
12. Identification and enumeration of phytoplankton in water body.
13. Identification and enumeration of zooplankton in water body.
14. Collection of affected leaves from roadside plantation and its comparison with reference plants.

Visit:

1. Meteorological Centre, Nagpur.
2. Natural Eco-System
3. National Environmental Engineering Research Institute (NEERI), Nagpur
4. 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. Clean Air initiative for Nagpur City
3. Plastic Waste Management – Urban Scenario

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

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

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - II

MESFS21: PAPER- I (Environmental Ecosystem and Biodiversity)

OBJECTIVES

To make Students:

1. Learn about concept of Ecosystem, Biogeochemical Cycles, Climate Change and Eco-System, Ecosystem perturbations driven by climate change, direct human impacts
2. Understand Wildlife Conservation in India, Wildlife Legislations, Biomes and Conservation of Forest
3. Recognize Biodiversity, Biodiversity Loss, Status of India's Biodiversity
4. Apply Biodiversity Conservation Strategies, Biodiversity Action Plan, Biodiversity Legislation

OUTCOMES:

Students shall be able to:

1. Interpret concept of Ecosystem, Biogeochemical Cycles, Climate Change and Eco-System, Ecosystem perturbations driven by climate change, direct human impacts
2. Explain Wildlife Conservation in India, Wildlife Legislations, Biomes and Conservation of Forest
3. Elucidate Biodiversity, Biodiversity Loss, Status of India's Biodiversity
4. Expound Biodiversity Conservation Strategies, Biodiversity Action Plan, Biodiversity Legislation

Unit-I: **(15 Hrs)**

A. Introduction to Ecosystem: Concepts, structure, functions and types of ecosystem, Abiotic and biotic components, Energy flow and energy dynamics of ecosystem, Food chains, Food web, Tropic Levels, Nature's ability to sustain all life forms on earth.

B. Biogeochemical Cycles: Carbon, Nitrogen, Phosphorus and Sulphur cycles, basic concept of productivity, productivity of different Ecosystem, Measurement of productivity and the factor affecting the productivity.

C. Climate Change and Eco-System: Co-relation and impact.

Ecosystem perturbations driven by climate change, direct human impacts, including reduced water supply and quality, the loss of iconic species and landscapes, distorted rhythms of nature and the potential for extreme events. Case studies.

Unit-II: **(15 Hrs)**

A. Wildlife Conservation in India: Importance of conservation, reason for extinction of wildlife, classification of scarce wildlife, History of wildlife conservation, wildlife conservation in India, Endangered species of India, Hot spot biodiversity in India.

B. Wildlife Legislations: Overview of Wildlife (Protection) Act 1972, The Wild life Protection Rules 1995. Illegal Wildlife Trade.

C. Biomes and Conservation of Forest: Biomes of the world with special emphasis on Indian biomes, characteristics features and different types of ecological indicator. Forest and its ecological significance, Major types of forest, Deforestation and its causes, Forest management, ―Chipko Movement‖, Afforestation, Social forestry, conservation, legislation, National Forest Policy, Joint Forest Management.

Unit-III: **(15 Hrs)**

A. Biodiversity: Definition, level and types of biodiversity, concept, significance, magnitude and distribution of biodiversity trends, Biogeographically classification of India, values of biodiversity, impact of biodiversity, biodiversity at Global, National and Regional level.

B. Biodiversity Loss: Land use change, over exploitation of plants and animals, climate emergency, pollution, invasive alien species. Co-relation between biodiversity and eco-system services. Biodiversity: foundation that supports all life on land and below water.

C. Status of India's Biodiversity: Methods for monitoring biodiversity trends, Hotspots of biodiversity, threats to biodiversity and causes of extinction, IUCN categories, Red Data Book, Endangered species, Vulnerable species, Restricted species, Man and wildlife conflicts, methods of wildlife conservation, Project Tiger, Project Elephant and Project Crocodile. Ecological consequences of reduction in biodiversity, Brief account of endangered flora and fauna of India.

Unit-IV: **(15 Hrs)**

A. Biodiversity Conservation Strategies: *'Ex-situ'* Conservation (Zoos) ***'In-situ'*** Conservation (National Parks and Sanctuaries), Restoration of Wilderness and Green Cover, Imparting Education.

B. Biodiversity Action Plan: Global Agreement and National concerns, sustainable utilization, Research and developmental activities, Education and training research, National Policy and Action Plan, Role of Forest Department in Conservation, Conservation of Domestic Cultivators, Integrated Protected Area System, RAMSAR Sites, and Convention on Biological Diversity (CBD), Implementation process in India. Conservation and management of mangroves and coral reeves.

C. Biodiversity Legislation: Biodiversity Act 2002, Biodiversity Rules 2004, hurdles in implementation, Indian perspective, Global Scenario, Case studies of biodiversity loss and remedial actions

Books for Reference:

1. Environmental Biology: P. D. Sharma, Rastogi Publications, Meerut.
2. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House, New Delhi.
3. Introduction to Social Forestry: Sitaram Rao, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, 1979.
4. Environmental Biology: P. S. Verma & V. K. Agarwal, S. Chand & Company, New Delhi (2004).
5. Environmental Science: S.C. Santra, New Central Book Agency, Kolkata (2001).
6. Environmental Biology: M. P. Arora, Himalaya Publishing House, New Delhi.
7. Environmental Science: Charles E. Kupchella and Margaret C. Hyland, Allyn and Bacon, Inc., Buston (1986)
8. A Textbook of Environmental Studies: G. R. Chatwal & Harish Sharma, Himalaya Publication House, New Delhi, (2004).
9. Environmental Biology: K.C. Agarwal, Agro-Botanica Bikaner.
10. Fundamentals of Ecology: M.C. Dash, Tata McGraw Hill Publishing Company Ltd, New Delhi.

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - II

MESFS22: PAPER- II (Natural Resources Management)

OBJECTIVES:

To make Students:

1. Learn about Renewable and Non Renewable energy Natural Resources
2. Know about Non-Renewable (Conventional Source of Energy), Renewable (Non-Conventional Source of Energy)
3. Distinguish Conservation of Energy, Mineral Resources, Management of Common International Resources
4. Understand Water Resources and Conservation Water Resources, Food Resources, Water Conservation and Watershed management
5. Discern Land, Forest and Marine Resources Land Resources, Marine Resource

OUTCOMES:

Students shall be able to:

1. Utilize the knowledge of Renewable and Non Renewable energy Natural Resources
2. Explain Non-Renewable (Conventional Source of Energy), Renewable (Non-Conventional Source of Energy)
3. Elucidate about Conservation of Energy, Mineral Resources, Management of Common International Resources
4. Reveal Water Resources and Conservation Water Resources, Food Resources, Water Conservation and Watershed management
5. Expound Land, Forest and Marine Resources Land Resources, Marine Resource

Unit-I: **(15 Hrs)**

A. Renewable and Non Renewable energy Natural Resources: Definition, broad classification, Renewable, Non-Renewable and Mineral Resources.

B. Non-Renewable (Conventional Source of Energy): Thermal power, Hydro Energy Atomic Energy, Nuclear Energy (Fission and Fusion) and fossil fuels (coal, petroleum oil and natural Gas).

C. Renewable (Non Conventional Source of Energy): Solar Energy, Wind Energy, Geothermal Energy, Tidal Energy, Biomass energy (biogas and electricity), Ocean Energy

and Magneto- Hydrodynamic Power (MHD), Impact on environment and their applications, Energy production consumption and energy use pertain in different part of the world

Unit II: **(15 Hrs)**

A. Conservation of Energy Conservation of Energy: Importance, methods of conservation, Barriers to energy conservation, Measures for promoting energy conservation, Eco-friendly energy sources, Energy Audit. Biomass Energy –Sources, types of biomass, advantages and disadvantage of biomass , biomass conversion- wet and dry process, Biomass feedstock, biomass production, Environmental impact of biomass energy, Case Studies in India

B. Mineral Resources: Metals and Non-Metals, Formation of mineral deposits, Consequences of over exploitation and conservation of mineral resources of India and their distribution. Mining, quarrying and their impacts. exploration of oil and Natural gas. types of soil erosion- Detrimental effects of soil pollutants, control measures, soil fertility and soil degradation.

C. Management of Common International Resources: Ocean, climate, International fisheries and management commissions; Antarctica: the evolution of an international resource management regime. : Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies. Poverty and implications in Resource Management in developing countries – Poverty in developing countries, causes and link with resources scarcity and poverty.

Unit-III: **(15 Hrs)**

A. Water Resources and Conservation Water Resources: Surface, ground and frozen, Water uses- Agriculture, Energy generation, Domestic consumption, causes for water stress, water availability and its demand. **Hydel Energy**: Turbine and generators for small scale hydroelectric generation, bulb, turbine, tube turbine, advantages and disadvantages. Dams–types and impacts

B. Food Resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case-studies.

C. Water Conservation: Goals of water conservation, Watershed management-Introduction, Integrated watershed management, Steps involved in watershed management. Rainwater Harvesting - Need for rainwater harvesting, methods of rainwater harvesting- rooftop harvesting, surface runoff, underground water recharge. Components of rainwater

harvestings. Sewage treatment and reuse – A Step towards water conservation. Case Studies-Rainwater harvesting, sewage treatment and reuse.

Unit-IV: (15 Hrs)

A. Land, Forest and Marine Resources Land Resources: Agricultural practices in India, exploitation of agricultural land, Range Land Management.

B. Importance of Forest Resources: Significance of forest, minor forest products, Forest based medicinal and pharmaceutical industries, Silviculture, Forest Fire: types and its control. Afforestation and Joint Forest Management – Social Forestry, Agro Forestry. Forest Act-Salient Features.

C. Marine Resource: Fish and other marine resources: Production, status, dependence on fish resource, unsustainable harvesting, issues and challenges for resource supply, new prospects.

Books for Reference

1. Environmental Ecology: Gurudeep Raj, P.R.Trivedi, Akashdeep Publishing House, New Delhi.
2. Forests in India: V. P. Agrawal, Oxford & IBH Publishing Co. Pvt.Ltd, New Delhi, (1968).
3. Introduction to Social Forestry: Sitram Rao, Oxford and IBH Pub. Co. Pvt. Ltd.
4. An Introduction to Environmental Management: Dr.Anand S. Bal, Himalaya Publishing House (2005).
5. Energy Resources and Environment: V.K. Prabhakar, Anmol Publisher
6. Environmental Biology: Biswarup Mukharjee by Tata McGraw Hill Publishing Company Ltd, New Delhi.
7. Biomas Energy and Environment: H.R. Ravindranath, Oxford University Press, New York. 1995.
8. Non Conventional Energy Sources: G.D. Rai, Khanna Publication, New Delhi.
9. Renewable Energy Sources and Emerging Technologies: D.B. Kothari and K.C. Singal, PHI Learning Pvt. Ltd. New Delhi, 2011.
10. A Textbook of Environmental Studies: Dr.Satyanaraya, Dr. S.R. Sitre, Dr. S.B. Zade, Dr. P.U. Meshram, Allied Publisher.
11. Environmental Geography- Savindra Singh, Prayag Pustak Bhavan, Allahabad (UP)

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - II

MESFS23: PAPER- III (Environmental Sampling and Research Methodology)

OBJECTIVES:

To make Students:

1. Learn Air Sampling-objective and criteria of air sampling, Instrumental Techniques, Types of Air Sampler
2. Know Basic concept of Water Sampling, Sampling Equipment and Water Quality Parameters, Significance and Measurement of various Parameters
3. Understand Soil and Solid Waste Sampling, Soil and Solid Waste Testing and Analysis, Basic Concept of Solid Waste
4. Recognize Foundation of Environmental Statistics, Research Methodology, Errors in Environmental Analysis

OUTCOMES:

Students shall be able to:

1. Elucidate Air Sampling-objective and criteria of air sampling, Instrumental Techniques, Types of Air Sampler
2. Utilize the knowledge of Basic concept of Water Sampling, Sampling Equipment and Water Quality Parameters, Significance and Measurement of various Parameters
3. Reveal Soil and Solid Waste Sampling, Soil and Solid Waste Testing and Analysis, Basic Concept of Solid Waste
4. Expound foundation of Environmental Statistics, Research Methodology, Errors in Environmental Analysis

Unit-I: **(15 Hrs)**

A. Air Sampling: Definition, objective and criteria of air sampling, selection of air sampling location, sampling methods and their importance (sedimentation, filtration, precipitation, centrifugal and impingement method), importance of reference sample, dispersion models.

B. Instrumental Techniques: Different instrumental techniques used in estimation of atmospheric air pollutant and their application, needle trap device, Micro Extraction by Packed Sorbent (MEPS), Air dispersion models, Sensor networks, Geographic Information System (GIS) models, Sensor Observation Service (SOS).

C. Types of Air Sampler: Operation, application and significance of different types of air samplers, Dust fall measurement, SPM and RSPM using High Volume Air Sampler, Air Samplers for microbiological monitoring of air quality. Case Studies – Air quality sampling surrounding Thermal Power Plants.

Unit-II: **(15 Hrs)**

A. Basic concept of Water Sampling: Necessity of water sampling, objectives, selection of sampling site, types of water samples, collection, handling and preservation of water sample, Importance of sampling in water and waste water treatment.

B. Sampling Equipment and Water Quality Parameters: Sampling equipment, classification of water quality parameters (inorganic, organic, nutrient and bacteriological).

C. Significance and Measurement of various Parameters: TSS, Oil and Grease, pH, DO, BOD, COD, Chloride, Hardness, Silica, TDS, heavy metals in water and wastewater. Impact of sampling on water and wastewater analysis

Unit-III: **(15 Hrs)**

A. Soil and Solid Waste Sampling: Objectives of soil and solid waste sampling, site selection criteria, collection and handling of soil and solid waste samples.

B. Soil and Solid Waste Testing and Analysis: Objective and importance, methods of sample collection, processing, precautions during sampling and processing, preservation, labelling and storage of samples, preparation of analysis and test report,

C. Basic Concept of Solid Waste: Concept and types of solid waste, major sources of solid waste, classification of solid waste, collection equipment, transportation equipment, physical, chemical and biological properties of solid wastes, bulkiness, combustibility, solubility, categories of urban solid waste, segregation of waste, Swachh Bharat Abhiyan, Treatment of solid waste.

Unit-IV: **(15 Hrs)**

A. Foundation of Environmental Statistics: Concept of environmental statistics, nature of environmental data (survey based and experimental data), statistical models in environmental science (population growth model, catch model)

B. Research Methodology: Introduction, Research problem and design, Data collection, Data representation, measure of central tendency, measure of variation, Correlation and regression, testing of hypothesis, Interpretation and report writing, Bias, Precision and Accuracy.

C. Errors in Environmental Analysis: Nature of errors, types of errors and importance of error, random error, Estimation of standard deviation, confidence limits of analytical results, combined effects of different random errors comparison of two means, comparison of two standard deviations, correction, limit of detection, concept of ANOVA-examples on one way and two-way classification.

Books for Reference

1. Biostatistics: P. N. Arora, P. K. Malhan, Himalaya publishing House, Delhi, 2008
2. Basic concepts of Biostatistics: N. Arumugam, Saras Publications, Kanyakumari, 2003
3. Biostatistics in theory and Practice: T. K. Saha, Emkay Publications, Delhi, 1992
4. Biostatistics: P. Ramakrishnan, Saras Publications, Kanyakumari, 1995
5. Statistical Methods: S. C. Gupta, S. Chand & Sons Publishers, New Delhi, 1997
6. Evolution Biostatistics & Computer Applications: A. Gopi, A. Meena, N. Arumugam,Saras Publications, Kanyakumari, 2003
7. Fundamentals of Computer: V. Rajaraman, Prentice Hall of India, New Delhi, 2008
8. Computer Fundamentals: Pradeep K. Sinha, Preeti Sinha, BPB Publications, New Delhi, 2007
9. Computer:Malhar V. Lathkar, Sadhusudha Prakashan, Nanded, 1995
10. Environmental Science Principles and Practices: R. C. Das, D. K. Behra, Prentice Hall, New Delhi, 2008
11. Environmental Chemistry : B. K. Sharma & H. Kaur(Goel Publishing House, Meerut)
12. A Manual on Water and Waste Water Analysis : National Environmental Engineering Research Institute, Nagpur
13. Air Pollution: M. N. Rao (Tata McGraw – Hill publishing company, New Delhi)
14. Air Pollution: B. K. Sharma, H. Kaur (Krishnaprakashan media, Meerut)

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. –I SEMESTER - II

MESFS24: PAPER- IV (Analytical Techniques for Environmental Monitoring)

OBJECTIVES:

To make Students:

1. Learn Chromatography, Major Types of Chromatography, Liquid Chromatography Principles, working and applications of Gas Chromatography (GC). High Performance Liquid Chromatography (HPLC)
2. Gain Knowledge of Absorption Spectrophotometry, Estimation of Various Elements, Instrumental Analysis
3. Distinguish Electro Chemical Techniques, Aniodic Stripping Voltametry, Ion Selective Electrodes
4. Understand Modern Instrumental Techniques, Mass Spectrometer, Analysis of Environmental Samples

OUTCOMES:

Students shall be able to:

1. Interpret Chromatography, Major Types of Chromatography, Liquid Chromatography Principles, working and applications of Gas Chromatography (GC). High Performance Liquid Chromatography (HPLC)
2. Utilize Knowledge of Absorption Spectrophotometry, Estimation of Various Elements, Instrumental Analysis
3. Elucidate Electro Chemical Techniques, Aniodic Stripping Voltametry, Ion Selective Electrodes
4. Expound Electro Chemical Techniques, Aniodic Stripping Voltametry, Ion Selective Electrodes
5. Describe Modern Instrumental Techniques, Mass Spectrometer, Analysis of Environmental Samples

Unit-I: **(15 Hrs)**

A. Chromatography: Introduction, Definition, theory of chromatographic separation, stationary and mobile phases, classification of chromatographic separations, Rf value

B. 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).

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

Unit-II: (15 Hrs)

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

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

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

Unit-III: (15 Hrs)

A. Electro Chemical Techniques: Introduction, types of Electro-chemical technique, principle, instrumentation and application of Polarography in environmental chemical analysis,

B. 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.

C. 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: (15 Hrs)

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

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

C. 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, Pragati Prakashan, 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: Gurdeep Chatwal (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

MESFS25 : LABORATORY COURSE

Practical-I : Environmental Ecosystem and Management and Natural Resources Management

A. Environmental Ecosystem and Management

OBJECTIVES:

To make Students:

1. Learn about the biotic components of a pond eco system
2. Distinguish different ecological indicators of an ecosystem
3. Understand forest ecosystem as biome, vegetation type characteristics and features of forest, soil type
4. Know about Collection and interpretation of wild life data with respective common spices, endanger spices rare spices
5. Recognize study of project tiger, project elephant, project crocodile in India with reference to conservation.

OUTCOMES:

Students shall be able to:

1. Interpret the biotic components of a pond eco-system
2. Utilize knowledge of different ecological indicators of an ecosystem
3. Elucidate forest ecosystem as biome, vegetation type characteristics and features of forest, soil type
4. Inspect Collection and interpretation of wild life data with respective common spices, endanger spices rare spices
5. Expound study of project tiger, project elephant, project crocodile in India with reference to conservation.

A. Environmental Ecosystem and Management

1. To study the biotic components of a pond eco system.
2. To study a biotic components of a lake ecosystem.
3. To study different ecological indicators of an ecosystem
4. To study of forest ecosystem as biome, vegetation type characteristics and features of forest, soil type etc.
5. Collection and interpretation of wild life data with respective common spices, endanger spices rare spices

6. Determination of important value index (NI) of vegetation
7. To study of project tiger, project elephant, project crocodile in India with reference to conservation.

B. Natural Resources Management

OBJECTIVES:

To make Students:

1. Learn the proximate analysis of coal for moisture volatile matter and carbon content
2. Know about study of calorific value of biomass
3. Distinguish Chemical Oxygen Demand and Biochemical Oxygen Demand of waste water sample
4. Understand analysis of biogas raw materials and outlet effluents for efficiency
5. Recognize estimation soil for Total Organic Carbon (TOC), NPK,CEC and SAR

OUTCOMES:

Students shall be able to:

1. Interpret Proximate analysis of coal for moisture volatile matter and carbon content
2. Utilize Study of calorific value of biomass
3. Estimate Chemical Oxygen Demand and Biochemical Oxygen Demand of waste water sample
4. Elucidate analysis of biogas raw materials and outlet effluents for efficiency
5. Describe Estimation soil for Total Organic Carbon (TOC), NPK,CEC and SAR

B. Natural Resources Management:

1. Proximate analysis of coal for moisture volatile matter and carbon contain.
2. Study of calorific value of biomass.
3. Estimation of Chemical Oxygen Demand of waste water sample.
4. Estimation of Biochemical Oxygen Demand of waste water sample.
5. Analysis of biogas raw materials and out late effluents for efficiency.
6. Estimation soil for Total Organic Carbon (TOC), NPK, CEC and SAR.

MESFS26 : LABORATORY COURSE

Practical-II : Industrial Chemistry and Analytical Techniques

A. Industrial Chemistry

OBJECTIVES:

To make Students:

1. Learn Study of raw material used in industries and their environmental significances
2. Distinguish Study of characteristics of different waste from industries
3. Discern Study of preliminary treatment, chemical treatment, biological treatment of wastewater.

OUTCOMES:

Students shall be able to:

1. Utilize knowledge of raw material used in industries and their environmental significances
2. Inspect characteristics of different waste from industries
3. Identify preliminary treatment, chemical treatment, biological treatment of wastewater.

A. Industrial Chemistry

1. Study of raw material used in industries and there environmental significances
2. Study of characteristics of different waste form industries.
3. Study of preliminary treatment of wastewater.
4. Study of chemical treatment of waste water.
5. Study of biological treatment of waste water

B. Analytical Techniques

OBJECTIVES:

To make Students:

1. Learn about Separation of amino acid by Thin Layer Chromatography
2. Recognize principles components of UV-Visible Spectrophotometer
3. Gain skill to Analyze phosphate and nitrate by Spectrophotometer
4. Understand Demonstration of AAS for trace and heavy metal analysis, HPLC and GC for pesticide analysis

OUTCOMES:

Students shall be able to:

1. Utilize Carry-out Separation of amino acid by Thin Layer Chromatography
2. Explain principles components of UV-Visible Spectrophotometer
3. Inspect phosphate and nitrate by Spectrophotometer
4. Expound Demonstration of AAS for trace and heavy metal analysis, HPLC and GC for pesticide analysis

B. Analytical Techniques

1. Separation of amino acid by Thin Layer Chromatography.
2. Study of principles components of UV-Visible Spectrophotometer.
3. Analysis of sulphate by Spectrophotometer.
4. Analysis of phosphate by Spectrophotometer.
5. Analysis of nitrate by Spectrophotometer.
6. Study of sodium, potassium, calcium and lithium by Flame photo-meter.
7. Demonstration of AAS for trace and heavy metal analysis.
8. Demonstration of HPLC and GC for pesticide analysis.

Visits:

1. Instrumentation Division of NEERI, Nagpur
2. Solid Waste Dumping Yard and Processing site
3. Biodiversity Park
4. Renewable Energy Plant

At least **two** field visits are 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. Segregation, collection and transportation of urban solid waste
2. Renewable Energy installation in Central India
3. Rain Water Harvesting & Ground Water Recharge

Students need to submit atleast **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

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - III

MESSS31: PAPER- I (Physico- Chemical Treatment of Water & Waste Water)

OBJECTIVES:

To make Students:

1. Learn about Wastewater Sources, Sewage Generation, Industrial Waste Water Generation
2. Understand Wastewater Collection, Stages of Waste Water Treatment Plant, Sludge Generation and Dewatering: Sources
3. Recognize Classification of Wastewater Treatment Methods, Basic Drawings: Concept and importance of Process Flow Diagram, Industry specific Basic Drawings
4. Know Physical Methods of Wastewater Treatment, Chemical Methods of Wastewater Treatment and Advanced Chemical Treatment

OUTCOMES:

Students shall be able to:

1. Interpret Wastewater Sources, Sewage Generation, Industrial Waste Water Generation
2. Elucidate Wastewater Collection, Stages of Waste Water Treatment Plant, Sludge Generation and Dewatering: Sources
3. Reveal Classification of Wastewater Treatment Methods, Basic Drawings: Concept and importance of Process Flow Diagram, Industry specific Basic Drawings
4. Expound Physical Methods of Wastewater Treatment, Chemical Methods of Wastewater Treatment and Advanced Chemical Treatment

Unit I : **(15 Hrs)**

A. Wastewater Sources: Historic background, domestic and industrial waste water generation, environmental issues. Objective of waste water treatment. Indian scenario.

B. Sewage Generation: Sources of sewage generation**,** Characteristics of sewage. Factors affecting sewage generation, mode of transportation of sewage from source to treatment site. Per capita sewage generation. Impact of lifestyle on characteristics of sewage.

C. Industrial Waste Water Generation: Characteristics of waste water from Industrial sectors– Brewery, Distillery, Sugar, Textile, Pharmaceuticals, Food, Dairy and Starch. Transportation – pumping, gravity.

Unit II : **(15 Hrs)**

A. Wastewater Collection: Objectives of Wastewater Collection, Systems of Collection, Design input & Importance of Peak Flow in sewage treatment, dry weather flow.

B. Stages of Waste Water Treatment Plant: Raw waste water characteristics, mass balancing of various streams, design of treatment plant, drawing input, civil construction, electromechanical erection, commissioning & trouble shooting.

C. Sludge Generation and Dewatering: Sources of generation of sludge in waste water treatment, Design calculation of sludge generation, sludge thickener, selection of dewatering unit. Operation of Decanter and Filter press- Advantages and disadvantages.

Unit III : **(15 Hrs)**

A. Classification of Wastewater Treatment Methods: General Aspect, Objectives of Treatment, Physical, Chemical, Biological and Tertiary treatment of waste water.

B. Basic Drawings: Concept and importance of Process Flow Diagram, Layout, Hydraulic Profile, Piping & Instrumentation Diagram. Power Chart – Installed and Operational power

C. Industry specific Basic Drawings: Flow Diagram, Layout & Hydraulic profile for treating waste water from Brewery, Starch, Pharmaceutical, Textile, Dairy, Food industries and Sewage.

Unit IV : **(15 Hrs)**

A. Physical Methods of Wastewater Treatment: Theory , design principle and function of Screen, Grit Chamber, Oil and Grease Trap, Cooling Towers, Primary Clarifier, Equalization tank.

B. Chemical Methods of Wastewater Treatment: Introduction, design principle of Chemical Treatment, Unit Operations Involved in Chemical Treatment, Coagulation and Flocculation, Theory of Coagulation. Types of Coagulants, reactions, Coagulant Aids, Determination of Optimum dose of Coagulants.

C. Advanced Chemical Treatment: Design & Operation of Dual Media Filtration, Theory of Filtration, types of filters, Filter back wash, Operational troubles and trouble shooting. Air Stripping, Ion Exchange Carbon Adsorption. Cost economics of chemical treatment technologies.

Books for Reference

1. **Wastewater Treatment for Pollution Control** by Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi

2. **Water Supply & Sanitary Engineering** by R. C. Rangwala and S. C. Rangwala,Charotal Publishing House, Anand.
3. **Wastewater Treatment** by M. N. Rao, A. K. Datta, IBH Publishing Company,New Delhi.
4. **A Textbook of Sanitary Engineering** by Vinayak Gharpure, Engineering Book Publishing Company, Pune.
5. **Water Pollution** by V. P. Kudesia, Pragati Prakashan, Meerut.
6. **Waste Water Engineering** by Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
7. **Waste Water Treatment**- Concept & Design Approach by G.L. Karia& R.A.Christian, Prentice Hall of India Press.
8. **Introduction to Environmental Engineering :** Mackenzie L. Davis & David A. Cornwell (Mc-Grew Hill Publishing Company, New Delhi)
9. **A Textbook of Environmental Chemistry & Pollution Control: S** S Dara, S.Chand & Company, New Delhi (2002).
10. **Waste Water Engineering Treatment and Reuse**: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
11. **Industrial Waste Water Management Treatment and Disposal by Waste Water** Mc Graw Hill III Edition 2008.
12. **Water-Wastewater Engineering** - Fair G.M., Geyer J.G and Okun,
13. **Fundamentals of Water Treatment Unit Processes - Physical, Chemical, and Biological** David Hendricks, CRC Press, ISBN: 978-1-4200-6191-8 (Hardback), 2011 Edition [DWH]
14. **Industrial Waste Water Treatment** by A.D Patwardhan
15. **Water and Waste Water Technology** by Mark J Hammer

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - III

MESSS32: PAPER- II (Biological Process in Wastewater Treatment)

OBJECTIVES:

To make Students:

1. Learn Anaerobic Treatment, Anaerobic Digester Configuration, Design of Anaerobic Digesters
2. Understand Aerobic Treatment: Concept, Aerobic Technologies, Activated Sludge Process:Origin & history
3. Understand Industry Specific Treatment, Biological Treatment Technologies, Biological Treatment for specific Industrial waste water, Cost Economics of Biological Treatment
4. Recognize Operation & Maintenance of Wastewater Treatment Plant, Maintenance Procedures, Documentation, Interpretation and Commissioning

OUTCOMES:

Students shall be able to:

1. Interpret Anaerobic Treatment, Anaerobic Digester Configuration, Design of Anaerobic Digesters
2. Utilize knowledge of Aerobic Treatment: Concept, Aerobic Technologies, Activated Sludge Process: Origin & history
3. Describe Industry Specific Treatment, Biological Treatment Technologies, Biological Treatment for specific Industrial waste water, Cost Economics of Biological Treatment
4. Expound Operation & Maintenance of Wastewater Treatment Plant, Maintenance Procedures, Documentation, Interpretation and Commissioning

Unit I : **(15 Hrs)**

A. Anaerobic Treatment: Basic principles of anaerobic treatment, application of anaerobic technology in waste water treatment. Types of anaerobic reactors and processes – Thermophilic and Mesophilic reactors.

B. Anaerobic Digester Configuration: Media based digester and non media based digesters. Types of media based digesters – Fixed Bed, Moving Bed, Expansion Bed, Recycled Bed, structure, properties and function of Bio-film, Up flow Anaerobic Sludge Blanket Reactor

(UASB), Continuous Stirred Tank Reactor (CSTR), Anaerobic Hybrid Digesters.

C. Design of Anaerobic Digesters: Basic design consideration of Media based, UASB, CSTR, Hybrid anaerobic digesters. Importance of Hydraulic Retention Time and Volumetric Loading Rate. Waste water specific suitability of anaerobic digester. Biogas Generation and utilization, Advantages of anaerobic treatment. Anaerobic treatment of biological sludge.

Unit II : **(15 Hrs)**

A. Aerobic Treatment: Concept & Origin of Aerobic Treatment. Application of aerobic technologies in waste water treatment.

B. Aerobic Technologies : Design basics, principles and operation of aerobic technologies - Aerated lagoon, Trickling Filters, Rotating Biological Contractor, Aerobic Bio-towers, Advantages and disadvantages of each aerobic technology.

C. Activated Sludge Process: Origin & history of Activated Sludge Process. Design inputs- Hydraulic Load, BOD Load, F/M Ratio, MLSS. Advancement in Activated Sludge Process. Methods of aeration- Advantages and Disadvantages. Flow Diagram of Activated Sludge Process. Design of Aeration Tank and Clarifier. Sludge Bulking. Sludge Volume Index. Suitability of ASP to various Industrial waste water. Advantage and Disadvantage of Activated Sludge Process.

Unit III: **(15 Hrs)**

A. Industry Specific Treatment: Selection of Biological Treatment Technologies based on type of industrial waste water. Factor affecting selection of technologies. Significance of BOD, COD, Oil & Grease, TSS, pH, Temperature in technology selection

B. Biological Treatment for specific Industrial waste water: Biological treatment for Brewery, Dairy, Textile, Starch Industries. Treatment Scheme, Flow Diagram for treating various industrial waste water.

C. Cost Economics of Biological Treatment : Factors affecting cost economics of biological treatment , payback period, capital cost & operational cost comparison with other contemporary treatment technologies.

Unit IV : **(15 Hrs)**

A. Operation & Maintenance of Wastewater Treatment Plant: Objectives & advantages of operation & maintenance of wastewater treatment plants. Role and duties of ETP in-charge. Probable Trouble Shooting Parameters and their Control.

B. Maintenance Procedures: Maintenance of various units and equipment - Screens, Grit Chamber, Skimming Tanks, Primary clarifiers, Anaerobic digesters (Media Based, UASB , CSTR , Hybrid), aeration tanks, secondary clarifiers and Filters.

C. Documentation, Interpretation and Commissioning: Operation and Maintenance Manual, record keeping, report & documentation, Log-sheet, Routine analysis of various parameters. Commissioning of waste water treatment plants.

Books for Reference

1. **Waste Water Treatment for Pollution Control :** Soli J. Arceivala (Tata Mc- GrewHill Publishing Company, New Delhi)
2. **Water Supply and Sanitary Engineering :** R. C. rangwala and S. C. rangwala (Charotal publishing house, Anand)
3. **Waste Water Treatment :** M. N. Rao, A. K. Datta (Oxford and IBH Publishing company, New Delhi)
4. **A Text Book of Sanitary Engineering :** Vinayak Gharpure (Engineering Book Publishing Company, Pune)
5. **Water Pollution :** V. P. Kudesia (Pragati Prakashan, Meerut)
6. **Environmental Chemistry :** B. K. Sharma (Goel Publishing House, Meerut)
7. **Waste Water Engineering :** Metcalf and Eddy (Tata Mc-Grew Hill Publishing Company, New Delhi)
8. **Environmental Chemistry :** A. K. De (Wiley eastern limited, New Delhi)
9. **Environmental Pollution :** H. M. Dix (New York)
10. **Environmental Chemistry :** B. K. Sharma and H. Kour (Villa Publication, Meerut)
11. **Waste Water Engineering Treatment and Reuse**: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
12. **Industrial Waste Water Management Treatment and Disposal by Waste Water** Mc Graw Hill III Edition 2008.
13. **Wastewater Treatment Concepts and Design Approach",** Karia G.L., and Christian R.A., (2001), Prentice Hall of India Pvt. Ltd., New Delhi.
14. **Water-Wastewater Engineering** - Fair G.M., Geyer J.G and Okun,
15. Fundamentals of Water Treatment Unit Processes-Physical, Chemical, and Biological David Hendricks, CRC Press, ISBN: 978-1-4200-6191-8 (Hardback),2011 Edition [DWH]
16. **Industrial Waste Water Treatment** by A.D Patwardhan
17. **Water and Waste Water Technology** by Mark J Hamme

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - III

MESSS33: PAPER- III (ELECTIVE – I: Water and Water Treatment)

OBJECTIVES:

To make Students:

1. Learn about Water Treatment Process, Coagulation, Water Treatment its Objectives, Principles
2. Know Filtration, Disinfection, Forms of Chlorination- Plain Chlorination, Pre-chlorination, Post chlorination, Super Chlorination, Double Chlorination, Break Point Chlorination
3. Discern Water Softening Process, Iron and manganese removal, Deflouoridation
4. Understand Removal of Physical Parameters, Distillation, Drinking Water Standards: Mineral Waters

OUTCOMES:

Students shall be able to:

1. Construe Water Treatment Process, Coagulation, Water Treatment its Objectives, Principles
2. Utilize Filtration, Disinfection, Forms of Chlorination- Plain Chlorination, Pre-chlorination, Post chlorination, Super Chlorination, Double Chlorination, Break Point Chlorination
3. Elucidate Water Softening Process, Iron and manganese removal, Deflouoridation
4. Expound Removal of Physical Parameters, Distillation, Drinking Water Standards: Mineral Waters

Unit I : **(15 Hrs)**

A. Water Treatment Process: Primary, Secondary and Tertiary, Theory, Mechanism and Significance of Aeration, Coagulation, Flocculation, Sedimentation, Filtration and Disinfection.

B. Coagulation: Different Coagulants used in coagulation process, Miscellaneous Treatment Methods, Removal of Taste and Odour, Standards for Quality of Treated Water.

C. Water Treatment: Objective of Water Treatment, Principles of Water Treatment, Water Treatment Flow Sheets, Physico-chemical and Bacteriological Parameters and their Role in Water Treatment.

Unit II : **(15 Hrs)**

A. Filtration: Objectives of Filtration, Classification of Filters, Filter Media and its Characteristics, Operation and Backwashing of Filters, Design Features of Slow and Rapid Sand Filters, Operational Problems in Water Filters, Pressure Filters.

B. Disinfection: Necessity of Disinfection, Method of Disinfection, Theory of Disinfection, Residual Chlorine and its Determination, Action of chlorine, Chemicals Used for Disinfection of Treated Water, Application of Chlorine and its Compounds.

C. Forms of Chlorination: Plain Chlorination, Pre-chlorination, Post chlorination, Super Chlorination, Double Chlorination, Break Point Chlorination, Role of Ozone and UV as a Disinfectant, Tests used for determination of free & combined chlorine.

Unit III : **(15 Hrs)**

A. Water Softening Process: Necessity of Water Softening, Types of Hardness, Units of Hardness, Effects of Water Hardness, Equivalent of Calcium Carbonate Concept, Methods of Water Softening, (Lime, Soda Process, Zeolite Process, Demineralization Process, Ion Exchange Resins) and their Chemical Reactions.

B. Iron and manganese removal: Occurrence of Iron and Manganese in Water, Objectives, Significance and Methods of Removal.

C. Deflouoridation: Occurrence of Fluoride in Water, Need for Removal, Chemical Treatment of Defluoridation and Mechanism Health Effects, Methods of Defluoridation, Nalgonda Technique.

Unit IV : **(15 Hrs)**

A. Removal of Physical Parameters: Introduction, Removal of Colour, Odour and Taste, Aeration, Treatment with Activated Carbon.

B. Distillation: De-salinisation of Brackish Waters, Distillation, Reverse Osmosis, Solar Distillation

C. Drinking Water Standards: Mineral Waters, Quality Requirement of Packaged Drinking Mineral Waters, Drinking water Standards, The Maharashtra Groundwater (Regulation for Drinking Water Purpose) Act- 1993

Books for Reference

01. **Environmental Chemistry:** B. K. Sharma, Goel Publishing House, Meerut.
02. **Waste Water Engineering:** Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
03. **Environmental Chemistry:** A. K. De, Wiley Eastern Limited, New Delhi.
04. **Environmental Pollution:** H. M. Dix, New York.
05. **Environmental Chemistry:** B. K. Sharma and H. Kour by Villa Publication, Meerut.
06. **Introduction to Environmental Engineering:** Mackenzie L. Davis & David A. Cornwell, McGraw Hill Publishing Company, New Delhi.
07. **Basic Water Treatment:** George Smethurst, Scientific Publishers, Jodhpur.
08. **Chemical And Biological Methods For Water Pollution Studies:** R. K. Trivedy, P. K. Goel, Environmental Publication, Karad.
09. **Basic Water Treatment :** George Smethurst (Scientific Publishers, Jodhpur)
10. **Water Pollution and disposal of Waste water on Land :** U. N. Mahida (Tata Mc-Grew Hill Publishing Company, New Delhi)
11. **Water Supply and Sanitary Engineering:** S.C. Rangwala (Charotar Publishing House Pvt. Ltd.-Twenty Eight Revised And Enlarged Edition-2015)

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - III

MESSS34: PAPER- III (ELECTIVE - II: Water Supply and Resources)

OBJECTIVES:

To make Students:

1. Know about Sources of Water Supply, Water Supply Scheme, Suitability of Water
2. Distinguish Surface and Ground Water Quality, Classification of Wells, Transformation and Transport Process in Water Body
3. Learn Quantity and Quality of Water, Demand and Quality of Water, Analysis of Water
4. Understand Distribution of Water, Maintenance of Water System, types of service reservoir, Types of Valves

OUTCOMES:

Students shall be able to:

1. Utilize Sources of Water Supply, Water Supply Scheme, Suitability of Water
2. Interpret Surface and Ground Water Quality, Classification of Wells, Transformation and Transport Process in Water Body
3. Elucidate Quantity and Quality of Water, Demand and Quality of Water, Analysis of Water
4. Expound Distribution of Water, Maintenance of Water System, types of service reservoir, Types of Valves

Unit I : **(15 Hrs)**

A. 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).

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

C. 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 : **(15 Hrs)**

A. 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).

B. 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.

C. 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 : **(15 Hrs)**

A. 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.

B. 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.

C. 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 : **(15 Hrs)**

A. Distribution of Water: Method of distribution system, requirement of distribution of water and their merits and demerits

B. 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.

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

Books for Reference

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

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - III

MESSS35: PAPER- IV (Foundation-I : Fundamentals of Environmental Science- I)

(Student shall opt for this paper from any other subject other than his / her main subject for Post-graduation.)

OBJECTIVES:

To make Students:

1. Know about Environmental Science, Types of Environment, Segments of Environment and their Interactions
2. Learn about Atmosphere, Hydrosphere, Evaporation, Condensation, Ground Water Exploration, Composition of Soil, Soil Formation, Properties of Soil, Soil Erosion and Biosphere
3. Distinguish Ecology, Ecological Landmark, Ecological Status in India, Concepts, Structure and Functions of Ecosystem, Food Chains, Food Web, Tropic Levels, Concept of Productivity, Productivity of Different Ecosystem
4. Discern Diversity of Wildlife, Wildlife in India, National Park, Wildlife Sanctuaries, Biosphere Reserve, Wildlife Protection Act 1972

OUTCOMES:

Students shall be able to:

1. Interpret the concept of Environmental Science, Types of Environment, Segments of Environment and their Interactions
2. Utilize Atmosphere, Hydrosphere, Evaporation, Condensation, Ground Water Exploration, Composition of Soil, Soil Formation, Properties of Soil, Soil Erosion and Biosphere
3. Elucidate Ecology, Ecological Landmark, Ecological Status in India, Concepts, Structure and Functions of Ecosystem, Food Chains, Food Web, Tropic Levels, Concept of Productivity, Productivity of Different Ecosystem
4. Expound Diversity of Wildlife, Wildlife in India, National Park, Wildlife Sanctuaries, Biosphere Reserve, Wildlife Protection Act 1972

Unit I : **(15 Hrs)**

1.1 Definition, and Scope of Environmental Science,

1.2 Man and Environment Relationship,

1.3 Types of Environment-Natural and Anthropogenic Environment,

1.4 Concept of Environmental Education – Formal and Non Formal,

1.5 Environmental Organizations and Agencies –National and International,

1.6 Classification of Total Environment- Segments of Environment and their Interactions with each other,

1.7 Environmental Calendar,

1.8 Activists in Environmental Movements and their role,

1.9 Institutions in environment

1.10 Necessity and awareness on Environmental Issues.

Unit II : **(15 Hrs)**

1.1 Atmosphere: Composition and Structure of Atmosphere, Lapse Rate and Temperature Inversion

1.2 Hydrosphere: Hydrological Cycle, Structure and Composition of Hydrosphere,

1.3 Evaporation, Condensation, Forms of Condensation-Mist, Fog, Clouds and Smog, Case Studies

1.4 Global Water Balance, Types of Water, Factors Influencing the Surface Water,

1.5 Ground Water Exploration, Rain Water Harvesting,

1.6 Lithosphere: Structure and Composition of Lithosphere,

1.7 Composition of Soil, Soil Formation: Factors Affecting the Soil Formation, Physico-Chemical and Biological Weathering, Soil Profile, Classification of Soil in India,

1.8 Properties of Soil, Soil Erosion, Types- Physical, Chemical and Biological SoilErosion,

1.9 Conservation of Soil –Aims and Objective, Soil Degradation- Causes and Impacts,

1.10 Biosphere: Concept of Biosphere, Exosphere.

Unit III : **(15 Hrs)**

1.1 Definition, Scope, Branches of Ecology,

1.2 Application and Significance, Ecological Landmark, Ecological Status in India.

1.3 Abiotic Environmental Factors- Temperature, Light, Water& Humidity

1.4 Biotic Environmental Factors

1.5 Concepts, Structure and Functions of Ecosystem

1.6 Types of Ecosystem, Fresh water Ecosystem –Lake Ecosystem, Forest and Grassland

Ecosystem.

1.7 Dynamics of Ecosystem, Energy flow,

1.8 Food Chains, Food Web, Tropic Levels,

1.9 Biogeochemical Cycles (Carbon, Nitrogen, Phosphorus and Sulphur)

1.10 Basic Concept of Productivity, Productivity of Different Ecosystem

Unit IV : **(15 Hrs)**

1.1 Concept, Definition, Diversity of Wildlife

1.2 Importance of Wildlife, Examples of Protected Wildlife Species.

1.3 Wildlife in India.

1.4 Endangered Flora and Fauna in India.

1.5 Categories of Threatened Species- Rare, Endangered, Vulnerable, Extinct, Species in Wildlife of India.

1.6 National Park, Wildlife Sanctuaries, Biosphere Reserve.

1.7 Habitat Preservation, Ex-Situ and In-Situ Conservation.

1.8 Wildlife Protection Act 1972.

1.9 Threats to Wildlife, Habitat Destruction,

1.10 Developmental Projects Project Tiger, Project Elephant,

Books for Reference

1. **Fundamentals of Ecology** – E.P. Odum, Revised Edition 1995-96

2. **Principles of Ecology** – P.S. Verma, V.K. Agarwal, S. Chand and Co. Delhi.

3. **Principles of Environmental Science** – Wart K.E.F. 1973, Mc Graw Hill Book Company.

4. **Fundamentals of Ecology** – M.P. Arora

5. Basic Ecology – E.P. Odum

6. **Concept of Ecology** – E.J. Koromondy, 1996, Concept of Modern Biology series, Prentice Hall.

7. **Modern Concepts of Ecology** – H.D. Kumar

8. **Environmental Biology** – P.D. Sharma, Rastogi Publication, Meerut.

9. **Ecology and Environment** - P.D. Sharma, Rastogi Publication, Meerut

10. **Basic concepts of soil science** – A.K. Kolay, Willey Estern Ltd., New Delhi

11. **Environmental Science** – Enger, Smith, Smith, W.M.C. Brown Company Publishing

12. **Fundamental of Ecology** – Dash M.C. Tata McGraw Hill Pub. Co. Ltd. New Delhi.

13. **Concepts of Ecology (Fourth Edition)**- Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.

14. **Environment forest**, ecology and man – Dixit R.K. Rastogi Publication, New Delhi.

15. **Physical geography** – Dasgupta

16. **Environment, Energy, Health Planning for Conservation** – V. Vidyanath, Gyan Publishing House, New Delhi.

17.**Environmental Chemistry** - B. K. Sharma & H. Kaur , Goel Publishing House, Meerut

18. **Industrial Chemistry**- B. K. Sharma, Goel Publishing House, Meerut

19. **Environmental Chemistry**- A. K. Dey, Wiley Eastern Ltd, 1987.

20. **A Text book of Environmental Chemistry**-O.D. Tyagi, M. Mehra, Anand Publications Pvt, Ltd, 1994.

21. **Elements of Environmental Chemistry**-H. V. Jadhav, Himalaya Publishing

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - III

MESSS36: PAPER- IV (Core (Subject Centric) 1 : Advanced Water & Waste Water Treatment)

Candidate can opt for this paper in their main subject of Post graduation ONLY).

OBJECTIVES:

To make Students:

1. Learn Introduction to Advanced Waste Water Treatment, Zero Liquid Discharge (ZLD), Common Effluent Treatment Plant (CETP)
2. Know Advancement in Water Treatment, Advanced Water Treatment Technologies, Desalination Plants
3. Distinguish Advancement in Waste Water Treatment, Advance Technologies, Reverse Osmosis
4. Understand Cost Economics of Modern Technologies, Cost economics of ZLD and CETP, Centralized & Decentralized STPs

OUTCOMES:

Students shall be able to:

1. Interpret Advanced Waste Water Treatment, Zero Liquid Discharge (ZLD), Common Effluent Treatment Plant (CETP)
2. Utilize knowledge of Advancement in Water Treatment, Advanced Water Treatment Technologies, Desalination Plants
3. Elucidate the Advancement in Waste Water Treatment, Advance Technologies, Reverse Osmosis
4. Describe Cost Economics of Modern Technologies, Cost economics of ZLD and CETP, Centralized & Decentralized STPs

Unit I : **(15 Hrs)**

A. Introduction to Advanced Waste Water Treatment: Basic concept of advance treatment. Need of advance treatment, present Indian and global scenario.

B. Zero Liquid Discharge (ZLD) : Discharge norms, Statutory Bodies – role and duties. Concept and need of Zero Liquid Discharge, treatment technology up gradation as per discharge guidelines. Capital cost and Operational cost. Case Study of ZLD - Brewery, Textile and Dairy Industry with flow diagram

C. Common Effluent Treatment Plant (CETP) : Concept of CETP. Origin, Indian scenario, design basics, advantages and disadvantages, case studies of CETPs.

Unit II : **(15 Hrs)**

A. Advancement in Water Treatment: Introduction, water scarcity and need of advance treatment. Indian and Global Scenario.

B. Advanced Water Treatment Technologies: Membrane filtration technology – Low pressure membrane, high pressure membrane, advanced oxidation, ultraviolet treatment, water softeners. Cost economics of various technologies

C. Desalination Plants: Design & operation of modern Desalination Plants. Advantages and disadvantages. Packaged drinking water and mineral water plants. Statutory guidelines for drinking water.

Unit III : **(15 Hrs)**

A. Advancement in Waste Water Treatment: Objectives & need of advancement in waste water treatment. Cost implication. Selection of advance technology. Automation in waste water treatment plant and its advantages.

B. Advance Technologies : Design and Operation of Dissolved Air Floatation Unit (DAF),High Rate Solid Contact Clarifier (HRSCC) ,Membrane Bio Reactor (MBR), Moving Bed Biofilm Reactor (MBBR), Multi Effect Evaporators, Advantages and Disadvantages of each technology

C. Reverse Osmosis – Definition, Spiral RO, Plate Tube RO, RO membrane, Ultra Filtration, Nano-Filtration. Advantages and disadvantages of RO. Maintenance of RO, Pre-Treatment to RO - Design of Hardness, Silica, TSS, Heavy Metal removal systems.

Unit IV : **(15 Hrs)**

A. Cost Economics of Modern Technologies: Importance of cost economics in selection of treatment technology. Reverse osmosis as a tool for water sustainability.

B. Cost economics of ZLD and CETP: Cost economics and decision making. Factors affecting cost economics of a ZLD & CETP plants.

C. Centralized & Decentralized STPs : Concept of Centralized and Decentralized STPs, comparison, advantages and disadvantages, factors affecting decision making, cost economics of centralized & decentralized STPs. Skid mounted STPs. Sewage treatment and reuse. Case Studies.

Books for Reference

1. **Waste Water Engineering**: Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
2. **Introduction to Environmental Engineering**: Mackenzie L. Davis & David A. Cornwell, McGrew Hill Publishing Company, New Delhi.
3. **Basic Water Treatment :** George Smethurst (Scientific Publishers, Jodhpur)
4. **Wastewater Treatment for Pollution Control** by Soli J. Arceivala, Tata Mc Graw Hill Publishing Company, New Delhi
5. **Water Supply & Sanitary Engineering** by R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.
6. **Wastewater Treatment** by M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.
7. **Waste Water Treatment**- Concept & Design Approach by G.L. Karia& R.A. Christian,Prentice Hall of India Press
8. **Introduction to Environmental Engineering :** Mackenzie L. Davis & David A. Cornwell (Mc-Grew Hill Publishing Company, New Delhi)
9. **Waste water Engineering Treatment and Reuse**: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
10. **Industrial Waste Water Management Treatment and Disposal by Waste Water** Mc Graw Hill III Edition 2008.
11. **Water-wastewater Engineering** - Fair G.M., Geyer J.G and Okun,
12. **Fundamentals of Water Treatment Unit Processes - Physical, Chemical, and Biological** David Hendricks, CRC Press, ISBN: 978-1-4200-6191-8 (Hardback), 2011 Edition [DWH]
13. **Industrial Waste Water Treatment** by A.D Patwardhan
14. **Water and Waste Water Technology** by Mark J Hammer

MESSS37 : LABORATORY COURSE

Practical-I : Physico-chemical treatment of water and waste water and Biological Process in waste water Treatment

OBJECTIVES:

To make Students:

1. Learn about Relative density test for a sample of waste water
2. Know about determination of Sludge Volume Index (SVI) and Sludge Density Index (SDI) of Sludge samples
3. Understand about determination of Phosphate, Sulphate, for fertility values
4. Understand Estimation of Chemical Oxygen Demands (COD), Biochemical Oxygen Demands (BOD) of waste water
5. Discern fixed solids, organic matter of sludge drying bed's sludge cake
6. Recognize the Estimation of suspended, dissolved, total, volatiles solids in sewages

OUTCOMES:

Students shall be able to:

1. Interpret Relative density test for a sample of waste water
2. Utilize knowledge of Sludge Volume Index (SVI) and Sludge Density Index (SDI) of Sludge samples
3. Carry-out estimation of Nitrogen, Phosphate, Sulphate, for fertility values
4. Estimate Chemical Oxygen Demands (COD), Biochemical Oxygen Demands (BOD) of waste water
5. Elucidate fixed solids, organic matter of sludge drying bed's sludge cake
6. Reveal Estimation of suspended, dissolved, total, volatiles solids in sewages

Practical-I : Physico-chemical treatment of water and waste water and Biological Process in waste water Treatment

1. Relative density test for a sample of waste water.
2. Determination of Sludge Volume Index (SVI) and Sludge Density Index (SDI) of sludge samples.
3. Estimation of Nitrogen by Kjeldahl's methods.
4. Estimation of Phosphate in sludge for fertilities values.
5. Estimation of Sulphate in sludge for fertilities values.
6. Estimation of Chemical Oxygen Demands (COD) of waste water.

7. Estimation of Biochemical Oxygen Demands (BOD) of waste water.

8. Determination of percent organic matter of sludge.

9. Estimation of fixed solids, organic matter of sludge drying bed's sludge cake.

10. Estimation of suspended, dissolved, total, volatiles solids in sewages.

11. Study of sewage treatment plant with respect to:

A. Flow measurement.

B. Design of screen, grit chamber, aeration tank, anaerobic digesters, settling units and filtration unit.

Visit to:

a. Sewage Treatment Plant

b. Industrial Waste water treatment plant

Case Studies:

Submission of case study of Sewage Treatment Plant & Industrial waste water treatment plant.

MESSS38 : LABORATORY COURSE

Practical-II : ELECTIVE – I Water & Water Treatment

OBJECTIVES:

To make Students:

1. Learn about impurities of water viz. Colour, Temperature, Odour and Taste of water
2. Know the determination of Total Solids in water (Suspended & dissolved)
3. Acquire knowledge analyzing Iron, Manganese, Hardness, Chloride in water samples
4. Distinguish Optimum Coagulant Dose and chlorine demand test of water sample
5. Understand the Determination of Fluoride SPADNS methods
6. Discern Carbonate and Bicarbonate in water samples

OUTCOMES:

Students shall be able to:

1. Interpret impurities of water viz. Colour, Temperature, Odour and Taste of water
2. Carry-out determination of Total Solids in water (Suspended & dissolved)
3. Estimate the concentration of Iron, Manganese, Hardness, Chloride in water samples
4. Utilize the skill of determining Optimum Coagulant Dose and chlorine demand test of water sample
5. Reveal Determination of Fluoride SPADNS methods
6. Inspect Carbonate and Bicarbonate in water samples

Practical-II : ELECTIVE – I Water & Water Treatment

1. Determination of impurities of water viz. Colour, Temperature, Odour and Taste of water.
2. Determination of Total Solids in water (Suspended & dissolved).
3. Determination of Iron by Spectrophotometer.
4. Determination of Manganese by Spectrophotometer.
5. Determination of Hardness in raw and treated water.
6. Determination of Chloride in water samples by Argentometric method.
7. Estimation of chlorine demand test of water sample. Determine Break Point Chlorination.
8. Determination of Optimum Coagulant Dose by Jar test apparatus.
9. Determination of Fluoride SPADNS methods/ Ions selective Electrodes in given water sample.
10. Determination of Carbonate and Bicarbonate in given water sample.
11. Draw Schematic Lay-out of water treatment plant.

Visit to: Water Treatment Plant

Case Study:

Submission of case study of water treatment plant highlighting the need, performance & operation.

MESSS39 : LABORATORY COURSE

Practical-II : ELECTIVE – II : Water Supply and Resources

OBJECTIVES:

To make Students:

1. Learn about turbidity, Optimum Coagulant dose, fluoride in water
2. Know Determination of the Langmuir calcium carbonate saturation Index
3. Understand about chlorine demand test of water sample of water. Determine Break Point Chlorination
4. Acquire knowledge of Alum Doses for De-fluoridation of water sample using Nalgonda Techniques.

OUTCOMES:

Students shall be able to:

1. Interpret turbidity, Optimum Coagulant dose, fluoride in water
2. Carry-out Determination of the Langmuir calcium carbonate saturation Index
3. Estimate the chlorine demand test of water sample of water. Determine Break Point Chlorination
4. Utilize the knowledge of Alum Doses for De-fluoridation of water sample using Nalgonda Techniques.

Practical-II : ELECTIVE – II : Water Supply and Resources

1. Determination of turbidity of the sample by Turbidity meter.
2. Determination of Optimum Coagulant Dose by Jar Test Apparatus.
3. Determination of fluoride by SPADNS methods / Ions selective Electrodes.
4. Determination of Langmuir calcium carbonate saturation Index.
5. Estimation of chlorine demand test of water sample of water. Determine Break Point Chlorination.
6. Determination of Alum Doses for De-fluoridation of water sample using Nalgonda Techniques.
7. Preparation of different models for Rain Water Harvesting.
8. Draw any schematic Layout of water supply scheme

Visit to: Water Supply Schemes

Case Study:

Submission of case study of water supply scheme highlighting the need, performance & operation.

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

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - IV

MESSS41: PAPER- I (Air and Noise Pollution Control Technology)

OBJECTIVES:

To make Students:

1. Learn basic Introduction of Atmosphere, Air Pollution, Effects of Air Pollution
2. Know about Air Sampling & Monitoring, Air Sampling equipment, Air Sampling Method
3. Understand Air Pollution Meteorology, Air Pollution Control, Control of Gaseous Pollutants
4. Recognize Noise Pollution, Noise Pollution Control, Standards for Noise Pollution, Noise Pollution (Regulation and Control) Rules, 2000

OUTCOMES:

Students shall be able to:

1. Interpret basic Introduction of Atmosphere, Air Pollution, Effects of Air Pollution
2. Utilize knowledge of Air Sampling & Monitoring, Air Sampling equipment, Air Sampling Method
3. Elucidate Air Pollution Meteorology, Air Pollution Control, Control of Gaseous Pollutants
4. Expound concept of Noise Pollution, Noise Pollution Control, Standards for Noise Pollution, Noise Pollution (Regulation and Control) Rules, 2000

Unit I : **(15 Hrs)**

A. Introduction of Atmosphere: Origin and Composition of Atmosphere, Structure of Atmosphere, Atmospheric Photochemical Reactions, Reactions of Nitrogen Oxides in Urban Atmosphere, Reactions of Hydrocarbons in Urban Atmosphere.

B. Air Pollution: Definition of Air Pollution, Classification of Air Pollutants and their Sources, Acid Rain, Photochemical Smog, Air Pollution Index, Types and Uses.

C. Effects of Air Pollution: Effects of Air Pollutants on Man, Animals, Plants, Microbes and Materials, Diseases caused by air pollution, Air Pollution episodes and Air Pollution Control Measures. Standards Prescribed for Air Quality in India.

Unit II : **(15 Hrs)**

A. Air Sampling & Monitoring: Criteria, Selection of Sampling Locations, Analytical and Instrumental Techniques Used in Estimation of Atmospheric Pollutants (Particulate Matter and Gases), Stack Sampling, Considerations Sampling, Point Selection for Circular and Rectangular Ducts.

B. Air Sampling equipment: Sources Sampling Equipment's for Gases and Particulars, Methodology of Measurement of SO2, NO and Dust. Collection of Particulates, Dust Fall Jar, High Volume Sampler.

C. Air Sampling Method: Sampling Methods for determination of Sulphation Rate, Sulphur Dioxide, Oxides of Nitrogen, Carbon Monoxide, Hydrocarbons, and Volatile Organic Carbons (VOC), Ozone, Air Quality Standards and Index (National and Euro standards).

Unit III : **(15 Hrs)**

A. Air Pollution Meteorology: Wind Speed, Wind direction and their vertical profiles, Turbulence (Mechanical & Thermal), Wind valley Effects, land/sea breeze-Effects, Mixing Height, Temperature inversion, Factor affecting on dispersion of air pollutants.

B. Air Pollution Control: Introduction, Characterizing the Air Stream, Control devices for Particulate matter, Principle, Working & Design of Scrubbers, Electrostatic Precipitator, Fabric Filters, Cyclones Collector, Gravity Settling Chamber.

C. Control of Gaseous Pollutants: Introduction, Principle, Working of Condensation, Absorption, Adsorption, Filtration, Impingement Separator, Flue Gas Desulfurization, NO2 removal, Fugitive Emissions

Unit IV : **(15 Hrs)**

A. Noise Pollution: Definition, Sources & Impact including Physiological and Psychological effects. Basic Properties of Sound, Sound Pressure and Intensity Levels, Equivalent Sound Pressure Levels (leq), Noise Pollution Levels (npl), Sound Exposure Levels (sel) Measurement of Noise, Decibel Scale.

B. Noise Pollution Control: Criteria, Equipment used for Noise Measurement, Noise Pollution Control in Industries, Noise Control and Abatement Measures, Sound Absorbing Materials, Acoustic Silencers, Mufflers, Barriers, Vibrations and Impact Isolation.

C. Standards for Noise Pollution: Standards Prescribed for Noise in Indian Context. The Noise Pollution (Regulation and Control) Rules, 2000. Classification of areas (industrial, commercial, residential), Responsibility of implementation, Case Studies related to impact of Noise Pollution.

Books for Reference

1. Air Pollution and its control: Sumit Malhotra (Pointer publishers, Jaipur)

2. Air Pollution: M. N. Rao (Tata McGraw – Hill publishing company, New Delhi)

3. Air Pollution: B. K. Sharma, H. Kaur (Krishna prakashan media, Meerut)

4. Pollution of our Atmosphere: B. Henderson, (Sellers Adam Hilger Limited, Bristol)

5. Fundamentals of Air Pollution: Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A. C. Stern (Academic Press, California)

6. Air Pollution control Engineering: Noel De Nevers (Mc Graw – Hill international, New York)

7. Air Pollution: S. K. Agarawal (A. P. H. Publishing corporation, New Delhi)

8. Air Pollution: V. P. Kudesia (PragatiPrakashan, Meerut)

9. Noise Pollution and Control Strategy: S.P. Singal, Narosa Publishing House, New Delhi.

10. Noise Pollution: B. K. Sharma, H. Kaur, Goel Publishing House, Meerut, 1994

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - IV

MESSS42: PAPER- II (Solid and Hazardous Waste Management)

OBJECTIVES:

To make Students:

1. Learn about Introduction to Solid Waste, Municipal Solid Waste, Collection and Handling of Solid Waste
2. Know about Solid Waste Management Introduction, Treatment & Disposal of Solid Waste, Solid Waste Management: Indian Scenario
3. Understand to Introduction to Hazardous Waste, Treatment of Hazardous Waste, Role of Treatment, Storage, Disposal Facility (TSDF)
4. Recognize Biomedical & E-Waste Management, Construction & Demolition (C&D) Waste Management, Plastic Waste

OUTCOMES:

Students shall be able to:

1. Interpret concept of Solid Waste, Municipal Solid Waste, Collection and Handling of Solid Waste
2. Elucidate Solid Waste Management Introduction, Treatment & Disposal of Solid Waste, Solid Waste Management: Indian Scenario
3. Expound Introduction to Hazardous Waste, Treatment of Hazardous Waste, Role of Treatment, Storage, Disposal Facility (TSDF)
4. Describe Biomedical & E-Waste Management, Construction & Demolition (C&D) Waste Management, Plastic Waste

Unit I : **(15 Hrs)**

A. Introduction to Solid Waste: Definition, Categories of Solid waste (Municipal, Biomedical, Hazardous, Construction and Demolition, E-Waste, Plastic Waste), Classification of Solid Waste, Problems created by Solid Waste

B. Municipal Solid Waste: Definition, Composition of Municipal Solid Waste, Characteristics (Physical, chemical, biological), Solid Waste Sampling

C. Collection and Handling of Solid Waste: Source Segregation, Solid Waste Collection and Storage, Transport and Transfer Stations, Material Recovery Facility (MRF) Centers (Basic concept, operation, unit processes)

Unit II : **(15 Hrs)**

A. Solid Waste Management Introduction: Definition, The waste hierarchy, History of Solid Waste Management, Legal Aspect of Solid Waste Management in India (Solid Waste Management Rules, 2016)

B. Treatment & Disposal of Solid Waste: Classification of Treatment methods, Composting, Biogasification, Sanitary Landfill (Landfill Planning, Designing, Construction and Operational Practices, Landfill Quality Control), Refuse Derived Fuel, Waste to Energy (WtoE)

C. Solid Waste Management: Indian Scenario : Swachha Bharat Mission, Swachha Survekshan, PPP (Public Private Partnership) Models in Waste Management, Entrepreneurial opportunities in Waste Management

Unit III : **(15 Hrs)**

A. Introduction: Definition, Identification, Sources of Hazardous Waste, Characteristics of Hazardous Waste, Environmental effects of improper handling of Hazardous Waste.

B. Treatment of Hazardous Waste: Physical Treatment (Filtration & Separation), chemical treatment (Solidification & Stabilization), biological treatment, Thermal Treatment (Incineration, Pyrolsis, Gasification), Secured Landfill, Leachate Management, Contaminated Site Remediation

C. Role of Treatment, Storage, Disposal Facility (TSDF): Waste Characterization (Comprehensive Analysis, Fingerprint Analysis), 7-copy Manifest, TREM Card, Hazardous Waste Storage Collection & Storage Guidelines, Hazardous Waste Label.

Unit IV : **(15 Hrs)**

A. Biomedical & E-Waste Management: Biomedical Waste (Definition of Biomedical Waste, Biomedical waste categories & their segregation, collection, treatment, processing & Disposal),

E-Waste (Definition, Collection, Disposal Methods, Extended Producer Responsibility

B. Construction & Demolition (C&D) Waste Management: Definition and Composition of C&D Waste, Impact of C&D waste in Environment, Process of C&D Waste Management, Recycling and Utilization of C&D waste.

C. Plastic Waste: Plastic Types, Sources, Impact of plastics on marine, wildlife, human health and Environment, Single Use Plastics, Possible Alternate materials to plastics (Greener Alternatives), Plastic Waste Management (Issues & Challenges), Plastic Resource Recovery & Circular Economy.

Books for Reference

01. Solid waste pollution :Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
02. Principals of Soil Science :M. M. Rai, McMillon Publication.
03. Soil pollution & Soil organisms : P. C. Mishra
04. Environmental Chemistry : B. K. Sharma, Goyal Publishing House, Meerut, U.P.1984
05. Environmental Science : S. C. Santra, New Central Book Agency, Kolkata, 2005
06. Environmental Pollution Control Engineering. S. Rao, New age International, Mumbai,2003
07. Fundamentals of Soil Science : Henry D. Foth, John Wiley & Sons, New York, 1984
08. Environmental Engineering : Davis & Cornwell, McGraw – Hill Publications, New York, 1998
09. Environmental Science Principles and Practices :R. C. Das, D. K. Behra, Printice Hall, New Delhi, 2008
10. Basic Environmental Technology: Jerry A. Nathanson, Prentice Hall of India Ltd. New Delhi, 2004
11. Municipal solid Waste Management Manual (Part II), CPHEEO, Ministry of Urban Development, Swachh Bharat Mission, Govt. Of India.

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - IV

MESSS43: PAPER- III (ELECTIVE-I: Environmental Impact Assessment and Legislation)

OBJECTIVES:

To make Students:

1. Learn about Environmental Impact Assessment, Nature of Impacts and Case Studies
2. Distinguish EIA Procedure, Methodologies of EIA, Legislation of EIA and EIA guideline for development project
3. Understand the Environmental Audit, Procedural Requirements of Conducting EA, ECO- Audit and Concept& Scope ISO 14000
4. Discern Environmental Legislation, Forest & Wild Life and Other Important Acts

OUTCOMES:

Students shall be able to:

1. Utilize Environmental Impact Assessment, Nature of Impacts and Case Studies
2. Interpret EIA Procedure, Methodologies of EIA, Legislation of EIA and EIA guideline for development project
3. Elucidate Environmental Audit, Procedural Requirements of Conducting EA, ECO-Audit and Concept& Scope ISO 14000
4. Expound Environmental Legislation, Forest & Wild Life and Other Important Acts

Unit I : **(15 Hrs)**

A. Environmental Impact Assessment: Definition, Basic Concepts and Evolution of EIA, Principles of EIA, Need for EIA, Elements of EIA.

B. 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.

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

Unit II : **(15 Hrs)**

A. EIA Procedure: Screening and Scoping in EIA, Impact Assessment ; Mitigation, Impact Management, EIA Report, Review & Licensing, Monitoring.

B. 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.

C. 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 : (15 Hrs)

A. Environmental Audit: Concept of Environmental Audit, Definition, Objective, Types of Environmental Audit, Benefits of Environmental Audit.

B. 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.

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

Unit IV : (15 Hrs)

A. 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

B. 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.

C. 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 Wiley and 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 & amp; Co. Ltd. New Delhi.
6. An Introduction to Environmental Management: Dr. Anand S. 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.

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - IV

MESSS44: PAPER- III (ELECTIVE-II: Environmental Management)

OBJECTIVES:

To make Students:

1. Learn Concept of Environmental Management, Standards, Environmental planning, Micro & Macro planning, rural & urban planning
2. Know Computer Programming, Remote Sensing and GIS, Application of GIS
3. Understand Global Environmental Initiatives, National Environmental Initiatives, Sustainable Development
4. Recognize Way Forward 2050Environment & Climate Literacy, NGO / Corporate Participation, Role of Policy & Decision Makers

OUTCOMES:

Students shall be able to:

1. Interpret Environmental Management, Standards, Environmental planning, Micro & Macro planning, rural & urban planning
2. Elucidate Computer Programming, Remote Sensing and GIS, Application of GIS
3. Reveal Global Environmental Initiatives, National Environmental Initiatives, Sustainable Development
4. Expound Way Forward 2050, Environment & Climate Literacy, NGO / Corporate Participation, Role of Policy & Decision Makers

Unit I : **(15 Hrs)**

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

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

C. 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 : **(15 Hrs)**

A. Computer Programming: Computer Organization, Computer Generation and Classifications, Structure, Function, Capabilities and Limitations of Computers, Operating System, MS-Office, Development of Different Environmental Models by Simple Computer Programming. Internet access to Generate the Environmental Data.

B. Remote Sensing and GIS: Definition, Principles and Scope of Remote Sensing, Electromagnetic Radiation, Sensors and Type of Scanning Systems, Basic Characteristics of Sensors; Salient Features of Sensors Used in LANDSAT, SPOT and Indian Remote Sensing Satellites. GIS Technology and Its Uses in Environmental Science,

C. Application of GIS: In Agriculture, Environmental Management and Land Use, Land Cover. GPS (Global Positioning System): Basic Concepts, GPS Positioning Techniques, GPS Procedures, Role of GPS in GIS and Remote Sensing

Unit III : **(15 Hrs)**

A. Global Environmental Initiatives: The Agenda 21 of Earth Summit, Major International Organizations and Agencies Involved in Environmental Management. Stockholm Conference on Human Environment 1972, 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.

B. 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.

C. Sustainable Development: Definition, Concept and Historical background, Sustainable Development Goals (SDGs), Development & Environment Conflict, Case studies.

Unit IV : **(15 Hrs)**

A. 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.

B. 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.

C. 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

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - IV

MESSS45: PAPER- IV (Foundation-II : Fundamentals of Environmental Science- II)

(Student shall opt for this paper from any other subject other than his / her main subject for Post-graduation.)

OBJECTIVES:

To make Students:

1. Learn about Air Pollution, Air Pollutants and their Sources, Control Measures, Air Pollution Index and Air Pollution Episodes, Climate Change and Global Warming
2. Know about Noise Pollution, Properties of Sound, Sound Pressure and Intensity Levels, Measurement of Noise, Control Measures, Noise Pollution Control in Industries
3. Distinguish Water Pollution, Sources, Bioaccumulation, Bio-Magnification and Eutrophication
4. Understand Water Sampling, Handling, preservation of samples, Water Pollution Control Act
5. Recognize Soil Pollution, Soil Pollutants, Causes and Effects, Nutrients in Soil, Methods of Solid Waste Treatment and Disposal, Biomedical Waste

OUTCOMES:

Students shall be able to:

1. Interpret about Air Pollution, Air Pollutants and their Sources, Control Measures, Air Pollution Index and Air Pollution Episodes, Climate Change and Global Warming
2. Utilize knowledge of about Noise Pollution, Properties of Sound, Sound Pressure and Intensity Levels, Measurement of Noise, Control Measures, Noise Pollution Control in Industries
3. Elucidate Water Sampling, Handling, preservation of samples, Water Pollution Control Act
4. Expound Soil Pollution, Soil Pollutants, Causes and Effects, Nutrients in Soil, Methods of Solid Waste Treatment and Disposal, Biomedical Waste

Unit I : **(15 Hrs)**

1.1 Definition of Air Pollution,

1.2 Classification of Air Pollutants and their Sources (Natural and Anthropogenic),

1.3 Effects of Air Pollutants on Man, Animals, Plants and Materials,

1.4 Air Pollution Control Measures, Taj Trapezium Zone (TTZ),

1.5 Standards Prescribed for Air Quality in India, Air Pollution Control Act,

1.6 Air Pollution Index and Air Pollution Episodes (Bhopal Gas Tragedy),

1.7 Acid rain-Sources, Effects and Chemical Reaction, Control Measures,

1.8 Sources and Effects of Green House Gases- O,O_3, H_2O, NH_3, N_2, NO, NO_2, NO_3, CH_4 and CFCs,

1.9 Climate Change and Global Warming,

1.10 Atmospheric Ozone, Mechanism of Ozone Depletion, Effects of Ozone Depletion.

Unit II : (15 Hrs)

1.1 Introduction of Noise Pollution, Definition of Noise Pollution

1.2 Basic Properties of Sound, Sound Pressure and Intensity Levels,

1.3 Equivalent Sound Pressure Levels (Leq), Noise Pollution Levels (NPL), Sound Exposure Levels (SEL)

1.4 Measurement of Noise, Decibel Scale,

1.5 Sources of Noise Pollution, Physiological and Psychological effects of Noise Pollution,

1.6 Noise Control Criteria, Equipment used for Noise Measurement,

1.7 Control Measures of Noise Pollutions, Noise Control and Abatement Measures,

1.8 Sound Absorbing Materials, Acoustic Silencers, Mufflers, Barriers, Vibrations and Impact Isolation.

1.9 Permissible exposure Limits, Noise Pollution Control in Industries,

1.10 Standards Prescribed for Noise in Indian Context.

Unit III : (15 Hrs)

1.1 Definition of Water Pollution, Classification Water Pollutants and their Adverse Effects,

1.2 Sources of Water Pollution From Urban, Industrial, Agricultural and Natural Waters,

1.3 Interaction in Aquatic System, Nature of Sources-Stationary, Intermittent, Continuous and Mobile,

1.4 Bioaccumulation, Bio-Magnification and Eutrophication,

1.5 Water Borne Diseases,

1.6 Water Sampling, Selection of sampling site, collection,

1.7 Handling, preservation of samples, Types of water samples,

1.8 Physico-Chemical Characteristics of Water Quality,

1.9 Water Quality Criteria for Drinking Purpose

1.10 Water Pollution Control Act

Unit IV : **(15 Hrs)**

1.1 Soil Pollution, Soil Pollutants, Causes and Effects of Soil Pollution,

1.2 Major Sources of Soil Pollution,

1.3 Nutrients in Soil (NPK); Domestic, Municipal, Industrial and Agricultural Wastes and their Role in Soil Degradation,

1.4 Introduction of Solid Waste,

1.5 Classification and Origin of Solid Waste, Characteristics of Solid Waste,

1.6 Methods of Solid Waste Treatment and Disposal, Pyrolysis, Recycling and Reuse of Solid Waste Management, Solid Waste Pollution Scenario in India,

1.7 Land Fill (Site Selection, Site Investigation and Site Characterization),

1.8 Hazardous Waste, Hazardous Waste Testing in Terms of Toxicity, Corrosivity, Ignitability and Reactivity,

1.9 Priority Pollutants, Acute and Chronic Toxicity, Bioaccumulation, Mutagenicity, Teratogenicity Carcinogenicity and Genotoxicity.

1.10 Biomedical Waste, Categorization of Biomedical Waste and disposal practices in urban area.

Books for Reference

01. Air Pollution and its control: Sumit Malhotra (Pointer Publishers, Jaipur)

02. Air Pollution: M. N. Rao (Tata McGraw – Hill Publishing Company, New Delhi)

03. Air Pollution: B. K. Sharma, H. Kaur (Krishna Prakashan media, Meerut)

04. Pollution of our Atmosphere: B. Henderson, (Sellers Adam Hilger Limited, Bristol)

05. Fundamentals of Air Pollution: Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A.C. Stern (Academic Press, California).

06. Air Pollution: S. K. Agarawal (A. P. H. Publishing corporation, New Delhi)

07. Air Pollution: V. P. Kudesia(Pragati Prakashan, Meerut)

08. Noise Pollution and Control Strategy: S.P. Singal, Narosa Publishing House, New Delhi.

09. Noise Pollution: B. K. Sharma, H. Kaur, Goel Publishing House, Meerut, 1994.

10. Environmental Engineering: Gerard Kiely, Vol. I, II,& III Liptak, Tata McGraw Hill, New Delhi(1998)

11. Environmental Chemistry: A.K. De,. 2nd edn., 1990, Wiley Eastern Ltd., New Delhi.

12. Industrial Pollution Control: Nancy J. Sell, , John Willey and Sons, Inc., New York (1992)

13. A Text Book of Environmental Chemistry and Pollution Control: S.S. Dara, S. Chand,

and Co. Ltd., New Delhi. (1995)

14. Solid Waste Management in Developed Countries: A. D. Bhide and B.B. Sundersen, INSDOC, New Delhi (1983)
15. A Book on Waste Management: Sinha R. K., Sinha A. K., Saxena V. S., INA, Shri Publishers, Jaipur (2000)
16. Solid Waste Pollution: Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
17. Soil Pollution and Soil Organism: P.C. Mishra

SUBJECT: ENVIRONMENTAL SCIENCE

M.SC. - II SEMESTER - IV

MESSS46: PAPER- IV (Core (Subject Centric) –II Disaster Management)

OBJECTIVES:

To make Students:

1. Learn about Disaster Management, Natural Disasters, Man-made Disaster
2. Know about Warning and Communication System, GIS and Remote Sensing, Applications of GIS and Remote Sensing
3. Understand Risk Assessment, Process of Risk Assessment, Vulnerability
4. Recognize Disaster preparedness, Disaster preparedness Plan, Disaster Response

OUTCOMES:

Students shall be able to:

1. Interpret disaster Management, Natural Disasters, Man-made Disaster
2. Elucidate warning and Communication System, GIS and Remote Sensing, Applications of GIS and Remote Sensing
3. Expound risk Assessment, Process of Risk Assessment, Vulnerability
4. Describe disaster preparedness, Disaster preparedness Plan, Disaster Response

Unit I: **(15 Hrs)**

A. Disaster Management: Meaning, Nature, Importance, Dimension and scope of Disaster Management, Disaster Management Cycle, National Disaster Management frame work, financial arrangement for Disaster Management, International strategy for Disaster reduction.

B. Natural Disasters: Meaning and nature of natural disaster, their types, causes and effects, Hydrological disasters (Flood, Flash flood, Drought and Cloud burst), Geological disasters (Earthquake, Volcanic eruption, Landslides, Avalanches, Tsunami and Mud flow).

C. Man-made Disaster: Meaning and nature of man-made disaster, their types, causes and effects, Chemical, Biological, Radiological and Nuclear disaster, Fire (Building fire, coal fire, forest fire and oil fire), Accidents (Road, rail, air and sea accidents).

Unit II: **(15 Hrs)**

A. Warning and Communication System: Early warning system, Community early warning system, Core Components of People centered early warning system, Emergency

Communication System, Wireless Communication, Bluetooth Wireless Technology HAM Radio, GPS Application in Emergency Communication.

B. GIS and Remote Sensing: Definition, Principle, fundamentals and Scope of Remote Sensing, Geographical Information System (GIS)-Definition Concept of Space and Time Domains of spatial information system, components of GIS (Hardware, Software, Data, People and Process)

C. Applications of GIS and Remote Sensing: Role of Remote Sensing and GIS in Disaster Management and Warning system, Methods of Collecting relevant information- Libraries, Internet, Survey, observation , Mass media, Role of Information from disaster affected community.

Unit –III **(15 Hrs)**

A. Risk Assessment: Risk concept, Elements of risk, Acceptable risk, Requirement in risk assessment, Role of Science and Technology in Disaster Risk Reduction, Strategies of risk reduction.

B. Process of Risk Assessment: Risk Analysis techniques, Process of risk assessment, Analytical system for risk assessment, Natural hazard/risk assessment, Understanding climate risk, Decision making for risk reduction, Problems in risk assessment.

C. Vulnerability: Observation and perception, vulnerability identification, vulnerability types and dimensions, Vulnerability (social & economic factor). Physical and social infrastructure for vulnerability reduction, Hazard resistant design and construction, systematic management and strategic planning for vulnerability reduction.

Unit IV: **(15 Hrs)**

A. Disaster preparedness: Concept and significance, Disaster preparedness measures, Institutional mechanism for disaster preparedness, Policy and programme of disaster preparedness.

B. Disaster preparedness Plan: Concept and significance, Community based Disaster preparedness plan. Prediction, Early warning and safety measures of disaster, Role of Government, NGOs and Information technology in Disaster preparedness.

C. Disaster Response: Essential components of disaster response, Disaster Response Plan (Communication, Participation and Activation of Emergency preparedness Plan), Search, Rescue, Evacuation and Logistic management, Relief and Recovery, Rehabilitation and Reconstruction.

Books for References:

1. Textbook of Environmental studies by Benny Joseph , McGrew-Hill Publishing Company Limited.
2. Disaster Management by Mukesh Dhunna, Vayu Education of India, New Delhi, 2009 First edition.
3. Introduction to Environmental Science by G. Tyler Miller, Jr. Scott Spoolman, Cengage learning Publication.
4. Environmental Science by S.C. Santra, New Central Book agency Pvt. Ltd. Kolkata , India.
5. Environmental Management by H.P. Behera and M.S. Khan, Himalaya Publication
6. Disaster Management Programmes And Policies by Siddhartha Gautam K Leelakrisha Rao , Publication - Vista International.
7. Introduction To Disaster Management ,by B.C.Bose 46 ,Rajat Publishers
8. Global Disaster Management ,by Arun Kumar,SBS Publishers
9. Handbook Of Disaster Management (2 Vol.set) , Author : Reepunjaya Singh ,ABD Publishers
10. Handbook of Disaster Management William L. Waugh 2005
11. Disaster Management : Text and Case Studies D.B.N. Murthy Jain Book Agency 200
12. Disaster Management and Risk Reduction: Role of Environmental Knowledge Anil K. Gupta, Sreeja S. Nair, Florian Bemmerlein Lux and Sandhya Chatterji Jain Book Agency, 2013
13. Disaster Management and Preparedness Nidhi Gaubha Dhawan CBS Publishers
14. Dr. Mrinalini Pandey Disaster Management Wiley India Pvt. Ltd.
15. Tushar Bhattacharya Disaster Science and Management McGraw Hill Education (India) Pvt. Ltd.
16. Jagbir Singh Disaster Management: Future Challenges and Opportunities K W Publishers Pvt. Ltd.
17. J. P. Singhal Disaster Management, Laxmi Publications.
18. Shailesh Shukla, Shamna Hussain Biodiversity, Environment and Disaster Management, Unique Publications.
19. C. K. Rajan, Navale Pandharinath Earth and Atmospheric Disaster Management : Nature and Manmade, B S Publication

MESSS47 : LABORATORY COURSE

Practical-I : Air and Noise Pollution Control Technologies and Solid and Hazardous Waste Management

A) Air and Noise Pollution Control Technologies

OBJECTIVES:

To make Students:

1. Learn about Determination of Suspended Particulate Matter (SPM) and RSPM
2. Distinguish the analysis of air sampling from residential, commercial, and industrial zone using key parameters like SOx and NOx
3. Know the measurement of noise pollution by Noise Meter in silent, residential, commercial, and industrial zone and comparison with standards

OUTCOMES:

Students shall be able to:

1. Interpret Determination of Suspended Particulate Matter (SPM) and RSPM
2. Utilize analysis of air sampling from residential, commercial, and industrial zone using key parameters like SOx and NOx
3. Estimate noise pollution by Noise Meter in silent, residential, commercial, and industrial zone and comparison with standards

A) Air and Noise Pollution Control Technologies

1. Determination of Suspended Particulate Matter (SPM) and RSPM in ambient air by using High Volume Sampler.
2. Comparative analysis of air sampling from residential, commercial, and industrial zone using key parameters like SOx and NOx.
3. Measurement of noise pollution by Noise Meter in silent, residential, commercial, and industrial zone and comparison with standards.
4. Determination of carbon monoxide in ambient air.
5. Preparation and interpretation of wind roses.
6. Estimation of poly aromatic hydrocarbons in air
7. Determination of settable particles by Dust fall jar method

B) Solid and Hazardous Waste Management

OBJECTIVES:

To make Students:

1. Learn Determination of moisture content of solid waste sample
2. Know the Determination of volatile and non- volatiles matter from solid waste sample
3. Understand bio medical waste generation and disposal practices in urban area

OUTCOMES:

Students shall be able to:

1. Interpret the Determination of moisture content of solid waste sample
2. Utilize Determination of volatile and non- volatiles matter from solid waste sample
3. Estimate bio medical waste generation and

B) Solid and Hazardous Waste Management

1. Determination of moisture content of solid waste sample.
2. Determination of volatile and non- volatiles matter from solid waste sample.
3. Estimation of calorific value of solid waste sample by Bomb Calorimeter.
4. Study of bio medical waste generation and disposal practices in urban area.

C) Environmental Impact Assessment and Legislation & Environmental Management

OBJECTIVES:

To make Students:

1. Learn Qualitative analysis of natural environment of any area with respect to soil, air, water, noise and socio-economics
2. Understand Data collection to evaluate impact of new industry on environment with respect to air, water, noise & socio economic parameters
3. Discern Base line data collection of water, air, soil and noise quality of the area
4. Recognize the Demonstration on ISO: 14001, ISO:14004, ISO: 9001

OUTCOMES:

Students shall be able to:

1. Interpret the Qualitative analysis of natural environment of any area with respect to soil, air, water, noise and socio-economics
2. Carry-out Data collection to evaluate impact of new industry on environment with respect to air, water, noise & socio economic parameters
3. Estimate Base line data collection of water, air, soil and noise quality of the area

4. Elucidate Demonstration on ISO: 14001, ISO:14004, ISO: 9001

C) Environmental Impact Assessment and Legislation & Environmental Management

1. Qualitative analysis of natural environment of any area with respect to soil, air, water, noise and socio-economics.
2. Data collection to evaluate impact of new industry on environment with respect to air, water, noise & socio economic parameters
3. Evaluate environment Impact due to any **two** upcoming mega infrastructure projects in Nagpur / Maharashtra.
4. Base line data collection of water, air, soil and noise quality of the area.
5. Study of environmental management practices in industries.
6. Demonstration on ISO: 14001, ISO:14004, ISO: 9001.

Visit To:

- Industries implemented ISO 14000
- NGO working in the field of Environmental Management.
- Bhandewadi, Nagpur Solid Waste Dumping Yard
- Remote Sensing Center, Nagpur.

Case Studies:

- Development v/s Environment.
- Operations & Impact of any one NGO of Nagpur City
- Solid Waste Collection System of Nagpur City

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

MESSS48 : LABORATORY COURSE

Practical-II: PROJECT WORK

OBJECTIVES:

To make Students:

1. Learn about writing background with historical information and a review of existing material
2. Understand to Describe the issue, methodology adopted for the study
3. Discern Presentation of data collected and detailed analysis of results
4. Know about Discussion on the data and results obtained and presentation of method suggested solving the problem
5. Recognize about summary of the dissertation and important conclusions drawn at the end of the investigation

OUTCOMES:

Students shall be able to:

1. Prepare background with historical information and a review of existing material
2. Utilize the knowledge to Describe the issue, methodology adopted for the study Carry-out
3. Elucidate Presentation of data collected and detailed analysis of results
4. Interpret Discussion on the data and results obtained and presentation of method suggested solving the problem

The project will carry 100 marks.

Research based project work (Instructions for Students):

Candidates will write a project on issues related to Environmental Science under the guidance of their respective guides. The regular full time teacher of the department / contributory teacher approved by university / scientist of government / private research laboratory appointed by university as a contributory teacher and having M. Phil. or Ph. D. degree can supervise the project work of the student.

The students will have to carry out the research based project work in lieu of practical in the fourth semester in the department or depending on the availability of placement; he/she will be attached to any of the national/ regional/ private research institute / organization for the duration of the fourth semester. The student will be randomly allotted the priority number for the selection of the supervisor in the third semester.

Each student will work independently on the topic. The project work must consist of review of literature and produce a deep insight of the subject on the basis of personal research. Project work will be initiated after passing M.Sc.-I. The students will undertake field wok in terms of collection of data and surveys. The project will have to be submitted at the end of the academic year for appraisal and acceptance by the University. The students should submit their project in the following format.

Chapter I: Introduction with Aims and Objectives.

A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study.

Chapter II: Methodology with Material and Methods.

Description of the issue, methodology adopted for the study.

Chapter III: Experimental

Presentation of data collected and detailed analysis of results.

Chapter IV: Result and Discussion

Discussion on the data and results obtained and presentation of method suggested solving the problem.

Chapter V: Summary and Conclusions.

A summary of the dissertation and important conclusions drawn at the end of the investigation.

Chapter VI: Bibliography or References

A list of references of cited in the text. The project should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. If the project contains such mistakes the student will have to resubmit their project after the necessary corrections. The project should be bound in hard black mounted cover. Project with spiral binding and paper cover will not be accepted. The students are expected to prepare 4 copies of the project of which three should be submitted to the University.

The project will carry 100 marks. Assessment of the project will be done at the end of the year. Students have to appear for PowerPoint presentation and shall carry 10 marks. Students will have to submit their project one month before the final practical examination. Assessment of the project shall be done by the Supervisor appointed by the institute.

Distribution of Marks (Project) Maximum Marks: 100

1. Introduction & Review of literature: 10
2. Presentation of Work: 10
3. Reasoning Capability: 10
4. Subject Knowledge: 15
5. Interpretation of Results: 15
6. Project Viva: 20

Total Marks: 80

(Evaluated jointly by External & Internal)

Internal Assessment 20

(Evaluated by Internal examiner)

A) VISIT TO ATLEAST TWO CENTERS OF THE FOLLOWING

i) National Environmental Engineering Research Institute (NEERI), Nagpur

ii) Remote Sensing Center

iii) Regional Meteorological Center, Nagpur

iv) Maharashtra Pollution Control Board, Nagpur

B) SEMINAR

Student may select any environmental related topic of their choice (in consultation with the faculty) and make a power point presentation for 30 minutes. The students have to deliver the seminar which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees and students. They shall be able to answer questions invited from the audience. **25 Marks**

C) FIELD DIARY

The student shall prepare their field diary under the following heads

i) Issue on local/regional/national problem of environmental interest (Case Studies).

ii) About famous personalities in environmental movements.

iii) New Acts and Judgments of environmental interests

D) GUEST LECTURE SERIES:

In each year guest lectures will be given by the faculty and other invited speakers on current topics and environmental issues. The course would run as a guest lecture series (at least five guest lecturers in chosen topics) with compulsory attendance.