Master of Science (M. Sc.)
(Environmental Sciences & Management)

SYLLABUS

Department of Environmental Science
Faculty of Engineering & Technology
Jamia Millia Islamia
New Delhi-110025(India)

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2022-2023

Preface

The Department of Environmental Science was established in 2021 with great emphasis on the production of environmental scientists and managers which can utilize their expertise in the saving and managing of environmental resources of the country or worldwide. The syllabus was developed and published in printed form in 2022. The course structure and course content were developed keeping in view the current trends in environmental science education and demands of the industry. The latest version of the syllabus is the outcome of a thorough revision of course structure and course content with inputs from subject experts and professionals. The syllabus has been designed to provide a solid foundation in the areas of environmental engineering, environmental management and environmental health and safety keeping in view the latest developments in these core subject areas.

I wish to acknowledge the hard work put in by the faculty members in the development course structure and syllabus. I also wish to convey my sincere thanks to the subject experts who gave their valuable inputs in finalizing this syllabus.

In-charge **Professor Sirajuddin Ahmed**

About the University

Jamia Millia Islamia, an institution originally established at Aligarh in United Provinces, India in 1920 became a Central University by an act of the Indian Parliament in 1988. In Urdu language, Jamia means 'University', and Millia means 'National'.

The story of its growth from a small institution in pre-independence India to a central university located in New Delhi—offering integrated education from nursery to research in specialized areas—is a saga of dedication, conviction and vision of a people who worked against all odds and saw it growing step by step. They "built up the Jamia Millia stone by stone and sacrifice by sacrifice," said Sarojini Naidu, the nightingale of India.

Under colonial British rule, two dominant trends joined hands and contributed towards the birth of Jamia. One was the anti-colonial Islamic activism and the other was the pro-independence aspiration of the politically radical section of western educated Indian Muslim intelligentsia. In the political climate of 1920, the two trends gravitated together with Mahatma Gandhi as a catalyst. The anti-colonial activism signified by the Khilafat and the pro-independence aspirations symbolised by the non-cooperation movement of the Indian National Congress helped to harness creative energies and the subsequent making of Jamia Millia Islamia. Rabindranath Tagore called it "one of the most progressive educational institutions of India".

The prominent members of this movement were Maulana MehmudHasan, Maulana Mohamed Ali, Hakim Ajmal Khan, Dr. Mukhtar Ahmad Ansari, and Abdul Majid Khwaja. Hakim Ajmal Khan, Dr. Mukhtar Ahmed Ansari and Abdul MajeedKhwaja supported by Gandhiji shifted Jamia from Aligarh to Karol Bagh, in New Delhi in 1925. In 1925, after long deliberation, a group of three friends studying in Germany—Dr. Zakir Husain, Dr. Abid Husain and Dr. Mohammad Mujeeb—decided to serve Jamia. .It was designated a Central University by an act of the Indian parliament in 1998.

Since then, Jamia Millia Islamia has grown tremendously by providing integrated education from nursery to research in numerous specialised fields, as well as educating students with devotion, conviction, and vision.

Currently, Jamia Millia Islamia has about 20,000 students, 800 academic members, 39 departments, and 30 centres of excellence and research. It has about 243 different courses. Jamia Millia Islamia's aims are to impart cutting-edge information and provide educational facilities for research and extension in a variety of academic areas.

It fosters education at all levels, from pre-school to PhD. Jamia's relentless pursuit of educational innovations leads to course reorganisation, innovative ways of instruction and learning, and integrated personality development.

Today, Jamia Millia Islamia and Faculty of Engineering and Technology are placed third and twenty sixth in the NIRF rankings, respectively and has received an A++ grade from NAAC.

About the Program

The Department of Environmental science is the newly established department in the Faculty of Engineering & Technology. Currently the department is offering a master degree program in Environmental Sciences and Management.

The Department of Environmental Science is involved in the academic, research, planning, analysis and consultancy for environmental modeling and mitigation and designing of various municipal and industrial wastewater treatment facilities. The primary focus of the faculty of group is mainly on extending the knowledge to students on basic concepts and principles of environmental science and applied to solve major environmental issues related to pollution control. The program provides excellent technical knowledge in the area of environmental science that deals with the design of municipal/industrial wastewater treatment facilities as well as air and noise pollution control systems. The ultimate goal of the master's program is to provide advanced learning with enhanced analytical abilities to solve problems that are interdisciplinary in nature and help in protecting the environment. Graduates of Environmental Science and Management would have a wide variety of employment opportunities in both the private and public sectors.

The department has been planning to modernize with State of Art facilities to be utilized for research and consultancy in addition to train the students.

PROGRAM OUTCOMES

The curriculum and syllabus for M.Sc. (Environmental Sciences and Management) program confirms to a result oriented teaching-learning process. The curriculum and syllabus have been structured to meet one or more problem outcomes (POs).

Program outcomes are statements that describe significant and essential learning that students have achieved and can reliably demonstrate at the end of a course or program. Program outcomes identify what students *will know and be able to do* by the end of a course or program – the essential and enduring knowledge, abilities (skills) and attitudes (values, dispositions) that constitute the integrated learning needed by a graduate of a course or program.

Graduates of the environmental engineering program will be able to:

1. Apply the knowledge of science and engineering and fundamental principles of basic biology to solve various problems related to environmental engineering discipline.
2. Conduct experimental research, analyze the data and interpret the results in the form of conceptual report and format it into a document in the form of thesis, professional report.
3. Follows the standard codes, specifications and IS codes to arrive at some consensus within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Learn basic techno-economic and techno-legal aspects of engineering projects, and preliminary aspects of project management and to work in a multidisciplinary environment.
5. Use current techniques, skills, and modern engineering tools/ software etc. necessary for computing and engineering practice.
6. Develop appropriate skills of written, oral and visual communications and make effective documentations and presentations.
7. Recognise and develop confidence for self-education and ability to engage in continuing professional development.
8. Analyze the local and global impact of contemporary engineering issues on individuals, organizations and society.
9. Demonstrate their role as managers or entrepreneurs and contribute their skills to the society.
10. Recognize the importance of Environmental Science and Engineering professional development by pursuing higher studies and research or face competitive examinations that offer challenging and rewarding careers.

SEMESTER I

S. No.	Course Title	Course Code	Credits	Marks		
				End Sem.	Mid Sem.	Total
1	Environmental Chemistry	MES-101	4	60	40	100
2	Environmental Microbiology and Biotechnology	MES-102	4	60	40	100
3	Ecology and Ecosystems	MES-103	4	60	40	100
4	Water and Wastewater Physico-chemical Treatment Process	MES-104	4	60	40	100
5	Solid Waste Management	MES-105	4	60	40	100
6	Environmental Monitoring Lab- I	MES-111	2	20	30	50
7	Communication Skill	MES-112	2	20	30	50
Total			**24**	**340**	**260**	**600**

SEMESTER II

S. No.	Course Title	Course Code	Credits	Marks		
				End Sem.	Mid Sem.	Total
1	Eco-toxicology and Environmental Health Monitoring	MES-201	4	60	40	100
2	Air Pollution and Control Technology	MES-202	4	60	40	100
3	Biological Wastewater Treatment Processes	MES-203	4	60	40	100
4	Environmental Geosciences	MES-204	4	60	40	100
5	Climate Change and Sustainable Development	MES-205	4	60	40	100
6	Environmental Monitoring Lab-II	MES-211	2	20	30	50
7	Data Analysis in Environmental Systems (Lab)	MES-212	2	20	30	50
Total			**24**	**340**	**260**	**600**

SEMESTER III

S. No.	Course Title	Course Code	Credits	Marks		
				End Sem.	Mid Sem.	Total
1	Industrial Pollution Control & Management	MES-301	4	60	40	100
2	EIA and Environmental Legislation	MES-302	4	60	40	100
3	Elective 1	----	4	60	40	100
4	Elective 2	----	4	60	40	100
5	Elective 3	----	4	60	40	100
6	Project Part-I	MES-303	4	60	40	100
Total			**24**	**360**	**240**	**600**

SEMESTER IV

S. No.	Course Title	Course Code	Credits	Marks		
				End Sem.	Mid Sem.	Total
1	Field Study/Industrial Training	MES-401	4	60	40	100
2	Project Part-II	MES-402	14	120	80	200
Total			**18**	**180**	**120**	**300**

List of Elective Subjects

A:- Institute Elective , B:- Departmental Elective

S. No.	Course Title	Course Code	Credits	Marks		
				End Sem.	Mid Sem.	Total
1	Energy Resources and Conservation	MES-501	4	60	40	100
2	Social Issues and Environment	MES-502	4	60	40	100
3	Human Population and Environment	MES-503	4	60	40	100
4	Natural Resources: Conservation and Management	MES-504	4	60	40	100
5	Environmental Economics	MES-505	4	60	40	100
6	Disaster Management	MES-506	4	60	40	100
7	Environmental Planning	MES-507	4	60	40	100
8	Environmental Instrumentation and Techniques	MES-508	4	60	40	100
9	Water Resources and Environmental Hydraulics	MES-509	4	60	40	100
10	Application of Nanotechnology in Environmental Science	MES-510	4	60	40	100
11	Advance Water and Wastewater Treatment Technologies	MES-511	4	60	40	100
12.	Noise Pollution and Control	MES-512	4	60	40	100
13	Application of Remote sensing and GIS in Environmental Management	MES -513	4	60	40	100
14	Environment Systems Analysis and Modelling	MES -514	4	60	40	100
15	Health Safety and Risk Assessment	MES-515	4	60	40	100

SYLLABUS

Environmental Chemistry

Paper Code MES – 101 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide understanding of basic concepts of Environmental Chemistry.
- Application of chemical reactions, equilibrium and mass balance in water & wastewater treatment processes.
- Water chemistry, chemical reactions and contaminants in water and wastewater, Air chemistry, Soil chemistry, reactions and process.
- Permissible limit of contaminants in Air, Water and Soil.

Course Learning Outcome

- Students will have sufficient knowledge in the application of chemical reactions and mass balance in the Air-Water-Soil continuum environment.
- Expected to apply reaction/rate kinetics to the environmental process.
- Students will be able to understand the chemistry behind various environmental processes.
- Learn about Air-Water-Soil continuum environment reactions and mechanisms.
- Develop concern about environmental issues.

Course Description

Unit 1

composition of air, Particles, ions and radicals in atmosphere, formation of organic and inorganic particulate matter, Photochemical and thermochemical reactions in the atmosphere, thermal inversion, photochemical smog, acid rain, chemistry of oxygen and ozone layer depletion, greenhouse gases and global warming

Unit 2

Water as a universal solvent, Solubility of gases in water, carbonate system, Precipitation, pH and redox potential (Eh), Absorption, Adsorption: Langmuir isotherm model: Assumptions and limitations, Freudlich isotherm model: Assumptions and limitations,

Unit 3

Types of chemical reactions: Addition, elimination and Substitution, stoichiometry, chemical kinetics, chemical equilibria, chemical potential, Gibbs energy, laws of thermodynamics, heat transfer processes, material balance

Unit 4

Toxic chemicals: Pesticides, their classification and harmful effects, Biochemical aspects of Heavy metals (Hg, Cd, Pb, Cr etc.) and metalloids (As, Se), CO, O3, PAN, VOC and POP, Carcinogens in the air,

Unit 5

Basic Chemistry: structure of atom, Bohr's Model, quantum numbers, Photoelectric effect, classification of elements: s, p, d and f block elements, saturated and unsaturated hydrocarbons, Aromatic hydrocarbons

Text Books

- Sawyer and McCarty, Chemistry of Environmental Sciences and Engineering, Tata McGraw Hills Pvt. Ltd. New Delhi, India.
- Manahan, S. E. (2008). Fundamentals of Environmental Chemistry (3rd Edition), CRC Press, USA.
- Benefield, L.D.,Process Chemical for Water and Wastewater Treatment, , Prentice Hall Inc. New Jersey, USA.
- D. J., Jacob, (1999). Introduction to atmospheric chemistry, Princeton University Press.
- De, A.K. Environmental chemistry, New age international publishers.

Reference Books

- Kiely, G., Environmental Engineering, The McGraw Hill Co. USA.
- Gilbert and Masters, Introduction to Environmental Engineering and Science, Pearsons, Education.
- Manahan, S. E. (2000). Environmental Chemistry 7th Edn. Lewis Publishers.
- Environmental Pollution Control Engineering by C. S. Rao. Wiley Eastern Limited.

Environmental Microbiology and Biotechnology

Paper Code MES – 102 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To understand basic as well as advanced aspects of environmental microbiology.
- To understand Microbiological aspects of water and wastewater.
- Understanding of biological processes involved in combating Environmental Contaminants.
- Application of microbiology in solving various Environmental Issues.

Course Learning Outcome

- Students are enriched with both theoretical and practical approaches to understand the problem and possible solutions.
- Understanding of microbial world.
- Students are equipped in understanding the role of Micro-organisms in Pollution control.
- Application of biotechnology and its tools in solving Environmental issues.
- Understanding of genetically engineered Micro-organisms in managing Hazardous Waste.

Course Description

Unit 1

Introduction, Basic definitions of terminologies, Systematics and taxonomy, Scope of microbiology, Types of microorganisms (protozoa, algae, bacteria, fungi, viruses, bacteriophages-lytic and lysogenic); Structure of prokaryotic and eukaryotic cells; Environmental significance of microorganisms.

Unit 2

Application of microbes in environment (Biogeochemical cycles), Biological fuel generation: Biohydrogen, biomethanation and alcohol production. Microbial interactions, Microorganisms and Ecosystems Microorganism and metal toxicity, Microbiological aspects of drinking water and drinking water distribution systems; Indicator organisms; Disinfection processes.

Unit 3

Microbial nutrition, Microbial growth and Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential and enrichment media, Microbial control-physical and chemical, Isolation of Pure Cultures.

Unit 4

Introduction to environmental biotechnology, Recombinant DNA technology, Polymerase chain reaction- Steps of PCR, Types of PCR, Sequence analysis, Nucleic acid-based methods of analysis- Extraction of nucleic acids from environmental samples.

Unit 5

Bioremediation and its applications, Factors influencing bioremediation (environmental factors, physical factors and chemical factors), In-situ bioremediation and Ex-situ bioremediation, Application of microorganisms, enzymes and plants (phytoremediation) in eradicating pollutants, Application of genetically engineered microorganisms for hazardous waste management. Bioscrubbers, Biosensors, Bioleaching, Bioindicators, Biofertilizers and Biofuels.

Text Books

- Environmental Engineering, Gerard Kiely, The McGraw Hill Co. USA.
- Introduction to Environmental Engineering and Science, Gilbert and Masters, Pearsons, Education.
- Environmental Biotechnology, Rittmann and McCarty, Tata McGraw Hill Pvt. Ltd. India.
- Environmental Biotechnology: Principles and Applications, BE Rittmann and PL McCarty, McGraw-Hill Publishing Co., 2001.
- Environmental Biotechnology, B Bhattacharya and R Banerjee, Oxford University Press, 2008.

Reference Books

- Chaudhury, G.R. Biological degradation and bioremediation of toxic chemicals, Dioscorides Press, Oregon, 1994.
- Martin. A.M. Biological degradation of wastes, Elsevier Applied Science, London, 1991.
- Blaine Metting .F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993.
- Mitchell, R., and Gu, J.D., Environmental Microbiology, 2nd Ed., Wiley-Blackwell, 2010.
- Environmental Biotechnology: Basic concepts and applications by Indu Shekhar Thakur. 1. K. International Pvt. Ltd.

Ecology and Ecosystem

Paper Code MES – 103 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To learn and understand the applied concepts of ecology and ecosystem.
- To enable the students to understand the different ecological processes and ecosystem dynamics.
- To equip students with knowledge of Marine ecosystem, Forest Ecosystem, and Microbial world.
- Learning of population dynamics and their interaction with the environment.

Course Learning Outcome

- The student would learn about the science of ecology and ecosystem.
- Knowledge about marine ecosystem characteristics and its key features.
- Understanding of Forest and Forest World regarding their types and key features.
- Students would learn about Microbial structure and their function.
- Knowledge of population dynamics.

Course Description

Unit 1

History and scope of ecology, autecology, synecology, population, community, biome, tolerance range and limiting factors. Community organization- concept of habitat, functional role and niche, keystone species, dominant species, ecotone and edge effect. Analytical characters, synthetic characters like forms, species diversity and measurement of diversity.

Unit 2

Forest and forest environment: Structure of forest ecosystem, major forest types of the world, forest types and forest cover of India Forest ecosystem function: Primary productivity of forest ecosystems, litter production and decomposition, nutrient cycling and nutrient conservation strategies. Forest management systems, joint forest management, , deforestation and sustainable forestry, Ecosystem services,

Unit 3

Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: *in situ*, *ex situ* and *in vitro* conservation. National parks, Sanctuaries, Biosphere reserve, Protected areas and Sacred groves in India. IUCN red list criteria and different categories. Concepts of gene pool, biopiracy and bio-prospecting.

Unit 4

The ecosystem concept, abiotic and biotic components. Energy input in ecosystem, standing crop, biomass, primary and secondary production, gross and net production, concept of food chain food web, ten percent law, net community production, methods of measuring productivity, pattern of primary production and biomass in the major ecosystem of the world, Energy flow, Feedback and control. Biogeochemical cycles Hydrological cycle, carbon cycle, nitrogen cycle, Sulphur cycle, phosphorus cycle, nutrient budget, man's impact on nutrient cycles.

Unit 5

Population dynamics: models for single and interacting population, stable points, stable cycles, chaos competition, prey predation, life history strategies (*r* and K selection)etc. Ecological succession, primary and secondary processes in successions, models of successions, climax community and types of climax. Types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions

Text Books

- Ramade, F. (1985). Ecology of natural resources.
- Sharma, P. D., & Sharma, P. D. (2012). Ecology and environment. Rastogi Publications.
- Whittaker, R. H. (1970). Communities and ecosystems. Communities and ecosystems.
- Odum, E. P., & Barrett, G. W. (1971). Fundamentals of ecology (Vol. 3, p. 5). Philadelphia: Saunders.
- Agarwal, S. K. (2008). Fundamentals of ecology. APH Publishing.

Reference Books

- Matlock, M. D., & Morgan, R. A. (2011). Ecological engineering design: restoring and conserving ecosystem services. John Wiley & Sons.
- Scherer-Lorenzen, M., & Schulze, E. D. (2005). Forest diversity and function: temperate and boreal systems (Vol. 176). Springer Science & Business Media.
- Woodley, S., & Kay, J. (1993). Ecological integrity and the management of ecosystems. CRC Press.
- Yazdani, S. S., & Agarwal, M. L. (1997). Elements of insect ecology. Alpha Science Int'l Ltd.

Water and Wastewater Physicochemical Treatment Process

Paper Code MES – 104 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide basic knowledge of water quality parameters and their standards.
- Provide scientific understanding on water and wastewater Physiochemical treatment operations and processes.
- Provide hands on expertise to design independently treatment systems.

Course Learning Outcome

- Expected to become a successful Environmentalist, having capability to design independently physiochemical treatment systems for water and wastewater.
- Students would learn about the scientific concept and engineering involved in different water treatment techniques.
- Students would acquire knowledge of hard water and soft water and various softening methods.
- Learning of disinfection techniques and their suitability in treating water coming from different sources.
- Students will be capable of understanding advance water treatment techniques and their suitability for treating wastewater coming from different sources.

Course Description

Unit 1

Water quality parameters, grit removal, Screening of water, different types and arrangements of screens; Aeration: removal of emulsified and non-emulsified oil, dissolved gases, Sedimentation theory and design, different types of settling and their applications.

Unit 2

Coagulation and flocculation: basic concepts, various types of coagulants and their applications, design of flocculators; theory of filtration; Types of filters: rapid and slow sand filters and dual filters, various types of filter design.

Unit 3

Water softening methods; chemical precipitation; ion balance; Ion exchange: Ion exchange principles, cation and anions exchangers, types of resins and their suitability; Heavy metal removal.

Unit 4

Disinfection: theory of disinfection, common disinfectants: bleaching powder, chloramine, ozone, UV-radiation etc., Chlorination: pre- chlorination, post chlorination, super-chlorination, de-chlorination, breakpoint chlorination, calculation of chlorine dosage, factors affecting disinfection efficiency.

Unit 5

Advance water treatment techniques; membrane separation techniques: micro-filtration, ultra-filtration, nano-filtration, reverse osmosis; Adsorption: types of adsorbents, applications and limitations.

Text Books

- Peavy and Row, Environmental Engineering, , Tata McGraw Hills Pvt. Ltd. New Delhi, India.
- Steel and McGhee, Water Supply, McGraw Hill Publications.
- Hammer and Hammer, Water Technology, , Tata McGraw Hills Pvt. Ltd. New Delhi, India.

Reference Books

- Kiely, G., Environmental Engineering, The McGraw Hill Co. USA.
- Sincero and Sincero, Environmental Engineering, Tata McGraw Hills Pvt. Ltd. New Delhi, India.
- Gilbert and Masters, Introduction to Environmental Engineering and Science, Pearsons, Education.

Solid Waste Management

Paper Code MES – 105 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Providing basic knowledge of solid waste in terms of characteristics and composition.
- Providing understanding of processes used for sustainable solid wastes disposal systems.
- To develop skills for design the municipal solid waste management systems.
- To inculcate knowledge of integrated waste management system and waste minimization techniques.

Course Learning Outcome

- Expected to become a competent Environmental expert having sufficient knowledge on design and application of solid waste management systems.
- Students would be able to understand the importance of waste segregation and waste minimization techniques.
- Students would acquire knowledge of waste screening criteria, properties of waste and various disposal methods.
- Students would develop sense of minimizing waste generation.

Course Description

Unit 1

Definition and classification of solid wastes; Types and sources of solid wastes: municipal, agricultural, industrial, Hazardous and biomedical; Impact on Environmental health; Issues and Challenges linked with SWM.

Unit 2

Concepts of waste reduction, recycling and reuse; Hazardous waste; Characterstics: Waste toxicity, Ignitable,, corrosivity, reactivity,infectious, radioactiveand health impacts; Hazardous waste management; E-waste: classification, methods of handling and disposal; Biomedical waste: types, characteristics and health impacts; Industrial wastes: types, characteristics and health impact, Plastic waste: sources, consequences and management.

Unit 3

Collection, storage and transportation of solid waste; Systems of collection; Garbage chutes; Bailing and compacting; Transfer station and transportation system; Route optimization. Treatment Methods: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. Generation rates, solid waste components, proximate and ultimate analyses of solid wastes.

Unit 4

Integrated wastes management system; Waste minimization; Process modification; Cost benefit analysis of waste minimization; material and energy recovery, concept of waste, various methods of refuse processing, composting and vermicomposting.

Unit 5

Disposal methods – landfills: site selection, estimation of area required for land fill sites , design and operation of sanitary landfills; , leachate and landfill gas measurement, design of natural and artificial lining system, geo-liner, design of leachate collection system, design of gas recovery system, Bio-methanation, Composting, GRI standards, Sense of performance.

Text Books

- Peavy and Row. Environmental Engineering, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Metcalf and Eddy. Wastewater Treatment, Treatment and Reuse, . Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Gorge Tchonobanoglous. Solid Waste management, Tata McGraw Hill Series.

Reference Books

- Environmental Engineering by Sincero and Sincero, Tata McGraw Hill Series.
- CPHEEO Manual on Municipal Solid Waste Management.

Environmental Monitoring Laboratory-1

Paper Code MES – 111 (Lectures-Tutorials-Practical/Week (0-0-4) Credit 2

Course Marks (Mid-End-Total) (30-20-50)

Course Objectives

- To provide learning on basic experimental techniques to analyze different water and wastewater, air and soil samples.
- To inculcate basic concepts for environmental quality monitoring, assessment and evaluation.

Course Learning Outcome

- To enable students to quantify and assess different water and wastewater quality parameters.
- To enable students to learn and assess air, soil and plant samples analysis methods.
- Expected to plan an approach for monitoring the industrial and municipal wastewater treatment facility and different field-testing.

Course Description

TITLE OF EXPERIMENT

A. Basics of solution preparation and volumetric analysis
    1. Standard solution preparation by titration.
    2. Stock solution and serial dilution.
    3. Strength of solution (Normality, molarity etc.).

B. Water and waste water quality parameters
    1. pH and Conductance.
    2. Alkalinity.
    3. Turbidity.
    4. Hardness.
    5. Dissolved oxygen (DO) and Biochemical Oxygen Demand (BOD).
    6. Chemical Oxygen Demand (COD).
    7. Sulphates and Chloride determination.
    8. Total Kjehldal Nitrogen (TKN).
    9. Coagulant dose determination by Jar Test.

Text Books

- Chemistry for Environmental Sciences and Engineering, Sawyer and McCarty, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Wastewater Treatment, Treatment and Reuse, Metcalf and Eddy, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Standard Methods for Examination of Water and Wastewater, AWWA, APHA, 21st edition, USA.

Reference Books

- Process Chemistry for Water and Wastewater Treatment, L.D. Benefield, Prentice Hall Inc. New Jersey, USA.
- Settle. Instrumental Methods of Analysis (6th ed.) - HH Willard, LL Merritt, and JA Dean, CBS Publishers, New Delhi, 1986.
- Modern Methods of Chemical Analysis - RL Recsok, LD Shields, John Wiley & sons, Inc, 1990.

Communication Skill

Paper Code MES – 112 (Lectures-Tutorials-Practical/Week (0-0-4) Credit 2

Course Marks (Mid-End-Total) (30-20-50)

Course Objectives

- To provide learning on the basic principle of presentation, scientific and technical writing skills.
- To develop problem analyzing, manuscripts writing, personality development etc.

Course Learning Outcome

- To enable students to know the scientific presentation skills.
- To enable students to learn scientific and technical writing skills.
- Expected to plan an approach for presenting research in conferences and meetings.

Course Description

Weekly Seminar and Presentations

To develop presentation skills in students, weekly seminars will be organized in the lab.
Personality development class, scientific and technical writing lectures.

Text Books

- Stuart, A. E. (2013). Engaging the audience: developing presentation skills in science students. *Journal of Undergraduate Neuroscience Education*, *12*(1), A4.
- Linsky, E., and Georgi, G. (2005, June). Introducing presentation skills in freshman engineering. In *2005 Annual Conference* (pp. 10-829).

Reference Books

- Wood, D. F. (2003). Problem based learning. *Bmj*, *326*(7384), 328-330.
- Gruba, P., and Al-Mahmood, R. (2004, January). Strategies for communication skills development. In *Proceedings of the Sixth Australasian Conference on Computing Education-Volume 30* (pp. 101-107).

Ecotoxicology and Environmental Health Monitoring

Paper Code MES – 201 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To impart knowledge on risk analysis and hazardous pollutants and their importance.
- To teach about methods followed for hazardous pollutants analysis.
- To develop concept of Bioassay, its type and characteristics.
- To create awareness regarding health monitoring programs.

Course Learning Outcome

- Students will be in a position to analyse the risk and hazardous pollutants involved in the processes.
- Students may undertake project related to risk analysis and hazardous pollutants.
- Check and verify various industrial Hazards in process of melting (Furnaces), Casing and Forging.
- Students would have acquired knowledge of environmental toxicants and their ill effects on living organisms.
- Students are expected to understand the importance of environmental monitoring programs.

Course Description

Unit 1.

Introduction to Ecotoxicology; Principles of Toxicology;; Types of toxic substances:in the environment (Inorganic, organic, gases, heavy metal, nano-materials, electromagnetic radiations, biocontaminants etc.), their sources, and entry routes.

Unit 2

Transport of toxicants by air and water; Transport through the food chain: bioaccumulation and bio-magnification in the food chain;; Physiological and metabolic effects on plants, human, animal and micobes a; Response of Planktons and Photosynthetic bacteria to toxicants.

Unit 3

Toxicology of major pesticides: biotransformation, biomonitoring, programs and parameters of biomonitoring; Environmental impacts of Pesticides; Bio-absorption of heavy metals; Biochemical basis of toxicity: Mechanism of toxicity and receptor mediated events, Acute and Chronic toxicity; **Unit 4**

Concepts of Bioassay: Toxicity Testing; Microbial bioassay for toxicity testing; Aquatic toxicity tests; Bioassay test models and classification; Threshold limit value: LC50, LD50.

Unit 5

Toxicology & epidemiology and occupational health; water pollution caused disease; air pollution caused disease; food-borne disease; electromagnetic radiation and human health; radioactive effects; vector transmitted disease; risk assessment. Toxicants treatment, prevention and Disposal Methods; Bioremediation of Contaminated Sites; Quantitative risk assessment.

Text Books

- Crowl,D.A and Louvar,J.F. 2002. Chemical process saftey; Fundamentals with applications, Prentice hall publication inc.
- La Grega, M.D., Buckingham, P.L., and Evans, J.C. 1994. Hazardous Waste Management, McGraw-Hill International Editions, New York..
- Freeman, H.W. 1989 Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw Hill, New York,.
- Ira. S. Richards 2008. Principles and practices of toxicology in public health. New Central Book Agency.
- Martin, E.J. and Johnson, J.H., 1987. Hazardous Waste Management Engineering, van Nostrand-Reinhold, New York.
- Skeleton, B., 1997. Process Safety Analysis, Institution of Chemical Engineers, U.K.

Reference Books

- Mc Cornick, E.J. and Sanders, M.S. 1982. Human Factors in Engineering and Design, Tata McGraw Hill.
- Accident Preventional Manual, NSC Chicago, 1982.
- Henrich, H.W. 1980. Industrial Accident Prevention, McGraw Hill.
- Less, F.P. 1986. Loss Prevention in Process Industries, Butterworth, New Delhi.
- Wentz, C.A. 1995. Hazardous Waste Management, 2nd Edition, McGraw Hill, New York.

Air Pollution and Control Technology

Paper Code MES – 202 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- The course provides basic understanding of air pollution, sources, effects and dilution mechanism of pollutants.
- Understanding of technical aspects of regulating and controlling air pollution.
- Trained the students to design the control equipment independently.
- The prime objective of this course is to develop skills among the students to design industrial stacks, predict the pollutant concentrations and design the control equipment.

Course Learning Outcome

- Expected to predict the pollutant concentrations and become well aware of air quality monitoring and with its instrumentations.
- The students will become well acquainted with basic design and operation of air pollution control systems.
- Developing concern regarding issues related with air pollution and its ill effect on human health, plants, animals and other material.
- Understanding of mechanism of pollutant dispersion in the atmosphere and factors affecting dispersion.

Course Description

Unit 1

Introduction; Definition of air Pollutants; primary and secondary pollutants; Criteria air pollutants; General nature of air pollution problem; Effects of major Pollutants on Human, Vegetation and other materials; Indian National Ambient Air Quality Standards; Indoor air pollution, Vehicular emissions and Urban air quality; air quality index.

Unit 2

Chemical composition of atmosphere; Meteorology; pressure, temperature, precipitation, humidity, mixing ratio, adiabatic lapse rate, environmental lapse rate; Stability conditions; Wind roses, Wind velocity profile; stack emissions, Stack plumes; Plume rise; Calculation of plume rise; Effective stack height. Fly ash: sources, composition and utilisation.

Unit 3

Dispersion of pollutant in the atmosphere; Factors affecting the desperation phenomena; Eddy diffusion model; Gaussian dispersion equation; Reduction of Gaussian dispersion equation to ground level; C/L concentration and for line sources; Assumptions and limitations.

Unit-4

Gaseous pollutants control devices and their working principle; Absorption; Adsorption; Combustion and Condensation; SOx control and NOx control; Particulate control equipments: Gravity settling chambers, Cyclone separators, Fabric filters, Electrostatic Precipitators and Wet scrubber, Working principle, Design, Advantage, Disadvantages and limitations of equipment;

Unit 5

Noise Pollution: Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, L_{DN}, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health. Sources of Thermal Pollution, Heat Islands, causes and consequences. Sources and impact of Marine Pollution.

Text Books

- Air Pollution and Control, Crawford, McGraw Hill Series.
- Environmental Engineering, Peavy and Rowe, McGraw Hill Series.
- Air Pollution, Neol De Nevers, Tata McGraw Hill Pvt. Ltd. New Delhi India.

Reference Books

- Fundamentals of Air Pollution (Fourth Edition), Daniel A. Vallero, Science Direct.
- Introduction to Environmental Engineering, Masters & Masters, Printice Hall.

Biological Wastewater Treatment Process

Paper Code MES – 203 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To provide basic knowledge of wastewater characterisation and their effluent discharge standards.
- To provide scientific understanding on biological wastewater treatment operations and processes.
- To provide hands on expertise to design independently wastewater treatment systems.

Course Learning Outcome

- Acquire the capability to design wastewater treatment systems.
- The students will become well acquainted with basic design and operation of treatment plants for biological treatment of sewage and industrial effluent with regard to carbon, nitrogen and phosphorous removal.
- Students will have sufficient knowledge of primary, secondary and tertiary treatment stages in municipal wastewater treatment.
- Students will be able to develop efficient low-cost treatment systems in view of already existing systems.
- Better understanding of role of microorganism in biological treatment.

Course Description

Unit 1

Wastewater: Characteristics and Composition; Preliminary treatment systems: Screening, Grit removal and Primary sedimentation: Theory and design; Flow measurement techniques.

Unit 2

Biological treatment process: Aerobic and Anaerobic treatment systems; Basic fundamentals of aerobic and anaerobic treatment of wastewater; Reaction kinetics; Aeration principle and mechanism; Diffused and surface aerators.

Unit 3

Aerobic biological treatment systems; Suspended and attached growth systems; Activated sludge process (ASP) and its modifications; Attached growth systems; Trickling filter; Types of trickling filters: reaction kinetics, efficiency calculations and design; Bio-filters and rotating biological contactors: Working principle and design; Sequence Batch Reactor; Membrane bio reactor.

Unit 4

Anaerobic biological treatment systems: high-rate anaerobic system, suspended and attached growth systems; Up-flow anaerobic sludge blanket reactors; Anaerobic filter; Fixed Film Reactor; Anaerobic Baffle Reactor; Anaerobic membrane bio reactor.

Unit 5

Low-cost systems: Stabilization ponds, Lagoons, Oxidation ditches; Tertiary treatment system; Sludge treatment generation and its treatment.

Text Books

- Wastewater Treatment, Treatment and Reuse, Metcalf and Eddy, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Wastewater Technology, Hammer and Hammer, Tata McGraw Hill Pvt. Ltd. New Delhi India.

Reference Books

- Benefield, L.D., Process Chemistry for Water and Wastewater Treatment, Prentice Hall Inc. New Jersey, USA.
- Qasim, S.R.,Treatment Plant Design, TA Publishing, USA.
- Masters. Introduction to Environmental Engineering and Science. Tata McGraw-Hill.

Environmental Geosciences

Paper Code MES – 204 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To provide knowledge to students about the geoscience, oceanography and soil science.
- To familiarize the students about the causes and consequences of natural phenomena.

Course Learning Outcome

- Knowledge about the earth surface and subsurface process.
- Students will learn the application of geosciences and its tools in solving environmental related issues.

Course Description

Unit 1

Origin of earth. Earth's internal structure and composition. Primary geochemical differentiation and formation of core, mantle and crust. Concept of minerals and rocks. Rock forming and ore-forming minerals. Plate tectonics, sea floor spreading, mountain building, evolution of continents and structural deformation. Concept of steady state and equilibrium.

Unit 2

Magma: Definition, physical properties, chemical composition and origin. Crystallization of magma: Bowen reaction series, magmatic differentiation and assimilation. Classification of Igneous rocks. Forms and structures of extrusive and intrusive igneous rocks. Types of metamorphism, classification of metamorphic rocks. Metamorphic rocks and facies.

Unit 3

Sediments: Origin, transportation, deposition and lithification. Classification of sedimentary rocks: terrigenous and chemical sedimentary rocks. Important primary sedimentary structures. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements.

Unit 4

Weathering including weathering reactions, erosion, transportation and deposition of earth's material by running water, wind and glaciers. Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Identification and characterization of clay minerals. Climate control on soil formation, cation exchange and mineralogical controls.

Unit 5

Coriolis force, pressure gradient, frictional force, geostrophic wind field and gradient wind. El Nino and La Nina Southern Oscillation (ENSO) in Pacific Ocean and concept of Indian Ocean dipole. Western disturbances, Climate of India. Indian monsoon and droughts. Prediction of hazards and mitigation of their impacts.

Text Books

- Thompson, G.R. and Turk, J. (1998). Introduction to physical geology. Saunders college publishers, Fort worth. 371p.
- Middlemost, A.K. (1985). Magmas and Magmatic Rocks: An introduction to igneous petrology. Longman.
- Winter, J.D. (2002). Principles of Igneous and metamorphic petrology. Prentice-Hall of India Pvt. Ltd.
- Pettijohn, F..J. (2004). Sedimentary rocks. CBS.

Reference Books

- Bridge, J. and Demicco, R. (2008). Earth surface process. Landforms and sediment deposits. Cambridge university press. 815p.
- Garrison, T. (2012). Essentials of Oceanography. Brooks/Cole Publishers, Belmont. 435p.
- Stewart, R.H. (2008). Introduction to Physical Oceanography. Texas and M University. 345p.

Climate Change and Sustainable Development

Paper Code MES – 205 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide basic understanding of climate change.
- Explain 17 SDGs: Challenges and strategic tools.
- Relevance of traditional paradigms for rural India.

Course Learning Outcome

- Students have sufficient knowledge of climate change and its environmental impacts.
- Students having clear vision about Sustainable development goals.
- Tools and strategies to achieve sustainable development goals.

Course Description

Unit 1

Climate change Fundamentals; weather and climate, Heat budget of the earth, Greenhouse effects, Global warming, Greenhouse gases, Radiative forcing and warming potentials of greenhouse gases, Carbon footprint , Approaches to deal with global warming,

Unit 2

Global scenario; Impact of climate change on Natural Resources; Climate induced diseases and impact of climate change on human health; Climate change and food production/agriculture; Climate change and adaptation; Climate change and water management. .

Unit 3

Policy and Mitigation Measures International Efforts in combating climate Change: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. Paris agreement, IPCC, UNEP, IGBP, India's Perception to Climate Change-India's National Action Plan (Eight Mission).

Unit 4

Green Technology: Aims and objectives; Introduction to Green Science & Tech; Green Technology Dimensions; Green Energy Technologies and Green Conventions, Green economy.

Unit 5

Basic concept of sustainable sustainability and sustainable development, Global challenges of sustainable development, Guiding principles of sustainable development, Sustainability indicators, National sustainable development strategies, Current debates on the issues of sustainability; Sustainable consumption and Circular Economy, , Social behavior and sustainability: relationships of ecological, economic and social systems, Indigenous technology and sustainability, 17 Sustainable Development Goals: Fundamental and challenges to measures to achieve SDGs.

Text Books

- LEAD India (Eds) (2002). Rio to Johannesburg: India's Experience in Sustainable Development, Orient Longman, Hyderabad,
- Lee, N. and Kirkpatrick, C. (Eds) (2000). Sustainable Development and Integrated Appraisal in a Developing World, Edward, Elgar, UK.
- Chopra, K. and Kadekodi, G.K. (1999). Operation listing Sustainable Development, Sage Publication, New Delhi.

Reference Books

- Roy, K.C., Sen, R.K. and Tisdell, C.A. (1996). Environment and Sustainable Agricultural Development (Volumes I and II). New Age International Pvt. Ltd., New Delhi,
- Kirkby, J., O'Keefe, P. and Timberlake, L. (Eds.) (1995). The Earth scan Reader in Sustainable Development, Earthscan Publications, London.
- Asolekar, S. R. and Gopichandran, R. (2005). Preventive Environmental Management – An Indian Perspective Foundation Books Pvt. Ltd., New Delhi (the Indian association of Cambridge University Press, UK).

Environmental Monitoring Laboratory- II

Paper Code MES – 211 (Lectures-Tutorials-Practical/Week (0-0-4) Credit 2

Course Marks (Mid-End-Total) (30-20-50)

Course Objectives

- To provide learning on advanced experimental techniques to analyze different water and wastewater, air and soil samples.
- To inculcate latest concepts for environmental quality monitoring, Assessment and Evaluation.

Course Learning Outcome

- To enable students to learn and operate advanced instruments like AAS, GCMS, HPLC.
- To enable students to know about the working procedure of advanced scientific instruments used for environmental sample analysis.
- Expected to plan an approach for solving the environmental problems.

Course Description

TITLE OF EXPERIMENT

1. Calibration of HVS by orifice method.
2. Determination of SPM, PM10 in ambient air.
3. Determination of SO2 in ambient air.
4. Determination of ammonia in ambient air.
5. Determination of NOx in ambient air.
6. Soil sample preparation and analysis by using XRD, XRF, ICP-OES and Q-ICP-MS.

Text Books

- Chemistry for Environmental Sciences and Engineering, Sawyer and McCarty, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Instrumental Methods of Chemical Analysis – GW Ewing, McGraw Hill Book Company, Inc. 1975.
- Fundamentals of Molecular Spectroscopy – CN Banwell, McGraw Hill, NY, 1990.
- Standard Methods for Examination of Water and Wastewater, AWWA, APHA, 21st edition, USA.

Reference Books

- Skoog, D. A., Holler, F. J., & Crouch, S. R. (2007). *Instrumental analysis* (Vol. 47). Belmont: Brooks/Cole, Cengage Learning.
- Settle. Instrumental Methods of Analysis (6th ed.) - HH Willard, LL Merritt, and JA Dean, CBS Publishers, New Delhi, 1986.
- Modern Methods of Chemical Analysis - RL Recsok, LD Shields, John Wiley & sons, Inc, 1990.

Data Analysis in environmental System (Lab)

Paper Code MES – 212 (Lectures-Tutorials-Practical/Week (0-0-4) Credit 2

Course Marks (Mid-End-Total) (20-30-50)

Course Objectives

- The course is designed to acquaint students with role of databases and data analysis in environmental science and management.
- The course includes basic statistical methods: computing descriptive statistics, hypothesis testing and analysis of variance along with graphical representation of data.
- The course aims to develop the ability among the students to analyze the environmental data and make it presentable form in a scientific manner.
- The course is designed to acquaint students with the principles of machine learnings and AI techniques.

Course Learning Outcome

- Environmental manager/scientist becomes familiar with basic statistical methods: computing descriptive statistics, hypothesis testing and analysis of variance along with graphical representation of data.
- Environmental Engineers having ability to analyze the experimental data and make it presentable form in a scientific manner.

Course Description

List of Exercise

1. Grain-size distribution parameters and soil texture (Gradistat).
2. Correlation and Regression analysis of the soil chemical compositions (SPSS).
3. Normal and log-normal distribution of the trace metal records (SPSS)
4. Poisson and F-distribution analysis of the soil chemical compositions (SPSS).
5. t-test, F-test, chi- square test of the records (SPSS).
6. ANOVA (one-way and two-way on soil chemical records (SPSS).
7. Model development for grain size data (End-member modeling) (R).
8. Forward modeling of heavy metals record for source characterization (MS-excel).
9. Models the population growth and interactions by using Lotka-Voltera model and Leslie's matrix model.
10. Probability theory and Sampling theory analysis.

Text Books

- Nagpal. Statistical Methods. Tata McGraw Hill Series.
- Zhang, Z. (2016). Environmental Data Analysis. De Gruyter.
- Paul L. and Thomas, H. Statistics Methods and Applications. Tata McGraw Hill.
- Piegorsch, W. W. and Bailer, A. J. (2005). Analyzing environmental data. John Wiley & Sons.

Reference Books

- Gerhard, B. Introduction to Basics of Statistics. Desy Books.
- Clark, J. S. and Gelfand, A. E. (2006). Hierarchical modelling for the environmental sciences: statistical methods and applications. OUP Oxford.
- Menke, W. and Menke, J. (2016). Environmental data analysis with Matlab. Academic Press.

Software or other Requirements

- R, Matlab, Statistica, Hydrus, RZWQM2, APSIM, Statsoft, SPSS

Industrial Pollution Control and Management

Paper Code MES – 301 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Providing basic knowledge of industrial operations and principal effluent generation units along with the effluent characterization.
- Imparting knowledge of industrial waste in terms of composition, characteristics and disposal standards.
- Major sources of Air pollution and Industrial solid Waste generation.
- Application of fundamental principles for the treatment and management of industry specific pollution.

Course Learning Outcome

- Expected to become a successful Environmental expert having capability to design independently industrial effluent treatment systems.
- Students will become acquainted with basic design and operation of Air pollution control system for specific industries.
- Students are expected to minimize and reuse various solid waste generation from industrial operation.

Course Description

Unit 1

Characteristics and composition of different industrial waste; Sampling; Preservations and analysis techniques; Standards for waste disposal.

Unit 2

General methods of treatment of industrial effluent; Nutrient and its role in the treatment; Pre-treatment of effluent waste volume and strength reduction; Equalization and proportioning of wastes; Neutralization of wastes; Oil removal and floatation; Electrophoresis and its application in effluent treatment.

Unit 3

Sources of pollution generation: its characteristics and treatment scheme for high strength organic effluent industries such as textiles, dairy, sugar, brewery, distillery pulp and paper, textile and dying etc.

Unit 4

Sources of pollution generation, its characteristics and treatment scheme for chemical industries, such as fertilizer, tanning, iron and steel, metal finishing and thermal power plant, petrochemical.

Unit 5

Resource recovery from solid waste: its minimization, reuse and recycle; Case Study and development of industry; Specific Environmental Management Plan.

Text Books

- Industrial Pollution Control, Numero Nelson, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Wastewater Treatment, Treatment and Reuse, Metcalf and Eddy, Tata McGraw Hill Pvt. Ltd. New Delhi India.

Reference Books

- Industrial Pollution Control, Eckenfelder, Tata McGraw Hill Series.
- Wastewater Treatment by M.N. Rao and A.K.Datta, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Design of municipal Wastewater Treatment Plants, WEF Manual of Practice No. 8, Vol.1, McGraw Hill Series, New York.

E.I.A. and Environmental Legislation

Paper Code MES – 302 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- This course aims at providing a sufficient insight into the environmental impact assessment methodologies and the laws governing the environmental issues.
- This course aims at providing a sufficient insight regarding the importance of development and environmentally friendly procedures that regulate, mitigate and plan effective regulations of natural resources.
- This course introduces students to the legal structure of India and fundamentals of environmental legislation and policy making.

Course Learning Outcome

- Become familiar with insight into the environmental impact assessment methodologies, environmental settings, prediction of impacts, evaluation of impacts and their mitigation plan.
- Acquire sufficient knowledge that helps to obtain environmental clearance from regulatory agencies.
- Understanding judicial response to environmental issues, role of National and International environmental institutions and Constitutional framework governing environment in India.

Course Description

Unit 1

Introduction to Environmental Impact Assessment: Concepts, Objectives and Procedure. Basic principles of EIA. Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). Impact Assessment Methodologies. Notification of 2006 and Amendments time to time.

Unit 2

Procedure for reviewing EIA of development projects. Life cycle analysis, cost benefit analysis. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO14000 series).

Unit 3

Economic and Social Aspects of the Environment mitigation. Prediction and assessment of impacts on the air environment, surface water environment, soil and ground water environment, noise environment and Biological environment. Case studies on EIA.

Unit 4

Environment protection: Provisions of constitution (article 48A, 51A). National Forest Policy, 1988. National Water Policy, 2002, National Environmental Policy, 2006. Forest Conservation Act, 1980, Indian Forest Act, Revised 1982. Biological Diversity Act, 2002. Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975. Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982. Environmental (Protection) Act, 1986 and Rules 1986. Motor Vehicle Act, 1988. Wildlife Protection Act, 1972 amendments 1991. Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

Unit 5

The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000. The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

qText Books

- EIA, Canter, Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Essentials of Environmental Studies, Joseph and Nagendran, Pearson Education.
- Green Book: Pollution Control Act, Rules and Notifications Issued Thereunder, (With CD-ROM) 6th Edition.
- Environmental Law by Dr. S.C.Tripathi.

Reference Books

- Environmental Impact Assessment: A Methodological Approach, Richard K. Morgan, Springer Science Publication.
- Environmental Impact Assessment" Cambridge, Gilpin.
- Introduction to Environmental Engineering and Science, Masters, Tata McGraw-Hill.
- Environmental Management in Organizations – The IEMA Handbook, John Brady, Earthscan, London.

Project Part I
Paper Code MES – 303 (Lectures-Tutorials-Practical/Week (-4-0) Credit 4
Course Marks (Mid-End-Total) (40-60-100)
Course Objectives
• The purpose of field/industrial training is to provide an exposure the students of various processes involved in industries for environmental issues associated with them and a hands on experience of developing an environmental management plan for the same. • Students are motivated to critically examine various environmental aspects of different industries visited by them.
Course Learning Outcome
• Students shall fully be aware of various environmental issues and a hands on exposure of developing environmental management plan.

Field/Industrial Training

Paper Code MES – 401 (Lectures-Tutorials-Practical/Week (-3-0) Credit 4

Course Marks (Mid-End-Total) (20-30-50)

Course Objectives

- The purpose of field/industrial training is to provide an exposure the students of various processes involved in industries for environmental issues associated with them and a hands on experience of developing an environmental management plan for the same.
- Students are motivated to critically examine various environmental aspects of different industries visited by them.

Course Learning Outcome

- Students shall fully be aware of various processes involved in industries related to environmental issues and a hands on exposure of developing environmental management plan.

Course Description

Visit to medium and large scale industries, environmental significant structure/settings e.g. reservoir, lake, dam,coastal areas, back-water and forest wetland etc.

Project Part II

Paper Code MES – 402 (Lectures-Tutorials-Practical/Week (0-0-4) Credit 4

Course Marks (Mid-End-Total) (10-150-250)

Course Objectives

- The purpose of project II is to provide an exposure the students about basics of data analysis, interpretation of results ad carrying out research on various processes involved in industries/municipal waste water treatment, environmental issues associated with them and a hands on experience of developing an environmental management plan for the same.
- Students are motivated to critically examine experimentally and analytically to evaluate various problems on water and waste water as well as soil and vegetables.

Course Learning Outcome

- Students shall fully be aware of various processes involved in industries and research institutes as well as universities related to environmental issues and a hands on exposure of data analysis.

Energy Resources and Conservation

Paper Code MES – 501 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide understanding of different types of energy resources.
- Basics of Conventional and non-conventional energy sources.
- Fundamentals and advancement of bio-energy.
- Environmental Conservation and national energy policy to sustainable development.

Course Learning Outcome

- Students have sufficient knowledge in the field of different energy resources.
- Expected to know the fundamentals about different energy resources.
- Learn about nuclear and bio-energy sources.
- National energy policy to achieve SDGs.

Course Description

Unit 1

Conventional Energy Sources: Coal, Oil, Biomass, and Natural gas; Non-conventional Energy sources: Hydroelectric power, Tidal, Wind, Geothermal energy, Solar collectors, Photovoltaics, Solar ponds, Nuclear-fission and fusion, Magneto-hydrodynamic power (MHD).

Unit 2

Energy use pattern in different parts of the world and its impact on the environment; Renewable and Alternative Energy sources: Solar energy, Solar power, Photovoltaic cells, Wind power, Geothermal energy, Ocean energy Fuel cells.

Unit 3

Non-renewable Energy Sources: Nuclear Energy, Nuclear fission and Fusion, Nuclear fuel cycle, Nuclear reactors (PWR, BWR, Gas Cooled Breeder) and Nuclear power.

Unit 4

Energy and Environment: Bioenergy, Biomass conversion processes, Biodiesel; Environmental consequences of biomass resource harnessing.

Unit 5

Energy Conservation: National energy policy, energy efficiency improvement, Audit and Energy saving.

Text/Reference Books

- M. Dayal. (6th Ed). 1997. Renewable Energy: Environment and Development. Konark Pub. Pvt. Ltd.
- S. Vandana. 2002. Alternative Energy. APH Publishing Corporation.
- S. K. Agarwal. 2003. Nuclear Energy: Principles Practice and Prospects. APH Publishing Corporation.
- P. Chaturvedi. 1995. Bio-Energy Resources. Concept Publications.
- V S. Mahajan. 1991. National Energy: policy, crisis and growth. Ashish Publishing House.

Social issues and Environment

Paper Code MES – 502 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- The course examines the relationship between the environment and society enabling the students to understand and appreciate the role played by environment, society, and their interface in shaping environmental decisions.
- The students will be able to think critically on environmental issues.

Course Learning Outcome

- Environmental engineers become familiar with the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- To understand the role of State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development. Appreciate the ethical, cross- cultural, and historical context of environmental issues and the links between human and natural systems.

Course Description

Unit 1

Social and cultural construction of 'environment'; Environmental thought from Historical and Contemporary perspective in light of the concepts of Gross Net Happiness and Aldo Leopold's Land Ethic; Developmental issues and related impacts such as ecological degradation. Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States.

Unit 2

Production and consumption-oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; Urban sprawl; Traffic congestion and Social-economic problems; Conflict between Economic and Environmental Interests.

Unit 3

Inequalities of race, class, gender, region and nation-state in access to healthy and safe environments; History and politics surrounding Environmental, Ecological and Social justice; Environmental Ethics, Issues and possible solutions; Regulatory framework: Brief account of Forest Conservation Act 1980 1988, Forest Dwellers Act 2008, Land Acquisition Act 1894, 2007, 2011, 2012, Land Acquisition Rehabilitation and Resettlement Act 2013. National Water Mission, National Mission for Sustaining the Himalayan Ecosystem

Unit 4

Water conservation-development of watersheds, Rain water harvesting and ground water recharge. Water conservation-development of watersheds, Rain water harvesting and ground water recharge. National river conservation plan – Namami Gange and Yamuna Action Plan. Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India. Case studies of Environmental Movements (Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement). Corporate Responsibility Movement; Appropriate Technology Movement; Environmental groups and Movements; Citizen groups; Role played by NGOs; Environmental Education and Awareness. Swachha Bharat Abhiyan.

Unit 5

Need of Environmental Management; Wildlife Conservation: Moral obligation, Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas; Natural World Heritage sites; Concept of Core and Buffer area in a protected range; Introduction of Tiger task force; Status of current protected areas in India. Epidemiological Issues: Fluorosis, Arsenocosis, Goitre, Dengue.

Text Books

- Elliot, D. 2003. Energy, Society and Environment, Technology for a Sustainable Future.Routledge Press.
- Woodroffe, R. 2005. People and Wildlife: Conflict and Coexistence. Cambridge.
- Woodroffe, R., Thirgood, S., &Rabinowitz, A. 2005. *People and Wildlife, Conflict or Coexistence?* (No. 9) Cambridge University Press.

Reference Books

- Leopold, A. 1949. *The Land Ethic.* pp. 201-214. Chicago, USA.
- National Research Council (NRC). 1996. *Linking Science and Technology to Society's Environmental Goals*. National Academy Press.
- Paty, C. 2007. *Forest Government and Tribe*. Concept Publishing Company.
- Treves, A. &Karanth, K. U. 2003. Human---carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology* 17: 1491-1499.

Human Population and Environment

Paper Code MES – 503 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Studying population growth gives students insight into how organisms interact with each other and with their environments.
- Providing basic knowledge to students on the increasing pressures on resourcesand certain ability to maintain a balance in our environment.
- To develop understanding among the students regarding possible sustainable solutions to the population/environment problems.

Course Learning Outcome

- Gaining in-depth knowledge on natural processes that sustain life and govern economy.
- Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation, social equity and sustainable development.
- Recognize and understand the role of both local and global environmental change on the quality of human life.
- Understand and describe technical and/or scientific approaches for addressing problems that arise in the relationship between human population and the environment.

Course Description

Unit 1

Global population growth; Problem of increasing Population; Population status in India and the world; Population explosion; Family welfare Programme; Environment and Human health; Role of Environmental Education in the Management of Environment; **Unit 2**

Knowledge about the Environment among Men and Women; impact of population on Environmental degradation:Impact on water resources, land resources, forest resources, energy resources; impact on global warming, climate change, green house impact etc.Environmental Movements and Conservation; **Unit 3**

Environmental issues and urban problems related to population; Water conservation; Rain water harvesting and watershed Management; Resettlement, Rehabilitation of people: its problems and concerns;; Population growth and family welfare programme; Human rights, Women and Child welfare.

Unit 4

Describing populations: Natality, Mortality, Fecundity, Survivorship curve, Age structure; Population growth; Carrying capacity and Environmental resistance; Logistic Equation; J-shaped and S shaped growth curve; Cybernetic model; Population regulation: density dependent and density independent factors.

Unit 5

Human population and sustainable development; sustainability; Role of government, policy makers, researchers, NGOs and media; The world population scenario and the future impact on global resources.

Text Books

- International Handbook of Population and Environment by Lori M. Hunter Clark Gray Jacques.
- Véronodum, E. P. and Barrett, G.W. (2004). Fundamentals of ecology. Cengage Learning.
- Lakshmana, C.M. Population, Development and Environment
- Ben Zuckerman; Jefferson, D. Human Population and the Environmental Crisis.
- Samson, B.F, and Knoff, F.L. (1996). Ecosystem Management. Springer-Verlag, New York.

Reference Books

- Singh, R. P., Singh, A., Vaibhav, S. Environmental Issues Surrounding Human Overpopulation.
- Dillon, J. and Wals, A.E. (2016). On the dangers of blurring methods, methodologies and ideologies in environmental education research. In Towards a Convergence Between Science and Environmental Education (pp. 113-124). Routledge.
- Brosius, P.J., Tsing, A.L. and Zerner, C. (eds.). (2005). Communities and Conservation: Histories and Politics of Community-Based Natural Resource Management. Rowman Altamira.
- Reid, W.V. et al (Ed.). (2005). Ecosystems and Human well-being: Synthesis. p.1-37. Millennium Ecosystem Assessment, World Resource Institute, Island Press, Washington DC.

Natural Resources: Conservation and Management

Paper Code MES – 504 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide understanding of basic natural resources.
- Water resources and management techniques.
- Land resources degradation and reclaim measure for waste land.
- Food resource management in changing climatic conditions.

Course Learning Outcome

- Students have sufficient knowledge about natural resources.
- Expertise about water resource management.
- Clear vision about resource conservation techniques.

Course Description

Unit 1

Definition, Classification of natural resources; Renewable non- renewable resources; Mineral prospects:, coal, petroleum and natural gas, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies, hydropower, tidal power; wind power, geothermal power and solar power.

Unit 2

Distribution of water in earth, hydrology, major basins and groundwater provinces of India, Vertical distribution of groundwater, Types of aquifers, Darcy's law, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, Groundwater quality, Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Unit 3

Land Resources: land contamination, Land degradation, Erosion and weathering of soil, reclaim of waste land, Land resource management and major issues.

Unit 4

Forest and food resources: types of forest, Deforestation, Forest conservation, Animal husbandry and environmental pollution, agricultural activities and environmental consequences; Impact of climate change on food production.

Unit 5

Approaches in Resource Management, Resource Management Paradigms, Management of Common International Resources.

Text Books

- B.R. Gurjar, Chandra S.P. Ojha, L.T. Molina. 2010. Air Pollution. CRC Press.
- W.N. Beyer and J.P. Meador. 2011. Environmental Contaminants in Biota. CRC Press.
- E.N. Laboy-Nieves, M.F.A. Goosen and E. Emmanuel. 2010. Environmental andHuman Health. CRC Press.

Reference Books

- Coastal Ecology & Management, Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280- 303.
- Harikesh N Mishra 2014 Managing Natural Resources- Focus on Land and Water. PHI Learning Publication.
- Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.

Environmental Economics

Paper Code MES – 505 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide understanding of basic economic aspects about environmental issues.
- Knowledge of Green marketing.
- Understanding WTO and global coverage of Environmental Standard.

Course Learning Outcome

- Students have sufficient knowledge about basics of environmental economics.
- Students have clear concept of green marketing and carbon credit.
- Students have knowledge of WTO operations and Environmental standard.
- Clear vision of environmental cost benefit analysis.

Course Description

Unit 1

Integration of theoretical studies and policy studies on environmental issues Interdisciplinary works of environmental economics.

Unit 2

The relation between Development and Environmental Quality: Environmental Kuznets **c**urve; Ecosystem flips and irreversibility: Krutilla- Fisher equation; Choice of time discount rate for evaluation.

Unit 3

Environmental standard as a determinant of (a) pattern of trade and its welfare implications, (b) the location distribution of polluting industries across the developed and developing countries and (c) that of the direction of flow of foreign direct investment.

Unit 4

WTO and global convergence of environmental standards. Analysis of three cases in GATT/WTO: Tuna-Dolphin, Beef-Hormone, and Shrimp-Turtle.

Unit 5

Economic Development and Environment; Development vs conservation of environmental resources; Environmental Cost-Benefit analysis under strong and weak conditions of sustainability. Sustainable Habitat: Green Building, GRIHA Rating Norms.

Text/Reference Books

- Hanley, N., Shorgen, J.F., White, B.,(1997/2006) Environmental Economics.
- MacMillan, Theory and Practice, First/Second Edition, Kolstad, C.D., (2012), Intermediate Environmental Economics, Indian Edition, Oxford University Press, New Delhi.
- Pearce, D.W.,Turner, R.K., (1990) Economics of Natural Resources and the Environment, Harvester Wheatsheaf.
- Callan, E.J., Thomas, J.M.,(2013) Environmental Economics and Management: Theory, Policy and Applications, Cengage Learning, Delhi.
- Sengupta, R., (2013), Ecological Limits and Economic Development, Oxford University Press, New Delhi.
- Hussen,A., (2013), Principles of Environmental Economics and Sustainability: An integrated economic and ecological approach, Routledge, UK.

Disaster Mitigation for Sustainable Development

Paper Code MES – 506 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To provide knowledge to students about the natural disasters and mitigation.
- To familiarize the students about the causes and consequences of natural disasters.

Course Learning Outcome

- Providing sufficient knowledge on the causes, consequences and mitigation efforts for different types of natural disasters - prevalent at national and international level.
- Environmental Engineers should be able to understand about the approach to mitigate the natural disasters.

Course Description

Unit 1

Disaster: definitions, concept, risk and vulnerability; Different types of disasters; Disaster and development; IDNDR / ISDR; Yokohama Strategy and Hyogo Framework of disaster mitigation and management; Disaster management policy and act: national and states; Recent initiatives at national and state level.

Unit 2

Natural Disasters: physical phenomenon, causes and consequences mitigation and management practices: cyclones, floods, earthquakes etc. Forecasting and early warning system; Documentation and case studies on natural disasters; Importance of communication and information technology in disaster management.

Unit 3

Disaster and environment; Natural resource management; Land use planning; Urban risk mitigation. Relationship between environmental pollution, global warming, ozone layer depletion, climate change with disaster mitigation efforts. El-Nino and la-Nina effects and their impacts; Environmental consequences of disaster events

Unit 4

Climate sustainability and disaster management, Climate change mitigation and adaptation, Disaster management and global sustainability, Disaster management approaches and models, Disaster management cycle, Vulnerability analysis, Risk analysis and case studies**.**

Unit 5

Disaster management mechanism: national, state and district levels; Select global practices; Disaster management plans: various levels; Role of NGOs / CBOs and Armed Forces in disaster management; Community Based Disaster Preparedness (CBDP): framework and formulation; Disaster education and awareness.

Text Books

- Peter P. Rogers. An Introduction to Sustainable Development, , Tata McGraw Hill.
- Andrew E. Collins . Disaster and Development, , Tata McGraw Hill.
- Bullock, J.B., Haddow, G.D., Haddow, K.S., Coppola, D.P. 2016. Living with Climate Change: How Communities Are Surviving and Thriving in a Changing Climate, CRC Press, Boca Raton, USA.

Reference Books

- A.L. Caressi, Routledge. Disaster Management, , taylor and Francis Publication.
- Coppola, D.P. 2015. Introduction to International Disaster Management, ButterworthHeinemann, Oxford, UK.

Environmental Planning

Paper Code MES – 507 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide understanding of concept of environmental planning.
- Urban planning for sustainable development.
- Energy efficient urban planning.
- Environmental planning for disaster management in urban regions.

Course Learning Outcome

- Students have sufficient knowledge in the application of chemical reactions and mass balance in the Air-Water-Soil continuum environment.
- Expected to learn water conservation and management in megacities.
- Learn about energy efficient urban planning.

Course Description

Unit 1

Concepts of Environmental Planning, History of Environmental Planning, Global Concerns, Development of habitat patterns, settlement structure and form in response to environmental challenges.

Unit 2

Environmental Zones (Hill, coastal, arid, characteristics, resources, settlements pattern, problems and potentials, regulating mechanisms for development.) Scientific methods for resource analysis for various ecosystems and development imperatives (land, geology, soil, climate, water, vegetation) characteristics, exploitation, causative factors for degradation and analytical techniques. Urban Ecosystem, Ecosystem Services and Biodiversity conservation.

Unit 3

Design as a determinant of Environmental quality Evolution of Environmental design, theories and practice of design Criteria of Urban Environmental design issues-pedestrian-vehicular conflict, City Center Environment, Housing areas, dereliction, environmental upgradation programmes, Built environment aesthetics of ensemble of buildings, techniques of study of building condition, conservation aspects of built-up areas.

Unit 4

Environmental approaches to design and planning of urban settlements, use of alternate technology in design of human settlements. Application of Energy code. Techniques of water harvesting, water treatment, recycling, waste disposal, waste minimization and their implications. Low cost and cleaner technologies. Technologies related to alternate energy- Solar, biomass, biogas, hydro, wind and their usefulness in settlements.

Unit 5

Introduction of Environmental Monitoring and Assessments, Environmental Protections, Appropriate Technology and Adaptations, The role of project formulation and appraisal in the Planning process, Methodology for project identification and formulation: Preparation of Preliminary studies, Feasibility Reports and Detailed Project Reports. Appraisal of Project and monitoring of Projects.

Text Books

- Das R.C. and Behera B.K. (2008) Environmental Science Principle and Practice, Prentice Hall of India Pvt. Ltd, Delhi.
- Rogers P.P., Jalal KF and Boyd J.A. (2007) An Introduction to sustainable development. Earth Scan.
- Kuhre W.L. (2000) ISO 14031 Environmental performance evaluation EPE,Prentice Hall, PTR.Upper Saddle River N.J.

Reference Books

- Lein, J. K. (2008). Integrated environmental planning. John Wiley & Sons.
- De Roo, G. (2017). Urban Environmental Planning: Policies, instruments and methods in an international perspective. Routledge.
- Selman, P. H., & Selman, P. (1999). Environmental planning: the conservation and development of biophysical resources.

Environmental Instrumentation and Techniques

Paper Code MES – 508 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide understanding of basic instruments for water pollution.
- Air pollution monitoring.
- Soil contaminants measurement.
- Noise pollution measurement.

Course Learning Outcome

- Students would have sufficient knowledge about instruments used in environmental monitoring.
- Learnt about water and wastewater pollution measurement techniques and instruments.
- Expertise in Air and noise pollution monitoring instrument handling.
- Learnt about water sampling methods and analytical techniques.
- Equipped with knowledge of Air, water, Soil and Noise pollution measurement techniques.

Course Description

Unit 1

Soil Pollution Measurement: Particle Size analyzer, XRD, XRF, Electron microscopy for surface morphology and Size: SEM, TEM, geochemical and isotopic analysis.

Unit 2

Wastewater sampling techniques and analyzers: Gravimetric, Titrimetry, chromatography: paper chromatography, TLC and HPLC, Flame photometry, Atomic absorption spectroscopy, Spectrophotometery: ICP-OES, ICP-MS, UV-Visible.

Unit 3

Air pollution control methods and equipment; Air sampling techniques; Gas analyzer; Gas chromatography; Measurement of automobile pollution; Smoke level meter: CO/HC analyzers.

Unit 4

Molecular spectroscopy: Rotational spectroscopy, Vibrational spectroscopy, electronic spectroscopy, NMR spectroscopy: Basic principle, instrumentation and significance of relaxation time; FTIR: working principle, instrumentation and sample preparation, Raman Spectroscopy; Laser based techniques.

Unit 5

Instrumentation and techniques for Noise pollution measurements; sound level meter, frequency analyser, impulse meters, Design of noise measuring instruments: Installation, efficiency analysis.

Text Books

- Walter, W. G. (1961). Standard methods for the examination of water and wastewater.
- Cooper, C. D., & Alley, F. C. (2010). Air pollution control: A design approach. Waveland press.
- Maiti, S. K. (2003). Handbook of methods in environmental studies (Vol. 2, pp. 110-121). Jaipur: ABD publishers.
- Fundamentals of Molecular spectroscopy (fourth edition), Colin N. Banwell and Elaine M McCash, McGraw Hill
- Inorganic chemistry (Fourth edition), Catherine E. Housecroft and Alan G. Sharpe, Pearson Education Limited.

Reference Books

- Mudroch, A., &MacKnight, S. D. (1994). Handbook of techniques for aquatic sediments sampling. CRC press.
- Cheremisinoff, P. N. (2018). Air pollution control and design for industry. Routledge.
- Harrison, R. M. (Ed.). (2012). Handbook of air pollution analysis. Springer Science & Business Media.

Water Resources and Environmental Hydraulics

Paper Code MES – 509 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To introduce the phenomena of hydrology, watershed and different parts involved in hydrologic cycle.
- To impart knowledge on the advanced areas of open-channel flow, and understand them in simple, lucid style.
- To provide students with
- basic skills and knowledge on hydraulics.
- To develop fundamental understanding of various means of formulation of water quality models and their adaptability under different conditions.
- To impart knowledge on various models used in prediction of water quantity and quality.

Course Learning Outcome

- Understand advanced hydrological processes and techniques necessary for tackling engineering and environmental problems.
- Apply advanced computer models for hydrological prediction.
- It is expected that the students will be better equipped to address various engineering problems related to water resources.
- Identify different problems related to water resources planning, management and development.

Course Description

Unit 1

Global water resources; Distribution of water in the earth's crust. Hydrological cycle. National river conservation plan – Namami Gange and Yamuna Action Plan. Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India. Integrated water resources management and water resource planning; Future of water and wastewater services.

Unit 2

Water need and consumption; Global challenges for water management; Threats to surface water resources; Principles and approaches to surface water management. Watershed management: Rain water harvesting and storage, recharging of ground water; Role of dams.

Unit 3

Groundwater exploration. Construction and design of different types of wells. Well completion and development. Groundwater development and management: Groundwater development in urban areas and rainwater harvesting, artificial recharge methods. Management of groundwater and groundwater legislation.

Unit 4

Vertical distribution of groundwater, Types of aquifers, springs and their classification, Environmental factors on Groundwater level fluctuations and Land subsidence, Effects of excessive use of groundwater resources, Salt water intrusion, Sources of salinity, Quality criteria for different uses, Groundwater quality in different provinces of India, pollution of groundwater resources.

Unit 5

Properties of sewage and industrial effluents; Effluent standards; treatment of industrial effluents, sewage treatment (primary, secondary and tertiary treatment), advanced treatments (nitrate and phosphate removal); Sludge treatment and disposal; Waste water use. Drinking water quality and water treatment (desalination, ion-exchange, reverse osmosis and disinfection of water).

Text Books

- Chaudhry, M. H. (1993). Open channel flow, Englewood Cliffs: Prentice Hall.
- French, R.H. (1986). Open Channel Hydraulics, McGraw Hill Book Co., New York.
- Linsley, R.K. and Paulhus, J.L.H. (1992). Water Resources Engineering, McGraw Hill Book Co.
- Streeter, V.L. and Wylie, E. B. (1983). Fluid Mechanics, McGraw Hill Book Co.,
- Subramanya, K. (2013). Engineering Hydrology, 4e. Tata McGraw-Hill Education.

Reference Books

- Schleiss, A.J. and Boes R.M. (2011). Dams and Reservoirs under Changing Challenges. CRC Press.
- Parkinson, J.N. Goldenfum, J.A. and Tucci, C.E.M. (2010). Integrated Urban Water Management. CRC Press.
- Findikakis, A.N. and Saro, K. (2011). Groundwater Management Practices. CRC Press.

Nanotechnology for Environmental Science

Paper Code MES – 510 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Gaining factual knowledge and Learning fundamental principles, generalizations, or theories of Nanotechnology.
- Learning to apply knowledge to make reasonable inferences about past or current environmental conditions.
- Developing specific skills on environmental nanotechnology research.
- To develop fundamental understanding of various means of formulation of logical preliminary interpretation of geochemical data used in prediction of water quantity and quality.

Course Learning Outcome

- Understanding the water quality parameters and how to interpret any laboratory results by using the proper software package.
- Understanding of the role of nanotechnology research applications in the controlling environmental pollution.
- Understanding of the processes involved in the distribution and transport of chemical substances between the atmospheric, continental and marine environments.
- Ability to reflect on the interactions among chemical, geological, physical and biological environmental processes.

Course Description

Unit 1

Historical background of Nanotechnology, Quantum phenomena, Size effect, Electronic confinement in 1D, 2D and 3D structures, Nanomaterials, Molecular Nanotechnology, Top-down and Bottom-up approaches, Green Nanotechnology and Applications of Nanotechnology.

Unit 2

Semiconducting Nanostructures: Metal oxide nanostructures: Background, Synthesis, Properties and Applications, Nanochalcogenides: Background, Synthesis, Properties and Applications, Organic Semiconductor Nanostructures: Background, Synthesis, Properties and Applications.

Unit 3

Carbon Nanomaterials: Introduction to Carbon allotropes and Carbon nanomaterials, Fullerenes: Background, Synthesis, Properties and Applications; CNTs (SWNTs and MWCNTs,): Background, Synthesis, Properties, and Applications; Nano-diamonds: Background, Synthesis, Properties and Applications; Graphene: Background, Synthesis, Properties and Applications; Carbon Nano-fibers and Carbon Nano-yarns: Background, Synthesis, Properties and Applications.

Unit 4

Nanotechnology: A Multidisciplinary Approach: Nanobiotechnology; Introduction and applications, Nanomedicine; Introduction and applications. Nanotechnology for a clean environment, Nanorobotics; future of robotics and applications and Nanotechnology in water desalination technologies.

Unit 5

Nanotechnology for Environmental Applications: Introduction, nanomaterials for clean water, wastewater treatment and Nanomaterials as adsorbents for removal of pollutants, microorganisms and heavy metals. Removal of pesticides and fungicides with Nanomaterials. Nanomaterials for water disinfection, Nanofiltration. Nanomaterials as a photocatalyst and catalyst. Nanomaterials for capturing CO_2. Nanomaterials for Air pollution remediation, Air purification and Emission mitigation using Nanomaterials. Nanotechnology for detection of pollutants in air and water, Nano Sensors and Application. Environmental risk due to Nanomaterials and Nanotoxicology.

Text Books

- Vakhrushev, A. V., Ameta, S. C., Susanto, H., & Haghi, A. K. (Eds.). (2019). Advances in Nanotechnology and the Environmental Sciences: Applications, Innovations, and Visions for the Future. CRC Press.
- Institute of Medicine. (2005). Implications of nanotechnology for environmental health research.
- Hussain, C. M., & Mishra, A. K. (2018). Nanotechnology in environmental science, 2 volumes (Vol. 1). John Wiley & Sons.

Reference Books

- Wiesner, M., & Bottero, J. Y. (2007). Environmental nanotechnology. New York: McGraw-Hill Professional Publishing.
- Grassian, V. H. (Ed.). (2008). Nanoscience and nanotechnology: environmental and health impacts. John Wiley & Sons.

Advanced Water and Wastewater Treatment Technology

Paper Code MES – 511 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To provide a more thorough theoretical understanding of the various unit processes used in water and wastewater treatment process.
- To provide scientific understanding on wastewater treatment operations and processes.
- To provide hands on expertise to design independently wastewater treatment systems.

Course Learning Outcome

- Students should have in-depth knowledge of physical chemical unit processes for advanced water treatment.
- The student will become well acquainted with basic design and operation of treatment plants for advanced physico-chemical-biological treatment of domestic wastewater.
- The candidate should be able to use knowledge from the discipline for scientific assignments and projects, and to publish research.

Course Description

Unit 1

Municipal wastewater – characteristics and composition; preliminary treatment systems - screening, grit removal and primary sedimentation – theory, design and flow measurement techniques.

Unit 2

Principle of biological treatment aerobic and anaerobic treatment systems, basic fundamentals of aerobic and anaerobic treatment of wastewater, reaction kinetics, Anaerobic treatment, Process microbiology and biochemistry, application for treatment of sewage, Concept of Common Effluent Treatment Plant.

Unit 3

Biological treatment systems, suspended and attached growth systems, activated sludge process (ASP) and its modifications, aeration principle and mechanism, diffused and surface aerators, biological nutrient removal, membrane separation and adsorption.

Unit 4

Attached growth systems; trickling filter, types of trickling filters, reaction kinetics, efficiency calculations and design, biofilters and rotating biological contactors – working principle and design, Low cost systems, stabilization ponds, lagoons, oxidation ditches, tertiary treatment system, recycling and resources recovery, sludge treatment.

Unit 5

Advanced wastewater treatment, Industry specific wastewater treatment for chloro-alkali, electroplating, distillery, tannery, pulp and paper, fertilizer, advanced oxidation process, Ion exchange process, Floating aquatic plant system and its design and operation.

Text Books

- Metcalf and Eddy. Wastewater Treatment, Treatment and Reuse. Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Arceivala, S.J. (1998) Wastewater Treatment for Pollution Control (3rd ed.) -, Tata McGraw Hill.
- Hammer and Hammer. Wastewater Technology. Tata McGraw Hill Pvt. Ltd. New Delhi India.
- Grady, C.L.P. and Lim, H.C. (1980). Biological Wastewater Treatment: Theory and Application. Marcel Dikker, NY.

Reference Books

- Benefield, L.D. Process Chemistry for Water and Wastewater Treatment. Prentice Hall Inc. New Jersey, USA.
- Eckenfelder, Jr. W.W. (1989). Industrial Water Pollution Control. McGraw Hill Edition, NY.
- Qasim, S.R. Treatment Plant Design. TA Publishing, USA.
- Introduction to Environmental Engineering and Science, Masters, Tata McGraw-Hill.

Noise Pollution and Control

Paper Code MES – 512 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Provide students with an introduction to air pollution control devices-constructional features and working principles.
- Understanding of technical aspects of regulating and controlling air pollution.
- Trained the students to design the control equipment independently.
- Familiarize the students to basic concept of noise pollution and its control.

Course Learning Outcome

- Expected to become a successful Environmental Engineers having capability to design independently air pollution control systems.
- The student will become well acquainted with basic design and operation of air pollution control systems.

Course Description

Unit 1

Noise Pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels, plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psycho-acoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure and Noise indices.

Unit 2

Demonstration of noise pollution monitoring equipment, Noise survey in a multiple noise sources situation in order to develop noise contour diagram for the entire locality. Noise monitoring at residential localities.

Unit 3

Frequency spectrum analysis of machine noise. Audiometry survey in order to assess the present status of hearing acuity of the subject. Traffic noise situation monitoring, human vibration monitoring Noise measurement techniques and analysis, Worksite, ambient and road transport. Noise prediction, modelling, and mapping. Noise impact assessment: Scultz fractional, Impact method; Value function curves.

Unit 4

Noise abatement measures - Sound absorption, acoustic barrier, vibration isolation, vibration damping, muffling, personal protector and green belt- Principles and design considerations. Noise pollution and management in mines, washeries, power plants, fertilizer plants and cement plants etc.

Unit 5

Noise prediction modeling, various types of models and input parameters required, application, advantages, disadvantages and limitations of noise prediction models, Noise control - control at source, during transmission and at receptor end, noise barriers and their design.

Text Books

- Environmental Noise Pollution - PE Cunniff, McGraw Hill, New York, 1987.
- Handbook of Noise Measurement - APG Peterson & EE Gross, General Radio Co., West Concord, Mass, 1967.
- Industrial Noise Control and Acoustics - RF Barron, Marcel Dekker, Inc., New York, 2003.
- Environmental Engineering, Peavy and Rowe, McGraw Hill Series.

Reference Books

- Engineering Noise Control: Theory and Practice - D Bies et al., Routledge Publishers, 2003.
- Noise control: Principles and Practice (2nd ed.) – Bruel, and Kjaer, B & K Publisher, Denmark, 1986.
- Vibrations from Blasting – D Siskind, International Society of Explosives, 2000.

Remote Sensing and GIS

Paper Code MES – 513 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- To study the basic concepts and principles of remote sensing.
- To study various image enhancement and classification techniques.
- To study and understand basic principles of GIS.
- To familiarize with different functionalities of GIS.

Course Learning Outcome

- The students will be able to know about different types of satellites products and their characteristics.
- They will be able to interpret and classify remote sensing data products.
- They will be able to georeference maps and images using different coordinate systems.
- They will learn the versatile application capabilities of different GIS analysis techniques.

Course Description

Unit-1

Geographic coordinates- latitude and longitude; Survey of India toposheets, basic projections and coordinate systems.

Unit-2

Basic concept of remote sensing- energy sources and radiation principle, EMR and spectrum; EMR interaction with atmosphere and earth surface features- reflection, absorption, emission and transmission; Spectral response pattern- vegetation, soil and water bodies. Characters of remote sensing system- platforms and sensors, orbits types and resolutions; Characters and applications of satellites- IRS series, LANDSAT series, SPOT series, high resolution satellites- CARTOSAT, IKONOS and QUICKBIRD series.

Unit-3

Image geometric distortion- sources and causes of distortion, rectification- GCP, resampling, image registration/geo-referencing; Image Enhancement- satellite image statistics, basics of the histogram; Contrast stretching- spatial feature manipulations, spatial filtering, convolution low pass and high pass filters, edge detection; Image Classification- introduction, classification techniques, supervised-training stage, classification stage, parallelepiped classifier, Gaussian maximum Likelihood classifier and unsupervised classification.

Unit-4

Introduction, definition of GIS, components of GIS, functions of GIS, spatial entity, spatial data model-raster and vector, data structure, attribute data- input and management, the concept of Metadata; Process of GIS- data capture, data sources, GPS, linking of spatial and attribute data.

Unit-5

Spatial data analysis- measurement of length, perimeter and area, queries, reclassification techniques, buffering and neighbourhood functions, spatial interpolation; Overlay analysis-Vector and raster overlay; Surface analysis and interpolation-DEM, slope, aspect, watershed analysis; Application of RS and GIS in water resource management, land cover/land use planning and management (urban sprawling, vegetation study, forestry, natural resource), waste management and climate change

Text Books

- Lilles and Kiefer. Remote Sensing and Image Interpretation. John Wiley & Sons, Inc.
- Burrough, P.A. and McDonnell, R.A. Principles of Geographic Information Systems. Oxford: Clarendon Press.
- Basudeb, B.. Remote Sensing and GIS. Oxford University Press.

Reference Books

- Paul, J. C. Principle of Remote Sensing. Longman, London and New York.
- Floyd, F. S. Remote Sensing Principles and Interpretation. W H Freeman and Company.
- Lavender, S. and Lavender. Practical handbook of remote sensing. CRC Press.

Software or other Requirement

- ERDAS IMAGINE
- ArcGIS, QGIS

Environmental System Analysis and Modeling

Paper Code MES 3–514 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (40-60-100)

Course Objectives

- Providing basic knowledge of environmental process modelling and optimization methods as a powerful tool that can be systematically applied for obtaining efficient and cost-effective solutions to a wide variety of environmental problems.
- To introduce and apply commercially available as well as open source simulation tools as the solution of environmental issues.

Course Learning Outcome

- Providing in depth knowledge on application of various application-oriented presentations of the fully array of traditional and recently developed environmental modelling and optimization tools and techniques.
- Emphasis is laid on the application of modeling tools and techniques to real-world problems from various areas of environmental science and management.
- Should have a sound knowledge of basic theoretical principles of system analysis and optimization and to formulate models.
- Students will acquire sufficient knowledge of process optimization techniques and computational procedures in environmental management.

Course Description

Unit 1

Systems approach: Concept and analysis; Problem formulation; Model construction and deriving solution from models using LPP; Linear programming; Graphical method; Simplex method; Duality in linear programming; Post-optimality analysis; LP for multi period decision process; Limitation and Application of LPP to environmental processes.

Unit 2

Introduction to optimization, Environmental application of optimization, Formulation of design problems as mathematical programming problems; Classification of optimization problems; Introduction to stochastic and deterministic algorithms.

Unit 3

Non-linear programming; Single variable and Multi variable unconstrained optimization techniques; Direct search methods; Descent methods; Constrained optimization; Multivariable optimization with equality and inequality constraints; Direct and indirect methods.

Unit 4

Dynamic programming; Characteristics of dynamic programming problems; Computational procedure; Multi decision processes; Concept of sub optimization and the principle of optimality; Discrete differential dynamic programming; Application of environmental engineering problems.

Unit 5

Transportation models; Dynamic programming models: Application to land use planning and air pollutant emission control; Present value concepts; Optimization over time; Fate and Transport of contaminants in surface and sub-surface environment; Streeter - Phelps model and introduction of various available software's.

Text Books

- Hillier, F. S. and Lieberman, G. J. (2001). Introduction to Operations Research. McGraw Hill.
- Fox, R.L. 1971. Optimisation Methods for Engineering Design. Addison Wesley USA.
- Pantell, R.H. (2001). Techniques for Environmental System Analysis. Wiley, NY.
- Haddley, G. (1962). Linear Programming", Reading, Mass., Addison-Wesley.
- Wayne, L. W. (2003). Operations Research: Applications and Algorithms, Cengage Learning; 4 edition.

Reference Books

- Deb, K. (2000). "Optimisation for Engineering Design", Prentice Hall of India.
- Rao, S. S. (1978). "Optimisation Theory and Applications", Wiley Eastern, New Delhi.
- Jorgensen, S.E. Sorensen, B.H. and Nielsen, S.N. (1995). Handbook of Environmental and Ecological Modelling. CRC Press.
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Health Safety and Risk Analysis

Paper Code MES – 515 (Lectures-Tutorials-Practical/Week (3-1-0) Credit 4

Course Marks (Mid-End-Total) (60-40-100)

Course Objectives

- To impart knowledge on environmental health and risk analysis.
- To teach about methods followed for ensuring environmental health.
- Spreading awareness regarding identification of hazard and its health risk.
- To teach various types of toxicity in Human caused by hazardous substances.

Course Learning Outcome

- Identify various types of water relay management systems.
- Execute the risk analysis exercise.
- Understanding of Hazard assessing equipments.
- Developing sense of following environmental regulations in order to safeguard our environment.

Course Description

Unit 1

Hazards Waste Fundamentals: Definition, types, Landmark episodes, Classification, and Generation. Physical Hazards: Noise and vibration, Instrumentation, Surveying procedure, Health effects and Control measures. Chemical Hazards: Recognition of hazards, TLV for air, gas and chemical contaminants.

Unit 2

Industries and construction sites health risks; exposure of hazardous and human health: Carcinogen, Immunomodulators, Genotoxicant, Hepatotoxicity: Common examples of hepatotoxicants, injuries caused to liver; Nephrotoxicity: Common examples of nepherotoxicants, injuries caused to kidney; Pulmonary toxicity: Common examples of pulmonary toxicants, injuries caused to lungs; Neurotoxicity: Common examples of neurotoxicants, injuries caused to nervous tissues.

Unit 3

Hazard identification safety audits; Safety performance: As per Indian and International standards; Safety management techniques; Safety inspection: Safety action, Safety survey, Disaster control; Regulations for Environment; Health and Safety; Factories Act and Rules; Environmental Pollution Act; Oil Industry Safety Directorate (OISD); Indian Electricity Acts and Rules; Mines Acts and Rules; Workmen Compensation Act; OSHA Standards; IS & BS Standards; API standards; Regulatory processes; Rules and Amendments; Guidelines for HWM.

Unit 4

Overall risk analysis; Generation of metrological data; Ignition date; Population data consequences analysis and total risk analysis; Disaster management plan; Emergency planning: on site & off-site emergency planning; Risk management ISO 140000; EMS models case studies; Marketing terminal; Gas processing complex refinery.

Unit 5

Risk analysis introduction, Quantitative risk assessment; Rapid risk analysis; Comprehensive risk analysis; Emission and dispersion-leak rate calculation; Single and two-phase flow dispersion model for dense gas; Flash fire; Plume dispersion; Toxic dispersion model; Evaluation of risk;; Tank on fire; Flame length; Radiation intensity, radiation property and its effect on human health.

.Text Books

- Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor & Francis ltd.
- Basic Environmental Health (2001): AnnaleeYassi, TordKjellstom, Theo de Kok, Tee.
- Guidotti Environmental Health: Monroe T. Morgan.
- Handbook of Environmental Health and Safety – principle and practices: H. Koren; Lewis Publishers.
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- Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
- Environmental pollution and Toxicology by MeeraAsthana and Astana D.K., Alka printers, 1990.
- Toxicology, by A.Sood, Sarup and sons New Delhi, 1999.
- Text book of Preventive and Social Medicine, by Park J.E. and Park K., Banosidas Bharat Publishers, Jabalpur, 1985.