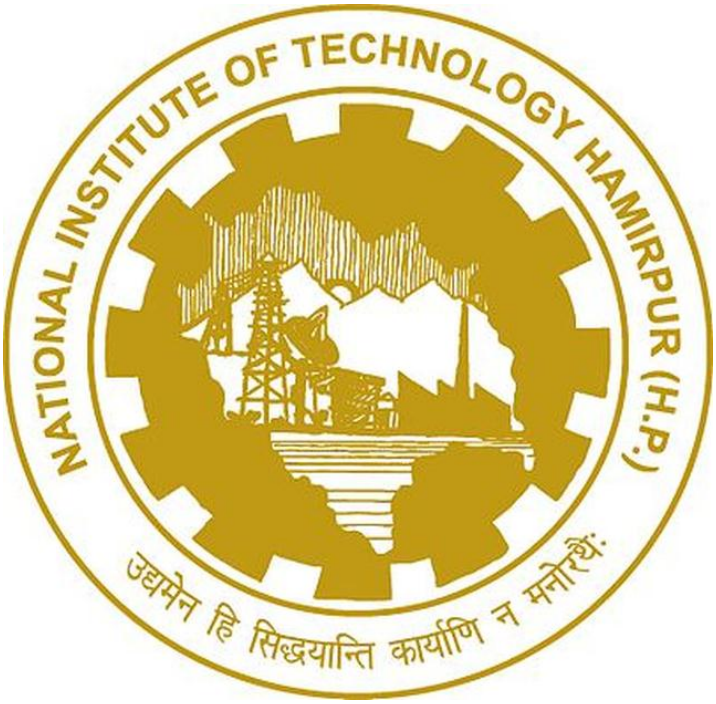
Master of Technology

In

Environmental Engineering

Course Structure & Syllabus



Department of Civil Engineering

National Institute of Technology Hamirpur

Hamirpur (HP) – 177005, India

Course Structure of M.Tech. Environmental Engineering

SEMESTER-I

S. No.	Course No.	Course Name	Teaching Schedule			Hours/ Week	Credit
			L	T	P		
1.	EN-631	Environmental Chemistry	4	0	0	4	4
2.	EN-632	Microbiology and Ecology	4	0	0	4	4
3.	EN-633	Advanced Water Treatment	4	0	0	4	4
4.	EN-7MN	Programme Elective-I	4	0	0	4	4
5.	EN-7MN	Programme Elective-II	4	0	0	4	4
6.	EN-634	Environmental Engg. Lab-I	0	0	4	4	2
Total			**20**	**0**	**4**	**24**	**22**

Programme Elective-I & II: List of Programme Electives is given in the Annexure.

SEMESTER-II

S. No.	Course No.	Course Name	Teaching Schedule			Hours/ Week	Credit
			L	T	P		
1.	EN-641	Environmental System Modelling	4	0	0	4	4
2.	EN-642	Advanced Wastewater Treatment	4	0	0	4	4
3.	EN-643	Air Pollution and Control	4	0	0	4	4
4.	EN-7MN	Programme Elective-III	4	0	0	4	4
5.	EN-7MN	Programme Elective-IV	4	0	0	4	4
6.	EN-644	Environmental Engg. Lab - II	0	0	4	4	2
Total			**20**	**0**	**4**	**24**	**22**

Programme Elective-III & IV: List of Programme Electives is given in the Annexure.

SEMESTER-III

S. No.	Course No.	Course Title	Hours/Week	Credit
1.	EN-800	M.Tech. Dissertation	---	20
Total				**20**

SEMESTER-IV

S. No.	Course No.	Course Title	Hours/Week	Credit
1.	EN-800	M.Tech. Dissertation	---	20
Total				**20**

Total Credit of the Programme=84

Annexure

List of Programme Electives

Programme Elective I

1. EN-731 - Solid & Hazardous Waste Management
2. EN-732 - Industrial Waste Management
3. EN-733 - Bioremediation-Principles and Applications

Programme Elective II

1. EN-734 - Environmental Impact Assessment
2. EN-735 - Environmental Law and Policy
3. EN-736 - Environmental Change and Sustainable Development

Programme Elective III

1. EN-741 - Treatment Plant Design
2. EN-742 - Environmental Toxicology and Health
3. EN-743 – Earth and Environment

Programme Elective IV

1. EN-744- GIS and its Application in Environmental Engineering
2. EN-745 - Statistical Methods and Modelling
3. EN-746 – Disaster Management

Course Name : Environmental Chemistry
Course Code : EN-631
Course Type : Core

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- To equip students with the knowledge of the chemical properties of elements and compounds.
- To quip students about the chemical reactions essential for the emergence and existence of the cycling and accumulation of pollutants in the environment.

Course Content

Types of chemical reactions, stoichiometric calculations, solutions, chemical thermodynamics, fundamentals of process kinetics, gas laws, ways of shifting chemical equilibria. Equilibrium calculation, alkalinity, acidity, buffers, buffer index. Solubility equilibrium for slightly soluble salts, effect of other solutes on salt solubility, competing acid-base equilibria, effect of complexions, hydrolysis, computing total soluble species concentration Oxidation-reduction processes, stability diagrams, redox potential. Fundamental of Process kinetics: Reaction rate, order and stoichiometry. Fundamental of surface and colloidal chemistry: surface charge on colloidal particles, electric double layer, adsorption isotherm. Basic concepts of quantitative analytical chemistry. Instrumental methods of analysis.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Synthesize and apply concepts from multiple sub-disciplines in environmental chemistry and toxicology.

CO2: Use technical and analytical skills to quantify the level and effects of xenobiotic in environmental compartments.

Books and References

1. Chemistry for Environmental Engineer by Sawyer, C.N., McCarty, P.L., and Parkin, G.F., McGraw Hill, New Delhi.
2. Process Chemistry for Water and Wastewater Treatment by Benefield, Judkins and Weand, Prentice Hall.

Course Name : Microbiology and Ecology
Course Code : EN-632
Course Type : Core

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- Understand the role of micro-organisms as agents of environmental change.
- Recognize micro-organisms as indicators of alteration of an ecosystem.
- Understand microbial processes aimed to solve environmental problems.

Course Content

Microorganisms - classification, prokaryotic and eukaryotic cells, structure, characteristics, nucleic acids, DNA and RNA, replication. Recombinant DNA. Viruses, their detection and quantification. Microscopy, Measurements and Isolation of Microorganism, Different Cultures, Media and Techniques of Staining and Enumeration of microorganism.

Enzyme and enzyme kinetics, Metabolism, respiration, fermentation, Glycolysis, Krebs's cycle, carbohydrate, protein, lipids, significance of energetics. Chemical composition of cell and nature of organic matter used by microorganisms. Metabolic classification of microorganisms : phototrophs, chemotropism, applications in environmental engineering

Distribution of microorganisms, indicator organisms, coliforms - fecal coliforms - E.coli, Streptococcus fecal is differentiation of coliforms - significance - MPN index, M.F. technique, standards. Microbiology of wastewater treatment processes such as activated sludge process, trickling filter, anaerobic processes.

Introduction to Microbiology of Soil and Air and Industrial Microbiology, Microbiology of bioremediation and solid waste treatment

Bio-sphere, earth energy budget, Ecosystem, Uniformitarianism, the ecology of population, Ecosystem and communities: Physical and biological properties

Course Outcomes

Upon successful completion of the course, the students will be able to:

CO1: Apply knowledge of biology on certain species of micro-organisms in order to use them as bio-indicators.

CO2: Apply the metabolic processes of micro-organisms to industrial processes related to environment.

CO3: Develop analysis and synthesis skills.

Books and References

1. Environmental Microbiology by Maier R M, Pepper I L and Gerba C P., Elsevier- AP.
2. Microbiology by Pelczar, Jr, M.J., Chan, E.C.S., Krieg, R.N., and Pelczar M. F, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Environmental Biotechnology: Principles and Applications by Rittman B, McCarty P L McCarty P, McGraw-Hill.

Course Name : Advanced Water Treatment
Course Code : EN-633
Course Type : Core

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- To provide an overview of both the theoretical and practical aspects of conventional and advanced water technology for surface water treatment.
- Select an appropriate treatment process for a specific application, and be able to identify appropriate pre-treatment and post treatment schemes, and cleaning protocols for these processes.

Course Content

Types of Sedimentation and coagulation, settling tests, scale up, Batch flow and continuous flow operations. Coagulation, mechanisms of coagulation, effect of turbidity and alkalinity, chemistry of coagulants.

Flow through beds of solids: Slow sand filters, rapid sand filters, ion exchange units, adsorption towers, contacting towers, flow through expanded beds, flow through porous plates and membranes.

Gas transfer and Disinfection Mechanism of transfer, film coefficients and equilibrium relationship, gas disperses, packed columns, tray columns, spray units. Disinfection, mechanism, different agents.

Advanced treatment operations: Adsorption, isotherms, reverses osmosis, electro-dialysis, ultrafiltration, etc. Applications of Unit Operations in Water Treatment and Design of Physical Facilities.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Depth knowledge of physical chemical unit processes.

CO2: Candidate should be able to use skills to perform research at a higher level.

Books and References

1. Wastewater Engineering: Treatment, and Reuse by Metcalf and Eddy Inc, Tata McGraw Hill.
2. Physicochemical Processes for Water Quality Control by Weber W. Wiley-Interscience, New York.
3. Water and Wastewater Treatment by Schroeder E D., McGraw-Hill.
4. Ministry of Urban Development, Govt of India – Manual for Water Treatment.

Course Name : Environmental Engineering Laboratory-I
Course Code : EN-634

Contact Hours/Week: 4L **Course Credits:** 02

Course Objectives

- To introduce students to how the common environmental experiments relating to water and wastewater quality are performed.
- This course will help students know which tests are appropriate for given environmental problems, statistically interpret laboratorial results and write technical reports, and apply the laboratorial results to problem identification, quantification, and basic environmental design and technical solutions.

List of Experiments

1. To determine Turbidity in water/wastewater sample.
2. To determine Alkalinity in water/wastewater sample.
3. To determine Hardness in water/wastewater sample.
4. To determine Chlorides, Sulphate and nitrates in water/wastewater sample.
5. To determine Dissolved Oxygen (DO) in water/wastewater sample.
6. To determine Biochemical Oxygen Demand (BOD) in water/wastewater sample.
7. To determine Chemical Oxygen Demand (COD) in water/wastewater sample.
8. Microbiological quality of water – MPN, Plate count and membrane filtration techniques
9. Isolation and growth of bacteria.
10. Microscopy, staining techniques.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

Upon successful completion of the course, the students will be able to:

CO1: Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.

CO2: Statistically analyse and interpret laboratorial results.

CO3: Apply the laboratorial results to problem identification, quantification, and basic environmental design and technical solutions.

CO4: Understand and use the water and wastewater sampling procedures and sample preservations.

Course Name : Environmental System Modelling
Course Code : EN-641
Course Type : Core

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- To study different types of modelling in Environmental Systems with an aim to develop understand and apply Computational Fluid Dynamics in Environment and economical modelling.

Course Content

Introduction to Environmental Modelling; Modelling and model Building- Sensitivity Analysis and its role, Errors and Uncertainty; Time Series: Analysis and Modelling; Spatial Modelling and Scaling Issues- Scale and scaling, Methodology for scaling physically based models; Forest-Management Modelling**;** Environmental Applications of Computational Fluid Dynamics- Introduction, CFD fundamentals, Applications of CFD in environmental modelling; Climate and Climate-System Modelling; Representing Human Decision-Making in Environmental Modelling- Scenario approaches, Economic modelling, Agent-based modelling; Current and future developments.

Course Outcomes

On successful completion of this course students will be able to:
CO1**:** Recognise, discuss, apply, test and critically evaluate different model types.
CO2: Recognise, discuss, apply, and test the applications of CFD in environmental modelling.

Books and References

1. Environmental Modelling: Finding Simplicity in Complexity by John Wainwright and Mark Mulligan, John Wiley & Sons, Ltd**.**
2. Building Environmental Models: A Primer on Simplifying Complexity by Mulligan, M. and Wainwright, J., John Wiley & Sons, Ltd, Chichester.
3. Earth-system science, in Blackwell Companion to Environmental Geography by Wainwright, J., Blackwell, Oxford.

Course Name : Advanced Wastewater Treatment
Course Code : EN-642
Course Type : Core

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- To apply knowledge of mathematics, physics, chemistry, and microbiology to solve and analyse engineering problems related to water and wastewater collection, transport, quality and treatment.
- To use the fundamental principles of mass balance, chemical kinetics and equilibrium to design water or wastewater reactors to achieve a desirable treatment goal.

Course Content

Kinetics of Biological Growth, Nutrition and growth conditions, Effect of environmental conditions, bacterial growth in terms of numbers and mass, growth curve, interpretation of curve, substrate limited growth, Monod's expression, substrate utilization and cell growth, effect of endogenous metabolism, inhibition, effect of temperature, application of growth and substrate removal kinetics to biological treatment.

Reactors and Reactor analysis, Types of reactors and their analysis.

Biological Processes, Fundamentals and design concepts of aerobic treatment processes. Anaerobic treatment processes, Nutrient removal and Pond treatment processes: Biological processes for nitrogen and phosphorus removal. Different pond treatment systems

Biological processes for sludge processing.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Select or construct appropriate treatment schemes to remove certain pollutants present in water or wastewater.

CO2: Design a water or wastewater treatment component.

CO3: Balance chemical reactions and use balanced reactions to determine the distribution of species at equilibrium

CO4: Learn how to characterize wastewater, and the best available technology (BAT) for physical, chemical and microbiological treatment of wastewater.

Books and References

1. Wastewater Engineering: Treatment, and Reuse by Metcalf and Eddy Inc, Tata McGraw Hill.
2. Biological Process Design for Wastewater Treatment by Benefield L D, and Randall, C W., Prentice Hall.
3. Water and Wastewater Treatment by Schroeder E D., McGraw-Hill.
4. Wastewater Treatment: Concepts and Design Approach by Karia G L and Christian R A., Prentice Hall.
5. Wastewater treatment for pollution control by Soli J Arceivala, Dr. Shyam R. Asolekar, McGraw Hill Education (India) Private Limited.

Course Name : Air Pollution and Control
Course Code : EN-643
Course Type : Core

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- To make the students aware of history of air pollution; definition of air pollution and various types of sources and classification of air pollutants.
- To make the student aware of techniques and instrumentation of ambient air monitoring, establishment of ambient air monitoring stations; stack monitoring and experimental analysis of air gaseous and particulate air pollutants; standards and limits.

Course Content

Air Quality and Standards, Important air pollutants, their sources, characteristics and effects. Sampling and Analysis: Ambient air sampling, stack sampling, Air quality standards.

Air Pollution Meteorology and Dispersion Models, Atmospheric motion, Lapse rate, atmospheric stability, inversion, atmospheric dispersion, maximum mixing depth, Diffusion models, plume rise.

Control of Particulates, Characteristics of particulates. Filters, gravitational, centrifugal-multiple type cyclones, prediction of collection efficiency, pressure drop, wet collectors, Electrostatic Precipitation theory-particle charging-particle collection-ESP design procedure.

Control of Gaseous Pollutants.

Adsorption, absorption. Emission control in coal-fired power plants and other important industries. Condensation and incineration

Automobile Pollution, Legislation for motor vehicle emission control, control of automobile pollution, internal combustion engines, modification of IC engines to reduce emission, air fuel ratio, catalytic converters.

Odour pollution and control, Indoor air pollution, Noise pollution and control.

Course Outcomes

Upon successful completion of the course, the students will be able to:

CO1: Grasp the fundamentals of air pollution and its associated environmental impacts.

CO2: Earn to describe the key concepts of air quality management.

Books and References

1. Air Pollution Control Engineering by De Nevers, McGraw-Hill, New York.
2. Air Pollution Its Origin and Control by Wark K, Warner C F and Davis W., Harper and Row, New York.
3. Air Pollution by Rao M N, Tata McGraw Hill, New Delhi.
4. Principles of Air Quality Management by Griffin R D, CRC Press, Boca Raton, USA.

Course Name : Environmental Engineering Laboratory-II
Course Code : EN-644

Contact Hours/Week: 4L **Course Credits:** 02

Course Objectives

- To introduce students to how the common environmental experiments relating to water and wastewater quality are performed.
- This course will help students know which tests are appropriate for given environmental problems, statistically interpret laboratorial results and write technical reports, and apply the laboratorial results to problem identification, quantification, and basic environmental design and technical solutions.

List of Experiments

1. To determine the H_2O_2 in a solution.
2. To determine the Sludge Volume Index (SVI) in the sewage sample.
3. To determine solids in wastewater sample.
4. To determine COD in waste water sample.
5. To determine the presence of invertebrates using microscope.
6. To determine Proximate Analysis in solid waste sample.
7. Determination of Fluoride in wastewater sample.
8. To determine optimum dose of Alum for Coagulation and Flocculation.
9. Isolation and Identification of micro-organisms.
10. To determine the presence of coliform organisms using MPN technique (Presumptive test).

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.
CO2: Statistically analyse and interpret laboratorial results.
CO3: Apply the laboratorial results to problem identification, quantification, and basic environmental design and technical solutions.
CO4: Understand and use the water and wastewater sampling procedures and sample preservations.

Course Name : Solid and Hazardous Waste Management
Course Code : EN - 731
Course Type : Programme Elective I

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- Understanding of problems of municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc.
- Knowledge of legal, institutional and financial aspects of management of solid wastes.
- Become aware of Environment and health impacts solid waste mismanagement.
- Understand engineering, financial and technical options for waste management.

Course Content

Solid waste sources - nature and characteristics - Quantities and Qualities - generation rates – Potential of disease - nuisance and other problems. Collection and Storage
Solid waste management – Functional elements of solid waste-on-site storage, collection and separation. – Containers and its location – collection systems- vehicle routing- route balance- transfer station - Processing- recovery and reuse. Disposal methods – sanitary land filling, planning, site selection, design. Monitoring Closure and post closure monitoring – Other methods like incineration, pyrolysis, and composting, biological digestion. Hazardous Waste Management Introduction to hazardous waste – Definition, characterization and composition – TCLP test – The magnitude of problem – Risk assessment - – Storage and transportation of hazardous waste – Labelling of hazardous waste – Physical, Chemical and Biological treatment of hazardous waste – Bioremediation of hazardous waste – Treatment of nuclear waste and Radio-active waste. Biomedical waste and BMW-98 Rules - MSW-2000 Rules – Legislation for E-waste and radioactive waste.

Course Outcomes

CO1: Do sampling and characterization of solid waste;
CO2: analysis of hazardous waste constituents including QA/QC issues;
CO3: understand health and environmental issues related to solid waste management;
CO4: Apply steps in solid waste management-waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of solid waste transport, treatment and disposal techniques.

Books and References

1. Municipal Solid Waste Management: Pollution Technologies Review by David Rimbers, Noyes Data Corporation, London.
2. Hazardous Waste Management by Michael D. Lagrega, Phillip L. Buckingham, Jeffrey C. Evans, McGraw Hill, New York.
3. Hazardous Waste Management by Gaynor W. Dawson, Basil W. Mercer, Wiley Interscience, New York.

Course Name : Industrial Waste Management
Couse Code : EN - 732
Course Type : Programme Elective I

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- Present scenario of industrial waste management in India nationally, in Maharashtra and in other states.
- Industrial waste generation patterns, as well as management and disposal techniques.
- Central and state pollution control board guidelines on industrial waste management.

Course Content

Industrial waste source, Nature and characteristics, quantity and quality of industrial wastes and their impact on the environment, waste volume reduction, waste strength reduction, neutralization, removal of suspended and colloidal solids, removal of inorganic and organic dissolved solids, disposal of sludge solid – treatment of cyanide waste – heavy metal and radio activity.

Management of industrial waste for various industries like dairy, sugar, paper, distillery, textile, tannery, food processing, fertilizer, pharmaceutical industrial.

Development of integrated treatment for waste water – physico chemical treatment tertiary treatment methodologies - recent trends in clean technologies – zero polluting industry concept – Reuse and recycle of waste water.

Course Outcomes

After the successful completion of the course student will be able to understand:

CO1: Schemes, incentives, policies on industrial waste management.

CO2: Overview of product design for waste minimization.

CO3: Cost benefit analysis of different waste management techniques

Books and References

1. Liquid waste of Industries by Nemerow, N.L., Addison Wesely.
2. Wastewater Treatment by Rao M N and Datta A K, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
3. Industrial Water Pollution Control by Eckenfelder, McGraw-Hill.
4. Wastewater Engineering-treatment, Disposal, Refuse by Metcalf and Eddy, T.M.H. Edition, New Delhi.

Course Name : Bioremediation-Principles and Applications
Couse Code : EN-733
Course Type : Programme Elective I

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- The purpose of this course is to introduce the underlying biogeochemical concepts pertinent to remediation of soil and groundwater, and describe how systems can be successfully engineered to support/promote remediation with an emphasis on bioremediation.

Course Content

Introduction; Contaminated soil remediation options; Containment systems - Cover systems , Vertical barriers , Horizontal barriers , Hydraulic control measures ; In-situ treatment systems ; Ex-situ treatment systems ; Factors affecting bioremediation - Microbial constrains , Chemical constrains , Biodegradability of contaminants ; Other contaminant properties - Nutrients , Oxygen, air, hydrogen peroxide, Alternative electron acceptors, Metal ions, Toxic compounds, Biogeochemical parameters; Environmental constrains- Temperature, pH, Moisture content - water activity, Redox potential.

Bio-stimulation; Bio-augmentation; Monitored natural attenuation; Biotransformation of metals, metalloids and radionuclides; Bio-precipitation; Bio-reduction –Bio-oxidation; Bio-sorption; Phytoremediation.

Course Outcomes

CO1. Identify which pollutants are of greatest concern, describe the principles of various physical and chemical remediation technologies and relate selection of these technologies to the properties of contaminants.

CO2. Determine what is needed for site characterization, explain the relevance to selection of appropriate remediation strategies, and determine when bioremediation is an appropriate technology and its advantages and limitations.

Books and References

1. Introduction and overview of bioremediation by Baker, K.H., and Herson, D.S., McGraw-Hill, New York.
2. Trends in Biotechnology by Hamer, G., Elsevier.
3. Fungi in Bioremediation by Gadd, G.M., Cambridge University Press.
4. Mycoremediation: fungal bioremediation by Singh, H., John Wiley & Sons.
5. Phytoremediation of Metal- Contaminated Soils by Morel, J.-L., Echevarria, G., and Goncharova, N. (Eds.), IOS Press, Amsterdam, and Springer in conjunction with the NA.

Course Name : Environmental Impact Assessment
Course Code : EN - 734
Course Type : Programme Elective II

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- Appreciate the purpose and role of EIA in the decision-making process.
- Understand strengths & limitations of environmental management.
- Know procedures Understand screening & scoping processes Interpret options for evaluating environmental and social impacts.

Course Content

Environment and its components, Concept of Ecological imbalances, carrying capacity and sustainable development. Evolution of environmental impact assessment (EIA), Current screening process in India. A step-by-step procedure for developing EIA. Elements of Environmental Analysis. Public consultation, Post monitoring, Data collection for Air Quality Impact analysis, Water Quality Impact Analysis and energy impact analysis. Impact Assessment Methodologies-Matrices, overlays, network analysis. Case studies of Industrial EIA and Water resources projects. Brief introduction about Environment legislation and Environmental Audit.

Course Outcomes

CO1: Understand the different steps within environmental impact assessment.
CO2: the implications of current jurisdictional and institutional arrangements in relation to environmental impact assessment.
CO3: Understand how to liaise with and the importance of stakeholders in the EIA process.

Books and References

1. Environmental Impact Assessment for Developing Countries by Asit K. Biswas, Butterworth-Heinemann.
2. Environmental Impact Analysis Handbook by G.J. Rau and C.D. Wooten, McGraw-Hill, New York.
3. Environmental Impact Assessment by C.W. Canter, McGraw-Hill Education.
4. Environmental Impact Assessment Theory and practice by Peter Wathern, Routledge.

Course Name : Environmental Law and Policy
Course Code : EN – 735
Course Type : Programme Elective II

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- The objective of this paper is to acquaint the students with the environmental issues, pollution and control and the measures taken for its protection along with the norms prevailing at international and national level.

Course Content

Introduction to Environmental Policies; Economics and environmental policies; Industries and environmental policies; Agriculture and environmental policies; Ecosystem and environmental policies; Environmental policy instruments (EPI); Environmental Policies and Programs in India; Forest conservation activities; NGO movements for environmental protection in India; Environmental Laws and Legislations; Private and Public law; Principles of international law; Indian Environmental Laws; International institutions; Key international treaties; Objectives and principles of legislation; Environmental Legislations in India; Evolution of Indian Legislations; Constitution of India; Union Government initiatives.

Course Outcomes

CO1. Students will be able to get basic knowledge of environment, pollution and various Principles.
CO2. Students will be able to get the knowledge about Constitutional provisions for the Protection of environment.
CO3. Students will learn about the legal provisions of the water pollution.
CO4. Students will also learn about the air pollution.

Books and References

1. The Limits of Growth by D. H. Meadows, D. L. Meadow, J. Randers and W. W. Behren, Earth Island Ltd., London.
2. World Commission on Environment and Development, Our Common Future. Oxford University Press, Oxford.
3. Environmental Policies in India by Surendra Kumar, Northan Book Centre, New Delhi.

Course Name :	Environmental Change and Sustainable Development
Couse Code :	EN - 736
Course Type :	Programme Elective II

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- Provide an interdisciplinary training to equip students for understanding of the environmental and climate change dimensions of development trends and interventions.

Course Content

Introduction; Environmental Change and Adaptation; Assessing the Impacts of, and Vulnerability and Adaptation to Climate Change- Information Gathering – Data, Systematic Observation and Monitoring; Information Analysis – Reporting of Impacts, Vulnerability and Adaptation; Adaptation to Climate Change.

Introduction to Sustainable Development; Sustainable Development: Definition and Principles; Challenges of the Global World; Production and Consumption; Protecting and Managing the Natural Resource Base of Economic and Social Development; Measuring Sustainability; Government and Civil Society; Sustainable Development in a Globalizing World; Means of Implementation- Finance, Trade, Technology, Science and Education, Population.

Course Outcomes

CO1: Gathering of data, assessing and reporting of Environmental Impacts.
CO2: Understand the meaning of sustainable development and its implementation in Finance, Trade, Technology, Science and Education and Population.

Books and References

1. Global Environmental Change by Paul C. Stenn, Oran R. Young and Daniel Druckman, National Academy Press.
2. An Introduction to Sustainable Development by Peter P. Rogers, Kazi F. Jalal and John A. Boyd, Earth Scan.
3. Environment and Sustainable Development by M. H. Fulekar, Bhawana Pathak and R. K Kale, Springer.

Course Name : Treatment Plant Design
Couse Code : EN - 741
Course Type : Programme Elective III

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- The course aims at advancing the students' knowledge in wastewater treatment systems and enhancing the principles of treatment plants design aspects. In addition, the course covers sludge characteristics and treatment methods

Course Content

Design of screens, grit chamber, skimming tank, and flotation tank. Design of equalization tank, Design of plug flow and complete mix activated sludge process, secondary settling tank, trickling filter, bio tower, rotating biological contactors, sequencing batch reactor, oxidation ditch, and aerated lagoon.
Design of oxidation ponds, Imhoff tank, septic tank, design of sludge digestion, sludge thickening unit, sludge trying bed, incinerators, Design of anaerobic reactors, Design of anaerobic filter, UASB reactor. Design of disposal system.

Course Outcomes

CO1: Identify and explain the main physical, chemical and biological processes for water and wastewater treatment.
CO2: Design basic treatment processes.
CO3: Develop treatment plant layouts.

Books and References

1. Water Works Engineering by Qasim S R, Motley E M and Zhu G, Prentice-Hall India.
2. Water Treatment Principles and Design by Montgomery, John Wiley and Sons.
3. Wastewater Engineering: Treatment, and Reuse by Metcalf and Eddy Inc, Tata McGraw Hill.

Course Name : Environmental Toxicology and Health
Couse Code : EN - 742
Course Type : Programme Elective III

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

- Exposure of man and animal to potentially hazardous environmental factors of chemical, biological or physical nature.
- The effects caused by such exposure on health of man, animal and environment.

Course Content

Dimensions of environmental health, causative agents of diseases, social factors, urban problems, housing and health, economy and health, climate and other atmospheric elements, violence, crime and mental health, family health practice, health care planning and delivery, chronic and communicable diseases.
Industrial and agricultural pollutants, occupational health, epidemiological data, occupational health hazards, environmental exposure and diseases, industrial toxicants, hazardous wastes, preventing exposure to unhealthy and unsafe working conditions, ergonomics, controlling stress of life.
Disease control, disease prevention, morbidity and mortality, diseases and progressive deterioration, controlling diseases and disability.
Foodborne and waterborne diseases outbreaks, Nuclear energy and environmental health, concerns and uncertainties about nuclear power, nuclear power plants, safety.
Environmental health planning, need for planning, the planning process. Environmental health services, various agencies, international efforts, role of industry, voluntary health agencies, Law and human welfare, public health and the law, constitutional right to healthy environment, environmental education Health aspects of water supply and sanitation, disposal of wastewater in rural and urban areas, integrated approach to health and sanitation.
Transmission of diseases through air, water and food. Insect vector and rodent control. Excreta treatment and management in rural and urban slums, low cost options. Software related to environmental health and hygiene.

Course Outcomes

CO1: Critically evaluate different advanced exposure assessment methods
CO2: Design strategies for exposure assessment
CO3: Analyze and interpret exposure measurements applying different modelling tools (stochastic and deterministic).

Books and References

1. Environmental Health Engineering in the Tropics by Cairncross S, Feachem R.,John Wiley & Sons.
2. Environmental Health by Morgan M T, Wadsworth Publishing Co.

Course Name : Earth and Environment
Couse Code : EN – 743
Course Type : Programme Elective III

Contact Hours/Week: 4L **Course Credits:** 04

Course Objective

- To understand the significance and principle behind basic biogeochemical cycles on earth.
- To know about the earth, major environmental concerns such as climate change, floods, risk associated with Dams and large reservoirs and their impact on environment.

Course Content

Understanding the earth, Atmosphere and processes governing environmental conditions, Biosphere, Earth's energy budget, Atmosphere, Climate and climate change, The geologic, Tectonic, Hydrological and biogeochemical cycles. Study and significance of natural resources, Renewable biological resources, Wildlife conservation/ management, Fisheries, Forestry, Energy resources, Energy consumption, Scarcity and conservation. Mineral resources, Mineral availability and recycling, Air, water and soil resources, World food supply, Traditional agriculture, Green revolution, Aquaculture, Modern agriculture, Ecological impacts of modern agriculture, Organic farming. Major environmental concerns, Natural hazards and processes, Environmental impacts, Dams and environment, Channelization and environment, Global climate and hazards. Effect of population increase on environment, Historical perspective of growing environmental concerns, Environmental and social issues, Case studies regarding local national-international environmental problem, Causes of global warming, Water-treaties, International treaties.

Course Outcomes

On successful completion of this course students will have a keen knowledge of:
CO1: Climate and climate change, biogeochemical cycles.
CO2: Green Revolution, organic farming and various water treaties.

Books and References

1. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change by Seinfeld, J.H. and Pandis, S.N., John Wiley Press.
2. Atmospheric Pollution: History, Science and Regulation by Jacobson, M.Z., Cambridge University Press.
3. Fundamental of Atmospheric Modeling by Jacobson, M.Z., Cambridge University Press.
4. Introduction to Environmental Engineering and Science by Masters G.M., PHI.
5. Environmental Engineering by Chaudhari, A.K. & Prakash, O. Dhanpat Rai & Sons.

Course Name :	GIS and its Application in Environmental Engineering
Couse Code :	EN - 744
Course Type :	Programme Elective IV
Contact Hours/Week: 4L	**Course Credits:** 04

Course Objectives

- Provide comprehensive instruction in the underlying concepts and principles of geographic information system (GIS) technology and its application to the design and analysis of civil and environmental engineering systems.

Course Content

Essential components of GIS, geographic grid, map projection, coordinate systems. Vector data and its representation, topological and non-topological vector data, TIN, vector analysis. Acquiring and handling of raster data, GIS data analysis. GIS packages and their salient features,
Advantage and disadvantage of GIS application. Selection of software and hardware, Need analysis. Remote sensing Application. GPS application, DEM Application, Mapping, Water and sewer model.

Course Outcomes

CO1: Analyze the basic components of GIS.
CO2: Classify the maps, coordinate systems and projections.
CO3: Process spatial and attribute data and prepare thematic maps.

Books and References

1. Concept and Techniques of Geographical Information systems by C.P. Lo, Prentice Hall.
2. Introduction to Geographical Information Systems by Kang-tsung Chang, McGraw-Hill.
3. Geographical Information systems, A Management Perspective by Stan Aromoff, WDL Publications.
4. GIS Applications for water, wastewater, and stormwater systems by U.M. Shamsi, CRC Press.

Course Name : Statistical Methods and Modelling
Couse Code : EN - 745
Course Type : Programme Elective IV

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

The objective of this course is to provide an understanding for the graduate business student on statistical concepts to include measurements of location and dispersion, probability, probability distributions, sampling, estimation, hypothesis testing, regression, and correlation analysis, multiple regression and business/economic forecasting.

Course Content

Introduction Measures of Central tendency, dispersion, skewness and kurtosis - Principle of least squares - Correlation and regression - rank correlation.

Sampling Distributions and Estimation

Sampling distributions - Point and interval estimates for population proportions, mean and variance – Maximum likelihood estimate method - Method of moments.

Testing of Hypothesis

Sampling distributions - Tests based on Normal, t, Chi-square and F distributions

Analysis of variance – one-way and two-way classifications.

Mathematical modelling and simulation, Defining systems and its components, Types of models and their applications.

Introduction to Soft Computing Techniques Fuzzy set theory and logic, Fuzzy MCDM and FRBS, simple applications in environmental engineering. Neural networks and Genetic Algorithsms **Models for Fate and Transport of Contaminants** Modelling of volatilization, chemical transformations, sorption/desorption, photochemical transformations, biological transformations. Brief review of mass, momentum and energy balance, advection, molecular diffusion, dispersion, their application in modelling of rivers, lakes, sediments, wetlands, subsurface flow and transport, air pollution modelling.

Course Outcomes

CO1: How to calculate and apply measures of location and measures of dispersion—grouped and ungrouped data cases.

CO2: How to apply discrete and continuous probability distributions to various business problems.

CO3: Perform Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases. Understand the concept of p-values.

Books and References

1. Statistics for Experimenters by Box G E P, Hunter J S and Hunter W G, John Wiley and Sons.
2. Statistics for Environmental Engineers by Berthouex P M and Brown L C., CRC Press.
3. Probability and Statistics for Engineers by Freund, J.E. and Miller, I.R., Prentice–Hall of India, New Delhi.
4. Integrated Environmental Modeling - Pollutant Transport by Fate, and Risk in the Environment, Ramaswami, A, Milford, J B, Small, M. J., John Wiley & Sons.
5. Principles of Geographical Information Systems by Burrough, P.A. and McDonnell, R.A., Oxford University Press.
6. Dynamics of environmental bioprocesses, modelling and simulation by Snape, J.B., Dunn, I.J. Ingham J and Prenosil J, Weinheim, VCH.
7. Surface Water Quality Modeling by Chapra S C, McGraw-Hil, Inc., New York.

Course Name : Disaster Management
Couse Code : EN - 746
Course Type : Programme Elective IV

Contact Hours/Week: 4L **Course Credits:** 04

Course Objectives

1. To provide students an exposure to disasters, their significance, types & Comprehensive understanding on the concurrence of Disasters and its management.
2. To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention, risk reduction and the basic understanding of the research methodology for risk reduction measures.
3. Equipped with knowledge, concepts, and principles, skills pertaining to Planning, Organizing, Decision- making and Problem solving methods for Disaster Management.

Course Content

Natural Hazards and Disasters, Concept of environmental hazards, Environmental stress & Environmental disasters, Types of environmental hazards and disasters, Natural hazard and disasters, Volcanic hazards/ disasters: Causes and distribution of Volcanoes, Hazardous effects of volcanic eruptions, Environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, Causes of earthquakes, Distribution of earthquakes- Hazardous effects of earthquakes, Earthquake hazards in India, Human adjustment, Perception & mitigation of earthquake. Man induced hazards & disasters, Mechanics & forms of Soil Erosion, Factors & causes of soil erosion, Conservation measures of soil erosion, Chemical hazards/ disasters, Release of toxic chemicals, Nuclear explosion, Sedimentation processes, Global sedimentation problems, Regional sedimentation problems, Sedimentation & environmental problems, Corrective measures of erosion & sedimentation, Biological hazards/ disasters, Population Explosion. Emerging approaches in Disaster Management, Pre-disaster stage (preparedness), Pre-disaster stage (mitigation), Emergency Stage, Post Disaster stage-Rehabilitation. Remedy to Disasters, Role of panchayats in disaster mitigations, Environmental policies & programs in India: Institutional & National, Centres for natural disaster reduction.

Course Outcomes

CO1: Develop perspective understanding and its Management in pre, during and post phases of disasters.
CO2: Equipped with potential knowledge, concepts & skills for effective Planning on Disaster management and Risk Reduction measures.
CO3: Application of the concepts in real life scenario.

Books and References

1. Disaster Science and Management by Bhattacharya,T., Mc-Graw Hill.
2. Understanding Earthquake Disasters by Sinvhal, A., Mc-Graw Hill.
3. Environmental Geography by Singh, S., Prayag Pustak Bhawan.
4. The Environment as Hazard by Burton, I., Kates, R.W. & White, G.F., Oxford University Press.
5. Disaster Management by Singh, R.B., Rawat Publications.
6. Disaster Management by Gupta, H.K., University Press.