Master of Technology

In

Civil Engineering (Environment)

Course Structure & Syllabus

Department of Civil Engineering

National Institute of Technology Hamirpur

Hamirpur (HP) – 177005, India

SEMESTER-I

S No.	Course No.	Course Name	L	P	Hours/ Week	Credit
1	CE-691	Environmental Impact Assessment	4	0	4	4
2	CE-692	Air Pollution and Control	4	0	4	4
3	CE-693	Water Supply and Sewerage Systems	4	0	4	4
4	CE-694	Environmental Engineering Lab - I	0	4	4	2
5	CE-7MN	Program Elective-I	4	0	4	4
6	CE-7MN	Program Elective-II	4	0	4	4
	Total		**20**	**4**	**24**	**22**

Program Elective-I & II: Any course listed in Annexure-I (List of Electives)

SEMESTER-II

S No.	Course No.	Course Name	L	P	Hours/ Week	Credit
1	CE-601	Solid & Hazardous Waste Management	4	0	4	4
2	CE-602	Water and Wastewater Treatment	4	0	4	4
3	CE-603	Environmental Disaster and Management	4	0	4	4
4	CE-604	Environmental Engineering Lab - II	0	4	4	2
5	CE-7MN	Program Elective-III	4	0	4	4
6	CE-70N	Institute Elective	4	0	4	4
	Total		**20**	**4**	**24**	**22**

Program Elective–III: Any course listed in Annexure-I (List of Electives)

SEMESTER-III

S No.	Course No.	Course Name	Hours/week	Credit
1	CE-798	M Tech Dissertation	--	18
	Total			**18**

SEMESTER-IV

S No.	Course No.	Course Name	Hours/week	Credit
1	CE-799	M Tech Dissertation	--	18
	Total		**--**	**18**

Total Credits of the Program: 80

Annexure I: List of Program Elective Courses

	Course No	Course Title
Program Electives	CE-766	Bioremediation – Principles and Applications
	CE-767	Advanced Water and Wastewater Treatment Plants
	CE-768	Environmental Toxicology and Health
	CE-769	Advanced Water Treatment Processes
	CE-770	Remote Sensing and GIS
	CE-759	Environmental Hydrology
	CE-771	Microbiology and Ecology
	CE-761	River Engineering
	CE-711	Geo-environmental Engineering
	CE-772	Hazardous Waste and Remediation of Contaminated Sites
	CE-773	Transportation Environment Interaction
	CE-774	Industrial Waste Management
	CE-775	Introduction to Climate Change
	CE-776	Environmental Management

Annexure II: List of Institute Elective Courses

	Course No	Course Title
Institute Electives	CE-701	Project Management
	CE-702	Disaster Management
	CE-703	Environmental Impact Assessment
	CE-704	Remote Sensing & GIS
	CE-705	Engineering Seismology

Course Name : **Environmental Impact Assessment**
Course Code : **CE-691**
Course Type : **Core**

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

Course Objectives

- To understand the concepts of ecology, sustainable development and EIA.
- To explore current EIA process in India.
- To acquire knowledge about various methods for conducting EIA, Environmental Legislation & Environmental Audit

Course Content

Environmental management- problems and strategies - Review of political, ecological and remedial actions - future strategies - multidisciplinary environmental strategies decision making and concepts of sustainable development. Concept of environmental audit - Life Cycle Analysis (LCA) - Environmental Management System - Introduction to ISO 14000, OSHA and Clean Development Mechanism (CDM) & Carbon credits. Introduction to various major natural disasters - flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami etc., Factors for disaster - climate change, global rise in sea level, coastal erosion, environmental degradation, large dams, Legislative responsibilities of disaster management. Environmental legislation of Air, Water & Hazardous Waste - Environment Protection Act-1986 - Regulatory standards of CPCB / GPCB / BIS - EIA need and Notification - Environmental clearance. Introduction and Planning: Evolution of Environmental Impact Assessment - concepts of EIA - EIA methodologies screening and scoping - rapid and comprehensive EIA - General framework of EIA - characterization and site assessment - Environmental inventory - Prediction and assessment of impact - Impact assessment methodologies like adhoc method, checklist, overlap, network, model and index method. Decision methods of evaluation of alternatives - development of decision matrix - Public participation in environmental decision making - Objective of public participation -Technique for conflict management and dispute resolution- Verbal communication and Public Hearing in EIA studies - Status of EIA in India - Some typical case studies of EIA industrial and infrastructure projects.

Course Outcomes

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

CO 1: Understand the importance & concepts of carrying out EIA.

CO 2: Acquire knowledge about the current EIA process in India.

CO 3: Acquire knowledge about various methods & data requirements for conducting EIA.

CO 4: Analyze the Impact associated with various components of the environment.

CO 5: Plan for mitigation of the impacts & monitor the mitigation measures.

CO 6: Acquire knowledge about Environmental Legislation & Environmental Audit.

Books and References

1. Larry W. Canter, "Environmental Impact Assessment", Tata Mcgraw Hill Co, Singapore, 1996.
2. R. K. Jain, L. V. Urban & G. S. Stacey, “Environmental Impact Analysis”, Van Nostrand Reinhold Company, New York. (1977)
3. R. E. Munn, “Environmental Impact Assessment”, John Wiley & Sons, Toronto, 1979.
4. Suresh K. Dhameja, “Environmental Engineering and Management”, S. K. Kataria & Sons, Delhi. (2004)
5. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules.

Course Name : **Air Pollution and Control**
Course Code : **CE-692**
Course Type : **Core**

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

Course Objectives

- To make the students aware of the history of air pollution, the definition of air pollution, and various types of sources and classifications 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. Odor 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
CO3: Ability to propose air pollution control measures

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 : **Water Supply and Sewerage Systems**
Course Code : **CE-693**
Course Type : **Core**

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

Course Objectives

- Impart knowledge in proper planning, analysis and design of water distribution systems.
- Study of different methods of analysis to know the spatial and temporal variation in water quality.
- Sanitary technology and engineering of wastewater facilities including hydraulics and hydrology applicable to sanitary studies.

Course Content

Water Supply Systems – surface water, groundwater, regional rural, and purchased water supply systems; water quantity and pressure requirements; municipal fire protection requirements; transmission lines; operation of waterworks; water distribution networks; water and energy conservation; *Hydraulic Principles and Head Losses in Pipes* – continuity and energy principles; Darcy-Weisbach formula; friction coefficient relationships; empirical formulae; minor head losses in pipes; equivalent pipes; pumps and valves; *Network Parameters and Types of Analysis* – configuration; pipe lengths and diameters; hydraulic gradient levels at demand and source nodes; formulation of equations; Hardy Cross, Newton-Raphson, Linear Theory, Gradient, and other methods; *Wastewater Flowrates and Constituent Loadings* – domestic wastewater sources and flowrates; variations in wastewater flowrates; impacts of collection system on wastewater flowrates; infiltration/inflow; statistical analysis of wastewater flowrate data; variations in constituent concentrations, statistical analysis of constituent; *Sewerage Systems* – system layout; sanitary and storm sewer systems; sewer pipe and jointing; hydraulic design; loads on buried pipes; sewer testing; sewer maintenance and cleaning; protection against floodwaters; wastewater pumping stations.
Energy Considerations in Wastewater Management – energy in wastewater; energy usage in wastewater treatment plants; energy audits and benchmarking; recovery and utilization of chemical, thermal, and hydraulic potential energy energy; energy management.

Course Outcomes

Upon successful completion of the course, the students will be able to:
CO1: Ensure the availability of water at different localities under several demand patterns.
CO2: Solve complex distribution/ sewer networks with the help of sophisticated computer softwares.
CO3: Clearly understand the interrelationships between individual unit operation and integrated systems as a whole.

Books and References

1. P. R. Bhave and R. Gupta.2006. Analysis of water Distribution Networks. Narosa Publishing House Pvt Ltd New Delhi.
2. Mark J. Hammer and Mark J. Hammer, Jr.2004. Water and Wastewater Technology, 5e. Prentice-Hall, Inc. New Jersey 07458 USA.
3. Metcalf & Eddy/ Aecom.2014. Wastewater Engineering – Treatment and Resource Recovery (Vol 1 and 2), 5e (McGraw-Hill International Edition). McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121.
4. Warren Viessman, Jr. and Mark J. Hammer.2005. Water Supply and Pollution Control, 7e. Pearson Education (Singapore) Pte Ltd, Indian Branch, 482 FIE Patpargang, Delhi 110092 India.
5. CPHEEO.2024. Manual on Water Supply and Treatment Systems. Central Public Health and Environmental Engineering Organization, Ministry of Housing and Urban Affairs, GoI.
6. CPHEEO.2013. Manual on Sewerage and Sewage Treatment Systems. Central Public Health and Environmental Engineering Organization, Ministry of Housing and Urban Affairs, GoI

Course Name : **Environmental Engineering Laboratory-I**
Course Code : **CE-694**

Contact Hours/Week: 4 **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 : **Solid and Hazardous Waste Management**
Course Code : **CE-601**
Course Type : **Core**

Contact Hours/Week: 4 **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 the environmental and health impacts of 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-2016 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 : **Water and Wastewater Treatment**
Course Code : **CE-602**
Course Type : **Core**

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

Course Objectives

- To apply mathematics, physics, chemistry, and microbiology knowledge to solve and analyze engineering problems related to water and wastewater collection, transport, quality and 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.
- 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

Types of Sedimentation and coagulation, settling tests, scale-up, Batch flow and continuous flow operations. Coagulation, mechanisms of coagulation, the effect of turbidity and alkalinity, the 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 water treatment operations: Adsorption, isotherms, reverses osmosis, electro-dialysis, ultrafiltration, etc. Applications of Unit Operations in Water Treatment and Design of Physical Facilities; 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: Depth knowledge of physical-chemical unit processes.
CO2: The candidate should be able to use skills to perform research at a higher level.
CO3: Select or construct appropriate treatment schemes to remove certain pollutants present in water or wastewater.
CO4: Balance chemical reactions and use balanced reactions to determine the distribution of species at equilibrium
CO5: Learn how to characterize wastewater and the best available technology (BAT) for physical, chemical and microbiological wastewater treatment.

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. Biological Process Design for Wastewater Treatment by Benefield L D, and Randall, C W., Prentice Hall
5. Ministry of Urban Development, Govt of India – Manual for Water and Wastewater Treatment.

Course Name : **Environmental Disaster and Management**
Course Code : **CE-603**
Course Type : **Core**

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

Course Objectives

- To impart knowledge about the disaster Management
- To introduce the fundamental concepts relevant to various aspect of disaster
- To enable the students to understand the factors that causes the disaster.
- To be able to assess risk and vulnerability for natural and man-made hazard

Course Content

Introduction to Natural & Man-made Disasters, Understanding Disasters, Geological and Mountain Area Disasters, Wind and Water Related Natural Disaster, Man Made Disasters, Technologies for Disaster Management role of information technology in Disaster Preparedness, Remote Sensing, GIS and GPS, Use and Application of Emerging Technologies, Application of Modern Technologies for the Emergency communication, Application and use of ICST for different disasters. Rehabilitation, Reconstruction and Recovery: Introduction and basic concept. Disaster Response and Management: Introduction to Response Essential Components, Stakeholders Co-ordination in Disaster Response, Human Behaviour and Response Management and Relief Measures. Disaster Mitigation: meaning and concept, Disaster Mitigation Strategies, Emerging Trends in Disaster Mitigation, Mitigation management, Role of Team and Coordination.

Course Outcomes

After learning the course, the students should be able to:
CO1: Understand disasters, disaster preparedness, role of IT, remote sensing, GIS and GPS,
CO2: Understand Rehabilitation, Reconstruction and Recovery,
CO3: Apply knowledge Disaster Response and Management, Risk Assessment and Vulnerability Analysis,
CO4: Understand Disaster Mitigation

Books and References

1. Natural Hazards, Bryant Edwards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4. Roy, P.S. (2000): Space Technology for Disaster management: A Remote Sensing & GIS Perspective, IIRS (NRSA) Dehradun.
5. Sharma, R.K. & Sharma, G. (2005) (ed) Natural Disaster, APH Publishing Corporation, New Delhi.
6. Singh Satendra (2003): Disaster Management in the Hills, Concept Publishing Company, New Delhi.
7. Taori, K (2005) Disaster Management through Panchayati Raj, Concept Publishing Company, New Delhi.

Course Name : **Environmental Engineering Laboratory-II**
Course Code : **CE-604**

Contact Hours/Week: 4 **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 : **Bioremediation-Principles and Applications**
Couse Code : **CE-766**
Course Type : **Programme Elective**

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

Course Objectives

- To introduce the underlying biogeochemical concepts pertinent to remediation of soil and groundwater,
- To 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,
CO3. 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 : **Advanced Water and Wastewater Treatment Plants**
Course Code : **CE-767**
Course Type : **Programme Elective**

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

Course Objectives

- To provide detailed information on wastewater treatment plants.
- Designing of components for environmental waste treatment plants

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, Inhoff 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

Upon successful completion of the course, the students will be able to
CO1: Understanding of waste water characteristics
CO2: Depth knowledge of designing of components of treatment plant.
CO3: Candidate should be able to calculate the design methods.

Books and References

1. Ministry of Urban development, Govt of India – Manual for Sewage Treatment.
2. Qasim S R, Motley E M and Zhu G. Water Works Engineering, Prentice-Hall India, 2006.
3. Montgomery – Water Treatment Principles and Design, John Wiley and Sons.
4. Metcalf and Eddy Inc – Wastewater Engineering: Treatment, and Reuse, 4th edition, Tata McGraw Hill, 2007.

Course Name : **Environmental Toxicology and Health**
Couse Code : **CE - 768**
Course Type : **Programme Elective**

Contact Hours/Week: 4 **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: Analyse 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 : **Advanced Water Treatment Processes**
Course Code : **CE-769**
Course Type : **Programme Elective**

Contact Hours/Week: 4 **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.
- To understand an appropriate treatment process for a specific application and be able to identify appropriate pre-treatment and post treatment operation and processes.

Course Content

Principles and design of aeration systems – two film theory, water in air system, air in water system. Principles of sedimentation: Types of settling and settling equations, design criteria and design of settling tanks; *Filtration* - Theory, types, hydraulics of filter bed, design criteria and design of filters, filter backwash, operational problems and trouble-shooting; *Disinfection* - different types, disinfectants, factors affecting disinfection, methods of disinfection, and chemistry of chlorination; *Water Softening* - Ions causing hardness, Langelier index, various methods. Fluoridation and de-fluoridation: Principles and design; *Adsorption Process* - Types, factors affecting adsorption, kinetics and equilibrium – different isotherm equations and their applications; *Advanced water treatment* - Ion exchange, electro-dialysis, Reverse Osmosis, Ultra filtration.

Course Outcomes

Upon successful completion of the course, the students will be able to:
CO1: To Understand the principles and operation of water treatment systems.
CO2: Appraise the suitability of the design of treatment plants and unit processes
CO3: To Evaluate process operations and performance
CO4: To Understand coagulation, flocculation, and sedimentation, filtration, and disinfection processes.

Books and References

1. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), "Environmental Engineering", McGraw Hill
2. Raju, B.S.N., (1995), "Water Supply and Wastewater Engineering", Tata McGraw Hill Pvt. Co. Ltd., New Delhi.
3. Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control"
4. AWWA, (1971), "Water Quality and Treatment "McGraw Hill.
5. CPHEEO Manual, (1991), "Water Supply and Treatment", GOI Publications.
6. APHA, (2002), "Standard Methods for Examination of Water and Wastewater"; 21st Edition.

Course Name : **Remote Sensing and GIS**
Course Code : **CE-770**
Course Type : **Programme Elective**

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

Course Objectives

- Understanding the need of CAD and GIS,
- Understanding map projection and working with coordinate systems,
- Understanding vector-based and raster-based data data analysis,
- Review of application areas of GIS in Civil Engineering, and
- Understanding basic principles of remote sensing.

Course Content

Introduction to Remote Sensing, data acquisition and processing, Electromagnetic Radiation (EMR) and its characteristics, Radiation principles, properties of solar radiant energy, atmospheric windows. Interaction in the atmosphere, nature of atmospheric interaction, atmospheric effects of visible, near infra-red thermal and microwave wavelengths, interaction at ground surface, interaction with soils and rocks, effects of soil moisture, organic matter, particles, size and texture, interaction with vegetation, spectral characteristics of individual leaf, vegetation canopies, effect of leaf pigments, radiation geometry. Introduction to GeographicalInformation Systems, Definition of GIS, Difference between GIS and CAD worlds, utility of GIS, various GIS packages and their salient features, essential components of a GIS, scanners and digitizers. Map projection and coordinate systems: Introduction, geographic Grid, Map projection, Coordinate systems. Vector data models and Analysis: vector data and its representation, topological data structure, non- topological vector data structure, TIN, Region, vector data editing and analysis. Raster data models and Analysis: acquiring and handling of raster data storage, function of raster based GIS data analysis. Engineering applications of GIS: applications of GIS in civil engineering.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Understand the principles of remote sensing,
CO2: Understand the principles of geographic information systems,
CO3: Apply remote sensing and GIS to solving problems of Civil Engineering,
CO4: Maximize the efficiency of planning and spatial decision making, and
CO5: Integrate geographically referenced data and develop queries to generate usable information.

Books and References

1. Remote Sensing and Image Interpretation : T.M. Lillensand and R.W. Keifer
2. Principles of Remote Sensing : P.J. Curren
3. Concept and Techniques of Geographical Information systems : C.P. Lo and Albert K.W.Yeung
4. Introduction to Geographical Information systems : Kang-tsung Chang
5. Geographical Information systems- A Management Perspective : Stan Aromoff

Course Name : **Environmental Hydrology**
Course Code : **CE-759**
Course Type : **Programme Elective**

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

Course Objectives

- To analyse and calculate the basic flows within the hydrological cycle in terms of the quantities of water and energy that move within various states.
- To integrate hydrological principles and river management objectives to negotiate and formulate water basin management contracts among opposing viewpoints.
- To enable students to describe the basic legal principles and conflict resolution alternatives that is relevant to river basin management.

Course Content

Basic concepts of environmental hydrology; water cycle, water balance and hydrological processes; environment and water; hydrology and climate, physical and biological interactions; water-related environmental problems; hydrological characteristics of India; drinking water, drinking water regulation and standards, water testing; forest hydrology, hydrological processes in forested area; urban hydrology, urbanization and hydrological processes, runoff process and flood; storm water storage and infiltration, reconstruction of urban water cycle; domestic, industrial, commercial, agriculture, and public water uses; water rights and development; water pollution and water quality policy, point and non-point source pollution and control, self-purification; sewage treatment; groundwater pollution, background and measurements of groundwater contamination, sources and fate of contaminants, organic solvents, phosphate and nitrate, remediation

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Effectively communicate hydrologic concepts and research.
CO2: Collect and analyze hydrologic data.
CO3: Understand a basic hydrologic or water resources research project that involves integrated problem solving.

Books and References

1. Environmental Hydrology by Ward A.D. and S.W. Trimble, Lewis Publishers, CRC Press.
2. Hydrology: An Environmental Approach by Watson and Burnett, CRC Press.
3. Soil and Water Management Systems by Schwab G. O, Delmar D. Fangmeier, Elliot, William J., John Wiley & Sons

Course Name : **Microbiology and Ecology**
Course Code : **CE-771**
Course Type : **Program Elective**

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 : **River Engineering**
Course Code : **CE-761**
Course Type : **Programme Elective**

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

Course Objectives

- To enable students to apply fundamental concepts and techniques of hydraulics and hydrology in the analysis, design, and operation of water resources systems.
- To understand the mechanism of transport of various matters in rivers, and acquire the skills for evaluating the amounts of sediment transport and river bed evolution, and applying each element technology to practical problems.

Course Content

Introduction to river engineering, River classifications, thresholds in river morphology, hydraulic geometry, meander plan form, geomorphic analysis of river channel responses; Fundamentals of alluvial channel flows, uniform and unsteady cases, shear stress distribution, flow resistance in rivers; Physical properties of sediments, sediment movement in rivers, shear stress, Shields diagram, scouring around bridge piers and embankments, river bed forms; Analysis of river meanders, design of stable alluvial channels-regime concept, dimensional model studies for rivers, braided rivers, scaling and hierarchy in braided rivers, alternate bars, bed load transport in braided gravel-bed rivers; Stream bank erosion, bank protection, flow control structures, bank protection and river training along braided rivers

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Identify and justify appropriate engineering solutions.
CO2: Make observations of and investigate hypotheses about river processes and the impacts of river engineering alternatives.
CO3: Familiarize regional and global river systems and management

Books and References

1. Fluvial Processes in River Engineering by Chang, H. H., John Wiley.
2. Fundamentals of Fluvial Geomorphology by Charlton, R., Taylor and Francis.
3. Braided Rivers: Process, Deposits, Ecology and Management by Gregory H., Blackwell Publishing.
4. Sediment Transport-Theory and Practice by Yang, C. T., McGraw Hill Companies, Inc., New Delhi.
5. Fluvial Forms and Processes by Knighton, D., Edward Arnold, Baltimore, MD.
6. Rivers Form and Process in Alluvial Channels by Richards, K., Methuen, NY.
7. River Mechanics, Vol. I and II by Shen, H.W., Water Resources Publication, Fort Collins, CO.
8. Applied fluvial geomorphology for river engineering management by Thorne, C R, Hey, R. D. and Newson, M.D. John Wiley & Sons

Course Name : **Geo-Environmental Engineering**
Course Code : **CE-711**
Course Type : **Program Elective**

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

Course Objectives:

1. Familiarize with the geo-environmental issues at global, regional, and local levels
2. Landfill design and considerations
3. Geosynthetics and natural geotextiles and their role in geo-environmental engineering
4. Understand the usage of different industrial waste products

Course Content

Introduction: Introduction to Geo environmental engineering, environmental cycle, sources, production and classification of waste, causes of soil pollution, factors governing soil-pollutant interaction, Safe disposal of waste. Contaminant Transport: Contaminant transport in sub surface, advection, diffusion, dispersion, governing equations, contaminant transformation, sorption, biodegradation and ion exchange. Landfill design and Considerations: Precipitation, hydrological consideration in land fill design, site selection for landfills, characterization of land fill sites, waste characterization, stability of landfills, current practice of waste disposal, different components of landfill, landfill closure and post closure plan. Geosynthetics in Geo-environmental Engineering: Application of geo synthetics in solid waste management, rigid or flexible liners, bearing capacity of compacted fills, foundation for waste fill ground. Utilization of Industrial Wastes: Geotechnical properties of different industrial wastes, problems in utilization, present status and future need for bulk utilization of different industrial wastes, case studies.

Course Outcomes:

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

CO1: Learn the design of landfills

CO2: Understand the usage of different industrial wastes.

CO3: Handle the geo-environmental problem in actual practice.

Books and References:

1. Waste disposal in engineered landfills by Manoj Dutta, Narosa Publishing House.
2. Geoenvironmental Engineering by Abdel M.O. Mohamed and Hogan E. Antia, Elsevier.
3. Solid Waste Management: Principles and Practice by Ramesha Chandrappa & Diganta Bhusan Das, Springer.
1. 4. Geotechnical Engineering - C. Venkatramaiah.

Course Name : **Hazardous Waste and Remediation of Contaminated Sites**
Course Code : **CE-772**
Course Type : **Programme Elective**

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

Course Objectives

1. Understand the hazardous waste issues at global, regional, and local levels
2. Familiarize with the current environmental problems
3. Identify the Sources of hazardous wastes
4. Learn contaminated sites remediation techniques

Course Content

Hazardous Waste: Hazardous waste control and storage system, stabilization/ solidification of hazardous wastes, mechanism of stabilization – organic and inorganic stabilization – utilization of solid waste for soil improvement. Encapsulation: Micro and macro encapsulation, absorption, adsorption, precipitation and detoxification. Remediation of contaminated sites: Rational approach to evaluate and remediate contaminated sites, monitored natural attenuation, exsitu and insitu remediation, solidification, bio–remediation, incineration, soil washing, electro kinetics, soil heating, verification and bio venting. Ground water remediation: – Ground water remediation, pump and treat, air sparging and reactive well.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Learn the sources of hazardous waste
CO2: Remediation techniques of contaminated sites and ground water.
CO3: Understand the hazardous waste issues at global, regional, and local levels

Books and References

1. Brezonik, Chemical Kinetics & Process Dynamics in Aquatic Systems,1994.
2. Fetter, Charles W. Jr., Contaminant Hydrogeology, Macmillan Publishing Co., 1993.
3. LaGrega, Michael, Hazardous Waste Management, McGraw-Hill Co., 1994.
4. Solid Waste Management, Engineering Principles and Management Issues, McGraw-Hill, Inc., 1993.
5. Handbook of Chemistry and Physics, CRC Press, any of the past fifteen years

Course Name : **Transportation Environment Interaction**
Course Code : **CE-773**
Course Type : **Programme Elective**

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

Course Objectives

- To impart the knowledge of how transportation facilities affecting the environment
- To make the students understand the noise sources and its mitigation for urban and non-urban transportation
- To make the students understand different vehicle emission parameters, pollution standards and its mitigation strategies

Course Content

Transportation Safety: Pre-crash, Crash and Post-crash models; Roles of vehicle, roadway, traffic, driver and environment; Crash and injury causations Modes of Transportation, Mixed Traffic Flow, Transport Related Pollution, Technology Vision-2020, Urban and Non-urban Traffic Noise, Noise Sources, Noise Level Factors, Effects of Traffic Noise, Noise Standards. Measurement and Prediction, Control Measures, Noise Studies, Road Transport related air pollution, Sources of air pollution, effects of weather conditions, Vehicular emission parameters, Pollution standards, measurement and analysis of vehicular emission, Mitigative measures, EIA requirements of Highway Projects, procedures, Ministry of Environment and Forests (MOEF)/World Bank/IRC/UK Guidelines, EIA Practices in India.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Map traffic noises
CO2: Model vehicle emission for given conditions
CO3: Design transportation facility ensuring less environmental impact as per standard guidelines

Books and References

1. Road Traffic Noise by Alexandra, A., Lamure, C. and Langdon, F.J., Applied Science Publishers Limited, London.
2. Highway Traffic Analysis and Design by Salter, R.J., Macmillan Press Limited, London.
3. Noise Control Management, Analysis and Control of Sound and Vibration by Wilson, C.E., Harper and Row Publishers, New York.
4. Environmental Factors in Urban Planning by Grand Jean, E., and Gilgen, A., Taylor and Francis Limited, London

Course Name : **Industrial Waste Management**
Couse Code : **CE-774**
Course Type : **Programme Elective**

Contact Hours/Week: 4 **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 : **Introduction to Climate Change**
Couse Code : **CE - 775**
Course Type : **Programme Elective**

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

Course Objectives

- Able to identify causes for climate change and to classify causes based on time-scales
- Gain the historical perspective necessary to assess our recent changes in climate (i.e. global warming over the last 100 years) and the scientific basis to analyze and critique policy issues related to global warming

Course Content

The physical science of climate change Climate System; Causes of Climate Change, Climate data and trends; Analyses of climate data; Global atmospheric composition: Greenhouse gases and aerosols; Extreme weather events, sea level rise; Climate projections and their uncertainties.

Climate impacts, vulnerability and risks Assessing climate impacts on key sectors and systems (heat stress, water resources, coastal zones, agricultural systems); Concepts of vulnerability and risk; Assessing vulnerability and risk; Concepts of coping, adaptation and risk management, adaptive capacity, indicators and metrics; Adaptation planning and management including mainstreaming and climate resilient development.

Climate mitigation and policy Economics of climate change, Least cost carbon strategies; Frameworks for multi-criteria mitigation assessment; Multilateral and national responses; International climate negotiations and geopolitics of response; Policies and measures, including CDM, emissions trading; National policies for climate change (NAPCC, national missions).

Course Outcomes

CO1: Identify the anthropogenic drivers of climate change.
CO2: Explain observed and projected trends and impacts in the climate
CO3: Analyse different climate change scenarios and their implications.

Books and References

1. IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. 2.
2. Atmospheric Science: An Introductory Survey, John. M. Wallace & Peter V. Hobbs, Academic Press 2006, pp1-60. 3.
3. IPCC, 2007: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.
4. Climate Change: From Science to Sustainability by Stephen Peake and Joe Smith, Oxford, 2nd ed., 2009
5. IPCC, 2011: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1075 pp.

Course Name : **Environmental Management**
Couse Code : **CE - 776**
Course Type : **Programme Elective**

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

Course Objectives

- Understand environmental management approaches
- Understand deliberate efforts to translate environmental knowledge into action in order to achieve particular outcomes in the way landscapes, societies and/or natural ecosystems are used and managed.
- Gain the historical perspective necessary to assess our recent changes in climate (i.e. global warming over the last 100 years) and the scientific basis to analyze and critique policy issues related to global warming

Course Content

Concept of Sustainable Development and Clean Development Mechanisms (CDMs); Overview of Environmental Laws and International Treaties; Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for Industries and other Developmental Projects; Life Cycle Assessment of Products, Processes and Services; Concepts of Environmental Justice and Environmental Ethics; Environmental Movements; Environmental Activism

Course Outcomes

CO1: Analyse environmental management in relation to the principles of sustainable development.
CO2: Translate generic concepts and methods into critical reviews of contemporary, real-world environmental management practices
CO3: Scientific basis to analyze and critique policy issues related to global warming

Books and References

1. Ramchandran T.V.; Vijay Kulkarni; Environmental Management, TERI, 2009.
2. Rosencranz, A., Divan, S. and Noble, M.L., Environmental Law and Policy in India : Cases, Materials and Statutes, Tripathi Pvt. Ltd, Bombay,
3. Welford, R., Corporate Environmental Management, Earthscan Publications Limited, London.