M.Tech. Degree

PROGRAMME

in

ENVIRONMENTAL ENGINEERING

CURRICULUM

(w. e. f. Session 2019-2020)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA - 136119

Vision and Mission of the Institution

Vision: To be a role-model in technical education and research, responsive to global challenges.

Mission: To impart technical education that develops innovative professionals and entrepreneurs and to undertake research that generates cutting-edge technologies and futuristic knowledge, focusing on the socio-economic needs.

Vision and Mission of the Department

Vision: To be a role model in Civil Engineering Education and Research responsive to global challenges.

Mission: The Department aims to realize the vision through the following:

1. To impart quality Civil Engineering Education that develops innovative professional & entrepreneurs.
2. To undertake research that generates cutting-edge technologies & futuristic knowledge, focusing on the socio-economic needs.
3. To prepare professionals with emphasis on leadership, team work and ethical conduct.

Vision and Mission of the PG Programme

Vision: To be an excellent programme of Environmental Education and research for protecting the environment and achieving goals of sustainable development.

Mission: To impart requisite knowledge, technical expertise and managerial capabilities and undertake research for handling complex and diverse environmental problems and providing sustainable solutions based on socio-economic needs of community.

Programme Educational Objectives (PEOs)

1. Graduates of the programme will actively engage and lead in solving complex and diverse environmental problems with spirit of team work and ethical conduct for environmental protection and sustainable development of society.

2. Graduates of the programme will be able to succeed in positions in Environmental Engineering practice or research or entrepreneurship and demonstrate their expertise in the field of Environmental Engineering.
3. Graduates of the programme will continue lifelong learning of ever changing technologies for field applications with commitment to service to the Environmental Engineering profession and society.

Program Outcomes

Graduates of the Environmental Engineering Programme will be able to:

PO1: Independently carry out research/investigation and development work to solve practical problems of environmental engineering.

PO2: Write and present a substantial technical report/document while handling environmental engineering projects.

PO3: Acquire in-depth knowledge of environmental engineering with global perspective to plan, design and operate water supply, sewerage, water and waste treatment, solid waste management, industrial and hazardous waste management, bioremediation and pollution control systems for environmental protection and sustainable development of society.

PO4: Use modern tools, resources and techniques to assess environmental pollution, predict fate of contaminants, assess environment risks as well as impacts and prepare environmental management plans.

Scheme of M. Tech (Civil) (Environmental Engineering) (w. e. f. Session 2019-20)

Sr. No.	Code	Course Title	Teaching Schedule				Credits
			L	T	P	Total	
Semester - I							
1	MCE5C01	Environmental Chemistry and Microbiology	3	-	-	3	3
2	MCE5C03	Design of Water Treatment Processes	3	-	-	3	3
3	MCE5C05	Design of Water Supply and Sewerage Systems	3	-	-	3	3
4		Elective-I*	3	-	-	3	3
5		Elective-II**	3	-	-	3	3
6	MCE5L07	Environmental Chemistry and Microbiology Lab	-	-	4	4	2
7	MCE5S09	Seminar-I	-	-	2	2	1
Total			15	-	6	21	18
Semester - II							
1	MCE5C02	Air and Noise Pollution and Control	3	-	-	3	3
2	MCE5C04	Design of Wastewater Treatment Processes	3	-	-	3	3
3	MCE5C06	Solid Waste Management	3	-	-	3	3
4		Elective-III*	3	-	-	3	3
5		Elective-IV***	3	-	-	3	3
6	MCE5L08	Environmental Pollution Monitoring Lab	-	-	4	4	2
7	MCE5S10	Seminar-II	-	-	2	2	1
Total			15	-	6	21	18
1	-	Summer Academic Activity Preparatory Work for Dissertation	-	-	-	-	-
Semester - III							
1	MCE5D/P/I-11	Dissertation/ Project Work/ Internship (Part –I)	-	-	28	28	14
Semester - IV							
1	MCE5-D/P/I-12	Dissertation/ Project Work/ Internship (Part –II)	-	-	28	28	14
Grand Total							64

*Electives can be opted from the list of electives of specialization

**Electives can be opted from the list of electives of specialization or core/elective subjects of other specializations of Civil Engineering Department

***Electives can be opted from the list of electives of specialization or core/elective subjects of other specializations of Civil Engineering Department/other departments

List of Electives (Environmental Engineering)

Electives for Odd Semester

MCE5E31	Bioremediation Principles and Applications
MCE5E33	Environmental Ethics and Legislation
MCE5E35	Ground Water Flow and Contaminant Transport through Porous Media
MCE5E37	Life Cycle Analysis and Design for Environment
MCE5E39	Modelling of Natural Systems
MCE5E41	Surface Water Quality Modeling and Control
MCE5E43	Water quality Management
MCE5E45	Water and Wastewater Treatment Processes

Electives for Even Semester

MCE5E32	Advance Wastewater Treatment
MCE5E34	Air Quality Modelling
MCE5E36	Environmental Planning and Management
MCE5E38	Environmental Impact Assessment
MCE5E40	Environmental Risk Assessment
MCE5E42	Hazardous Waste Management
MCE5E44	Indoor Air Quality
MCE5E46	Industrial Waste Management

Open Elective

MCE5O71/72	Noise pollution and control

Syllabus of each Course in Environmental Engineering Programme

MCE5C01	**ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY**	**Core**	**3 – 0 – 0**	**3 Credits**

Internal-50	**End semester-50**	**Total-100**

Course Learning Objectives

1. To study the basic concepts of environmental chemistry and acid base equilibria
2. To use the solubility equilibria approach for the removal of heavy metals from water and wastewater
3. To discuss the application of Redox chemistry in water and wastewater treatment
4. To describe the characteristics and growth kinetics of microbial populations

Course Content

Environmental Chemistry - Chemical Equilibria and kinetics fundamentals – Chemical thermodynamics; Acid Base Equilibria - Equilibrium Diagrams - Alkalinity and Acidity, Carbonic Acid System, Buffer and buffer intensity; Gas Laws; Solubility Equilibria-Removal of Heavy Metals from Complex Water and Wastewater Systems; Oxidation Reduction Equlilibria - Stability Diagrams - Application of Redox Chemistry; Water Stabilization- Langelier Saturation Index - Caldwell Lawrence Diagrams – Water Softening and Neutralization - Chemical Precipitation.

Microbiological concepts – classification and structure of microorganisms– Microbialmetabolism - respiration and energy generation- microbial growth-enzyme kinetics –bio kinetics – control of microbes - Microbiology of water and wastewater treatment – Industrial microbiology – economic importance.

Books:

1. Sawyer C.N, McCarty P.L. and Parkin G.F: Chemistry for Environmental Engineering and Science, McGraw Hill Inc., 2003.
2. Benfield L.D., Weand B.L., Judkins, J.F.: Process chemistry for water and wastewater, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1982.
3. Weber Jr. W.J.: Physico-chemical Process for Water Quality Control, Wiley Inc. New York, 1972.
4. Pelczar M. J., Chan E.C.S. and Krieg N. R.: Microbiology, 5th Edition, Tata McGraw Hill, N. Delhi, 1993.

5. Tortora. G. J., B. R. Furke, and C. L. Case, Microbiology- An introduction (11th Ed.),Benjammin /Cummings publ. Co. ,Inc., California, 2013.

Course Outcomes

At the end of the course student will be able

1. to infer the chemical processes involved in the treatment of water and wastewater
2. to apply the concepts of solubility equilibria and redox chemistry for treatment of industrial wastewater
3. to quantify the dosage of chemicals requirement based on chemical reactions inwater treatment
4. to differentiate between different microbial species and their growth kinetics

MCE5C03	DESIGN OF WATER TREATMENT PROCESSES	Core	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To learn about water quality requirements for various uses
2. To provide an understanding of various physicochemical methods for treatment of water
3. To explain the limitations, advantages and disadvantages of various unit operations and processes
4. To study the principle and design of the physical and chemical treatment units used for the removal of undesirable constituents (contaminants) from water

Course Content

Introduction: Wholesomeness of water, aim of water treatment, hygienic, aesthetic and economic requirements, schematic flow schemes.

Aeration: Theory and design of aeration systems.

Sedimentation: Type of settling, general equation for settling, factors affecting, designs of settling units.

Coagulation and Flocculation: Theory, determination of optimum dose, coagulant aids, design of coagulation and flocculation units.

Adsorption: Introduction, equilibria and isotherms, factors affecting adsorption, fixed bed adsorption column operation.

Filtration: Theory, preparation of filter material, design of filters, multimedia filters, operation and maintenance of filters.

Disinfection: Factors affecting disinfection - Concentration, time, temperature, different methods of disinfection.

Specific Treatment: Removal of hardness, arsenic, fluoride, iron and manganese.

Books:

1. American Water Works Association (1971) Water quality and treatment, A Handbook of Public Water Supplies, McGraw Hill Inc., USA
2. Fair, Geyer and Okun (1971) Elements of Water Supply and Wastewater Disposal, John Wiley and Sons, New York
3. Weber, W. J. (1972) Physicochemical Processes for Water Quality Control, Wiley Interscience, New York.

4. Peavy, Rowe and Tchobanoglous (1987) Environmental Engineering, McGraw-Hill Book Company, Singapore.
5. CPHEEO (1999) Manual on Water Supply and Treatment, Ministry of Urban Development, New Delhi.

Course Outcomes: At the end of the course the student will be able to:

1. Decide types of processes to treat water for various uses.
2. Configure processes for water treatment systems.
3. Design water treatment units for conventional and specific water treatment
4. Operate and maintain various processes in water treatment plants.

MCE5C05	Design of Water Supply and Sewerage Systems	Core	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To learn about planning of water supply and sewerage systems
2. To study the various components of water supply system
3. To learn design of water distribution, sewer networks and storm water drains
4. To study about selection of pumps and design of pumping stations

Course Content

Planning of water supply projects, basic design considerations, components of water supply scheme, water demands and estimation of design capacity, surface sources and design of intake works, selection of pumps and design of pumping station, economical size of pumping main, hydraulics analysis of distribution network, design of distribution systems, leakage detection and measures to protect water mains against pollution due to sewers and drains.

Planning of wastewater management projects, basic design considerations, estimation of municipal sewage and storm runoff, design of sewerage systems, selection of pumps and design of pumping stations, sewer appurtenances, construction and maintenance of sewerage system.

Books:

1. Metcalf and Eddy (2003) Wastewater Engineering, Treatment and Reuse. Fourth edition, McGraw Hill Education (India) Pvt. Limited, New Delhi.

2. Peavy, Rowe and Tchobanoglous (1987) Environmental Engineering, McGraw Hill Book Company, Singapore.

3. CPHEEO (2013) Manual on Sewerage and Sewage Treatment Systems, Part A Engineering, Ministry of Urban Development, New Delhi.

4. CPHEEO (1999) Manual on Water Supply and Treatment, Ministry of Urban Development, New Delhi.

5. Fair, Geyer and Okun (1971) Elements of Water Supply Wastewater Disposal, John Wiley and Sons, New York.

Course Outcomes: At the end of the course the student will be able to:

1. Plan water supply and wastewater management projects
2. Gain the knowledge of various components of water supply and wastewater collection systems
3. Plan and design water and wastewater pumping stations
4. Plan and design water distribution and sewerage systems
5. Understand operation and maintenance of water supply and sewerage systems

MCE5L07	Environmental Chemistry and Microbiology Lab	Lab	0-0-4	2 Credits

Internal-60	End semester-40	Total-100

Course Learning Objectives

1. Understand various physico-chemical and bacteriological analytical techniques
2. To familiarize the methods to estimate the organic strength of wastewater
3. To analyse the physical, chemical and bacteriological characteristics of water and wastewater
4. To determine dose of disinfectant and coagulant

Course Content

Physicochemical and bacteriological analysis of raw water and treated water to determined its quality status, suitability for various uses of water and suggest dose of alum and chlorine for water treatment.

Physicochemical and bacteriological analysis of raw wastewater, treated wastewater and polluted water to determined strength of wastewater, degree of treatment required, suitability of treated effluent for disposal in surface water or land disposal, suitability for reuse of treated wastewater for various applications

1. To determine pH, acidity, alkalinity and hardness
2. To determine colour, turbidity and conductivity
3. To determine total solids, total dissolved solids, total suspended solids, volatile solids, fixed solids and settleable solids
4. To determine oil and grease
5. To determine chloride, sulfate, fluoride
6. To determine DO, BOD,COD and TOC
7. To determine the optimum coagulant dose
8. To determine residual chlorine and chlorine dose
9. To determine MPN and total plate count
10. To determine nitrogen and phosphorous
11. To determine metals using AAS
12. To determine major ions in water using ion chromatograph

Books:

1. Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012
2. Sawyer, C.N., McCarty, P.L., Parkin, G.F., Chemistry for Environmental Engineering, Tata McGraw-Hill, 2000.
3. Pelczar, M. J. (Jr), Chan, E C S and Krief, N. R., Microbiology, 5th Ed., McGraw-Hill, 1996
4. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4th Edition, 2003.

Course outcomes

At the end of the course student will be able to

1. Relate the theoretical knowledge of sampling and analysis into lab practice
2. Decide appropriate water and wastewater quality parameters for analysis of water and wastewater
3. Apply different analysis techniques for the measurement of physical, chemical and bacteriological parameters of water and wastewater
4. Determine dose of coagulant, chlorine

MCE5C02	**AIR AND NOISE POLLUTION AND CONTROL**	**Core**	**3– 0 – 0**	**3 Credits**

Internal-50	**End semester-50**	**Total-100**

Course Learning Objectives

1. To provide general understanding of air and noise quality and its impact on the environment and human health
2. To study the fate and transport of air pollutants and measurement techniques of air pollutants and noise pollution
3. To discuss the different control methods and design principles for gaseous andparticulate pollutant, and noise pollution
4. To explain the principles of biological air pollution control technologies and its limitations

Course Content

Composition and structure of atmosphere - Air pollutants - Sources and sinks - classification of pollutants - effect on human health vegetation and property - Reactions of pollutants and their effects - Smoke, smog and ozone layer disturbance - Greenhouse effect - Ambient and stack sampling - pollution measurement methods - Criteria pollutants - Ambient air quality and emission standards – Air pollution indices - Air Act - Industrial sources of air pollution - Behaviour of pollutants in atmosphere - Atmospheric stability and temperature inversion - Emission factors - regulations - control strategies and policies - Choosing appropriate air pollution control technology - Particulate Pollutant Control - Settling chambers - Filtration - Electrostatic precipitation - Cyclone separation – Wet collectors - Design of various particle control devices - Gaseous Pollutant Control – Gas absorption in tray and packed towers - Absorption with/without chemical reaction - Adsorption in fixed beds - Breakthrough - Wet scrubbers - Design of various pollutant control devices - Control technologies for removal of SO2, NOx, VOC – Control technologies for motor vehicles - Biological air pollution control technologies - bioscrubers - biofilters - Integrated air pollution control systems.

Noise Pollution – definition, sources, effects, measurement, standards and limit values, instrumentation and monitoring procedure, and control.

Books:

1. Wark Kenneth and Warner C.F.: Air Pollution: Its origin and control, Harper and Row Publishers, New York, 1997.
2. Rao C.S.: Environmental Pollution Control Engineering, New Age International Ltd., New Delhi, 2007.

3. Peavy H.S., Rowe D.R., Tchobanoglous G.: Environmental Engineering, McGraw Hills, New York, 1985
4. Perkins H.C.: Air Pollution, McGraw Hill, New York, 1974.
5. Stern A.C.: Air Pollution, Vol. 1, 2, and 3, Academic Press, New York, 1977.
6. Seinfeld J. H.: Atmospheric Chemistry and Physics of Air Pollution, John Wiley and Sons Inc., USA, 1986.
7. Sincero A.P. and Sincero G.A.: Environmental Engineering, Prentice Hall of India.
8. Cunniff P.F.: Environmental Noise Pollution, McGraw Hill, New York, 1987.
9. Peterson A.P.G. and Gross E.E.: Handbook of Noise Measurement, General Radio Co., West Concord, Mass.

Course Outcomes

At the end of the course student will be able

1. to classify the types and sources of air pollutants and to understand their effects on human health and the broader environment
2. to differentiate and design various air pollution control technologies for particulates and gaseous pollutants and
3. to choose appropriate technologies for removal of selective air pollutants and control of noise pollution
4. to establish and implement air and noise quality management components

MCE5C04	DESIGN OF WASTEWATERT TREATMENT PROCESSES	Core	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To learn about objective of wastewater treatment, effluent standards and reuse guidelines for treated wastewater
2. To study about estimation of design flow, wastewater characteristics and treatment chain
3. To study about various unit operations and processes for the wastewater treatment
4. To learn about design principles and operational problems involved in various treatment processes

Course Content

Introduction: Objective of treatment, effluent standards and treated wastewater quality guidelines for specified uses, design wastewater flow and raw wastewater characteristics, unit operations and processes, recent trends in technologies in sewage treatment, selection of treatment chain, site selection, treatability studies.

Design of physiochemical unit operation: Screening, grit removal, equalization, sedimentation, floatation.

Design of secondary treatment process: Objective, types of secondary treatment processes, activated sludge process, trickling filters, rotating biological contractors, upflow anaerobic sludge blanket (UASB) reactor, anaerobic filters.

Sludge disposal: Sludge thickening, , aerobic and anaerobic digestion of sludge, sludge drying

Design of low cost systems: Oxidation ponds, aerated lagoons.

Hydraulics of treatment plants and hydraulic profile though treatment plant

Books:

1. Metcalf and Eddy (2003) Wastewater Engineering, Treatment and Reuse. Fourth edition, McGraw Hill Education (India) Pvt. Limited, New Delhi.
2. CPHEEO (2013) Manual on Sewerage and Sewage Treatment Systems, Part A Engineering, Ministry of Urban Development, New Delhi.
3. Peavy, Rowe and Tchobanoglous (1987) Environmental Engineering, McGraw Hill Book Company, Singapore.
4. Eckenfelder, W.W. (2000) Industrial Pollution Control, McGraw Hill Book Company, Singapore.

Course Outcomes: At the end of the course the student will be able to:

1. Calculate design flow, characterize wastewater and prepare wastewater treatment flow schemes
2. Plan and design the components of wastewater treatment systems
3. Understand underlying principles of processes involved in primary and secondary wastewater treatment systems.
4. Plan and design sludge treatment and disposal system.

MCE5C06	SOLID WASTE MANAGEMENT	Core	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To understand the importance of proper solid waste management and of integrated waste management system
2. To study about segregation, collection and transportation of solid waste
3. To study about generation, characteristics and composition of municipal solid waste
4. To enumerate and describe different disposal and treatment methods for municipal solid waste

Course Content

Introduction: Necessity and importance of proper solid waste collection and disposal, definitions, sources, classifications and characteristics, data collection, Solid Waste Management Rules, 2016, Integrated Solid Waste Management Hierarchy, waste minimisation, extended producer responsibility (EPR).

Segregation, Collection and Transportation: Segregation and storage of solid waste at source, collection systems and services, vehicles and equipments for collection, community involvement and role of informal sector in waste collection, transfer stations.

Recycling and Recovery: Advantages of recycling, important recycling materials, stages of material recovery in solid waste management chain, principal unit operations and equipments employed at material recovery facilities.

Composting: Aerobic and anaerobic composting, benefits of composting, factors affecting composting process, windrow, aerated static pile, in-vessel and decentralized composting technologies, vermicomposting.

Waste to Energy: Energy recovery potential, basic techniques of energy recovery; Incineration – Process 3Ts, incinerator details, prevention of air pollution; Pyrolysis - Process description, various operations involved, end products; biomethanation; refuse derived fuels, gasification.

Sanitary Land Filling: Definitions, types of wastes to be accepted at landfills, site selection, essential components of municipal sanitary landfill, landfilling methods, sanitary landfill design, leachate management, active and passive control of landfill gases.

Books:

1. CPHEEO (2016) Municipal Solid Waste Management Manual, Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, New Delhi

2. Tchobanoglous G, Theisen H and Vigil SA (1993) Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill.
3. Vesilind PA, Worrell W and Reinhart D (2002) Solid Waste Engineering' Brooks/Cole Thomson Learning Inc.
4. Peavy, H.S, Rowe, D.R., and Tchobanoglous, G. (1985) Environmental Engineering, McGraw Hill Inc., N.York.
5. Tchobanoglous., G. And Frank Kreith (2002) Hand Book of Solid Waste Management, McGrawHill, Inc., N.York.

Course Outcomes: At the end of the course the student will be able to:

1. Develop understanding of sources of solid waste, classification of solid waste, importance of proper solid waste disposal and integrated solid waste management hierarchy.
2. Determine physical and chemical characteristics of solid wastes to decide appropriate processing and disposal methods
3. Plan solid waste segregation, collection and transportation system
4. Plan and design various operations and processes to recover materials and energy from solid waste and final disposal of inert /non-biodegradable residues & processing rejects

MCE5L08	ENVIRONMENTAL POLLUTION MONITORING LAB	Lab	0-0-4	2 Credits

Internal-60	End semester-40	Total-100

Course Learning Objectives

1. To measure the particulate concentration in ambient air
2. To measure the gaseous pollutant concentration in ambient air
3. To familiarize the technique of stack monitoring emissions
4. To study noise pollution measurement and monitoring

Course Content

Ambient Air Quality Analysis - Determination of SPM, PM10, PM 2.5, CO, NOX and SOX -stack emission monitoring.

Experiment 1: Demonstration of air pollution monitoring instruments

Experiment 2: Determination of SPM; PM10; PM2.5

Experiment 3: Determination of SO2 in ambient air

Experiment 4: Determination of NOx and CO in ambient air;

Experiment 5: Demonstration of stack monitoring kits.

Experiment 6: Sampling and analysis of inorganic and organic particulates, SOx , NOx, NH3 etc.

Experiment 7: Demonstration of noise pollution monitoring equipment

Experiment 8: Noise survey in a multiple noise sources situation in order to develop noise contour diagram for the entire locality

Experiment 9: Noise monitoring at residential localities.

Experiment 10: Frequency spectrum analysis of machine noise.

Experiment 11: Traffic noise situation monitoring

Course outcomes

At the end of the course student will be able

1. to apply different analysis techniques for the measurement of parameters of ambient air
2. to explain the operation and mechanism of different analytical equipments and their
1. advantages and limitations
2. to relate the theoretical knowledge of sampling and analysis into lab practice
3. to estimate the concentration of various parameters in ambient air

MCE5E31	BIO-REMEDIATION: PRINCIPLES AND APPLICATIONS	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study the sources of soil and groundwater contamination and potential hazards.
2. To learn about various factors affecting contaminant degradation and types of biodegradation processes
3. To learn about biodegradation of various organic contaminants, microbial metal transformations and genetically engineered microorganisms
4. To understand the state of the art methodologies for soil and groundwater decontamination

Course Content

Introduction: Present state of environment, potential hazards and solutions, bioremediation, potential advantages and disadvantages, intrinsic and engineered bioremediation, microbial ecology, factors affecting contaminant biodegradability - Natural versus synthetic compounds, effect of halogenations, contaminant mixtures.

Biodegradation Process: Aerobic and anaerobic mineralization, cometabolism and polymerisation; Factors influencing contaminant degradation: Toxicity, Bioavailability, Contaminant structure - steric and electronic effects; Biological and environmental factors - Rate of contaminant degradation, extent of contaminant degradation, nutrient ratio and availability, organic matter content, nutrient availability, terminal electron acceptors, soli respiromentry, temperature, moisture, pH, adsorption and absorption, contaminant migration in ground water, bioavailability, soil matric potential, redox potential.

Biodegradation of organic pollutants aliphatics, alicyclics, aromatics, dioxins and PCBs, heterocyclic compounds and pesticides under aerobic and anaerobic conditions.

Metal pollution: Cause of concern, type of metals, metal solubility, bioavailability and speciation, metal toxicity effects on microbial cell, mechanisms of microbial metal resistance and detoxification, microbial metal transformations: oxidation-reduction, methylation, physicochemical methods of metal remediation, microbial approaches in remediation of metal contaminated soils and aquatic systems.

Bioremediations systems and processes: Ex-situ and in-situ remediation techniques, land farming, biobed, reactor, bioslurping, in-situ land farming, bioventing, hydraulic cycles, biosparging, groundwater circulation wells, bioscreen and monitored natural attenuation techniques.

Microbial cleaning of gases: Biofiltration process fundamentals, design and operation considerations.

Application of genetically engineered microorganisms for bioremediation, obstacles associated with use of GEM in bioremediation applications

Books:

1. Ergas, S.J., Chang, D.P.Y., Schreoder, E.D. and Eweis J. B., Bioremediation Principles, WCB/McGraw-Hill, 1998.
2. Sharma, H. D. and Reddy, K. R. (2004) Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies, John Wiley and Sons Inc., Hoboken, New Jersey.
3. Maiee R. M., Pepper, I. L. and Gerba, C. P. (2009) Environmental Microbiology, Second Ed., Academic Press, California.
4. Rittmann, B.E., and McCarty, P.L., Environmental Biotechnology: Principles and Applications, McGraw Hill, 2001.

Course Outcomes: At the end of the course the student will be able to:

1. Describe fundamental concepts and principles of bioremediation processes
2. Understand various transformation reactions, degradation reactions and detoxification mechanisms involved during aerobic and anaerobic biodegradation of contaminants.
3. Design various ex-situ and in-situ bioremediation process and systems for contaminated sites, ground water and air.
4. Decide application of genetically engineered microorganisms based on ethical, environmental, societal and safety issues related to bioremediation while using these organisms.

MCE5E33	**ENVIRONMENTAL ETHICS AND LEGISLATION**	**Elective**	**3– 0 – 0**	**3 Credits**

Internal-50	**End semester-50**	**Total-100**

Course Learning Objectives

1. To deliberate the issues of environmental ethics and legislation.
2. To deliberate the role of judiciary in sustainable development
3. To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India
4. To learn the legal aspects of environmental problems

Course Content

Environmental Ethics- Need, Issues and Possible Solutions. Constitutional Provisions and Environment Protection in India – National Environmental policies – Sustainable development and role of Indian Judiciary in promoting it with special reference to Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – Forms of legislation / regulations - multilateral environmental agreements, conventions and protocols.

Acts related to environmental protection – Water (P&CP) Act 1974, Air (P&CP) Act 1981, Environment (Protection) Act 1986 - Relevant provisions of Forest (Conservation) Act 1982, Wild Life (Protection) Act 1972 ;

Issues involved in enforcement of Environmental Legislation. Public interest litigation – writ petitions - Supreme Court Judgments in landmark cases – Indian Council for Enviro-legal Action v. UOI AIR 1996 SC 1446, MC Mehta v. Union of India (Oleum gas leak case) AIR 1987 SC 1086, MC Mehta v. UOI (Kanpur Tanneries case), Indian Handicraft Emporium v. UOI (2003) 7 SCC 589.

Books:

1. Divan S. and Roseneranz A.: Environmental law and policy in India – Cases, Material & Statements, Oxford University Press, New Delhi, 2001.
2. CPCB: Pollution Control Acts, Rules and Notifications issued there under Pollution Control Series, Central Pollution Control Board, N. Delhi.
3. Diwan P.: Environmental administration –law and judicial attitude Vols. I & II, Vedams eBooks (P) Ltd, N. Delhi, 1992.
4. Jaswal P.S. and Nistha: Introduction to Environmental Law, Allahabad Law Agency, Allahabad, 2017

Course Outcomes

At the end of the course student will be able

1. To have an understanding of the Indian policies and legislation pertaining to prevention and control of environmental pollution
2. to have an insight into the environmental protection acts
3. to rules knowledge on the institutional setup for environmental management and pollution control
4. to critically examine the legal aspects of environmental issues and to transfer theoretical knowledge to new environmental situations

MCE5E35	**GROUNDWATER FLOW AND CONTAMINANT TRANSPORT THROUGH POROUS MEDIA**	**Elective**	**3– 0 – 0**	**3 Credits**

Internal-50	**End semester-50**	**Total-100**

Course Learning Objectives

1. To provide an understanding of water movement in subsurface environment
2. To study the fate and transport of contaminants through porous media
3. To enumerate various model input parameters for transport of contaminants in subsurface water
4. To familiarize the groundwater modeling tools for model development and prediction

Course Content

Water Movement in the Subsurface - Groundwater Environment - Types of Aquifers - Sources of Contamination - Saturated Flow - Continuity Equation - Darcy's Law - Equation of Flow - Analytical Solutions and Numerical Modeling - Transport of Contaminants - Transport Equation - Dispersion and Diffusion in Porous Media - Reaction Terms - Adsorption and Surface Complexation Models - Soil Chemical Kinetics - Modeling Groundwater Pollution - Coupling of Contaminant - Soil Interactions with Transport - Reaction and Transport of Trace Metals, Ligands and Non-polar Organic Solutes - Model Input Parameters - Initial and Boundary Conditions - Calibration - Sensitivity Analysis - Groundwater Transport Modelling Using VISUAL MODFLOW

Books:

1. Zheng, C. and Bennett, G. D., Applied contaminant Transport Modeling, A John wiley& sons, inc, publication, Newyork, 2002.
2. Freeze, R.A. and Cherry. J.A. Groundwater, Prentice Hall, 1979.
3. Sun, N. Z., Mathematical modelling of groundwater Pollution, Springer –Verlac Newyork Inc., and Geological publishing house, 1996.
4. Grathwohl, P., Diffusion in Natural Porous Media: Contaminant Transport, Sorption, desorption and Dissolution Kinetics, Kluwer Academic, Boston, 1998

Course Outcomes

At the end of the course student will be able to

1. Develop flow and transport model for contaminant in subsurface water
2. Differentiate various numerical techniques for solving flow and transport equations
3. Develop reactive transport model for reactive species
4. Apply the software packages to develop contaminant transport model for field condition

MCE5E37	LIFE CYCLE ANALYSIS AND DESIGN FOR ENVIROMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To provide the concept of sustainable development and to discuss the strategies andbarriers of sustainability
2. To deliberate the principles and concepts of cleaner production and its importance
3. To discuss the green processes and green energy management in various industrial processes
4. To learn the principles and methods of occupational safety and health, risk assessment and its management

Course Content

Environmental and Sustainable Development - Precautionary Principle, Polluter Pays Principle; Growth of Human Population – population explosion, environmentally sustainable and environmentally optimum populations, Malthus Hypothesis; Engineering Methodology in Planning and its Limitations - Tragedy of Commons, Concept of carrying capacity, relation among quality of life, carrying capacity and resource utilization, Implications of Impact Equation for Sustainable Development, Carrying capacity based short and long term regional planning.

Environmental Management - Hierarchy - Source Reduction Techniques - Process and Equipment Optimization, Reuse, Recovery, Recycle, Raw Material Substitution - Overview of CP Assessment Steps and Skills - Process Flow Diagram - Material Balance - CP Option Generation - Technical and Environmental Feasibility Analysis - Economic Valuation of Alternatives - Total Cost Analysis - Pollution Prevention and Cleaner Production Awareness Plan - Waste Audit -Environmental Statement - Green House Gases and Carbon Credit – Carbon Sequestration- Sustainable Development through Trade - Carbon Trading -Ecotoxicology - Hazards by Industry and its Environmental Effects - Relationship of Occupational Hygiene / Safety and Disease - Overview, Planning, Hazard Identification and Risk Assessment - Pesticides and Environment - Response to Toxic Exposures -Dose Response, Frequency Response and Cumulative Response - Lethal and Sub-Lethal Doses - Dose - Response Relationships between Chemical and Biological Reactions -Detoxification in Human Body - Detoxification Mechanisms, Organs of Detoxification -Green Energy and Green Process Management in industry - Environmental Quality Management -Total Quality Management (TQM) and ISO 14000 Series of Standards.

Books:

1. Kirkby J., O'Keefe P. and Timberlake: Sustainable Development, Earthscan Publication,London, 1999.
2. Danoy G.E. and Warner R.F.: Planning and Design of Engineering Systems, Unwin Hyman Publications, 1969.

3. Bishop P.L.: Pollution Prevention: Fundamentals and Practice, McGraw HillInternational, 2004.
4. Goetsch D.L.and Stanley D.: ISO 14000 Environmental Management, Prentice Hall, Upper Saddle River, NJ, 2001.
5. Chanlett E.T.: Environmental Protection, McGraw Hill Publication, USA, 1973
6. Koren H.: Handbook of Environmental Health and Safety -principle and practices,Lewis Publishers, 3rd Edition, 1995.
7. Harrison Lee: Environmental Health, and Safety Auditing Handbook, McGraw Hill Inc., USA, 1995.
8. Shaw I.C. andChadwick J.: Principles of Environmental Toxicology, Taylor & Francis Ltd., 2000.

Course Outcomes

At the end of the course student will be able to

1. Modify schemes applied at different governance levels to achieve sustainable innovation
2. Prepare process flow diagram and material balance for various industrial processes
3. Summarize various techniques for cleaner production and to apply environmental sustainable management concepts in industries
4. Examine the toxicological and ecological aspects of ecotoxicology and to transfer knowledge of Eco toxicological theory to new environmental situations

MCE5E39	MODELING OF NATURAL SYSTEMS	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study the transport and fate of pollutant in natural systems such as lakes, rivers, estuaries and atmosphere
2. To provide an understanding of mathematical model development for natural systems
3. To brief the mass balance approach and some special models for prediction of air and water quality
4. To learn the numerical techniques for solving the system equations

Course Content

Definition - Classification - Examples of Models for Environmental Systems - Concepts of Scale in Natural Systems - Brief Review of Mass, Momentum and Energy Balance - Transport and fate of pollutant in aquatic systems - Lakes - Rivers - Dissolved oxygen model for streams - Estuaries - Finite Difference and Linear Algebraic Methods to Solve the System Equations - Some Special Models - Introduction to Air Quality Models- Meteorology - Atmospheric Stability and Turbulence - Gaussian Plume Model and Modifications.

Books:

1. Chapra, Steven C., Surface water quality modeling, McGraw Hill International Edition, 1997.

2. Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, McGraw Hill International Editions, 1998.

3. Pevy, Rowe, and Techobanoglous, Environmental Engineering, McGraw Hill Publishing company, Newyork, 2007.

4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice- Hall of India Pvt. Ltd., Newdelhi, 3rd Edition, 2007

5. Martin, L.J. and McCucheon, S.C, Hydrodynamics of transport for water quality modeling, Lewis Publishers, Boca Raton, 1999.

Course Outcomes

At the end of the course student will be able to:

1. Develop contaminant transport model for natural systems
2. Predict the quality of water in river, lakes and estuaries using specific models
3. Solve the transport equation using numerical techniques
4. Estimate the concentration of pollutant in ambient air using dispersion models

MCE5E41	SURFACE WATER QUALITY MODELING AND CONTROL	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. to study river hydrology and physical and hydrological characteristics of lakes
2. to learn derivation of stream and estuary equations, and various models
3. to study fate of microorganisms and basic mechanisms of eutrophication
4. to learn about calibrations, verification and application of various models

Course Content

River hydrology and derivation of the stream equation, Derivation of the estuary equation, Distribution of water quality in rivers and estuaries, Physical and hydrological characteristics of lakes, Finite difference steady state river, estuary and lake models, Dissolved oxygen models in rivers, estuaries and lakes, Fate of indicator bacteria, pathogens and viruses in water, Basic mechanisms of eutrophication, Lake phytoplankton models, River eutrophication analysis, finite segment models, Elements of toxic substance.

Books:

1. Thomann and Mueller (1987) Principles of Surface Water Quality Modeling and Control, Harper and Row, New York.
2. Tchobanglons and Schroeder (1987) Water Quality: Characteristics, Modeling and Modifications, Addison -Wesley Pub. Co, USA.
3. Middlebroooks, E. J. (1974) Modeling the Eutrophication Process, Ann Arbor Science, Ann Arbor, USA.
4. Schnoor, J. L. (1996) Environmental Modeling, John Wiley and Sons, USA.

Course Outcomes: At the end of the course the student will be able to:

1. Formulate water quality models and analyze water quality data
2. Apply models currently used in environmental engineering practice for predicting water quality in rivers and lakes.
3. Understand how water quality models may be calibrated, verified, and applied to environmental engineering problems, such as total maximum daily loads or fate and transport modeling of toxic organic chemicals.

4. Acquaint with current issues in surface water quality and aware of the technical, political, ethical and sociological components of these issues.

MCE5E43	WATER QUALITY MANAGEMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study sources of pollution and importance of water quality management
2. To learn about eutrophication, thermal pollution, acid rains and control strategies
3. To study important water quality parameters\
4. To discuss planning and various techniques of water quality monitoring

Course Content

Introduction: Quality parameter and classification of natural water, Physico-Chemical and biological water quality classification of aquatic systems. Sources of pollution: characteristics of point and non-point sources of pollution. Eutrophication in natural water bodies: causes processes and control Toxic wastes: Sources, transportation and management strategies.

Thermal pollution: causes, model and control.

Acid rains: Occurrences, impacts and strategies for control

Water quality monitoring: Objectives, requirements, planning and various techniques.

Case studies related to water quality monitoring under various river actions plans including Ganga and Yamuna Action plans.

Books:

1. Reckhow and Chapra (1983) Engineering Approaches for Lake Management, Vol. 1, Butterworth, Boston.

2. Thomson and Mueller (1987) Principles of Surface Water Quality Modelling and Control, Harper and Row, NY.

3. Tchobanoglous and Schroeder (1987) Water Quality: characteristics, Modelling and modification, Addition – Wesley Pub. Co., USA

4. APHA (1998) Standard Methods for Examination of Water and Wastewater, 20th Edition, Washington, D.C.

5. Velz, C.J.(1970) Applied Stream Sanitation, Wiley Interscience, NY.

Course Outcomes: At the end of the course the student will be able to:

1. Learn about importance of water quality management, water quality criteria and standards, and effects of thermal pollution and acid rains on water quality
2. Classify sources of water based on water quality parameters and contaminates.
3. Understand various water quality parameters and select appropriate parameters for assessing water quality of river and lake
4. Plan and implement water quality monitoring programme under various river action plans.

MCE5E45	WATER AND WASTEWATER TREATMENT PROCESSES	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study properties of water, water quality parameters and their significance
2. To explain basic mechanisms involved in various treatment processes
3. To learn about application of various treatment processes
4. To study about water stabilization

Course Content

Structure and basic properties of water and their significance in environmental engineering. Source of water impurities; Water quality parameters; Epidemiological and toxic aspects; physical and chemical interactions due to various forces; Suspension and dispersions; Surface and colloidal chemistry; Settling of particles in water, Coagulation and flocculation, floatation, filtration mechanisms and interpretations, ion exchange and adsorption, Chemical Oxidation/reduction processes; Disinfection using chlorine, UV, ozonation. Water stabilization, aeration and gas transfer. Reverse osmosis, electrodialysis and desalination; treatment and sludge management.

Books:

1. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw Hill., 1984
2. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning, New Delhi, 2009
3. M. Hanif Chaudhary, Applied Hydraulic Transients, 3rd Ed., Springer., 2014.

Course Outcomes: At the end of the course the student will be able to:

1. Learn about basic properties of water, sources, types and effects of impurities and water quality parameters
2. Understand basic principles and fundamentals involved in water and wastewater treatment processes
3. Evaluate various physico-chemical water and wastewater treatment processes
4. Apply concept of water stabilization to protect water conveyance mains and appliances.

MCE5E32	ADVANCE WASTEWATER TREATMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To learn the fundamentals of process kinetics and bioreactors
2. To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors
3. To explain concepts of carbon, nitrogen and phosphorous removal involved in biological treatment processes
4. To study about various advance physico-chemical and natural treatment processes

Course Content

Microbiological concepts: Classification and characteristics of living organisms, characterisation techniques, microbial growth kinetics.

Kinetics and modelling of reactors: Types of reactors, biochemical and growth kinetics, modelling of suspended growth systems, techniques for evaluation of kinetic and stoichiometric parameters.

Concepts and principles: Carbon oxidation, nitrification, denitrification, biological phosphorous removal, methanogenesis, sulphate reduction.

Physico-chemical treatment: Membrane filtration processes, adsorption, gas stripping, ion exchange, advance oxidation processes, chemical precipitation.

Biological nutrient removal: Tertiary treatment, aerobic and anaerobic treatment processes; overland flow system and constructed wetlands.

Books:

1. Metcalf and Eddy (2003) Wastewater Engineering, Treatment and Reuse. Fourth edition, McGraw Hill Education (India) Pvt. Limited, New Delhi.
2. Reynolds, T. D. and Richards, P. A. (1996) Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, Cenage Learning India Pvt. Limited, New Delhi
3. Eckenfelder, W.W. (2000) Industrial Pollution Control, McGraw Hill Book Company, Singapore.
4. Peavy, Rowe and Tchobanoglous (1987) Environmental Engineering, McGraw Hill Book Company, Singapore.

Course Outcomes: At the end of the course the student will be able to:

1. Understand basic concepts of microbial classification, characterization and growth kinetics.
2. Apply reaction kinetics and model suspended growth systems
3. Understand carbon oxidation, nitrification, denitrification, biological phosphorous removal, methanogenesis and sulphate reduction involved in wastewater treatment systems
4. Design advanced physico-chemical and natural wastewater treatment processes

MCE5E34	AIR QUALITY MODELLING	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study about importance, principles and applications of air quality models
2. To study air pollution metrology
3. To learn about basic diffusion equation and various modeling approaches
4. To learn theory and application of various types of models

Course Content

Introduction to Air Quality Modelling: Approaches to model formulation. Model classification, criteria for model selection. Air pollution meteorology – meteorological parameters, stability classification; plume rise, plume behaviour, dispersion parameters. Basic diffusion equation, deterministic, numerical and statistical modelling approach. Introduction to boundary layer turbulence – physical modelling approach. Stochastic modelling approach to air pollution dispersion. Theory of Gaussian plume model and its application. Introduction to indoor air quality model. ISCST3; CALINE4; ROADAIR. Case studies.

Books:

1. Seinfeld, J.H. (1986) Atmospheric Chemistry and Physics of Air Pollution, John Wiley and Sons Inc., USA

2. Seinfeld, J.H. (1975) Air Pollution: physical and Chemical Fundamentals, McGraw Hill Inc. USA

3. Peavy, Rowe and Tchobanoglous (1987) Environmental Engineering, McGraw Hill Book Company, Singapore.

Course Outcomes: At the end of the course the student will be able to:

1. Understand the fundamentals of air quality modelling.
2. Describe the operational principles of air quality modelling and its applications
3. Apply the knowledge of modelling to understand the sources of air pollution and the meteorological conditions that trigger air pollution.
4. Estimate the concentration of pollutant in ambient air using dispersion models

MCE5E36	ENVIRONMENTAL PLANNING AND MANAGEMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To provide the concept of sustainable development and to discuss the strategies and barriers of sustainability
2. To deliberate the principles and concepts of cleaner production and its importance
3. To discuss the green processes and green energy management in various industrial processes
4. To learn the principles and methods of occupational safety and health, risk assessment and its management

Course Content

Environmental and Sustainable Development - Precautionary Principle, Polluter Pays Principle; Growth of Human Population – population explosion, environmentally sustainable and environmentally optimum populations, Malthus Hypothesis; Engineering Methodology in Planning and its Limitations - Tragedy of Commons, Concept of carrying capacity, relation among quality of life, carrying capacity and resource utilization, Implications of Impact Equation for Sustainable Development, Carrying capacity based short and long term regional planning.

Environmental Management - Hierarchy - Source Reduction Techniques - Process and Equipment Optimization, Reuse, Recovery, Recycle, Raw Material Substitution - Overview of CP Assessment Steps and Skills - Process Flow Diagram - Material Balance - CP Option Generation - Technical and Environmental Feasibility Analysis - Economic Valuation of Alternatives - Total Cost Analysis - Pollution Prevention and Cleaner Production Awareness Plan - Waste Audit -Environmental Statement - Green House Gases and Carbon Credit – Carbon Sequestration- Sustainable Development through Trade - Carbon Trading -Ecotoxicology - Hazards by Industry and its Environmental Effects - Relationship of Occupational Hygiene / Safety and Disease - Overview, Planning, Hazard Identification and Risk Assessment - Pesticides and Environment - Response to Toxic Exposures -Dose Response, Frequency Response and Cumulative Response - Lethal and Sub-Lethal Doses - Dose - Response Relationships between Chemical and Biological Reactions -Detoxification in Human Body - Detoxification Mechanisms, Organs of Detoxification -Green Energy and Green Process Management in industry - Environmental Quality Management -Total Quality Management (TQM) and ISO 14000 Series of Standards.

Books:

1. Kirkby J., O'Keefe P. and Timberlake: Sustainable Development, Earthscan Publication, London, 1999.

2. Danoy G.E. and Warner R.F.: Planning and Design of Engineering Systems, Unwin Hyman Publications, 1969.
3. Bishop P.L.: Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2004.
4. Goetsch D.L. and Stanley D.: ISO 14000 Environmental Management, Prentice Hall, Upper Saddle River, NJ, 2001.
5. Chanlett E.T.: Environmental Protection, McGraw Hill Publication, USA, 1973
6. Koren H.: Handbook of Environmental Health and Safety -principle and practices, Lewis Publishers, 3rd Edition, 1995.
7. Harrison Lee: Environmental Health, and Safety Auditing Handbook, McGraw Hill Inc., USA, 1995.
8. Shaw I.C. and Chadwick J.: Principles of Environmental Toxicology, Taylor & Francis Ltd., 2000.

Course Outcomes

At the end of the course student will be able

1. to modify schemes applied at different governance levels to achieve sustainable innovation
2. to prepare process flow diagram and material balance for various industrial processes
3. to summarize various techniques for cleaner production and to apply environmental sustainable management concepts in industries
4. to examine the toxicological and ecological aspects of ecotoxicology and to transfer knowledge of Eco toxicological theory to new environmental situations

MCE5E38	ENVIRONMENTAL IMPACT ASSESSMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To learn the importance of environmental impact assessment in various engineering projects
2. To brief the various methodologies involved in environmental impact assessment
3. To identify the prediction tools for the assessment of different environmental impacts
4. To describe the concepts of environmental management system

Course Content

Evolution of EIA - Concepts - Rapid and Comprehensive EIA - Legislative and Environmental Clearance Procedures in India Screening - Scoping - Base Line Studies - Methodologies - Check List - Matrices - Mitigation - Prediction Tools for EIA - Assessment of Impacts - Air - Water - Soil - Noise - Biological - Socio Cultural Environment - Public Participation - Resettlement and Rehabilitation - Documentation of EIA - Environmental Management Plan - Post Project Monitoring - Environmental Audit - Life Cycle Assessment – Environmental Management Systems - Case Studies in EIA.

Books:

1. Canter R. L., Environmental Impact Assessment, Mc Graw Hill International Edition, 1997.
2. John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company, 1980.

Course Outcomes

At the end of the course student will be able to:

1. Analyse the environmental impacts of proposed projects
2. Predict the magnitude of an impact using mathematical tools
3. Propose proper mitigation measures to avoid environmental impacts
4. Summarise the EIA report with suitable environmental management plan

MCE5E40	ENVIRONMENTAL RISK ASSESMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study about basic concepts, definitions and hazard identification procedure for environmental risk assessment
2. To learn about various type of models for risk assessment
3. To study about risk incidence frequency estimation techniques
4. To study risk management, rules and regulations

Course Content

Introduction: Basic concepts of environmental risk and definitions; hazard identification procedures; environmental risk zonation.

Consequence analysis and modelling (discharge models, dispersions models, fire and explosion models effect models etc.)

Estimation of incident frequencies: Estimations of incident frequencies from historical date, frequency modelling techniques e.g., Fault Tree Analysis (FTA) and Event Tree Analysis (ETA).

Human factors in risk analysis; Calculation and presentation of risk (individual risk, societal risk); Risk management, rules, regulations and conventions, case studies.

Books:

1. Masters, G.M. (1998) Introduction to Environmental Engineering and Science, Prentice Hall, USA

2. Schwarzenbach, Gschwend, and Imboden (1993) Environmental Organic Chemistry, John Wiley and Sons, Inc. NY.

Course Outcomes: At the end of the course the student will be able to:

1. Understand background and importance of environmental risk assessment
2. Gain knowledge and apply various models for risk assessment.
3. Estimate incident frequency using various analysis techniques
4. Calculate risk and ensure compliance as per risk management rules and regulations.

MCE5E42	HAZARDOUS WASTE MANAGEMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To provide a knowledge about sources, characteristics and regulations for hazardous waste management
2. To study about collection and transportation of hazardous waste
3. To discuss about various methods and measures for waste minimization, recovery of materials and to generate energy from hazardous wastes
4. To enumerate and describe different disposal and treatment methods for municipal hazardous waste

Course Content

Introduction: Definition, Sources and classification, Lake Mark episodes, regulation for hazardous waste management.

Hazardous waste characteristics and site assessment: Ignitability, corrosivity, reactivity, toxicity, EPA-designated hazardous wastes, assessment of hazardous sites.

Waste minimization and resource recovery: Approaches to waste reduction, benefits of hazardous waste reduction, properties in hazardous waste management, development of tracking system, selection of the waste minimization process, case studies on by product recovery from incineration.

Transportation of hazardous wastes: Regulation, containers for hazardous materials, bulk and non-bulk transport, hazardous substances emergency response.

Chemical, physical and biological treatment: Description of unit operation and process, case study on oil field waste treatment with mobile system.

Thermal process: Advantages and disadvantages of incineration, chemistry of incineration, thermodynamics of incineration, design of an incineration system. incineration standards, types of incinerators: Liquid injection, rotary kiln and fluid bed, multiple hearth furnaces, fluidized and catalytic incinerator.

Land-fill disposal: Landfill at disposal sites, developing a new facility, operating a landfill.

Site remediation: Site assessment and inspection, the hazardous system and the national priority list, remedial action, monitoring of disposal sites.

Books:

1. Wentz, C.A. (1989) Hazardous waste management, McGraw Hill

2. LaGerga and Mercer (2001) Hazardous Waste Management, McGraw Hill Inc., USA.

3. Cornwell, D. (1998) Introduction to Environmental Engineering, McGraw Hill Inc. USA.

Course Outcomes: At the end of the course the student will be able to:

1. Understand problems due to hazardous wastes and regulatory requirements for handling and management of hazardous waste
2. Classify and characterize hazardous wastes
3. Select suitable methods and measures for waste minimization, recovery of materials and to generate energy from hazardous wastes.
4. Design of hazardous waste transportation, processing and containment systems as per regulatory standards.

MCE5E44	INDOOR AIR QUALITY	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To assess the level of pollutants in indoor and outdoor air
2. To learn the modeling tools and concepts for indoor air quality assessment
3. To study the various outdoor sources contributing indoor air pollution
4. To elaborate various control technologies and strategies for indoor air pollution

Course Content

Indoor Activities of Inhabitants - Levels of Pollutants in Indoor and outdoor Air - Design and Operation of Buildings for Improvements of Public Health - IAQ Policy Issues - Sustainability - Air Pollutants in Indoor Environments - Private Residences, Offices, Schools, Public Buildings - Ventilation - Control of Several Pollutant Classes - Radon - Toxic Organic Gases - Combustion Byproducts - Microorganisms such as Molds and Infectious Bacteria - Concepts and Tools - Exposure - Material Balance Models - Statistical Models - Indoor Air Pollution from Outdoor Sources - Particulate Matter and Ozone - Combustion Byproducts - Radon and its Decay Products - Volatile Organic Compounds - Odors and Sick - Building Syndrome - Humidity - Bio Aerosols - Infectious Disease Transmission - Special Indoor Environments - A/C Units in Indoor - Measurement Methods - Control Technologies - Control Strategies.

Books

1. Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000.
2. Nazaroff W.W. and L. Alvarez-Cohen, Environmental Engineering Science, Wiley sons, Newyork, 2001.
3. Indoor Air Quality Handbook, John D. pengler, John F. McCarthy, and Jonathan M. Same, McGraw Hill, 2000.

Course Outcomes

At the end of the course student will be able to:

1. Point out the factors affecting Indoor Air Quality (IAQ)
2. Predict the indoor air quality using mathematical model
3. Suggest the control techniques for indoor air pollution
4. Measure the pollutant concentration in indoor environment

MCE5E46	INDUSTRIAL WASTE MANAGEMENT	Elective	3 – 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To study the sources and characteristics of industrial wastes
2. To learn various pollution prevention options
3. To learn about flow sheet analysis, waste audit and concepts of eco-parks
4. To study about waste treatment flow sheet for different industries

Course Content

Nature and characteristics of industrial wastes: Prevention versus control of industrial pollution; Linkage between technology and pollution prevention; Tools for clean processes, reuse, recycle, recovery, source reduction, raw material substitution, toxic use reduction and process modifications.

Flow sheet analysis; Energy and resources (material and water) audits for efficient usage and conservation; waste audits, emission inventories and waste management hierarchy for process industries; Thermodynamics constraints to waste minimization; Holistic and critical technology assessment; Environmental performance indicator; Concept of industrial ecology and symbiosis of eco-parks.

Water and energy use and industry, industrial water quality requirements, deteriorations in water quality. Control and removal of specific pollutants in industrial wastewaters i.e., oil and grease, cyanide, fluoride, toxic organics, heavy metals, radioactivity. Recent trends in industrial waste management.

Case studies of various industries, e.g., dairy, fertilizer, distillery, sugar, pulp and paper, iron and steel, metal plating, refining, thermal power plants.

Books:

1. Industrial Wastewater Management, Treatment and Disposal, WEF Manual of practice No. FD-3, 3rd Ed., WEF Press and McGrawHill, 2008
2. Numersorn, N.L., Liquid Waste from Industry – Theories, Practice and Treatment, Addison-Wesley, 1971
3. Patwardhan, A.D., Industrial Waste Water Treatment, PHI Learning, 2009 Rao, M.N., and Dutta, A.K., Wastewater Treatment, IBH Publ., 1995.

Course Outcomes: At the end of the course the student will be able to:

1. Understand characteristics of industrial wastes and assess impacts of industrial waste disposal on sewerage system, rivers and municipal sewage treatment plants

2. Understand and apply various tools for cleaner production and pollution prevention.
3. Understand and apply concepts of energy, resource and waste audits, waste management hierarchy and industrial ecology and eco-parks
4. Design alternate treatment process flow schemes for various types of industrial wastewater.

MCE5O71/72	NOISE POLLUTION AND CONTROL	Elective	3– 0 – 0	3 Credits

Internal-50	End semester-50	Total-100

Course Learning Objectives

1. To provide general understanding of noise and its impact on human health
2. To study the measurement techniques of noise pollution
3. To discuss the different control approaches of noise pollution
4. To apprise and study special noise environments

Course Content

Elementary sound theory - sound perception - special types of noise - measurement of noise and calculation methods for traffic noise -basics of acoustics and specification of sound - sound power, sound intensity and sound pressure levels - plane, point and line sources, multiple sources - outdoor and indoor noise propagation - psycho-acoustics and noise criteria - effects of noise on health – industrial noise pollution- noise standards and limit values - noise instrumentation and monitoring procedure - noise indices - annoyance rating schemes - special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom - methods of abatement of noise pollution - guidelines and laws governing air and noise pollution.

Books:

1. Rao C.S.: Environmental Pollution Control Engineering, New Age International Ltd., New Delhi, 2007.
2. Sincero A.P. and Sincero G.A.: Environmental Engineering, Prentice Hall of India.
3. Cunniff P.F.: Environmental Noise Pollution, McGraw Hill, New York, 1987.
4. Peterson A.P.G. and Gross E.E.: Handbook of Noise Measurement, General Radio Co., West Concord, Mass.

Course Outcomes

At the end of the course student will be able

1. to classify the sources of noise pollution and to understand their effects on human health
2. to understand outdoor and indoor noise propagation
3. to choose appropriate technologies for control of noise pollution
4. to establish and implement noise quality management components