MASTER OF TECHNOLOGY

ENVIRONMENTAL ENGINEERING

SYLLABUS FOR CREDIT BASED CURRICULUM (2015-2016)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620015

Master of Technology

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DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015, INDIA.

VISION OF THE INSTITUTE

- To provide valuable resources for industry and society through excellence in technical education and research.

MISSION OF THE INSTITUTE

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes.
- To generate new knowledge by engaging in cutting-edge research.
- To undertake collaborative projects with academia and industries.
- To develop human intellectual capability to its fullest potential.

VISION OF THE DEPARTMENT

Shaping infrastructure development with societal focus

MISSION OF THE DEPARTMENT

Achieve International Recognition by:

Developing Professional Civil Engineers
Offering Continuing Education
Interacting with Industry with emphasis on R&D

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	Graduates of the programme will become effectively as environmental engineers in government, industry, or other organizations; designing, improving, and implementing efficient environmental engineering practices that is sustainable.
PEO 2	Graduates of the programme will provide solutions to environmental engineering problems that account for economical, societal, ethical, as well as with standards both as individuals and in team environments, by applying acquired engineering knowledge.
PEO 3	Graduates of the programme will continue their lifelong learning to remain effective professionals to maintain and enhance technical, personal and professional growth.

PEO AND MISSION MAPPING

Department Mission	PEO 1	PEO 2	PEO 3
Developing Professional Civil Engineers	H	L	H
Offering Continuing Education	M	H	L
Interacting with Industry with emphasis on R&D	H	M	M

Note: H - High; M - Medium; L – Low

The first program educational objective of the program aims at attaining the mission by

- Technical Expertise
- Industry readiness
- Problem solving skills

The second program educational objective strongly addresses the mission component by,

- Ethical sensitivity
- Synergizing men and machines
- Leadership skills

The second program educational objective strongly addresses the mission component by,

- Updating knowledge
- Alternate problem solving
- Work – person balance

PEO AND CURRICULUM MAPPING (THEIR CONTRIBUTIONS TOWARDS ATTAINING THE PEOS)

Code	Course of Study	Semester	PEO 1	PEO 2	PEO 3
	Core Courses				
MA601	Numerical Methods and Applied Statistics	1	H	L	L
CE701	Environmental Chemistry and Microbiology	1	M	L	L
CE703	Physico-chemical Process for Water and Wastewater Treatment	1	H	H	H
CE709	Environmental Quality Measurements Laboratory	1	M	L	L
CE702	Biological Process Design for Wastewater Treatment	2	H	H	H
CE704	Transport of Water and Wastewater	2	H	M	L
CE706	Air Quality Management	2	M	M	M
CE710	Environmental Microbiology and Engineering Laboratory	2	H	M	L
	Elective courses				
CE711	Solid and Hazardous Waste Management	1,2	M	H	M
CE712	Industrial Wastewater Management	1,2	H	M	H
CE713	Environmental Impact Assessment	1,2	M	H	L
CE714	Water and Air Quality Models	1,2	H	M	M
CE715	Contaminant Transport Modeling	1,2	H	L	M
CE716	Environmental Systems Analysis	1,2	H	M	M
CE717	Design of Air Pollution Control Systems	1,2	H	L	M
CE718	Indoor Air Quality	1,2	M	L	M
CE719	Ecological and Ecosystems Engineering	1,2	M	M	L
CE720	Process chemistry for water and wastewater treatment	1,2	H	H	M
CE721	Membrane Technology for Water and Wastewater Treatment	1,2	H	M	H
CE722	Biodegradation and Bioremediation Techniques	1,2	M	H	H
CE723	Environmental Policies and Legislations	1,2	M	M	H
CE724	Cleaner Production and Environmental Sustainable Management	1,2	H	M	H
CE725	Environmental Health and Eco-Toxicology	1,2	M	H	M
CE726	Analytical Methods for Environmental Monitoring	1,2	H	M	H

CE727	Environmental Biotechnology	1,2	M	H	M
CE728	Environmental Geotechnology	1,2	M	M	H
CE729	River Engineering	1,2	M	L	L
CE730	Surface and Ground water modeling	1,2	M	M	H
CE731	Water Resources Systems Management	1,2	M	L	H
CE732	Environmental Engineering Structures	1,2	H	M	M
CE733	Remote Sensing and GIS for Environmental Applications	1,2	L	M	H

PROGRAMME OUTCOMES (POs)

Graduates of the Environmental Engineering Programme will be able:

a. To acquire in-depth knowledge of environmental engineering, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
b. To analyze complex environmental engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
c. To think laterally and originally, conceptualize and solve environmental engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
d. To extract information pertinent to unfamiliar environmental engineering problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually / in group(s) to the development of scientific / technological knowledge in one or more domains of environmental engineering.
e. To create, select, learn and apply appropriate techniques, resources, and modern environmental engineering and modeling tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
f. To possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
g. To demonstrate knowledge and understanding of environmental engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after considerisation of economical and financial factors.
h. To communicate with the engineering community, and with society at large, regarding complex environmental engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

i. To recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
j. To acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
k. To observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

GRADUATE ATTRIBUTES (GA)

1. Scholarship of Knowledge
2. Critical Thinking
3. Problem Solving
4. Research Skill
5. Usage of modern tools
6. Collaborative and Multidisciplinary work
7. Project Management and Finance
8. Communication
9. Life-long Learning
10. Ethical Practices and Social Responsibility
11. Independent and Reflective Learning

GA AND PO MAPPING

The Programme Outcomes have been derived from the Graduate Attributes. Hence, they are aligned to each other one to one as indicated below:

Graduate Attributes	**Programme outcomes**										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
1	√										
2		√									
3			√								
4				√							
5					√						
6						√					
7							√				
8								√			
9									√		
10										√	
11											√

CORRELATION BETWEEN THE POS AND THE PEOS

Three levels of correlation have been identified between the Pos and the PEOs, viz, High, Medium and Low. The correlation matrix is given below:

PEOS		Programme Outcomes										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**K**
Programme Educational Objectives	**1**	H	H	H	M	M	H	M	M	M	H	H
	2	M	M	H	L	L	M	H	H	M	H	M
	3	M	M	M	L	L	H	L	H	H	M	M

Note: H - High; M - Medium; L - Low

COURSE OUTCOME AND PO MAPPING

CORE SUBJECTS

Course Outcomes: On successful completion of the course, students will be able to:

Course Code	Course Name	CO	Course outcomes At the end of the course student will be able	a	b	c	d	e	f	g	h	i	j	K
MA701	Numerical methods and applied statistics	CO1	to distinguish the concepts of linear and nonlinear systems	H	H	M	L					M		
		CO2	to solve the problems through linear programming approaches	M	H	H	M					L		
		CO3	to correlate any results using statistical methods		H	M	H		L			H		M
		CO4	to develop statistical models between variables		M			H				M		M
CE701	Environmental chemistry and microbiology	CO1	to develop analytical and conceptual skills required for environmental chemistry research.	M	M		H		M			M		M
		CO2	to evaluate the causes and consequences of environmental pollution	M	H							M	H	L
		CO3	to categorize various water borne diseases and its transmitting agents	H	L		M		M			L		
		CO4	to differentiate between different microbial species and their role in wastewater treatment	M			H	L	M			L		
CE703	Physico chemical process for water and wastewater treatment	CO1	to evaluate various physical and chemical treatment options for treatment of water and wastewater	H	H				H			L		M
		CO2	to explain the mechanism behind the treatment processes and their advantages and disadvantages	H	M	M	M		M			H		

		CO3	to design various physico-chemical units for the treatment of water and wastewater	H	H	H	M		H			M		L
		CO4	to use the modeling concepts in the real field applications		M	H	M	L	L	L		M	M	M
CE709	Environmental quality measurement laboratory	CO1	to apply different analysis techniques for the measurement of physical and chemical parameters of water and wastewater	H	M		H	L	M			L		M
		CO2	to explain the operation and mechanism of different analytical equipment and their advantages and limitations	H			M		M			L		
		CO3	To relate the theoretical knowledge of sampling and analysis into lab practice	H	H	L	H		L			L		
		CO4	To estimate the concentration of various parameters in soil, water, wastewater and air	H	M		H	H						
CE702	Biological process design for wastewater treatment	CO1	to describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants.	H	L	L	M	L			M	L		
		CO2	to design the biological reactors based on biokinetics	H	H	M	M		M					M
		CO3	to select appropriate processes for specific applications, and have some knowledge of practical design considerations.	M	H	M	H	H	H	M			L	L
		CO4	to execute and assess the performance of bioreactors in laboratory scale		H	M	M	H	L			L		H
CE704	Transport of water and wastewater	CO1	to categorize the various appurtenances used in the distribution system	H	L									

		CO2	to design the water distribution network and sanitary sewage flow	M	H	H		H	L			M		L
		CO3	to differentiate hydraulics of sewers under various flow conditions		H	M	M					H		
		CO4	to evaluate water supply and sewer systems using software		H	H	M	H						M
CE706	Air quality management	CO1	to classify the type and sources of air pollutants and to understand their effects on human health and the broader environment	H			M		H				H	
		CO2	to differentiate various air pollution control technologies for particulates and gaseous pollutants	H	H		M		L			M		
		CO3	to choose appropriate technologies for removal of selective pollutants	M	H	M	M	M						
		CO4	to establish and implement air quality management	M	L	L			L	L		H	H	M
CE710	Environmental microbiology and engineering laboratory	CO1	to assess the microbial contamination in water	L	L	M	H	M				L		L
		CO2	to measure the performance of biological reactors	L	M		H	M						M
		CO3	to quantify the requirement of chemicals for treatment of water	L		M	M	L		L		L		M
		CO4	to estimate the pollutant concentration in atmosphere	M		M	M	L					L	M

ELECTIVES

Course Code	Course Name	CO	Course outcomes	a	b	c	D	e	f	g	h	i	J	k
CE711	Solid and hazardous waste management	CO1	to explain the various functional elements involved in waste management system	H	L		M				L		L	
		CO2	to quantify and categorize solid wastes for any region	H	L		M	M		H	L	M	H	H
		CO3	to prepare concept design for the common functional elements of the waste management systems	H	M	L	L	L					M	M
		CO4	to select suitable waste processing technologies and disposal methods	M	H	H	L	M	L	M		L	H	H
CE712	Industrial wastewater management	CO1	to recognize various environmental problems due to improper management of industrial wastewater	M	H		M		M	L			H	
		CO2	to explain various technologies for removal of pollutants from industrial wastewater	H	M	L	M					L	M	M
		CO3	to design waste treatment flow sheets for industries	H	M	M	M	M	L			L	H	M
		CO4	to recommend the pollution control methods for specific industries	M	M	L	L		H	M	L	L	H	M
CE713	Environmental impact assessment	CO1	to analyse the environmental impacts of the proposed projects	H	H	M	L	M	M	L	M	L	H	M
		CO2	to predict the magnitude of an impact using mathematical tools	M	L	L	L	H				L		M
		CO3	to propose proper mitigation measures to avoid environmental impacts	M	H	M	L		L	M	H	M	H	H
		CO4	to summarize the EIA report with suitable environmental management plan	H	H		H		L	L	H		M	M

CE714	Water and air quality models	CO1	to predict the quality of water in river, lakes and estuaries using mass balance approach and specific models	H	H	L	M	H			L	L	L	M
		CO2	to differentiate various transport mechanisms in estuary and river	H	M	M	M	L	L			L		
		CO3	to estimate the microbial population using growth models	M	H		H	M				L		M
		CO4	to evaluate the concentration of pollutant in ambient air using dispersion models	M	M	L	H	H	L			L		M
CE715	Contaminant transport modeling	CO1	to distinguish the contaminant transport in surface and subsurface water	H	H	M	H	M	L			L		M
		CO2	to develop flow and transport model for contaminant in surface and subsurface water	H	M	L	H	M	L			L	M	M
		CO3	to predict the future concentration of pollutants using numerical techniques	M	M	L	H	H				M		L
		CO4	to apply the software packages to develop contaminant transport model for field conditions	M	M	M	H	H	L	M	L	L	H	H
CE716	Environmental systems analysis	CO1	to analyse the system performance using simulation models	H	M	M	M	M				L		L
		CO2	to optimize environmental engineering systems using optimization models	H	H	M	M	M	L			L		L
		CO3	To employ model-based environmental analysis	M	H	L	M	M	L			L		M
		CO4	To choose a suitable environmental system analysis method and tool for a given decision situation	M	M	M	H	L				M	M	L
CE717	Design of air pollution control systems	CO1	to select specific pollution control device for particulate and gaseous air pollutants	H	H	M	M	L	L			L	M	L

		CO2	to design the effective air pollution control systems that meet appropriate technical and economic objectives	H	M	M	M	L	L			L	L	M
		CO3	to outline specific policies with respect to environmental regulations	M	H	L	L		M	M	H	L	H	H
		CO4	to choose proper Integrated air pollution control systems	H	H	M	L	L	M	L		M	H	M
CE718	Indoor air quality	CO1	to point out the factors affecting Indoor Air Quality (IAQ);	H	H	M	M	L	M	L	M	L		M
		CO2	to predict the indoor air quality using mathematical model	M	L	M	M	H				M		M
		CO3	to suggest the control techniques for indoor air pollution	H	H	M	M	L	L	L		M	H	M
		CO4	to measure the pollutant concentration in indoor environment	M	M	H	H	H	L	L	L	L		M
CE719	Ecological and eco systems engineering	CO1	to classify, evaluate and design interface ecosystems	H	H	L	L	M	L	L	L	M	M	H
		CO2	to design sustainable loading of ecosystems	M	H	M	M	H	M	L	L	M	H	M
		CO3	to model in different ecological scenarios and applications in real field	H	H	L	M	H	M	H	H	M	H	M
		CO4	to expertise on eco sanitation regarding different ecosystem	H	H	H	M	M	M	L		M	H	M
CE 720	Process chemistry for water and wastewater treatment	CO1	to infer the chemical processes involved in the treatment of water and wastewater.	M	M	L	M	L	L		L	M	L	M
		CO2	to apply the concepts of solubility equilibria for the treatment of industrial wastewater using advanced oxidation processes	M	M	M	H	L	L			M		L
		CO3	to differentiate the various biological conditions in the reactor by measuring redox potential	M	M	H	H	M	L			L		M

		CO4	to quantify the dosage of chemicals requirement based on chemical reactions and equations in water treatment	M	L	M	M	L	L			L		L
CE721	Membrane technology for water and wastewater treatment	CO1	to differentiate various membrane processes, principles, separation mechanisms and its applications	H	H	M	H	H	L			L		
		CO2	to explain the selection criteria for different membrane processes	H	H	L	H	L	L			M		
		CO3	to design membrane bioreactors	H	M	M	H	H	M			M		M
		CO4	to develop synthetic membranes by various preparation techniques	M	H	L	H	M	L	L		M	L	M
CE722	Biodegradation and bioremediation techniques	CO1	to analyze the benefit of microorganisms in degrading organic contaminants	H	M	L	H	L	M			M	L	M
		CO2	to evaluate the biodegradation process of selected compound using microorganisms	H	M	M	M	M	L	L		L		L
		CO3	to outline the chemical contamination and its effect on environment	M	H	L	H	L	L			M	M	
		CO4	to predict the fate of contaminant through modelling	H	H	M	H	M	L	L		M		M
CE723	Environmental policies and legislations	CO1	to relate and analyse Indian and International environmental policies and legislation	H	M	L	M		M		M	M	H	L
		CO2	to summarize the pollution control acts for water and air pollution	H	M		M		M		L	M	H	
		CO3	to analyse global environmental issues and to recommend suitable control methods	H	H	H	M	L	M	L	M	L	H	M
		CO4	to point out principles and various indicators of sustainability	M	H		H	M				M	H	

CE724	Cleaner production and environmental sustainable management	CO1	to modify schemes applied at different governance levels to achieve sustainable innovation.	H	H	L	L	L	H	L	L	M	H	L
		CO2	to prepare process flow diagrams and material balance for various industrial processes	M	M		L	L			M		H	
		CO3	to summarize various techniques for cleaner production	M	M	L	H		M	L		L	H	
		CO4	to apply environmental sustainable management concepts in industries	M	H	H	M	L	M	H	M	M	H	H
CE725	Environmental health and eco-toxicology	CO1	to differentiate the carriers or vectors that promote the transfer of these agents from the environment to humans.	H	M	L	H	M	M			M	L	
		CO2	to examine the toxicological and ecological aspects of ecotoxicology	H	H	M	H	H	M			L	M	L
		CO3	to transfer knowledge of ecotoxicological theory to new environmental situations	H	M	H	M	L	M	L		L	M	M
		CO4	to explain detoxification in human body and its mechanisms	H	M	H	H	M	M		L	M		M
CE726	Analytical methods for environmental monitoring	CO1	to analyse the principles of volumetric and instrumental analytical methods in environmental monitoring.	H	M	L	H	M	L			H		
		CO2	to use statistical methods for evaluating and interpreting data of environmental interest	M	M	M	H	M	M	L		M		M
		CO3	to discriminate electrochemical techniques	M	H	L	M	L	L			M	L	
		CO4	to summarize various material characterization techniques and its principles	H	L	L	H	L	L			L		

CE727	Environmental biotechnology	CO1	to explain the mechanisms of detoxification and biodegradation of solid wastes	H	M	L	H	L	M			L		
		CO2	to list out the different methods for bioremediation of environment	M	L	L	M	L	M	M		M	L	
		CO3	to design the biological system for the removal of nutrients	H	H	H	H	M	M	L		L	M	M
		CO4	to estimate the risk involved through risk assessment studies	H	H	M	H	M	M	M	M	L	H	M
CE 728	Environmental geotechnology	CO1	to analyse the mineralogical characteristics of soil	H	M	L	H	L	L			M		M
		CO2	to summarize the impact of contaminants on the properties of soil	H	M		M		M	L		M	H	
		CO3	to explain the concept of various waste containment facilities	M	L		M		M		L	M		
		CO4	to evaluate the stability of landfill liner for waste containment	H	M	M	H	M	L	L		M	M	M
CE729	River engineering	CO1	to calculate velocity and pressure distribution of free surface flow	M	L	M	M	M	M			L		M
		CO2	to develop flow and momentum equation for open channel flow	H	H	M	H	H	M		L	L	M	M
		CO3	to differentiate the hydrological characteristics and water quality in various surface sources	H	M	L	H	L	M	L		L	L	
		CO4	to analyse the sediment transport and its properties	H	H	L	H	M	M			M		M
CE730	Surface and groundwater modeling	CO1	to create flow models from borehole and other subsurface data.	H	H	M	H	M	M		L	M	M	M
		CO2	to describe the relations and interactions between surface and ground water resources	H	M	L	M	H	L		M	M		
		CO3	to explain the procedures to estimate the aquifer properties	H	M		H	M			M	M		

		CO4	to use the numerical techniques in surface and groundwater flow modelling	M	M	M	M	H	M			L	M	M
CE731	Water resources systems management	CO1	to plan multireservoir systems and to design dams	H	H	M	M	H	M	H	M	M	H	L
		CO2	to explain various rainwater harvesting techniques	H	L		M	L	L		M	M		
		CO3	to design and solve optimization models of water systems	H	H	H	H	H	M		L	M		H
		CO4	to analyse, assess monitor and manage problems related to drought	H	H	H	H	M	H	M	M	M	H	M
CE732	Environmental engineering structures	CO1	to select the fundamental requisites to design an environmental structure	M	M	M	H	M	L			L	L	
		CO2	to describe the inter-relationships between the built environment and natural systems	H	H		H	L	M	L	L	M	M	
		CO3	to evaluate different types of structural and non structural cracks	H	H	M	H	M	L			M	L	L
		CO4	to analyse suitable alternatives for repair and rehabilitation of environmental structures	H	H	H	H	M	M		L	M	H	L
CE733	Remote sensing and GIS for environmental applications	CO1	to describe the various satellites data products available for the environmental applications.	H	M	L	H	H	M		L	M		
		CO2	to apply the GIS and Remote Sensing techniques for various environmental problems	H	M	L	H	H	M	M		M		L
		CO3	to explain different softwares for modelling and data creation	H			M	H	M		L	M		
		CO4	to summarize the basic spectral mechanism behind GIS and remote sensing techniques	H	L		M		H		L	H		

MODES OF DELIVERY OF COURSES HELP IN ATTAINMENT OF THE POS

The teaching learning process comprises of different combinations of the modes of delivery of courses listed below;

- MD1: Lectures with interactions
- MD2: Tutorial
- MD3: Assignment
- MD4: Seminar / Term paper
- MD5: Presentations
- MD6: Group discussions
- MD7: Demonstrations / hands on training (Models, Laboratory) / mini project
- MD8: Case studies / field visit

	METHOD	**Justification**	**Attainment of POs**	Sample Courses
MD1	**LECTURE WITH INTERACTIONS** Formal discourse in which the instructor presents a series of events, facts, or principles, explores a problem or explains relationships	1. To orient students towards the content of the subject 2. To introduce a subject, to present basic material and to give directions on procedures. 3. To introduce a demonstration, discussion, or performance. 4. To illustrate principles, or concepts and to review, clarify, emphasize or summarize.	PO a, b, c, e, f, h, i	Numerical Methods and Applied Statistics, Environmental Chemistry and Microbiology, Water and Air Quality Models, Contaminant Transport Modeling, Environmental Systems Analysis Solid and Hazardous Waste Management, Industrial Wastewater Management, Environmental Impact Assessment
MD2	**TUTORIAL** A method of instruction in which an instructor works directly with an individual	1. A detailed presentation of view, which shows and explains the user interface to the user. 2. Demonstration of the	**PO a, e, f, h, i**	Physico-chemical Process for Water and Wastewater Treatment, Biological Process Design for Wastewater Treatment

	student.	process with the help of examples to exhibit how a process or workflow is achieved. 3. Method of review which tests or reinforces the understanding of particular content in related section or module. 4. Transition to additional sections or modules, which are built on previously provided instructions.		
MD3	**ASSIGNMENT** A method in which the instructor assigns reading to books, periodicals, project or research papers or exercises for the practice.	1. To orient students to a topic prior to classroom or Laboratory work. 2. To set the stage for a lecture demonstration or discussion. 3. To provide for or capitalize on individual differences in ability, background, or experience through differentiated assignments. 4. To provide for the review of material covered in class or to give practice. 5.	**PO a, b, c, d, e, f, g, h, i, j, k, l**	Numerical Methods and Applied Statistics, Environmental Chemistry and Microbiology, Water and Air Quality Models, Contaminant Transport Modeling, Environmental Systems Analysis Solid and Hazardous Waste Management, Industrial Wastewater Management, Environmental Impact Assessment
MD4	**SEMINAR / TERM PAPER** An arrangement involving the instructor and groups, rather than instructor and individual.	1. To provide general guidance for a group working on an advanced study or research project. 2. To exchange information on techniques and approaches	**PO a, h**	Physico-chemical Process for Water and Wastewater Treatment, Biological Process Design for Wastewater Treatment, Industrial Wastewater Management, Transport of Water and Wastewater

		being explored by members of a study or research group. 3. To develop new and imaginative solutions to problems under study by the group. 4. To stimulate active participation.		
MD5	**PRESENTATIONS** A method in which group discussion techniques are used to reach instructional objectives.	1. To develop imaginative solutions to problems and to stimulate thinking and interest and to secure student participation. 2. To emphasize main teaching points and to supplement lectures, reading, or laboratory exercises. 3. To determine how well student understands concepts and principles and to prepare students for application of theory of procedure. 4. To increase students acceptance and commitments and utilizes student knowledge and experience.	**PO a, e, h**	Physico-chemical Process for Water and Wastewater Treatment, Biological Process Design for Wastewater Treatment, Industrial Wastewater Management, Transport of Water and Wastewater, Solid and Hazardous Waste Management, Environmental Impact Assessment
MD6	**GROUP DISCUSSION**	1. Whole group discussions provide for greater interaction between teacher and students. 2. Teachers can check on what	**PO a, b, c, f, h**	Environmental Impact Assessment, Environmental Policies and Legislations

		students are retaining through questions posed. 3. Students have a tendency to stay focused on the lesson because they might be called on to answer questions 4. Students may feel more comfortable asking questions during whole group discussions.		
MD7	**DEMONSTRATION** A method of instruction where the instructor by actually performing an operation or doing a job shows the students what to do, how to do it, and through explanations brings out why, where, and when it is done.	1. To teach manipulative operations or procedures. 2. To teach troubleshooting and to illustrate principles. 3. To teach operation or functioning of equipment and to set standards of workmanship. 4. To teach teamwork and to teach safety procedures.	**PO a, b, c, d, e, f, g, h, i, j, k**	Air Quality Management, Indoor Air Quality,
MD8	**Case Studies / field visit**		**PO a, b, d, f, h, i, j**	

The above seven methods of content delivery are further classified into simple elements for each course category as given in the table below;

S.No.	Course Category	Modes of Course delivery	Tools used for Course delivery
1.	Mathematics	▪ MD1: Lectures with interactions ▪ MD2: Tutorial ▪ MD3: Assignment	▪ Black board ▪ Multimedia Presentation
2.	Professional Core (Analytical)	▪ MD1: Lectures with interactions ▪ MD2: Tutorial ▪ MD3: Assignment ▪ MD4: Seminar / Term paper ▪ MD5: Presentations ▪ MD6: Group discussions ▪ MD7: Demonstrations / hands on training (Models, Laboratory) / mini project	▪ Black board ▪ Multimedia Presentation ▪ NPTEL materials http://nptel.iitm.ac.in ▪ Video Lectures ▪ MIT Open Courseware http://ocw.mit.edu /index.htm
3.	Professional Core (Laboratory)	▪ MD1: Lectures with interactions ▪ MD6: Group discussions ▪ MD7: Demonstrations / hands on training (Models, Laboratory) / mini project	▪ Black board ▪ Multimedia Presentation
4.	Professional Core (Design)	▪ MD1: Lectures with interactions ▪ MD2: Tutorial ▪ MD3: Assignment ▪ MD4: Seminar / Term paper ▪ MD5: Presentations ▪ MD6: Group discussions ▪ MD7: Demonstrations / hands on training (Models, Laboratory) / mini project ▪ MD8: Case studies / field visit	▪ Black board ▪ Multimedia Presentation ▪ NPTEL materials http://nptel.iitm.ac.in ▪ Video Lectures ▪ MIT Open Courseware http://ocw.mit.edu /index.htm
5.	Electives	▪ MD1: Lectures with interactions ▪ MD2: Tutorial ▪ MD3: Assignment ▪ MD4: Seminar / Term paper ▪ MD5: Presentations ▪ MD6: Group discussions ▪ MD7: Demonstrations / hands on training (Models, Laboratory) / mini project ▪ MD8: Case studies / field visit	▪ Black board ▪ Multimedia Presentation ▪ NPTEL materials http://nptel.iitm.ac.in ▪ Video Lectures ▪ MIT Open Courseware http://ocw.mit.edu /index.htm

6.	Open Electives	▪ MD1: Lectures with interactions ▪ MD2: Tutorial ▪ MD3: Assignment ▪ MD4: Seminar / Term paper ▪ MD5: Presentations ▪ MD6: Group discussions ▪ MD7: Demonstrations / hands on training (Models, Laboratory) / mini project	▪ Black board ▪ Multimedia Presentation ▪ NPTEL materials http://nptel.iitm.ac.in ▪ Video Lectures ▪ MIT Open Courseware http://ocw.mit.edu /index.htm

The modes of delivery methods are chosen to meet the Program Outcomes. The mapping of modes of Course delivery to the Program Outcomes is shown in the Table

Modes of Delivery	**Programme Outcomes**										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
MD1	√	√	√		√	√		√	√		
MD2	√				√	√		√	√		
MD3	√	√	√	√	√	√	√	√	√	√	√
MD4	√							√			
MD5	√				√			√			
MD6	√	√	√			√		√			
MD7	√	√	√	√	√	√	√	√	√	√	√
MD8	√	√		√		√		√	√	√	

SEMESTER – I

Code	Course of Study	L	T	P	C
MA601	Numerical Methods and Applied Statistics	3	0	0	3
CE701	Environmental Chemistry and Microbiology	3	0	0	3
CE703	Physico-chemical Process for Water and Wastewater Treatment	3	1	0	4
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Elective III	3	0	0	3
CE709	Environmental Quality Measurements Laboratory	0	0	3	2
		18	**1**	**3**	**21**

SEMESTER – II

Code	Course of Study	L	T	P	C
CE702	Biological Process Design for Wastewater Treatment	3	1	0	4
CE704	Transport of Water and Wastewater	3	0	0	3
CE706	Air Quality Management	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
CE710	Environmental Microbiology and Engineering Laboratory	1	0	3	2
		19	**1**	**3**	**21**

SUMMER TERM

Code	Course of Study	L	T	P	C
	Practical Training (4 Weeks)	-	-	-	-

SEMESTER III

Code	Course of Study	L	T	P	C
CE747	*Project Work*	0	0	24	12

SEMESTER IV

Code	Course of Study	L	T	P	C
CE748	*Project Work*	0	0	24	12

ELECTIVES

Sl. No.	Code	Course of Study	L	T	P	C
1.	CE711	Solid and Hazardous Waste Management	3	0	0	3
2.	CE712	Industrial Wastewater Management	3	0	0	3
3.	CE713	Environmental Impact Assessment	3	0	0	3
4.	CE714	Water and Air Quality Models	3	0	0	3
5.	CE715	Contaminant Transport Modeling	3	0	0	3
6.	CE716	Environmental Systems Analysis	3	0	0	3
7.	CE717	Design of Air Pollution Control Systems	3	0	0	3
8.	CE718	Indoor Air Quality	3	0	0	3
9.	CE719	Ecological and Ecosystems Engineering	3	0	0	3
10.	CE720	Process chemistry for water and wastewater treatment	3	0	0	3
11.	CE721	Membrane Technology for Water and Wastewater Treatment	3	0	0	3
12.	CE722	Biodegradation and Bioremediation Techniques	3	0	0	3
13.	CE723	Environmental Policies and Legislations	3	0	0	3
14.	CE724	Cleaner Production and Environmental Sustainable Management	3	0	0	3
15.	CE725	Environmental Health and Eco-Toxicology	3	0	0	3
16.	CE726	Analytical Methods for Environmental Monitoring	3	0	0	3
17.	CE727	Environmental Biotechnology	3	0	0	3
18.	CE728	Environmental Geotechnology	3	0	0	3
19.	CE729	River Engineering	3	0	0	3
20.	CE730	Surface and Ground water modeling	3	0	0	3
21.	CE731	Water Resources Systems Management	3	0	0	3
22.	CE732	Environmental Engineering Structures	3	0	0	3
23.	CE733	Remote Sensing and GIS for Environmental Applications	3	0	0	3
24.		Any other elective				

Course Code	**:**	MA701
Title of the Course		**NUMERICAL METHODS AND APPLIED STATISTICS**
Designation as a required or elective	**:**	Core
Prerequisites	**:**	Basic knowledge in Mathematics
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To gain an understanding of statistical methods relevant to upper division interdisciplinary courses.
- To study the concepts of both discrete and continuous probability distribution
- To calculate the confidence intervals for various population parameters.
- To solve problems using Linear programming approach

Course Content

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion – Gauss seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods – interpolation – Newton's and Lagrange's interpolation
Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes' theorem
Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function
Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares
Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design – Time series analysis.

References

1. *Bowker and Liberman, Engineering Statistics, Prentice-Hall, 1972.*
2. *Venkatraman, M.K., Numerical Methods in Science and Engineering,* National Publisher Company.

Course outcomes

At the end of the course student will be able

- to distinguish the concepts of linear and nonlinear systems
- to solve the problems through linear programming approaches
- to correlate any results using statistical methods
- to develop statistical models between variables

Course Code	**:**	CE701
Title of the Course	**:**	**ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY**
Designation as a required or elective	**:**	Core
Prerequisites	**:**	Basic knowledge in Chemistry and Microbiology
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To provide detail understating of various aspects of chemistry, which are particularly valuable to environmental scientific practice
- To give knowledge about the principles and applications of various environmental monitoring instruments.
- To study the techniques for testing the microorganisms.
- To describe the characteristics and growth kinetics of microbial populations

Course Content

Colloids – Redox potentials – partition co-efficient – Beer – Lambert's Law – Limitations – UV visible spectroscopy – basic principles – application – Atomic spectroscopy – Principles and applications – Principles of green chemistry – Error Analysis of Environmental Data
Transport and transformation of chemicals – DO, BOD and COD – Photobcatalysis – Degradation of food stuffs, detergents, pesticides and hydrocarbons. Soil chemistry – acid – base and ion-exchange reactions in soil – salt affected soil and its remediation. Classification of microorganisms- prokaryotic, eukaryotic, structure, characteristics, nucleic acids-DNA, RNA, replication. Culturing of microoraganisms- Environmental factors influencing miribial growth.
Distribution of microrganisms- Water, Air and Soil, Indicatorborganisms, coliforms-fecal coliforms, E.coli, Streptococcus,Clostridium, Significance in water. Algae in water supplies-problems and control. MPN and MFT.
Ecotoxicology- toxicants and toxicity, factors influencing toxicity, effects- acute, chronic, concentration,bioaccumulation, biomagnification, bioassay, biomonitoring.

References

1. *C.N. Sawyer, P.L. McCarty, and G.F Parkin, Chemistry for Environmental Engineering, Tata McGraw-Hill, New Delhi, 2003.*
2. *G. W. Vanloon and S. J. Duffy Environmental chemistry – a global perspective, Oxford University press, Newyork., 2000.*
3. *Tortora. G.J, B.R. Furke, and C.L.Case, Microbiology- An introduction (4th Ed.), Benjammin/Cummings publ.Co.,Inc., California,1992.*
4. *Pelczar, M.J., Chan E.C.S. and Krieg, N.R. Microbiology, Tata McGraw Hill, New Delhi, 1993.*

Course Outcomes

At the end of the course student will be able

- to develop analytical and conceptual skills required for environmental chemistry research.
- to evaluate the causes and consequences of environmental pollution
- to categorize various water borne diseases and its transmitting agents
- to differentiate between different microbial species and their role in wastewater treatment

Course Code	**:**	**CE703**
Title of the Course	**:**	**PHYSICO CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT**
Designation as a required or elective	**:**	Core
Prerequisites	**:**	Basic knowledge in water and wastewater
Contact Hours, Type of Course	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To learn the physical, chemical and biological characteristics of water and wastewater.
- To provide an understanding of various physicochemical methods for treatment of water and wastewater.
- To explain the limitations, advantages and disadvantages of each unit operations and processes.
- To study the principle and design of the physical and chemical treatment units used for the removal of undesirable constituents (contaminants) from water and wastewater

Course Content

Water Quality-Physical, chemical and biological parameters of water- Water Quality requirement-Potable water standards-Wastewater Effluent standards-Water quality indices.
Water purification systems in natural systems-Physical processes-chemical processes and biological processes-Primary, Secondary and tertiary treatment-Unit operations-unit processes.
Mixing, clarification – sedimentation; Types; Aeration and gas transfer – Coagulation and flocculation, coagulation processes-stability of colloids- destabilization of colloids-destabilization in water and wastewater treatment-transport of colloidal particles, Clariflocculation.
Filtration processes- slow sand filtration- rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration.
Adsorption, adsorption equilibria- adsorption isotherms, Disinfection – chlorine dioxide; chloramines; ozonation; UV radiation.
Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis.

References

1. *Weber, W.J. Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.*
2. *Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.*
3. *Metcalf and Eddy, Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.*

Course outcomes

At the end of the course student will be able

- to evaluate various physical and chemical treatment options for treatment of water and wastewater
- to explain the mechanism behind the treatment processes and their advantages and disadvantages
- to design various physico- chemical units for the treatment of water and wastewater
- to use the modeling concepts in the real field applications

Course Code	**:**	CE709
Title of the Course	**:**	**ENVIRONMENTAL QUALITY MEASUREMENT LABORATORY**
Designation as a required or elective	**:**	Laboratory
Prerequisites	**:**	Basic knowledge in water and wastewater analysis
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To analyse the physical and chemical characteristics of water and wastewater
- To familiarize the methods to estimate the organic strength of wastewater
- To measure the concentration of pollutants in ambient air
- To evaluate the ability of soil sample for cation exchange

Physical and chemical characteristics of water – pH, Electrical conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates. Analysis of solids content of water: Total solids, Suspendd solids, volatile solids, non volatile solids, Residual chlorine analysis, Optimum coagulant dose, Break point Chlorination.
Test on dissolved oxygen, BOD and COD.
Ambient air quality Analysis: Determination of SPM, CO, NO_X and SO_X.
Soil Analysis: pH, Conductivity, Cation exchange capacity, Sodium Adsorption ratio

Course outcomes

At the end of the course student will be able

- to apply different analysis techniques for the measurement of physical and chemical parameters of water and wastewater

- to explain the operation and mechanism of different analytical equipments and their advantages and limitations
- to relate the theoretical knowledge of sampling and analysis into lab practice
- to estimate the concentration of various parameters in soil, water, wastewater and air

Course Code	**:**	CE702
Title of the Course	**:**	**BIOLOGICAL PROCESS DESIGN FOR WASTEWATER TREATMENT**
Designation as a required or elective	**:**	Core
Prerequisites	**:**	Basic knowledge in wastewater and its treatment
Contact Hours, Type of Course	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To learn the fundamentals of process kinetics and bioreactors
- To study about various biological treatment processes and its operations for the wastewater treatment.
- To explain the design principles and operational problems involved in various biological treatment processes
- To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors

Course Content

Constituents of wastewaters-Sources-Significant parameter-Fundamentals of Process Kinetics, Zero order, First order, Second order Reactions, Enzyme reactions –Bio reactors-Types- Classification- Design principles.
Design of wastewater treatment systems-Primary, secondary and tertiary treatments-Evaluation of Biokinetic Parameters -Activated Sludge and its process- Modifications, Biological Nitrification and denitrification.
Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors
Waste stabilization ponds and Lagoons: Aerobic pond, facultative pond, anaerobic ponds-polishing ponds, aerated Lagoons
Anaerobic processes-Process fundamentals-Standard, high rate and hybrid reactors, Anaerobic filters-Expanded /fluidized bed reactors-Upflow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Two stage/phase anaerobic reactors- Sludge Digestion, Sludge disposal.

References

1. *Benefield, L.D. and Randall C.W. Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.*
2. *Grady Jr. C.P.L and Lin H.C. Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980.*

3. *Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.*

Course outcomes

At the end of the course student will be able

- to describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants.
- to design the biological reactors based on biokinetics
- to select appropriate processes for specific applications, and have some knowledge of practical design considerations.
- to execute and asses the performance of bioreactors in laboratory scale

Course Code	**:**	CE704
Title of the Course	**:**	**TRANSPORT OF WATER AND WASTEWATER**
Designation as a required or elective	**:**	Core
Prerequisites	**:**	Basic knowledge in transport of water and wastewater
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To give an idea about various components involved in transport of water and wastewater
- To analyze the water distribution network using various mathematical techniques
- To explain the design concepts of water distribution network, sewerage and storm water drainage system
- To apply the software in the design of water supply networks

Course Content

Water storage – Impounding reservoirs – Intakes – pressure conduits – pumps – Economic design of pumps and pumping mains – Pipes – Pipe appurtenances – Water hammer.
Rapson methods, Distribution network analysis- methods of control and prevention of corrosion.
Sanitary sewage flow estimation – Sewer materials – Hydraulics of flow in sanitary sewers – Partial flow – Sewer designs – Sewer layouts – Storm drainage.
Storm runoff estimation – Hydraulics of flow in storm water drains – hydraulics of flow in storm water drains-storm water drain materials and section-design of storm water drains.
Maintenance of sanitary sewerage and storm drainage – equipments – corrosion in sewers – prevention and control – Waste water pumping networks, Application of software in design of water supply networks.

References

1. *Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.*
2. *Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.*

Course Outcomes

At the end of the course student will be able

- to categorize the various appurtenances used in the distribution system
- to design water distribution network and sanitary sewage flow
- to differentiate hydraulics of sewers under various flow conditions
- to evaluate water supply and sewer systems using software

Course Code	**:**	CE706
Title of the Course	**:**	**AIR QUALITY MANAGEMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Basic knowledge in Air pollution
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To provide general understanding of air quality and its impact on the environment.
- To study the fate and transport of air pollutants and its measurement techniques.
- To discuss the different control methods and its principles for gaseous pollutant.
- To learn the biological air pollution control technologies and its limitations.

Course Content

Air pollutants – Sources and classification of pollutants and their effect on human health vegetation and property- Effects - Reactions of pollutants and their effects-Smoke, smog and ozone layer disturbance - Greenhouse effect – Ambient and stack sampling.
Atmospheric diffusion of pollutants - Transport, transformation and deposition of air contaminants - Air sampling & pollution measurement methods - Ambient air quality and emission standards - Air pollution indices - Air Act
Control principles – Removal of gaseous pollutants by adsorption, absorption, reaction and other methods.
Particulate emission control- settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation.
Biological air pollution control technologies - bioscrubers, biofilters, and Indoor air quality.

References

1. *Wark Kenneth and Warner C.F, Air pollution its origin and control. Harper and Row Publishers, New York, 1981.*

2. *Rao C.S., Environmental pollution control Engineering, New age international Ltd, New Delhi, 1995.*
3. *Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.*

Course Outcomes

At the end of the course student will be able

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

Course Code	**:**	CE710
Title of the Course	**:**	**ENVIRONMENTAL MICROBIOLOGY AND ENGINEERING LABORATORY**
Designation as a required or elective	**:**	Core
Contact Hours, Type of Course	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To study the various techniques for the examination of microorganisms.
- To familiarise the kinetics of activated sludge process.
- To brief application of various physico-chemical processes in water and wastewater treatment.
- To know about the measurement of various air quality parameters.

Microscopic Examination of Microorganisms: Preparation of bacterial smear - staining - Hanging drop technique - plate count test, MPN tests and MFT Tests. Determination of MLSS and MLVSS in ASP - Coagulation and flocculation of water – Optimization of dose / pH / time of flocculation. Color removal from wastewater by adsorption - Estimation of suspended particulate matter / SPM, NO_x, SO_x.

Course Outcomes

At the end of the course student will be able

- to assess the microbial contamination in water
- to measure performance of biological reactors
- to quantify the requirement of chemicals for treatment of water
- to estimate the pollutant concentration in atmosphere

ELECTIVES

Course Code	**:**	CE711
Title of the Course	**:**	**SOLID AND HAZARDOUS WASTE MANAGEMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Fundamental knowledge in Waste management
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To understand the nature of the various functional elements in regional waste management systems and the relationships among them.
- To provide a knowledge about generation, characteristics and composition of urban solid waste, hazardous waste and biomedical waste.
- To enumerate and describe different disposal and treatment methods for municipal solid waste, hazardous waste and biomedical waste.
- To discuss the various elements of integrated waste management system.

Course Content

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management
Waste generation rates – Composition- Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse.
Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations - labeling and handling of hazardous wastes.
Waste processing – processing technologies – biological and chemical conversion technologies –Composting - thermal conversion technologies-energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes.
Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – closure of landfills – landfill remediation
Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes.
Elements of Integrated waste management.

References

1. *George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York, 1993*
2. *CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.*

Course Outcomes

At the end of the course student will be able

- to explain the various functional elements involved in waste management system
- to quantify and categorize solid wastes for any region
- to prepare concept design for the common functional elements of the waste management systems
- to select suitable waste processing technologies and disposal methods

Course Code	**:**	CE712
Title of the Course	**:**	**INDUSTRIAL WASTEWATER MANAGEMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Basic knowledge in water and wastewater treatment
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To study the sources and characteristics of industrial wastewater.
- To learn various pollution prevention options.
- To familiarize the various industrial wastewater treatment methods.
- To give an idea about waste treatment flow sheet for different industries.

Course Content

Sources and types of industrial wastewater – Environmental impacts – Regulatory requirements – generation rates – characterization – Toxicity and Bioassay tests.
Prevention Vs Control of Industrial Pollution– Source reduction techniques – Waste Audit- Evaluation of pollution prevention options.
Waste minimization - Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal – adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies - Individual and Common Effluent Treatment Plants – Zero effluent discharge systems - Wastewater reuse – Disposal of effluent on land.
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – Metal finishing – Petroleum Refining – Pharmaceuticals – Sugar and Distilleries – Food Processing – Fertilizers – Thermal Power Plants and Industrial Estates, Waste Audit.

References

1. *Eckenfelder, W.W., Industrial Water Pollution Control, McGraw-Hill, 1999.*
2. *Arceivala, S.J., Wastewater Treatment for Pollution Control, McGraw-Hill, 1998.*
3. *Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001*.

Course Outcomes

At the end of the course student will be able

- to recognize various environmental problems due to improper management of industrial wastewater
- to explain various technologies for removal of pollutants from industrial wastewater
- to design waste treatment flow sheets for industries
- to recommend the pollution control methods for specific industries

Course Code	**:**	CE713
Title of the Course	**:**	**ENVIRONMENTAL IMPACT ASSESSMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Basic knowledge in Impact Assessment
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

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

Course Content

Evolution of EIA – Concepts – Methodologies – Screening – Scoping – Base line Studies-Mitigation – Matrices – Check list.
Rapid and Comprehensive EIA – Legislative and Environmental clearance procedures in India – 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 – EMS - Case studies in EIA.

References

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.*

Course Outcomes

At the end of the course student will be able

- to analyse the environmental impacts of proposed projects
- to predict the magnitude of an impact using mathematical tools
- to propose proper mitigation measures to avoid environmental impacts
- to summarise the EIA report with suitable environmental management plan

Course Code	**:**	CE714
Title of the Course	**:**	**WATER AND AIR QUALITY MODELS**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Basic knowledge in water and air quality
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To list out various modeling approaches for water quality in river, estuary and lakes
- To provide an understanding of mass balance approach for the prediction of air and water quality
- To brief the models for microorganisms growth and decay
- To give an idea of micro meteorological processes and its role in the transport of air pollutants.

Course Content

Modeling approaches to water quality - classification – Mathematical Models for water quality- Conservation of mass- mass balance- steady state system- time variable response system

Mass transport mechanisms - Advective and diffusive mass transport - DO and BOD models for Streams – Point source and multiple point sources Streeter Phelps model - oxygen 'sag' curve - deoxygenation and reaeration coefficients – anaerobic condition-Benthal oxygen demand

Models for Estuary-Estuary transport -Estuary Streeter Phelps -dispersion coefficient-Models for lakes – eutrophication-thermal stratification - physical chemical and biological processes - water quality distribution – temperature models.

Models for microorganisms decay- bacterial growth- microbial kinetics- batch reactor- CSTR reactor

Air quality models - Micrometeorological processes – lapse rate - wind rose – dispersion – stability classes - Gaussian dispersion model - Regional air quality models- Line source models- area source models- An Indoor air quality model

References

1. *Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, Mc Graw Hill International Editions, 1998.*

2. *Pevy, Rowe, and Techobanoglous, Environmental Engineering, Mc Graw Hill Publishing company, Newyork.*
3. *Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd., Newdelhi.*
4. *Bibbero. R.J, and I.G.Young, Systems approach to Air pollution control, John wiley & Sons, Newyork, 1974.*
5. *Chapra, Steven C., Surface water quality modeling, McGraw Hill International Edition, 1997.*

Course Outcomes

At the end of the course student will be able

- to predict the quality of water in river, lakes and estuaries using mass balance approach and specific models
- to differentiate various transport mechanisms in estuary and river
- to estimate the microbial population using various growth models
- to evaluate the concentration of pollutant in ambient air using dispersion models

Course Code	**:**	CE15
Title of the Course	**:**	**CONTAMINANT TRANSPORT MODELING**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE714 / WATER AND AIR QUALITY MODELS
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To study the transport phenomena of contaminants in surface and subsurface water
- To enumerate various model input parameters for transport of contaminants in surface and subsurface water
- To differentiate various numerical techniques for solving flow and transport equations
- To familiarize the surface and groundwater modelling tools for model development and prediction

Course Content

Transport phenomenon – advection - diffusion – dispersion — adsorption - conservative and non-conservative pollutants- Extrinsic and Intrinsic properties- laws of conservation- Reynolds Transport Theorem.
Governing Equations for flow and transport in surface and subsurface waters - chemical and biological process models - simplified models for lakes, streams, and estuaries.
Model complexity - model resolution - coupled and uncoupled models - linear and nonlinear models - Solution techniques – Model input parameters- Initial and boundary conditions - calibration – sensitivity analysis - application and evaluation of environmental control – bioremediation.

Numerical models: FDM- explicit vs. implicit methods - numerical errors - High resolution techniques -Finite volume techniques
Stream quality modeling using QUAL2K - Groundwater transport modeling using VISUAL MODFLOW

References

1. Martin, L.J. and McCucheon, S.C, *Hydrodynamics of transport for water quality modeling*, Lewis Publishers, Boca Raton, 1999.
2. Freeze, R.A. and Cherry. J.A. *Groundwater*, Prentice Hall, 1979.
3. Zheng, C. and Bennett, G. D., Applied contaminant Transport Modeling, A John wiley & sons, inc, publication, Newyork, 2002.
4. Sun, N. Z., Mathematical modeling of groundwater Pollution, Springer –Verlac Newyork Inc., and Geological publishing house, 1996.

Course Outcomes

At the end of the course student will be able

- to distinguish the contaminant transport in surface and subsurface water
- to develop flow and transport model for contaminant in surface and subsurface water
- to predict the concentration of pollutants using numerical techniques
- to apply the software packages to develop contaminant transport model for field conditions

Course Code	**:**	CE716
Title of the Course	**:**	**ENVIRONMENTAL SYSTEMS ANALYSIS**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Fundamental Knowledge in systems
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To brief the role of optimization models in planning and design of environmental engineering projects
- To list out various optimization models and its limitations
- To learn the application of simulation models in environmental projects
- To provide an understanding of application of modern tools in different case studies

Course Content

Systems Engineering – Analysis - Design – synthesis - applications to environmental engineering Systems.
Role of optimization models - Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models.

Formulation of objective functions and constraints for environmental engineering planning and design.
Probabilistic models - fuzzy models - Simulation models.
Modern tools - Expert systems - Neural networks - Genetic Algorithm - Case studies.

References

1. *Rich L.G., Environmental Systems Engineering, McGraw Hill, 1973.*
2. *Thoman R.V., Systems Analysis & water Quality control, McGraw Hill, 1978.*

Course Outcomes

At the end of the course student will be able

- to analyse the system performance using simulation models
- to optimize environmental engineering Systems using optimization models
- to employ model-based environmental analysis
- to choose a suitable environmental systems analysis method and tool for a given decision situation

Course Code	**:**	CE717
Title of the Course	**:**	**DESIGN OF AIR POLLUTION CONTROL SYSTEMS**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE706 / Air quality Management
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To give an idea of air pollution regulation and policies
- To enumerate and describe the various air pollution control methods
- To familiarize the approaches for the design of gaseous and particulate pollutant control
- To brief the various components of integrated air pollution control systems

Course Content

Industrial sources of air pollution- Emission factors-regulations- control strategies-policies.
Particulate Pollutant Control: Settling chambers - laminar and turbulent flow- Filtration – interception- Impaction- Convective diffusion- Collection of particles by cylindrical fibres and granular beds- Electrostatic precipitation - Cyclones - Wet collectors.
Gaseous Pollutant Control: Gas absorption in tray and packed towers- Absorption with/without chemical reaction- Removal of SO_2 - Adsorption in fixed beds- Breakthrough.
Removal of HCs/ VOCs- NO_X removal - Wet scrubbers.
Integrated air pollution control systems.

References

1. Lawrence K. Wang, Norman C Perelra, Yung-Tse Hung, *Air pollution control Engineering,* Tokyo.
2. Noel de Nevers, *Air pollution control Engineering*, McGraw Hill, New York.

Course outcomes

At the end of the course student will be able

- to outline the specific policies with respect to environmental regulations
- to select specific pollution control device for particulate and gaseous air pollutants
- to design effective air pollution control systems that meet appropriate technical and economic objectives
- to choose proper Integrated air pollution control systems

Course Code	**:**	CE718
Title of the Course	**:**	**INDOOR AIR QUALITY**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE706 / Air quality Management
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To assess the level of pollutants in indoor and outdoor air
- To learn the modelling tools and concepts for indoor air quality assessment
- To study the various outdoor sources contributing indoor air pollution
- 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.

References

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*.

Course outcomes

At the end of the course student will be able

- to point out the factors affecting Indoor Air Quality (IAQ)
- to predict the indoor air quality using mathematical model
- to suggest the control techniques for indoor air pollution
- to measure the pollutant concentration in indoor environment

Course Code	**:**	CE719
Title of the Course	**:**	**ECOLOGICAL AND ECO SYSTEMS ENGINEERING**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Fundamental Knowledge in Ecology
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To familiarize the principles and concepts of ecosystem
- To differentiate the structural and functional interactions of environmental systems
- To provide the knowledge about modelling of ecological systems
- To brief the sustainable loading of ecosystems

Course Content

Development and evolution of ecosystems – Principles and concepts – Energy flow and material cycling – productivity – Classification of ecotechnology – ecological engineering.
Classification of systems – Structural and functional interactions of environmental systems – Mechanisms of steady-state maintenance in open and closed systems.
Modeling and ecotechnology – Classification of ecological models – Applications- Ecological economics- Self-organizing design and processes – Multi seeded microcosms.
Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.
Ecosanitation – soil infiltration systems – Wetlands and ponds – Source separation systems – Aqua cultural systems – Agro ecosystems – Detritus based treatment for solid wastes – marine systems- Case studies.

References

1. *Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and Practice, Lewis Publishers, New York, 2003.*
2. *Etnier, C. and Guterstam, B., Ecological Engineering for Wastewater Treatment, Lewis Publishers, New York, 1997.*

Course Outcomes

At the end of the course student will be able

- to classify, evaluate and design interface ecosystems
- to design sustainable loading of eco systems
- to develop model in different ecological scenarios and applications in real field
- to expertise on eco sanitation regarding different ecosystem

Course Code	**:**	CE720
Title of the Course	**:**	**PROCESS CHEMISTRY FOR WATER AND WASTEWATER TREATMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Fundamental Knowledge in Process chemistry
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

The course aims

- To generalize the basic concepts of environmental chemistry
- To study the concept of acid base equilibria
- To use the solubility equilibria approach for the removal of heavy metals from water and wastewater
- To discuss the application of redox chemistry for the treatment of water by chemical processes

Course Content

Environmental Chemistry Basic concepts from general chemistry: chemical equations, types of chemical reactions, calculations from chemical equations, solutions, activity and activity coefficients, chemical equilibria, chemical thermodynamics, factors affecting chemical equilibrium. Gas laws.
Acid Base Equilibria: fundamentals, equilibrium diagrams, alkalinity and acidity, the carbonic acid system, buffering in water systems, measuring alkalinity.
Solubility Equilibria: Solubility equlilibria for slightly soluble salts, effect of other solutes on salt solubility, removal of heavy metals from complex water and wastewater systems.
Oxidation reduction Equlilibria: oxidation reduction processes galvanic cell and chemical thermodynamics, stability diagrams measuring redox potentials.
Water Stabilization: Electrochemical aspects of corrosion, water stabilization, Langelier saturation index, Caldwell Lawrence diagrams, Water softening and neutralization: chemical precipitation, ion exchange Application of Redox Chemistry:

References

1. Benfield, L.D.; Weand, B.L.; Judkins, J.F. (1982) *Process chemistry for water and wastewater*. Prentice Hall Inc Englewood Cliffs New Jersey.
2. Weber Jr., W.J. (1972) *Physico-chemical Process for Water Quality Control*. Wiley Inc. Newyork.

Course Outcomes

At the end of the course student will be able

- to infer the chemical processes involved in the treatment of water and wastewater
- to differentiate the various biological conditions by measuring redox potential
- to apply the concepts of solubility equilibria for treatment of industrial wastewater using advanced oxidation processes
- to quantify the dosage of chemicals requirement based on chemical reactions and equations in water treatment

Course Code	**:**	CE721
Title of the Course	**:**	**MEMBRANE TECHNOLOGY FOR WATER AND WASTEWATER TREATMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE712 / Industrial wastewater Management
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To provide a general overview of membrane materials, modules, transport phenomena, and process engineering fundamentals
- To focus on the most commonly employed membrane processes for water purification
- To study the role of membrane bioreactors for the treatment of wastewater
- To brief the membrane preparation methods and its applications

Course Content

Principles of Membrane processes- Types and Classification- Theory of Membrane separation- Types and choice of membranes– Liquid Membranes- Characterization of membranes-Recent development in membranes-Modules and washing process.
Electrodialysis- principles- Electro dialysis stack and its various components- ion exchange capacity- Electrical resistance of ion exchange membrane-Donnon dialysis- Reverse osmosis- theory and principle- membrane materials- design considerations.
Filtration- theory- Nanofiltration- Ultrafiltration- Microfiltration- Membrane Module/Element designs- Design of Membrane systems- Membrane bioreactors- Biotreatment Fundamentals, Biomass Separation MBR Principles- MBR Design Principles – Submerged anaerobic membrane bioreactors.

Fouling- Pretreatment methods and strategies – Langlier and Silt indexes- cleaning methods- Foulants analysis- disposal of RO concentrate- rejects in membranes.
Synthetic Membranes- preparation methods- composite membranes- preparation methods and applications- immersion precipitation preparation techniques- phase inversion membranes- Introduction to module and process design -zero Liquid effluent discharge Plants.

References

1. R.D. Noble and S.A. Stern, Membrane Separations Technology: Principles and Applications, Elservier, 1995.
2. E.D. Schroeder, Water & Wastewater Treatment, McGraw Hill, 1977.
3. J.G. Crespo and K.W. Boddekes, Membrane Processes in Separation and Purification, Kluwer Academic Publications, 1994.
4. R. Rautanbach and R.Albrecht, Membrane Process, John Wiley & Sons, 1989.

Course Code	**:**	CE722
Title of the Course	**:**	**BIODEGRADATION AND BIOREMEDIATION TECHNIQUES**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE711 / Solid and Hazardous waste Management
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To give a basic knowledge of the bioremediation and biodegradation techniques
- To study the fate and transport of contaminants in soil and water bodies.
- To provide an understanding of the bioremediation monitoring and toxicological risk assessment
- To learn current engineering methods/design used to enhance biodegradation.

Course Content

Bioremediation and biodegradation- Historical perspectives of biodegradation and bioremediation -contaminant bioavailability- microbial catabolism of organic pollutant - catabolic enzymes- properties- designing of microorganisms- biodegradation measurement potential-impediments to microbial biodegradation.
Biodegradation Detoxication Reactions – Principles of biodegradation- Biodegradation kinetics- Effect of pollutant chemical structure on biodegradation- Fate and transport of contaminants in soils and water bodies- Requirements of biodegradation- nutritional factors- Chemical structure- environmental factors- biological factors- Bioavailability and aging
Bioremediation monitoring and assessment methods- conventional plating and microbial enumeration- biochemical and physiological methods- BIOLOG- soil enzyme assay- immunochemical methods- phospholipids fatty acid analysis- molecular biology based methods- bacterial biosensors- molecular techniques- Toxicological risk assessments.
Biodegradation of organic compounds- anaerobic biodegradation of benzene and ethyl benzene- polyaromatic transformation and degradation- co-metabolic process for

polychlorinated biphenyl degradation- aerobic hexachlorocyclohexane biodegradation- co posting of contaminated soil.
Improved bioremediation by engineering microbes- Bioadsorbents- metal precipitation- enzymatic transformation of metals- strains for enhanced biodegradation-improved biodegradation by protein

References

1. A. Singh and O.P. Ward Biodegradation and bioremediation, Springer-Verlag Berlin Heidelberg New York, 2004.
2. K.H. Baker and D.S. Herson, Bioremediation, McGraw-Hill, Inc., New York, 1994.
3. M. Alexander, Biodegradation and Bioremediation, Academic Press, 1999.

Course Outcomes

At the end of the course student will be able

- to analyse the benefit of microorganisms in degrading organic contaminants
- to evaluate the biodegradation process of selected compound using microorganisms
- to outline the chemical contamination and its effect on environment
- to predict the fate of contaminant through modelling

Course Code	**:**	CE723
Title of the Course	**:**	**ENVIRONMENTAL POLICIES AND LEGISLATIONS**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	Fundamental knowledge in Environmental policies
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To give an idea about the most relevant environmental legislations and policies
- To provide an overview of the development of statutory environmental law in India
- To discuss about the global environmental issues and international laws to control them
- To familiarize the various environmental movements for sustainable developments

Course Content

Common environmental laws-Role of judiciary in environmental protection- Criminal law, Common law-Criminal procedure Code-Indian Penal Code-Fundamental Rights and Fundamental Duties-International and national efforts at environmental protection-Green funding and taxes-National Environmental policies-Framework for environmental impact assessment.
Pollution control acts for water and air pollution-Water Prevention and Control of Pollution) Act, 1974-Water (Prevention and Control of Pollution) Cess Act, 1977 - Air (Prevention & Control of Pollution) Act, 1981.

Other environmental protection acts-Environmental (Protection) Act, 1986; Forest Conservation Act, 1980 - National Forest Policy 1988 - Wild Life (Protection) Act, 1972, Public Insurance & Liabilities Act, 1991- Biomedical wastes (management and handling)- Noise pollution, Eco - labeling, and E.I A. Coastal zone Notification (1991).
International laws- Stockholm Conference- The Rio Earth Summit, 1992 - Rio+5 and the Rio+10- Montreal Protocol, Kyoto Summit, 1997 - Nairobi Declaration, World Summit on sustainable development, 2002- Role of UN authorities in protection of Global Environment - Global environmental issues and International laws: to control Global warming, Ozone depletion, Acid rains, hazardous waste.
Sustainable developments and environmental movements-Sustainable development principles, indicators of sustainability - sustainable development models- national and international sustainable development scenarios

References

1. S. Divan and A. Roseneranz, Environmental law and policy in India, Oxford University Press, New Delhi, 2001.
2. R. K. Sapru, Environmental Management in India Vol. I & II): Ashish Publishing House, 2004.
3. Gupta, K.R., Environmental Legislation of India, Atlantic Publishers, 2006.

Course Outcome

At the end of the course student will be able

- to relate and analyze Indian and International environmental policies and legislation
- to summarize pollution control acts for water and air pollution
- to analyse global environmental issues and to recommend suitable control methods
- to point out principles and various indicators of sustainability

Course Code	**:**	CE724
Title of the Course	**:**	CLEANER PRODUCTION AND ENVIRONMENTAL SUSTAINABLE MANAGEMENT
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE711 / Solid and Hazardous waste Management
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To provide the concept of sustainable development and to discuss the strategies and barriers of sustainability
- To deliberate the principles and concepts of cleaner production and its importance
- To enumerate the various elements of life cycle assessment
- To discuss the green building and green energy management in various industries

Course Content

Concepts of Sustainable Development – Indicators of Sustainability – Sustainability Strategies, Barriers to Sustainability – Resource degradation - Industrialization and Sustainable development – Industrial Ecology – Socio economic policies for sustainable development - Clean development mechanism, cleaner Production (CP) in Achieving Sustainability.
Principles and concepts of Cleaner Production- Definition – Importance – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches – Environmental Management Hierarchy – Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Internet Information & Other CP Resources.
Overview of CP Assessment Steps and Skills- Preparing for the Site visits-Information Gathering -Process Flow Diagram- Material Balance- CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Establishing a Program – Organizing a Program – Preparing a Program Plan – Measuring Progress – 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.
Elements of Life Cycle Assessment **(**LCA) – Life Cycle Costing – Eco Labelling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit, Green building & green energy concepts and management.
Industrial applications of CP, LCA, EMS and Environmental Audits- green energy and green process management in Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel industries.

References

1. J. Kirkby, P. O'Keefe and Timberlake, Sustainable Development, Earthscan Publication, London, 1996.
2. P.L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2000.
3. P. Modak, C. Visvanathan and M. Parasnis, Cleaner Production Audit, Environmental System Reviews, Asian Institute of Technology, Bangkok, 1995.

Course Outcome

At the end of the course student will be able

- to modify schemes applied at different governance levels to achieve sustainable innovation.
- to prepare process flow diagram and material balance for various industrial processes
- to summarize various techniques for cleaner production
- to apply environmental sustainable management concepts in industries

Course Code	**:**	CE725
Title of the Course	**:**	**ENVIRONMENTAL HEALTH AND ECO-TOXICOLOGY**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE719 / Ecological and Ecosystems Engineering
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To provide a broad overview of different aspects of Ecotoxicology.
- To learn the principles and methods of occupational safety and health administration
- To discuss the health risk assessment and its management in different industries
- To study the transport of toxicants in air and water

Course Content

Need for developing Environment- Health and Safety systems in work places- Extent of industrial pollution- Public exposure from industrial sources- Major chemical contaminants at workplace- Hazards by industry and its environmental effects- Status and relationship of Acts- Regulations and Codes of Practice.
The relationship of occupational hygiene/ safety and disease-Occupational Safety and Health Administration- Principles and methods of occupational health- Occupation Health and Safety Policy- OH & SMS Documentation- Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals- Health hazard in agriculture - Pesticides and environment- Pesticides and human health- Right to know Laws.
Overview, planning, hazard identification and risk assessment- Biological, chemical, physical and psychological health hazard- Health risk assessment and management in Tanneries, Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel industries.
Toxic substances in the environment- their sources and entry roots- Routes of toxicants to human body – entry through inhalation, skill absorption, indigestion and injection- Eco-system influence on the fate and transport of toxicants; Transport of toxicants by air and water-Transport through food chain - bio-transformation and bio-magnification
Accident Causation - Need for Accident Investigation, Accident investigation plan, Methods of Acquiring Accident Facts, 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. Education and Training in health Hygiene.

References

1. H. Koren, Handbook of Environmental Health and Safety – principle and practices, Lewis Publishers, 1991.
2. I. C. Shaw and J. Chadwick, Principles of Environmental Toxicology, Taylor & Francis ltd, 1998.

Course Outcome

At the end of the course student will be able

- to differentiate the carriers or vectors that promote the transfer of these agents from the environment to humans
- to examine the toxicological and ecological aspects of ecotoxicology
- to transfer knowledge of ecotoxicological theory to new environmental situations
- to explain detoxification in human body and its mechanisms

Course Code	**:**	CE726
Title of the Course	**:**	**ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	-
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To enumerate the various instrumental methods and its principles for environmental monitoring
- To identify the ion selective electrodes for measurement of ions in water and wastewater
- To study the principle of chromatography, spectrophotometry and their applications.
- To provide the information about various material characterization techniques

Course Content

Classification of instrumental methods- Performance characteristics of instruments (static and dynamic)- errors and uncertainties in performance parameters- noise reduction- Sensitivity and detection limit- Errors-types- expression of errors- Precision and accuracy- Calibration of instrumental methods.
Spectophotometry - Electromagnetic radiation -Atomic absorption and emission spectrometry -Ultraviolet-visible spectrophotometry principle and instrumentation- Atomic adsorption spectroscopy principle and instrumentation- Flame photometer- Fluorimetry- nephelometry and turbidimety- principles
Chromatography- principle and classification- column efficiency and resolution- quantitative determination- Column Chromatography- Thin Layer Chromatography- Principle and application of Ion-chromatography- Application Gas Chromatography(GC)- Principle and application of high precision liquid chromatography (HPLC)- Ion Chromatography- Mass Spectroscopy-GC-MS.
Electro chemical methods- electrochemical cell- reference electrodes- Cyclic votametry- Polarograph- Oscilloscopi Polarography- Ion Selective Electrodes- Conductomety- electrolytic conductivity specific- equivalent and molar conductance- working principles of pH, EC, TDS meters.
Material characterization techniques- SEM, TEM, XRD, FTIR, thermal analysis- working principles and applications.

References

1. D.A. Skoog, D.M. West and T.A. Nieman, Principles of Instrumental Analysis,5th Ed. Thomson Asion (P) Ltd. Singapore, 2004
2. H.H, Willard, L.L. Merit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 7th Ed. CBP Publishers and Distributors, New Delhi, 1986

Course Outcome

At the end of the course student will be able

- to analyse the principles of volumetric and instrumental analytical methods in environmental monitoring.
- to use statistical methods for evaluating and interpreting data of environmental interest
- to discriminate various electrochemical methods
- to summarize various material characterization techniques and its principles

Course Code	**:**	CE727
Title of the Course	**:**	**ENVIRONMENTAL BIOTECHNOLOGY**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	-
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To study the principles and concepts of environmental biotechnology
- To learn the applications of various biotechnological tools for the treatment and betterment of environment
- To enumerate the various biotechnological remedies for environmental pollution
- To brief the environmental effects and ethics of microbial technology

Course Content

Environmental Biotechnology -Principles and concepts - usefulness to mankind.
Degradation of high concentrated toxic pollutants- halogenated, non halogenated, petroleum hydrocarbons, metals - Mechanisms of detoxification – oxidation - dehalogenation - biotransformation of metals - biodegradation of solid wastes.
Biotechnological remedies for environmental pollution - decontamination of groundwater – bioremediation - Production of proteins – biofertilizers - Physical, chemical and microbiological factors of composting – health risk – pathogens – odor management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology– extra cellular polymers - Biogas technology.
Concept of rDNA technology – expression vectors – cloning of DNA – mutation – construction of microbial strains - radioactive probes - protoplast fusion technology – applications.

Environmental effects and ethics of microbial technology – genetically engineered organisms- Microbial containment-Risk assessment.

References

1. *Chaudhury, G.R., Biological degradation and Bioremediation of toxic chemicals, Dioscorides Press, Oregon, 1994.*
2. *Martin.A.M, Biological degradation of wastes, Elsevier Applied Science, London, 1991.*
3. *Blaine Metting.F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993*

Course outcomes

At the end of the course student will be able

- to explain the mechanisms of detoxification and biodegradation of solid wastes
- to list out the different methods for bioremediation of environment
- to design biological system for the removal of nutrients
- to estimate the risk involved through Risk assessment

Course Code	**:**	CE728
Title of the Course	**:**	**ENVIRONMENTAL GEOTECHNOLOGY**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	-
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To discuss the role of environmental geotechnology in waste management.
- To brief the mechanisms of the soil, water and contaminant interactions
- To provide the concept of waste containment facilities
- To familiarize the advanced soil characterization techniques

Course Content

Soil as a multiphase system; Soil – environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.
Soil mineralogy; significance of mineralogy in determining soil behavior; Mineralogical characterization.
Mechanisms of soil - water interaction: Diffused double layer models; force of attraction and repulsion; soil – water – contaminant interaction; theories of ion exchange; influence of organic and inorganic chemical interaction.
Introduction to unsaturated soil mechanics; water retention property and soil water characteristic curve; flow of water in unsaturated soil.
Concept of waste containment facilities; desirable properties; contaminant transport and retention; contaminated site remediation.

Introduction to advanced soil characterization techniques; Volumetric water content; Gas permeation in soil; electrical and thermal properties; pore size distribution; contaminant analysis.

References

1. *Mitchell, J.K and Soga, K Fundamentals of soil behavior, John Wiley and sons Inc., 2005.*
2. *Fang, H-Y, Introduction to Environmental Geotechnology, CRC Press, 1997.*
3. *Daniel, D.E, Geotechnical practice for waste disposal, Chapman and Hall, 1993.*
4. *Rowe, R.K, Quigley, R.M and Booker, Clay Barrier systems for Waste disposal facilities, J.R., E & FN Spon, 1995.*
5. *Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook , Kluwer Academic publishers, 2001.*
6. *Reddi, L.N. and Inyang H.F, Geoenvironmental Engineering – Principles and Applications, Marcel Dekker Inc., 2000.*
7. *Sharma, H.D. and Lewis, S.P, Waste Containment systems, Waste stabilization and Landfills: Design and evaluation, John Wiley & sons Inc., 1994.*

Course Outcomes

At the end of the course student will be able

- to analyse the mineralogical characteristics of soil
- to summarize the impact of contaminants on the properties of soil
- to explain the concept of various waste containment facilities
- to evaluate the stability of landfill liner for waste containment

Course Code	**:**	CE729
Title of the Course	**:**	**RIVER ENGINEERING**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE716 / Environmental Systems Analysis
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To learn the classification of free surface flow and flow profiles
- To provide an understanding of energy and momentum principles in open channel
- To give an idea about river hydrology and hydrological characteristics of lakes
- To discuss the sediment transport and its mechanism

Course Content

Classification of free surface flow, velocity and pressure distribution, Uniform flow.
Dynamics equation for gradually varied flow- Classification of flow profiles, Computational methods, Prismatic channels.

Energy and Momentum principles in open channel flow, Rapidly Varied Flow, Hydraulic jump- Analysis.
River Hydrology & Distribution of water quality Rivers, Estuaries, Physical and Hydrological Characteristics of Lakes.
Sediment Transport, Properties, Initiation of Sediment Transport, Bed load, Bed forms, Bed roughness, Suspended load, Total load, Meandering of Rivers, Scouring at different structures.

References

1. *Garde, R.J. Rangaraju, K.G."Mechanics of Sediment Transportation and Alluvial Stream problems", 1978.*
2. *Santhosh Kumar Garg., "Irrigation Engineering & Hydraulic structures", Khanna Publishers, 2006.*
3. *Subramanya., "Flow in Open Channels", Tata McGraw Hill, 2001.*

Course Outcomes

At the end of the course student will be able

- to calculate velocity and pressure distribution of free surface flow
- to develop flow and momentum equation for open channel flow
- to differentiate the hydrological characteristics and water quality in various surface sources
- to analyse the sediment transport and its properties

Course Code	**:**	CE730
Title of the Course	**:**	**SURFACE AND GROUNDWATER MODELING**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE714 / Water and Air quality models
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To provide a fundamental understanding of Surface and ground water quality modelling.
- To understand and apply various analytical methods in the development of surface and groundwater models.
- To discuss the concepts related to groundwater flow equations, well hydraulics, and aquifers
- To study the application of finite difference in groundwater modelling

Course Content

Land Processes – Subsurface and channel processes – Precipitation – Rain gauge network – Abstractions, Infiltration, Evaporation, Transpiration, Process and Models.

Unit Hydrograph and S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed model and Conceptual model.
Occurrence and movement of ground water- Properties of aquifer, Ground water flow equation, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.
Pumping tests, Analysis of unconfined and non leaky and leaky confined aquifer and water table aquifer, locating hydrogeologic boundaries, well design criteria.
Natural and artificial recharge of groundwater - salt water intrusion, application of finite difference in ground water.

References

1. *Ven Te Chow,"Applied Hydrology", Mc GrawHill Science Publishers, 1988*
2. *Singh ,Vijay ., "Elementary Hydrology", Prentice Hall ,1994*
3. *Raghunath. "Ground water", Mc Graw Hill, 2007*
4. *Bear , J., Hydraulics of Ground water, Mc Graw Hill, 2007*

Course Outcomes

At the end of the course student will be able

- to create flow models from borehole and other subsurface data
- to describe the relations and interactions between surface and ground water resources
- to explain the procedures to estimate aquifer properties
- to use the numerical techniques in surface and groundwater flow modelling

Course Code	**:**	CE731
Title of the Course	**:**	**WATER RESOURCES SYSTEMS MANAGEMENT**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	CE716 / Environmental systems analysis
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To brief about reservoir and river basin planning and design
- To study the design of water resource systems like dams, weirs and barrages.
- To enumerate various methods of rainwater harvesting system
- To apply various systems approach for the design and operation of reservoir

Course Content

Reservoir planning, Management, Multireservoir systems, Real time operation, River basin planning, water logging, soil salinity, salinity control.
Design of Dams, Non gravity Dams, Weirs and Barrages, Conjunctive use of Irrigation Water, Quality of Irrigation water, Contaminants and their effects on various crops.

Rain water Harvesting and Management- different types and methods of harvesting in urban and agricultural areas.
Drought analysis, NCA classification, Direct and Indirect losses, Drought severity assessment, Drought Monitoring, Drought Management.
Introduction to systems approach, Linear programming, Problem formulation, Solution by simplex method, Application to design and operation of reservoir, Non-Linear Programming, Sensitivity analysis, Monte Carlo Simulation.

References

1. *Dilip Kumar Majumdar, "Irrigation Water Management (Principles and practices)", Prentice Hal of India (P). Ltd., 2004.*
2. *Water Resources Systems, "Vedula & Mujumdar", Mc Graw Hill, 2005.*
3. *Daniel P. Loucks, "Water resources systems Planning and Management (Studies and Reports in hydrology)", 2006.*

Course Outcomes

At the end of the course student will be able

- to plan multireservoir systems and to design dams
- to explain various rainwater harvesting techniques
- to analyze, assess monitor and manage problems related to drought
- to design and solve optimization models of water systems

Course Code	**:**	CE732
Title of the Course	**:**	**ENVIRONMENTAL ENGINEERING STRUCTURES**
Designation as a required or elective	**:**	Elective
Prerequisites	**:**	-
Contact Hours, Type of Course	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To study the design concepts of various environmental engineering structures
- To enumerate the various repair and rehabilitation methods for various waste treatment units
- To differentiate the design concepts of surface and subsurface structures
- To identify different types of structural failures in treatment units

Course Content

Structural design of Concrete- Prestressed Concrete - anchorage for pipes - massive outfalls.
Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory.
Design of water retaining structures- Design of circular, rectangular, spherical and Intze type of tanks- Design of prestressed concrete cylindrical tanks.

Underground reservoirs and swimming pools- Intake towers- Structural design of settling tanks- clarifloculators- aeration tanks - effect of earth pressure and uplift considerations.
Identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

References

1. *Krishna Raju, Prestressed Concrete, Tata McGraw Hill, 1988.*
2. *Sinha N.C., Roy S.K., Reinforced Concrete, S. Chand and Co, 1985.*

Course Outcome

At the end of the course student will be able

- to select the fundamental requisites to design an environmental structure
- to describe the inter-relationships between the built environment and natural systems
- to evaluate different types of structural and non-structural cracks
- to analyze suitable alternatives for repair and rehabilitation of structures

Course Code	**:**	CE733
Title of the Course	**:**	**REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS**
Designation as a required or elective	**:**	Core
Prerequisites	**:**	-
Contact Hours, Type of Course	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, Semester Examination

Course Learning Objectives

- To discuss the various environmental applications of remote sensing and GIS
- To learn the fundamentals of remote sensing and Geographic Information system
- To give an idea about the various image processing techniques
- To familiarize the modelling concepts of different environmental issues and projects

Course Content

Fundamentals of geographic information system, geo-data type, Input Sources, Raster and Vector data structures, Comparison of Raster and Vector data structure, Analysis using Raster and Vector data, Projection and transformation, Retrieval, Reclassification, Overlaying, Buffering.
Electro-magnetic energy, spectrum, EMR interaction with atmosphere, Scattering, Atmospheric Windows and its Significance, EMR interaction with Earth Surface Materials, Spectral Signature EMR interaction with water, soil and Earth Surface. Introduction to image processing, Pre-processing and corrections, Visual Interpretation of Satellite Images, Environmental Satellites: GOES, NOAA, AVHRR, CZCR, OCM and MODIS.

Data base creation and quality modelling using GIS, Water supply and sewage network using GIS, Eutrophication in lakes and reservoir, Groundwater vulnerability, DRASTIC model, Remote Sensing application of reservoir and coastal water quality modelling,
Remote Sensing application on soil salinity mapping, soil erosion-land degradation, Impact of agricultural and industrial activity on soil properties, Catchment nutrients transport modelling, Monitor and mapping of atmosphere constituents, aerosol using MODIS satellite.
Modeling of land slides, suitable site for disposal of solid waste using Multi Criterion Analysis, GIS for health and emergency management, Impact analysis.

References

1. Sabins, F., Remote Sensing Principles and Interpretation, W. H. Freeman and Company, New York, Third edition, 2007.
2. Allan Brimicombe., GIS Environmental Modeling and Engineering, Taylor &Francis, 2003.
3. Lai, Poh C., Mak, Ann S.H. (Eds.)GIS for Health and Environment, Springer Publication, 2007.
4. Uzair M.S., GIS Tools for Water, Wastewater, and Storm water Systems, ASCE Press, 2002.
5. George Joseph, Fundamentals of Remote sensing, University Press, Second edition, 2005.

Course Outcome

At the end of the course student will be able

- to describe the various satellites data products available for the environmental applications
- to apply the GIS and Remote Sensing techniques for various environmental problems
- to explain different software for modelling and data creation
- to summarize the basic spectral mechanism behind GIS and remote sensing techniques