COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014
(An Autonomous Institution affiliated to ANNA UNIVERSITY, CHENNAI)
DEPARTMENT OF CIVIL ENGINEERING
REGULATIONS 2023 CHOICE BASED CREDIT SYSTEM

M. E. ENVIRONMENTAL ENGINEERING

VISION

To provide quality education in Civil Engineering and to become a state-of-the-art source of world-class Civil Engineers and Researchers.

MISSION

- M1 - To impart quality education in diverse areas of civil engineering to achieve the industrial expectations.
- M2 - To offer state-of the art facilities towards academic and research excellence.
- M3 - To nurture intellectual knowledge in modern technologies of Civil Engineering for enhancing entrepreneurship qualities and employability skills.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

Programme Educational Objectives of the post graduate program of Environmental Engineering are

PEO 1: Empower graduates with advanced technical and managerial proficiencies in environmental engineering and they will adeptly solve global and national environmental challenges.

PEO 2: Excel in various professional contexts, honing their problem-solving, research, and communication skills and they will contribute effectively to interdisciplinary teams and complex problem-solving scenarios.

PEO 3: Exemplify ethical leadership, addressing environmental issues responsibly and they will exhibit awareness of societal needs, promoting sustainable solutions with a focus on social well-being.

PROGRAM OUTCOMES (POs)

Three Graduate Attributes as given by NBA as per Washington Accord agreement should be considered for all the PG programmes without any change for POs.

PO1: An ability to independently carry out Research / Investigation and Development work to solve practical Problems in Environmental Engineering

PO2: An ability to write and present a substantial Technical Report / Document

PO3: Students should be able to demonstrate a Degree of Mastery over the area as per the specialization of the program.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the program M.E. Environmental Engineering will be able to

PSO1: Acquire advanced knowledge and design capabilities in environmental engineering, applying current codes, tools, and techniques to develop sustainable solutions for societal needs

PSO2: Analyze and solve complex environmental engineering problems through integrated experimental, analytical, and numerical approaches, considering safety, serviceability, economy, durability, and environmental impact.

PSO3: Effectively collaborate in scientific research, drawing upon acquired knowledge contribute to decision-making and advance innovative solutions for environmental engineering challenges.

MAPPING OF PROGRAMME EDUCATIONAL OUTCOMES WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC COUTCOMES

PEOs	PROGRAMME OUTCOMES			PSOs		
	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	x	x	x	x	x	x
2	x	x	x		x	
3				x	x	x

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M. E. ENVIRONMENTAL ENGINEERING

CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	23MEN111	Applied Statistics and Probability	FC	3	1	0	4	4
2.	23MEN112	Environmental Chemistry	PCC	3	0	0	3	3
3.	23MEN113	Environmental Microbiology	PCC	3	0	0	3	3
4.	23MEN114	Physical and Chemical Treatment Systems for Water and Wastewater	PCC	3	0	0	3	3
5.		Elective I	PEC	3	0	0	3	3
6.		Department Specific One Credit Course	EEC	2	0	0	2	1
PRACTICALS								
7.	23MEN221	Environmental and Processes Monitoring Laboratory	PCC	0	0	4	4	2
8.	23MEN222	Environmental Microbiology and Quality Analysis Laboratory	EEC	0	0	4	4	2
			TOTAL	**17**	**1**	**8**	**26**	**21**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	23MEN211	Biological Treatment Process for Wastewater	PCC	3	0	0	3	3
2.	23MEN212	Air and Noise Pollution Control Engineering	PCC	3	0	0	3	3
3.	23MEN213	Industrial Wastewater Pollution-Prevention and Control	PCC	3	0	0	3	3
4.		Elective II	PEC	3	0	0	3	3
5.		Elective III	PEC	3	0	0	3	3
6.		Value Added Course	EEC	2	0	0	2	1
PRACTICALS								
7.	23MEN221	Environmental and Processes Monitoring Laboratory	PCC	0	0	4	4	2
8.	23MEN222	Environmental Microbiology and Quality Analysis Laboratory	EEC	0	0	4	4	2
		TOTAL		**17**	**0**	**8**	**25**	**20**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Elective IV	PEC	3	0	0	3	3
2.		Elective V	PEC	3	0	0	3	3
3.		Elective VI/Open Elective	PEC/ OEC	3	0	0	3	3
PRACTICALS								
4.	23MEN331	Practical Training (4 Weeks)	EEC	0	0	0	0	2
5.	23MEN332	Project Work Phase I	EEC	0	0	6	4	2
		TOTAL		**9**	**0**	**6**	**15**	**14**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	23MEN441	Project Work Phase II	EEC	0	0	30	30	15
		TOTAL		**0**	**0**	**30**	**30**	**15**

LIST OF PROFESSIONAL ELECTIVE COURSES:

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	23MENE01	Solid and Hazardous Waste Management	PEC	3	0	0	3	3
2.	23MENE02	Natural Systems for Wastewater Treatment	PEC	3	0	0	3	3
3.	23MENE03	Environmental System Analysis	PEC	3	0	0	3	3
4.	23MENE04	Environmental Impact Assessment	PEC	3	0	0	3	3
5.	23MENE05	Septage and Onsite Wastewater Treatment Technologies	PEC	3	0	0	3	3
6.	23MENE06	Sustainability Engineering	PEC	3	0	0	3	3
7.	23MENE07	Project Formulation and Implementation	PEC	3	0	0	3	3
8.	23MENE08	Advanced Oxidation Process	PEC	3	0	0	3	3
9.	23MENE09	Computing Techniques in Environmental Engineering	PEC	3	0	0	3	3
10.	23MENE10	Geo Environmental Engineering	PEC	3	0	0	3	3
11.	23MENE11	Environmental Monitoring Instruments	PEC	3	0	0	3	3
12.	23MENE12	Water Quality Modeling	PEC	3	0	0	3	3
13.	23MENE13	Marine Pollution and Control	PEC	3	0	0	3	3
14.	23MENE14	Climate Change and Modeling	PEC	3	0	0	3	3
15.	23MENE15	Operation and Maintenance of Water and Wastewater Treatment Systems	PEC	3	0	0	3	3
16.	23MENE16	Air Quality Modeling	PEC	3	0	0	3	3
17.	23MENE17	Fate and Remediation of Emerging Contaminants	PEC	3	0	0	3	3
18.	23MENE18	Environmental Reaction Engineering	PEC	3	0	0	3	3
19.	23MENE19	Membrane Separation for Water and Wastewater Treatment	PEC	3	0	0	3	3
20.	23MENE20	Ecological Engineering	PEC	3	0	0	3	3
21.	23MENE21	Water Transmission, Water Distribution and Sewerage Systems	PEC	3	0	0	3	3
22.	23MENE22	Carbon Management	PEC	3	0	0	3	3
23.	23MENE23	Environmental Sustainability Governance Model	PEC	3	0	0	3	3
24.	23MENE24	Environmental Risk Analysis	PEC	3	0	0	3	3

LIST OF OPEN ELECTIVE COURSES OFFERED FOR THE STUDENTS OF OTHER PG PROGRAMMES:

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C	PG PROGRAMME
1.	23MSEOE01	Disaster Management	OEC	3	0	0	3	3	SE, CM, ES
2.	23MSEOE02	Energy Efficient Buildings	OEC	3	0	0	3	3	SE, CM, ES
3.	23MCMOE01	Landscape And Architecture	OEC	3	0	0	3	3	SE, CM, ES
4.	23MENOE01	Climate Change And Adaptation	OEC	3	0	0	3	3	SE, CM, ES

SUMMARY

Category; FC – Foundational course, PCC –Professional Core, PE- Professional Elective Course, OE-Open Elective Course, EEC –Employability Enhancement Course

M.E. ENVIRONMENTAL ENGINEERING						
Sl. No.	Subject Area	Credits per Semester				Total Credits
		I	II	III	IV	
1.	FC	4				**4**
2.	PCC	11	11			**22**
3.	PEC	3	6	6		**15**
4.	OEC			3		**3**
5.	EEC	3	3	5	15	**26**
					TOTAL CREDITS	**70**

SEMESTER I

23MEN111	APPLIED STATISTICS AND PROBABILITY	L	T	P	C
		4	0	0	4

MODULE I TESTING OF HYPOTHESIS **12**

Sampling distributions - Small and large samples -Tests based on Normal, t, F and Chi square distributions for testing of means, variance and proportions-Goodness of fit-Independence of attributes

MODULE II CORRELATION AND REGRESSION **12**

Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations.

MODULE III DESIGN OF EXPERIMENTS **12**

Selection of treatment–design of municipal water treatment plant units–aerators–chemical feeding– flocculation–clarifier–tube settling–filters–rapid sand filters, slow sand filter, pressure filter, dual media filter – disinfection flow charts– layouts –hydraulic profile ,PID-construction and O&M aspects– case studies, residue management – upgradation of existing plants – recent trends.

MODULE IV PROBABILITY SAMPLING METHODS **12**

Probability sampling methods - simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method - convenience sampling, judgment sampling, quota sampling.

MODULE V MULTIVARIATE ANALYSIS **12**

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Apply the concept of testing of hypothesis for small and large samples in real life problems.

CO2: Concept of linear regression, correlation, and its applications.

CO3: Design and analyze experiments related to municipal water treatment plants.

CO4: Label the different types of probability and non-probability sampling methods.

CO5: Recall the steps involved in calculating the mean vector and covariance matrix of a random vector.

TOTAL: 60 PERIODS

REFERENCES:

1. “Probability and Statistics for Engineers and Scientists” 10th Edition, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye,Pearson Education,2021.
2. "Fundamental of Mathematical Statistics" Gupta.S.C and Kapoor. V.K., Sultan Chand &

Sons, 12th edition, 2022.

3. "Probability and Statistics for Engineering and the Sciences", Jay L.Devore, 9th edition, Thomson and Duxbury, Singapore, 2016.
4. "Applied Multivariate Statistical Analysis", Johnson, R.A. and Wichern, D. W., 7th Edition, Pearson Education, Asia, 2018.
5. "Probability and Statistics for Engineers" Johnson, R.A and Gupta, C.B., Miller & Freund's,Pearson Education, Asia, 9th Edition, 2020.
6. "Introduction to Linear Regression Analysis" Montgomery, Douglas C., Peck, Elizabeth A., Vining, G.Geoffrey, Wiley,Hoboken,NJ, 2021.
7. "Probability and Statistics for Engineers and Scientists" Walpole, R.E., R.H. Myers, and S.L. Myers, Pearson, 2022.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	2	2	2	2	1
2	2	3	2	2	2	1
3	3	3	3	3	3	3
4	2	1	2	2	2	1
5	1	1	1	1	1	1
Avg.	**2**	**2**	**2**	**2**	**2**	**1.4**

1-low, 2-medium, 3-high

		3	0	0	3

MODULE I FUNDAMENTALS **9**

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product (Ksp), heavy metal precipitation, amphoteric hydroxides, CO2 solubility in water and species distribution – Ocean acidification, Chemical kinetics, First order- 12 Principles of green chemistry.

MODULE II AQUATIC CHEMISTRY **9**

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction, pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation.

MODULE III ATMOSPHERIC CHEMISTRY **9**

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO2 capture and sequestration – acid rain- origin and composition of particulates - black carbon, air quality parameters determination.

MODULE IV SOIL CHEMISTRY **9**

Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

MODULE V EMERGING POLLUTANTS **9**

Heavy metals-chemical speciation –Speciation of Hg & As - endocrine disturbing chemicals-Pesticides, Dioxins & Furan, PCBs, PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites, environmental applications.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Examine fundamental principles of chemistry to solve problems related to environmental chemistry.

CO2: Assess the fate and behavior of chemicals in aquatic environments.

CO3: Identify the various factors contributing to atmospheric pollution.

CO4: Examine the principles of soil chemistry to address soil-related challenges.

CO5: Infer the speciation and toxicity of emerging pollutants.

TOTAL: 45 PERIODS

REFERENCES:

1. “Chemistry for Environmental Engineering and Sciences", Sawyer, McCarty, and Parkin, 7th edition, McGraw-Hill in 2018.

2. "Environmental Engineering - A Design Approach", Sincero, A.P. and Sincero, G.A., 5th edition, PHI Pub., New Delhi, 2019.
3. "Environmental Chemistry", De, A.K., 10th edition, New Age International Ltd., New Delhi, 2021.
4. "Environmental Chemistry", Colin Baird, Michael Cann, Macmillan Learning, 2012.
5. "Environmental Chemistry", Manahan, S.E., Eleventh Edition, CRC press, 2021.
6. "Elements of Environmental Chemistry", Ronbald A. Hites Wiley, 3rd Edition, 2012
7. "Environmental Organic Chemistry", R. P. Schwarzenbach, P. M. Gschwend, D.M.Imboden, J. Wiley and Sons, Inc., 3rd Edition, 2016.
8. "Pollution: Causes, Effects and Control", Harrison, R. M.,Cambridge , UK, 2022

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	2	2	2	1	1
2	2	2	3	3	2	1
3	2	2	2	2	2	1
4	2	2	2	2	2	1
5	2	2	2	2	2	1
Avg.	**1.8**	**2**	**2.2**	**2.2**	**1.8**	**1**

1-low, 2-medium, 3-high

23MEN113	ENVIRONMENTAL MICROBIOLOGY	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF MICROBIOLOGY **9**

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, concentration and detection of virus. Control of microorganisms - preservation of microorganisms, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

MODULE II MICROBIAL DIVERSITY AND NUTRIENT TURNOVER **9**

Distribution of microorganisms in different environments – diversity of microorganisms – fresh and marine, terrestrial – microbes in surface soil, air – outdoor and Indoor, aerosols, bio safety in laboratory – extreme environment – archae bacteria – occurrence in water supplies – problems and control. Bio geochemical cycles-nitrogen, carbon, phosphorus, sulphur – Role of Microorganism in nutrient cycle.

MODULE III METABOLISM OF MICROORGANISMS **9**

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism–respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics, disruption in metabolism and disease. Bio degradation of organic pollutants.

MODULE IV MICROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS **9**

Microbiology of biological treatment processes – aerobic and anaerobic, α-oxidation, β-oxidation, nitrification and denitrification, eutrophication. nutrients removal – BOD, nitrogen, phosphate -microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, E-coli, streptococcus, clostridium, Bioleaching.

MODULE V TOXICOLOGY **9**

Ecotoxicology – toxicants and toxicity, factors influencing toxicity. Effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bio concentration – Bioaccumulation, bio magnification, bioassay, bio monitoring.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Classify microorganisms based on their cell structure and characteristics.

CO2: Summarize the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.

CO3: Examine the nutrition and metabolism of microorganism.

CO4: Evaluate the microbiology of wastewater treatment system.

CO5: Infer the principles of ecotoxicology and toxicity testing.

TOTAL: 45 PERIODS

REFERENCES:

1. "Environmental Microbiology", Maier, R.M., Pepper, I.L. and Gerba, C.P, Academic Press, U.S.A., 2014.
2. "Microbiology", Pelczar Jn., M.J. Chan, E.C.S., Noel, K.R. and Foss, P.M, 8th Edition, Tata McGraw-Hill, New Delhi, 2021.
3. “Brock Biology of Microorganisms”, Michael T. Madigan, John M. Martinko, Jack Parker, and David A. Stahl, 15th Edition, 2020.
4. "Hand Book of Environmental Microbiology", Bhatia S.C, Part 1 and 2, Atlantic Publisher, 15th edition, 2020.
5. “Prescott's Microbiology”, by Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton, and Valerie Sundaramoorthy, 13th Edition, 2023.
6. “Environmental Microbiology for Engineers”, Volodymyr Ivanov, 2nd Edition, CRC Press, 2015.
7. "Environmental Microbiology", Raina M. Maier, Ian L. Pepper, Charles P. Gerba, Academic Press.
8. “Principles and Applications of Environmental Microbiology”, Brian J. McCabe and Ronald D. Bruch, Jones and Barlett Learning, 2020.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	2	2	1	1	1
2	2	2	2	1	1	1
3	2	2	2	1	1	1
4	2	2	2	2	2	1
5	2	2	2	1	1	1
Avg.	**1.8**	**2**	**2**	**1.2**	**1.2**	**1**

1-low, 2-medium, 3-high

23MEN114	PHYSICAL AND CHEMICAL TREATMENT SYSTEMS FOR WATER AND WASTEWATER	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Pollutants in water and wastewater–characteristics, standards for performance- significance of physico-chemical treatment–Selection criteria-types of reactor-reactor selection-batch-continuous type-kinetics.

MODULE II TREATMENT PRINCIPLES **9**

Physical treatment - screening – mixing, equalization –sedimentation – filtration – evaporation– incineration–gas transfer–mass transfer coefficient adsorption – isotherms – membrane separation, Reverse Osmosis, nanofiltration, ultrafiltration and electrodialysis, distillation– stripping and crystallization – recent advances. Principles of Chemical treatment– Coagulation - flocculation–Precipitation – flotation - solidification and stabilization– Disinfection, Ion exchange, Electrolytic methods, Solvent extraction–advanced oxidation/reduction– recent trends.

MODULE III DESIGN OF MUNICIPAL WATER TREATMENT PLANTS **9**

Selection of treatment–design of municipal water treatment plant units–aerators–chemical feeding– flocculation–clarifier–tube settling–filters–rapid sand filters, slow sand filter, pressure filter, dual media filter – disinfection flow charts– layouts –hydraulic profile ,PID-construction and O&M aspects– case studies, residue management – upgradation of existing plants – recent trends.

MODULE IV DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS **9**

Design of industrial water treatment units-selection of process–design of softeners – demineralizers– Reverse osmosis plants–flow charts–layouts–hydraulic profile, PID-construction and O&M aspects– case studies, residue management–upgradation of existing plants –recent trends.

MODULE V DESIGN OF WASTEWATER TREATMENT PLANTS **9**

Design of municipal wastewater treatment units-screens- grit chamber-settling tanks- sludge thickening - sludge dewatering systems - sludge drying beds - design of industrial wastewater treatment units - equalization - neutralization - chemical feeding devices – mixers - floatation units - oil skimmer - flowcharts – layouts – hydraulic profile, PID, construction and O&M aspects – case studies, retrofitting - residue management – upgradation of existing plants – recent trends.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the significance of various pollutants present in water, wastewater and develop the kinetics for reactor design.

CO2: Summarize the physico-chemical systems for effective water and wastewater treatment.

CO3: Design the municipal and industrial water, wastewater to meet the specific needs on

residue management and up gradation of existing plants.

CO4: Identify environmental issues in the society on wastewater treatment and formulate technical solutions that are economically feasible and socially acceptable.

CO5: Compose research to identify and design most appropriate treatment schemes for the emerging environmental issues on treatment systems.

TOTAL: 45 PERIODS

REFERENCES:

1. “Wastewater engineering, treatment and reuse”, Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Fourth Edition, McGraw-Hill, 2017
2. "Environmental Engineering: Fundamentals, Sustainability", Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous, McGraw Hill Education, 2021.
3. “Water and Wastewater Engineering: Treatment and Reuse”, Mackenzie Davis and David Cornwell McGraw-Hill Education, 2020
4. “Wastewater Treatment and Reuse”, Qasim.S.R. Guang Zhu, Volume 1& 2 2018.
5. “Wastewater Treatment, Concepts and Approach Design”, G.L. Karia, R.A. Christian, Second Edition, PHI Learning Private Limited, Delhi.
6. "Wastewater Treatment for Pollution Control and reuse", Arceivala S.J., and Asolekar S.R, McGraw Hill, fourth Edition, New Delhi, 2020.
7. “Manual for water supply and treatment”, CPHEEO manual Ministry of Urban development, New Delhi, 2019.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	2	3	3	3	1
2	2	2	3	3	3	1
3	3	3	3	3	3	2
4	3	2	3	3	3	2
5	3	3	3	3	3	2
Avg.	**2.6**	**2.4**	**3**	**3**	**3**	**1.6**

1-low, 2-medium, 3-high

23MEN121	ENVIRONMENTAL CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. Good Laboratory Practices, Quality control, calibration of Glassware
2. Sampling and Analysis of water (pH, alkalinity, hardness, chloride, Sulphate, turbidity EC, TDS,TS, nitrate, fluoride and Iron)
3. Sampling and Wastewater analysis (BOD, COD, Phosphate, Ammonia, TKN, Oil & Grease, Surfactant and heavy metals)
4. Sampling and characterization of soil (Moisture, EC, pH, Na and K)

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Apply GLP principles to conduct experiments with accuracy, reliability, and traceability.

CO2: Identify and mitigate potential sources of error in experimental procedures.

CO3: Interpret water analysis results and explain their significance in water quality assessment.

CO4: Elucidate wastewater analysis results and describe their implications for pollution control and environmental management.

CO5: Interpret soil characterization results and explain their significance in soil fertility, land management, and environmental assessment.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	1	1	1	1	1	1
2	2	2	2	2	2	1
3	3	3	3	3	3	2
4	3	3	3	3	3	2
5	3	3	3	3	3	2
Avg.	2.4	2.4	2.4	2.4	2.4	1.6

1-low, 2-medium, 3-high

23MEN112	RESEARCH PROPOSAL WRITING AND IPR	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. **Introduction to Research Proposal Writing**
    - Understanding the significance of research proposals
    - Differentiating between reactive and proactive proposals
    - Overview of the proposal development process
    - Components of a Research Proposal
2. **Problem Identification and Needs Assessment**
    - Techniques for conducting needs assessment (e.g., PRA, participatory tools)
    - Rationale and Literature Review
    - Incorporating previous research into project rationale
    - Goals, Objectives, and Sustainability
    - Formulating clear and SMART objectives
    - Strategies for project sustainability beyond initial funding
3. **Project Implementation and Management**
    - Developing project activities and using tools like log frames
    - Creating project work plans and GANTT charts
4. **Budgeting and Intellectual Property Rights**
    - Devising project budgets considering expenses and funding sources
    - Introduction to Intellectual Property Rights (IPR) and its relevance in research
5. **Monitoring, Evaluation, and Institutional Capability**
    - Designing effective monitoring and evaluation plans
    - Addressing management and institutional capacity in proposals
6. **Proposal Writing Practice and Review**
    - Hands-on proposal writing exercises
    - Peer review and feedback sessions
7. **IPR Considerations in Proposal Writing**
    - Explain copyright, patents, and other IPR concepts
    - Incorporating IPR considerations in research proposals

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Apply the Skill at generating well-suited proposals to meet distinct demands.

CO2: Apply the Skill in the creation of proactive proposals.

CO3: Illustrate the components of a proactive proposal and the process.

CO4: Evaluate a financial plan for the project, taking into consideration all required costs and potential avenues for funding.

CO5: Evaluate a comprehensive monitoring and evaluation scheme to assess the project's progress and outcomes.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	3	2	2	2	1
2	2	3	2	2	2	1
3	2	3	2	2	2	1
4	2	2	2	2	2	1
5	2	3	2	2	2	1
Avg.	**2**	**2.8**	**2**	**2**	**2**	**1**

1-low, 2-medium, 3-high

23MEN211	BIOLOGICAL TREATMENT PROCESS FOR WASTEWATER	L	T	P	C
		3	0	0	3

SEMESTER II

MODULE I REACTION KINETICS AND BIO REACTORS **9**

Objectives of biological treatment – significance – principles of aerobic and anaerobic treatment - kinetics of biological growth – factors affecting growth – attached and suspended growth - determination of kinetic coefficients for organics removal - enzyme kinetics biodegradability assessment - selection of process- reactors- biokinetics - batch reactor - continuous flow stirred tank reactor-plug flow reactor - flow charts, layout, PID, hydraulic profile.

MODULE II CONVENTIONAL AEROBIC TREATMENT PROCESSES **9**

Design of sewage treatment plant units –activated sludge process and variations - trickling filters- bio- tower- RBC- fluidized bed reactors, aerated lagoons, waste stabilization ponds – natural treatment systems, constructed wetland – nutrient removal systems- disposal options – reclamation and reuse recent trends.

MODULE III ADVANCED AEROBIC TREATMENT PROCESSES OF WASTEWATER **9**

Sequencing batch reactors- moving bed biofilm reactors- membrane bioreactor- reclamation and reuse of wastewater -application of membrane separation technologies in reuse of sewage -nutrient removal systems-case studies.

MODULE IV ANAEROBIC TREATMENT OF WASTEWATER **9**

Attached and suspended growth process - design of units – UASB – post treatment systems for UASB reactor-anaerobic filters – expanded bed and fluidized bed anaerobic systems - septic tank and soil disposal system - anaerobic baffled reactor – design of nutrient removal systems - anaerobic ammonium oxidation process - recent trends.

MODULE V SLUDGE TREATMENT, OPERATION AND MAINTENANCE **9**

Sources and its characteristics-design of sludge management facilities, sludge thickening-sludge digestion - biogas generation- sludge dewatering- mechanical – ultimate residue disposal – recent advances-construction and operational maintenance problems in STPs– trouble shooting – planning, organizing and controlling of plant operations – capacity building - retrofitting case studies.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Select appropriate bioreactors for specific wastewater treatment processes based on kinetic principles and reactor dynamics.

CO2: Evaluate the conventional aerobic treatment systems.
CO3: Design and size the different components of advanced aerobic treatment systems.
CO4: Examine in detail about the anaerobic treatment of wastewater which includes the design of attached and suspended growth processes.
CO5: Design the different elements of sludge treatment systems and infer the importance O&M issues pertaining to biological treatment systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. “Wastewater engineering, treatment and reuse”, Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Fourth Edition, McGraw-Hill, 2017
2. "Wastewater Treatment for Pollution Control and reuse", Arceivala S.J., and Asolekar S.R McGraw Hill, Fourth edition, New Delhi, 2017.

REFERENCES:

1. “Manual for water supply and treatment”, CPHEEO manual Ministry of Urban development, New Delhi, 2019.
2. “Manual for Sewerage and Sewage Treatment Systems”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
3. "Wastewater Treatment and Reuse. Theory and Design Examples", Qasim, S. R. and Guang Zhu, CRC Press, New York, 2018.
4. "Fundamentals of Water Treatment Process", David Hendricks, 2nd edition, CRC Press, New York 2020.
5. "Hand Book of Water and Wastewater Treatment Plant operations", F.R. Spellman, 4th edition, CRC Press, New York 2015.
6. “Wastewater engineering: Treatment and reuse”, Metcalf & Eddy, Inc. McGraw-Hill Education,2020

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	2
2	2	2	2	3	3	2
3	3	3	3	3	3	3
4	3	2	3	3	3	2
5	2	2	3	3	3	2
Avg.	**2.6**	**2.2**	**2.8**	**3**	**3**	**2.2**

1-low, 2-medium, 3-high

23MEN212	AIR AND NOISE POLLUTION CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Structure and composition of atmosphere – sources and classification of air pollutants – effects of air pollutants on human health, vegetation & animals, Materials & Structures – effects of air pollutants on the atmosphere, soil & water bodies – Longterm effects– global climate change, Ozone Holes – ambient air quality and emission standards – air pollution indices – emission inventories.

MODULE II AIR POLLUTION MONITORING AND MODELLING **9**

Ambient and stack sampling and analysis of particulate and gaseous pollutants -effects of Air Pollution climatology - meteorology on air pollution - fundamentals, atmospheric stability, inversion, wind profiles and stack plume patterns- transport & dispersion of air pollutants – modelling techniques- Fixed-box and Gaussian dispersion models.

MODULE III CONTROL OF PARTICULATE POLLUTANTS **9**

Factors affecting selection of control equipment; gas particle interaction, – working principle, design and performance equations of gravity separators, cyclones, Fabric filters, particulate scrubbers, electrostatic precipitators – operational considerations - costing of APC equipment – recent advances.

MODULE IV CONTROL OF GASEOUS POLLUTANTS **9**

Factors affecting selection of control equipment -working principle, design and performance equations of absorption, adsorption - condensation, incineration, bio-scrubbers, bio-filters – control technologies-SO2, NOx, CO, H2S; process control and monitoring - operational considerations - costing of APC equipment –emerging trends.

MODULE V AUTOMOBILE, NOISE AND INDOOR AIR POLLUTION **9**

Vehicular Pollution: Automobile emission- types of emissions- prevention and control of vehicular pollution -Noise Pollution: Sources and effects of noise pollution – measurement – standards –control and preventive measures.- Indoor Air Pollution: Sources and effects – control and preventive measures

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Summarize the various kinds of air pollutants and their consequences on the environment and human health.

CO2: Infer the meteorological concepts and modeling techniques to predict and interpret air pollution patterns.

CO3: Analyze the efficiency and limitations of different PM control technologies for specific

applications.

CO4: Select and optimize appropriate gaseous pollutant control technologies based on pollutant types and emission targets.

CO5: Formulate comprehensive strategies to prevent and mitigate vehicular pollution, noise pollution, and indoor air pollution.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Air Pollution Control Engineering", Nevers, N.D., 3rd Edition, McGraw-Hill International, 2016.
2. "Environmental Science and Engineering", Gary W. Miller and Susan R. Babcock, 9th edition, 2021.

REFERENCES:

1. “Environmental Engineering”, Peavy, Rowe and Tchobanoglous, 5th Edition, McGraw Hill Publishers, New Delhi, 2017.
2. "Transport Processes and Separation Process Principles (Includes Unit Operations)", Geankoplis, C.J., 5th edition, PHI Pub., New Delhi, 2015.
3. "Principles of Environmental Engineering and Science", Mackenzie Davis and Susan Masten, 6th edition, 2023.
4. “Air Pollution Control Engineering”, C.S. Rao, Alpha Science International Ltd, 2023.
5. “Fundamentals of Air Pollution”, C. D. Cooper and F.C. Alley, Waveland press, 2022.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	1	2	2	2	1
2	2	2	2	2	2	2
3	3	2	2	2	3	2
4	3	2	2	2	3	2
5	3	2	2	2	3	2
Avg.	**2.6**	**1.8**	**2**	**2**	**2.6**	**1.8**

1-low, 2-medium, 3-high

23MEN213	INDUSTRIAL WASTEWATER POLLUTION - PREVENTION AND CONTROL	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Industrial scenario in India– industrial activity and environment - uses of water by industry – sources and types of industrial wastewater – nature and origin of pollutants - industrial wastewater and environmental impacts – regulatory requirements for treatment of industrial wastewater – industrial waste survey – industrial wastewater monitoring and sampling - generation rates, characterization and variables – toxicity of industrial effluents and bioassay tests – major issues on water quality management - composition and economic value of sludge.

MODULE II INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION **9**

Prevention vs. control of industrial pollution – benefits and barriers – waste management Hierarchy - source reduction techniques – periodic waste minimisation assessments – evaluation of pollution prevention options – cost benefit analysis – pay-back period – implementing & promoting pollution prevention programs in industries.

MODULE III INDUSTRIAL WASTEWATER TREATMENT **9**

Flow and load equalization – solids separation – removal of fats, oil & grease- neutralization-removal of inorganic constituents – precipitation, heavy METAL removal, nitrogen & phosphorous removal, Ion exchange, adsorption, membrane filtration, electro dialysis & evaporation – removal of organic constituents – biological treatment processes, chemical oxidation processes, advanced oxidation processes – treatability studies.

MODULE IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT **9**

Individual and common effluent treatment plants – Joint treatment of industrial and domestic wastewater - zero effluent discharge systems - quality requirements for wastewater reuse industrial reuse , present status and issues - disposal on water and land – residuals of industrial wastewater treatment – quantification and characteristics of sludge – thickening, digestion, conditioning, dewatering and disposal of sludge – management of RO rejects.

MODULE V CASE STUDIES **9**

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for textiles – tanneries – pulp and paper – metal finishing – Oil refining–pharmaceuticals–sugar and distilleries

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the industrial scenario in India, water usage, wastewater sources, pollutants,

environmental impacts, regulations, and key management approaches for industrial wastewater.

CO2: Evaluate and recommend source reduction techniques for industrial pollution prevention, considering economic feasibility and implementation strategies.

CO3: Design and select appropriate treatment processes for specific industrial wastewater characteristics, considering removal efficiency, cost, and environmental impact.

CO4: Assess the feasibility and sustainability of wastewater reuse applications for specific industries and propose appropriate residual management strategies.

CO5: Apply course knowledge to critically analyze industrial wastewater challenges and propose integrated solutions for specific sectors.

TOTAL: 45 PERIODS

REFERENCES:

1. "Industrial Wastewater Treatment, Wastewater reuse & Disposal", Metcalf & Eddy, McGraw-Hill Education, New York, USA, 2020.
2. "Environmental Engineering: A Design Approach", Sincero A.P. and Sincero G.A., PHI Learning Private Limited, Delhi, India, 2019.
3. "Water and Wastewater Engineering", Davis M.L. and Cornwell D.A., Cengage Learning, Stamford, USA, 2015.
4. "Industrial Waste Management for Pollution Control and Resource Recovery", Pandey S.N., Goyal A. and Mudgal V., CRC Press, Taylor & Francis Group, Boca Raton, USA, 2018.
5. "Industrial Wastewater Management, Treatment & Disposal", Water Environment Federation, 4th edition, McGraw-Hill Education in 2019.
6. "Industrial Wastewater Management", Mohsen Mostafaeipour, Springer, 2018
7. "Handbook of Water and Wastewater Treatment Plant Operations", Cheremisinoff, CRC Press, 2019

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	2
2	3	2	2	3	3	2
3	3	3	3	3	3	3
4	3	2	2	3	3	2
5	3	2	3	3	3	2
Avg.	**3**	**2.2**	**2.6**	**3**	**3**	**2.2**

1-low, 2-medium, 3-high

23MEN221	ENVIRONMENTAL AND PROCESSES MONITORING LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. Coagulation and Flocculation
2. Batch studies on settling
3. Studies on Filtration- Characteristics of Filter media
4. Water softening
5. Adsorption studies/Kinetics
6. Langelier Saturation Index and Silt Density Index- For Membrane Filtration
7. Kinetics of suspended growth process (activated sludge process)-and Sludge volume Index
8. Anaerobic Reactor systems / kinetics (Demonstration)
9. Advanced Oxidation Processes – (Photo catalysis) Demonstration
10. Disinfection for Drinking water (Chlorination)
11. Ambient Air Sampling-Determination of PM10, PM2.5, SO2 and NO2
12. Noise Monitoring-Determination of Equivalent Noise Level Demonstration

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Conduct treatability studies on water and wastewater treatment.

CO2: Determine the removal / degradation of pollutants from water and wastewater and arrive at kinetics.

CO3: Design scaled up reactors for treatment of water and wastewater treatment based on laboratory studies.

CO4: Determine ambient air quality of given study area in terms of Particulate and Gaseous Pollutants.

CO5: Determine Equivalent Noise Level by noise monitoring.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	2	1	2	3	3	2
2	3	2	2	3	3	2

3	3	3	3	3	3	3
4	3	1	2	3	3	2
5	3	1	2	3	3	2
Avg.	**2.8**	**1.6**	**2.2**	**3**	**3**	**2.2**

1-low, 2-medium, 3-high

23MEN222	ENVIRONMENTAL MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. Preparation of culture media
2. Isolation and culturing of microorganisms
3. Microscopical identification of Microorganisms (algae, bacteria and fungi)
4. Measurement of growth of microorganisms,
5. Analysis of air borne microorganisms
6. Staining of bacteria.
7. Effect of pH, temperature on microbial growth
8. Bacteriological analysis of wastewater (Coliforms, E.coli, Streptococcus) – MPN
9. Bacteriological analysis of wastewater (Coliforms, Streptococcus) - MF techniques,
10. Effect of Heavy metals on microbial growth
11. Detection of Anaerobic bacteria (Clostridium sp.)
12. Bioreactors (cultivation of microorganisms)

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Conduct treatability studies on water and wastewater treatment.

CO2: Determine the removal / degradation of pollutants from water and wastewater and arrive at kinetics.

CO3: Design scaled up reactors for treatment of water and wastewater treatment based on laboratory studies.

CO4: Determine ambient air quality of given study area in terms of Particulate and Gaseous Pollutants.

CO5: Determine Equivalent Noise Level by noise monitoring.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	1	2	3	3	2
2	3	2	2	3	3	2

3	3	3	3	3	3	3
4	3	1	2	3	3	2
5	3	1	2	3	3	2
Avg.	**2.8**	**1.6**	**2.2**	**3**	**3**	**2.2**

1-low, 2-medium, 3-high

SEMESTER III

23MEN331	**PRACTICAL TRAINING**	**L**	**T**	**P**	**C**
		0	**0**	**0**	**2**

PRACTICAL TRAINING

The students individually undertake training in reputed engineering companies doing Environmental Engineering related works during the vacation period for a specified duration of four weeks. At the end of the training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Identify key engineering principles and practices applied in the specific industry sector they trained in.

CO2: Explain the concepts, methodologies, and techniques used in their assigned projects during the industrial training.

CO3: Apply theoretical knowledge learned in coursework to solve practical engineering problems encountered during the internship.

CO4: Critically evaluate the strengths and weaknesses of the engineering solutions implemented in their training projects.

CO5: Prepare clear, concise, and well-organized reports that effectively communicate complex engineering information.

CO-PO & PSO MAPPING

CO	**PO**			**PSO**		
	1	**2**	**3**	**1**	**2**	**3**
1	2	1	3	3	2	1
2	2	3	2	3	2	1
3	3	2	2	3	3	2
4	2	2	2	3	3	2
5	3	3	2	2	2	1
Avg.	**2.4**	**2.2**	**2.2**	**2.8**	**2.4**	**1.4**

1-low, 2-medium, 3-high

23MEN322	PROJECT WORK PHASE I	L	T	P	C
		0	0	6	3

PROJECT WORK PHASE I

The student individually works on a specific topic approved by faculty member who is familiar in his/her area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Identify and define a significant environmental problem, considering its global or national implications.

CO2: Develop creative and sustainable solutions to the identified environmental problem, incorporating technical and managerial approaches.

CO3: Create a comprehensive project plan, outlining tasks, milestones, and resource requirements for the required duration.

CO4: Gather relevant data using appropriate methods and techniques, demonstrating competence in fieldwork, laboratory analysis, or data simulation. They will apply robust analytical skills to interpret data, identify trends, and draw meaningful conclusions.

CO5: Prepare clear and organized project reports, effectively communicating their problem-solving approach, methodologies, findings, and proposed solutions. They will also deliver a comprehensive final presentation that showcases their project's significance and outcomes.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	3	3
2	3	2	2	3	3	3
3	3	3	3	3	3	3
4	3	2	2	3	3	2

5	2	3	3	3	2	3
Avg.	**2.8**	**2.4**	**2.4**	**3**	**2.8**	**2.8**

1-low, 2-medium, 3-high

SEMESTER IV

23MEN441	**PROJECT WORK PHASE II**	**L**	**T**	**P**	**C**
		0	**0**	**30**	**15**

PROJECT WORK PHASE II

The student individually works on a specific topic approved by a faculty member who is familiar in his/her area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains a clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Identify and define a significant environmental problem, considering its global or national implications.

CO2: Develop creative and sustainable solutions to the identified environmental problem, incorporating technical and managerial approaches.

CO3: Create a comprehensive project plan, outlining tasks, milestones, and resource requirements for the required duration.

CO4: Gather relevant data using appropriate methods and techniques, demonstrating competence in fieldwork, laboratory analysis, or data simulation. They will apply robust analytical skills to interpret data, identify trends, and draw meaningful conclusions.

CO5: Prepare clear and organized project reports, effectively communicating their problem-solving approach, methodologies, findings, and proposed solutions. They will also deliver a comprehensive final presentation that showcases their project's significance and outcomes.

CO-PO & PSO MAPPING

CO	**PO**			**PSO**		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	3
2	3	2	2	3	3	3
3	3	3	3	3	3	3
4	3	2	2	3	3	2

5	2	3	3	3	2	3
Avg.	**2.8**	**2.4**	**2.4**	**3**	**2.8**	**2.8**

23MENE01	**SOLID AND HAZARDOUS WASTE MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1-low, 2-medium, 3-high

PROFESSIONAL ELECTIVES

MODULE I WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS **9**

Sources and types of solid and hazardous wastes - need for solid and hazardous waste management – salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries – elements of integrated waste management and roles of stakeholders - seven elements and seven step approach to integrated solid waste management planning.

MODULE II WASTE CHARACTERIZATION, SOURCE REDUCTION AND RECYCLING **9**

Waste sampling and characterization plan - waste generation rates and variation – physical composition, chemical and biological properties – hazardous characteristics – ignitability, corrosivity and TCLP tests –source reduction, segregation and onsite storage of wastes – waste exchange - extended producer responsibility - recycling of plastics, C&D wastes and E wastes.

MODULE III WASTE COLLECTION, TRANSPORT AND MATERIAL RECOVERY **9**

Door to door collection of segregated solid wastes - analysis of hauled container and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes –- principles and design of transfer and transport facilities - hazardous waste transport and manifests-mechanical processing and material separation technologies – Size reduction – size separation - density separation - magenetic separation – compaction – principles and design of material recovery facilities – physico chemical treatment of hazardous wastes - solidification and stabilization – case studies on waste collection and material recovery.

MODULE IV BIOLOGICAL AND THERMAL PROCESSING OF WASTES **9**

Biological and thermo chemical conversion technologies – composting – biomethanation – incineration – pyrolysis- plasma arc gasification –principles and design of biological and thermal treatment facilities - MSW processes to energy with high-value products and specialty By-Products- operation of facilities and environmental controls - treatment of biomedical wastes – case studies and emerging waste processing technologies.

MODULE V WASTE DISPOSAL **9**

Sanitary and secure landfills - components and configuration– site selection - liner and cover systems - geo synthetic clay liners and geo membranes - design of sanitary landfills and secure landfills- leachate collection, treatment and landfill gas management – landfill construction and operational controls - landfill closure and environmental monitoring – landfill bioreactors – rehabilitation of open dumps and biomining of dumpsites-remediation of contaminated sites- Case studies.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the various functional elements of solid and hazardous waste management including the associated legal, health, safety, and cultural issues as well as responsibilities of different stakeholders

CO2: Interpret the knowledge of science and engineering fundamentals to characterize different types of solid and hazardous wastes, assess the factors affecting variation and assess performance of waste treatment and disposal systems.

CO3: Develop designs for transfer stations and transport vehicles that optimize safety, efficiency, and compatibility.

CO4: Evaluate biological and thermochemical conversion technologies.

CO5: Select appropriate methods for processing and disposal of solid and hazardous wastes.

TOTAL: 45 PERIODS

REFERENCES:

1. “Municipal Solid Waste Management Engineering Principles and Management Issues”, (Second Edition) by George Tchobanoglous, Frank Kreith, and Ronald Yazdani.
2. , “Manual on Municipal Solid waste management”, CPHEEO, Vol I, II and III, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2016.
3. “Solid Waste Engineering - A Global Perspective” William A. Worrell, P. Aarne Vesilind, Christian Ludwig, 3rd Edition, Cengage Learning, 2017.
4. “Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York,2010.
5. “Waste Management Practices”, John Pitchtel, CRC Press,Taylor and Francis Group,2014.
6. “Environmental Resources Management, Hazardous waste Management”,5th Edition, Michael Gerrard and Michael D. LaGrega.
7. “Solid and Hazardous Waste Management”, Cherry P M, CBS publishers and distributors Pvt Ltd, 2018
8. “Solid and hazardous waste management – Science and Engineering”, Rao M.N, Razia Sultana, Sri Harsha Kota, Butterworth-Heinemann, 2016.

23MENE02	NATURAL SYSTEMS FOR WASTEWATER TREATMENT	L	T	P	C
		3	0	0	3

CO	PO			PSO		
	1	2	3	1	2	3
1	3	2	2	3	3	2
2	3	2	2	3	3	2
3	3	3	3	3	3	2
4	3	2	2	3	3	2
5	2	3	3	3	2	2
Avg.	2.8	2.4	2.4	3	2.8	2

CO-PO & PSO MAPPING

1-low, 2-medium, 3-high

MODULE I INTRODUCTION TO WETLAND TREATMENT SYSTEM **9**

Definition and concept of wetland - types of wetland. Wetland - ecology, flora and fauna, ecological aspects, human health and wetland, onsite applications - introduction to constructed wetland-types- free water surface, subsurface wetland-horizontal and vertical flow- wastewaters and their application in wetland - constructed wetland plants-media – in constructed wetland.

MODULE II CONSTRUCTED WETLAND AND REMOVAL MECHANISMS **9**

Site identification - construction and design of wetland, startup, operation and maintenance of wetland system-wetland hydrology- hydraulics. Treatment of domestic wastewater and its performance, mechanisms of pollutant removal- suspended solids, organic matter, nitrogen, phosphorus, pathogen and other contaminants. Reuse of treated wastewater and its applications- limitation of constructed wetland system.

MODULE III CASE STUDIES ON CONSTRUCTED WETLAND SYSTEM **9**

Constructed wetland- treatment of domestic wastewater- greywater - landfill leachate – treatment of industrial wastewaters- textile wastewater – dairy wastewater and its performance. Removal of specific pollutants such as heavy metals, aromatics and emerging contaminants etc. Use of amendments in wetland construction, and its performance. Capital and maintenance costs.

MODULE IV DESIGN OF WASTEWATER POND SYSTEMS **9**

Introduction- facultative -partial -mix aerated- ponds -complete -mix aerated pond systems - anaerobic ponds -nitrogen removal in lagoons. Modified high -performance aerated pond systems for nitrification and denitrification - nitrogen removal in ponds coupled with wetlands and gravel bed nitrification filters -Control of algae and design of settling basins. Hydraulic control of ponds -removal of phosphorous -removal of pharmaceuticals and personal care products and antibiotic resistant genes.

MODULE V SLUDGE MANAGEMENT AND TREATMENT **9**

Sludge quantity and characteristics - stabilization and dewatering -sludge freezing -reed beds

- vermi stabilization -comparison of bed type operations -composting land application and surface disposal of bio solids onsite wastewater systems -effluent disposal and reuse. Sludge quantity and characteristics-stabilization and dewatering-sludge freezing reed beds-vermi stabilization- Comparison of bed-type operations-composting land application and surface disposal of biosolids- on-site wastewater systems- effluent disposal and reuse

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the concept of wetland treatment systems, including types, ecological aspects, human health interactions, and onsite applications.

CO2: Evaluate and design constructed wetland systems, considering site selection, construction methods, operation and maintenance, hydraulics, and pollutant removal mechanisms.

CO3: Compare and contrast the performance of constructed wetlands in treating various wastewater types (domestic, industrial, etc.) and assess the removal of specific contaminants and the use of amendments.

CO4: Design and optimize wastewater pond systems, including different pond types, aeration strategies, nitrogen removal methods, algae control, and settling basins.

CO5: Select and implement appropriate sludge management and treatment techniques, considering stabilization, dewatering, land application, and effluent disposal.

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TOTAL: 45 PERIODS

REFERENCES:

1. "Natural Wastewater Treatment Systems", Ronald L. Droste, 2020.
2. "The Constructed Wetland Handbook", Robert H. Kadlec and Robert W. Kadle, 3rd Edition, 2019.
3. "Design of Wastewater Treatment Plants: Including Activated Sludge, Lagoons, and Biosolids", William J. McAnally, 6th Edition, 2020.
   "Wastewater Engineering: Treatment and Reuse", Metcalf & Eddy, Inc., 5th Edition, 2018.
4. "Constructed wetlands for industrial wastewater treatment system", Alexandros I.Stefanakis, Wiley black well, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	2	3	2
2	3	3	3	2	3	2
3	3	2	2	2	3	2
4	3	2	2	2	3	2
5	2	3	3	2	2	2
Avg.	**2.8**	**2.4**	**2.4**	**2**	**2.8**	**2**

1-low, 2-medium, 3-high

23MENE03	ENVIRONMENTAL SYSTEM ANALYSIS	L	T	P	C
		3	0	0	3

MODULE I ECOLOGICAL SYSTEM **9**

Basic concepts in ecology and ecological modelling, population dynamics: birth and death processes. Single species growth, prey-predator models: Lotka-Volterra, Rosenzweig-MacArther, Kolmogorov models. Multi - species modeling - structural analysis and stability of complex ecosystems.

MODULE II REACTOR MODELLING **9**

CSTR, plug-flow, dispersion. A case study of a tubular reactor with axial dispersion, parameter calibration: search algorithms for nonlinear dynamical models, variance of estimated parameters - application to Monod and Haldane kinetics.

MODULE III WATER QUALITY MODELLING **9**

Rivers and streams water quality modeling -dispersion and mixing- water quality modelling process- model sensitivity-assessing model performance; models for dissolved oxygen and pathogens- pollutant and nutrient dynamics -dissolved oxygen dynamics -groundwater quality modeling.

MODULE IV MICROBIAL DYNAMICS AND ENERGETICS **9**

Requirements for carbon and nutrient removal. Activated sludge: process schemes: completely mixed, plug-flow, SBR, nutrient removal. Anaerobic digestion: process dynamics, operational control of wastewater treatment processes.

MODULE V COMPUTER BASED SOLUTIONS **9**

Formulation of linear optimization models - linear programming - sensitivity testing and duality. Solution techniques and computer programming; Formulation of linear optimization models. Application of models- simulation, parameter estimation and experimental design.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze and interpret ecological models, including single-species, prey-predator, and multi-species models.

CO2: Formulate and apply reactor models like CSTR, plug-flow, and dispersion models to various environmental systems, considering parameter estimation and model limitations.
CO3: Evaluate and critique water quality models for rivers, streams, and groundwater, assessing performance and interpreting pollutant dynamics.
CO4: Design and optimize wastewater treatment processes like activated sludge and anaerobic digestion based on microbial dynamics and energetics.
CO5: Formulate and solve linear optimization models for environmental problems, incorporating sensitivity analysis and applying computational tools.

TOTAL: 45 PERIODS

REFERENCES:

1. "Integrated Solid Waste Management: Engineering Principles and Management Issues", George Tchobanoglous, Frank Kreith, and Ronald Yazdani,3rd Edition,2019.
2. "Environmental Resources Management, Hazardous waste Management", Michael Gerrard and Michael D. LaGrega, 5th Edition in 2018.
   "Wastewater Engineering: Treatment and Reuse", Metcalf & Eddy, Inc.,5th Edition,2018
3. "Surface Water Quality Modelling", Steven C. Chapra, Tata McGraw-Hill Companies,Inc., New Delhi 2018.
4. "Computational Modeling in Biotechnology", Ralf Steuer, 2nd Edition, 2018.
5. "Ecological Modeling and Prediction", Alan Hasting published, 2019.
6. "Environmental Modeling", R,James O. Evans, 2nd Edition, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	3
2	3	3	3	3	3	3
3	3	2	2	3	3	3
4	3	2	2	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**2.4**	**2.6**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE04	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle - legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues-public hearing in EIA- EIA consultant accreditation.

MODULE II IMPACT IDENTIFICATION AND PREDICTION **9**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological –– cumulative impact assessment.

MODULE III SOCIO-ECONOMIC IMPACT ASSESSMENT **9**

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. Factors and methodologies- individual and family level impacts. Communities in transition-rehabilitation.

MODULE IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN **9**

Documentation of EIA findings -Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – – ethical and quality aspects of environmental impact assessment.

MODULE V LEGISLATIVE PERSPECTIVES AND CASE STUDIES **9**

Manufacture - use - import - export - storage of hazardous microorganisms - genetically engineered organisms or cells - Rules 1989 - coastal zone regulation 2019 - Biomedical waste management rules 2020 - Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the historical context and legal framework of EIA in India, demonstrating the process, limitations, and cross- sectoral considerations.

CO2: Evaluate and apply various tools and techniques to identify and predict potential environmental impacts, including air, water, soil, noise, biological, and cumulative effects.

CO3: Assess the social and economic implications of projects, considering community dynamics, rehabilitation plans, and ethical aspects.

CO4: Develop and analyze EIA documentation and environmental management plans, including mitigation, monitoring, and ethical considerations.

CO5: Interpret and apply environmental regulations to specific industries and project types, drawing insights from case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. “EIA Notification 2016 including recent amendments”, Ministry of Environment, Forest and Climate Change, Government of India
2. “Sectoral Guidelines under EIA Notification”, Ministry of Environment, Forest and Climate Change, Government of India
3. “Environmental Impact Assessment”, John Glasson, Riki Thérivel and Andrew Chadwick, 5th Edition, 2020.
4. "Impact Assessment: Practical Solutions to Recurrent Problems and Contemporary Challenges", Lawrence, D.P., Wiley-Interscience, New Jersey. 2010.
5. Environmental Assessment in Practice: A Practitioner's Guide" Lee N. and George C. Chichester Willey, 2018,
6. “World Bank –Source book”, EIA, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	3
2	3	2	3	2	3	3
3	3	2	2	2	3	3
4	3	3	3	3	3	3
5	3	2	3	3	3	3
Avg.	**3**	**2.2**	**2.6**	**2.6**	**3**	**3**

1-low, 2-medium, 3-high

23MENE05	SEPTAGE AND ONSITE WASTEWATER TREATMENT TECHNOLOGIES	L	T	P	C
		3	0	0	3

MODULE I URBANIZATION AND SANITATION **9**

Sanitation infrastructure in urban india - emerging recognition of faecal sludge and septage management -sanitation service chain - faecal sludge and septage - need for faecal sludge and septage management - septage management and sewerage systems -components of sanitation value chain- approach to septage management in cities.

MODULE II DESLUDGING AND CONVEYANCE OF SEPTAGE **9**

Planning for emptying services - current status of emptying services -need for periodic cleaning of septic tanks - prohibition of employment as manual scavengers and their rehabilitation act- technologies for desludging - parameters for assessing conveyance options - demand based desludging - schedule based desludging - private sector participation.

MODULE III SEWAGE TREATMENT **9**

Unit operations and processes – selection of treatment processes — onsite sanitation – septic tank- grey water harvesting- decentralized sewage treatment – design of septic tank with depression pit – DEWATS, intermittent sand filters – anaerobic filters – waste stabilization ponds – design and operation.

MODULE IV SLUDGE STABILIZATION **9**

Objectives - aerobic and anaerobic sludge digestion processes – types of anaerobic digesters – design of low rate and high rate digesters – two stage digester-aerobic digestion-pure oxygen and thermophilic aerobic digestion - chemical and thermal stabilization process.

MODULE V REUSE AND LAND APPLICATION OF SEWAGE SLUDGE **9**

Introduction- beneficial use-requirements and associated risks-handling and management-storage - operation aspects of transport and application of biosolids application land-lagooning - landfilling- land farming - Composting-windrow composting -Vermicomposting - Laws and regulations on sludge management.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the challenges and opportunities associated with faecal sludge and septage management in urban India within the broader sanitation service chain.

CO2: Evaluate and select appropriate technologies and strategies for desludging and conveying septage considering technical, economic, and social factors.

CO3: Design and assess onsite wastewater treatment options such as septic tanks, decentralized systems, and constructed wetlands for various contexts.

CO4: Compare and select appropriate sludge stabilization methods, considering factors like efficiency, environmental impact, and resource recovery potential.

CO5: Develop safe and sustainable strategies for reuse or land application of sewage sludge, complying with regulations and minimizing risks.

TOTAL: 45 PERIODS

REFERENCES:

1. "Septage Management: A Guide for Decision-Makers and Practitioners", Feachem et al., 3rd Edition, 2019.
2. "Wastewater Engineering – Treatment and Reuse", Metcalf & Eddy, INC, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.
3. "National Policy on Faecal Sludge and Septage Management (FSSM)", Ministry of Urban Development Government of India, 2017
4. "Manual on Septage Management: Volume 1 - Introduction to Septage Management", World Bank, 2nd Edition, 2017.
5. "Reusing Treated Wastewater: A Practical Guide for Local Governments", World Health Organization, 2nd Edition, 2017.
6. "Guidelines for the Land Application of Sewage Sludge", US Environmental Protection Agency (EPA), 4th Edition, 2017.
7. "Decentralized Wastewater Treatment Systems: Planning, Design, and Operation", Tchobanoglous et al., 2nd Edition, 2017.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	2
2	3	2	2	2	3	2
3	3	3	3	3	3	2
4	3	2	2	3	3	2
5	2	3	3	3	2	2
Avg.	**2.8**	**2.4**	**2.4**	**2.8**	**2.8**	**2**

1-low, 2-medium, 3-high

23MENE06	SUSTAINABILITY ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I SUSTAINABILITY **9**

Introduction to sustainability concepts, the magnitude of the pressures on resources and ecosystems, roles of engineers in developing sustainable society, energy, materials use, environmental emissions – ozone depletion, global warming, air quality, water quality, wastes in the India – water, air, solid.

MODULE II RISK AND LIFE CYCLE BASED FRAMEWORKS FOR SUSTAINABILITY **9**

Environmental risk – risk assessment, risk based environmental law, life cycle – life cycle assessment, life cycle based environmental law, life cycle assessment tools, pollution prevention concepts.

MODULE III SUSTAINABLE MATERIALS **9**

Environmental and natural resource use footprints – material extraction and production, material flows in engineered systems, environmental releases- chemical and physical properties, estimate environmental partitioning, persistence and measures of exposure.

MODULE IV DESIGN FOR SUSTAINABILITY **9**

Sustainable engineering design principles, economic performance indicators, environmental performance indicators, social performance indicators, environmental cost analysis.

MODULE V CASE STUDIES **9**

Sustainable built environments, biofuels for transportation, electric vehicles, bioplastics.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the interconnected environmental, social, and economic dimensions of sustainability challenges, identifying the role of engineers in creating sustainable solutions.

CO2: Apply risk assessment and life cycle analysis tools to evaluate the environmental impacts of engineering projects and products, recommending sustainable alternatives.

CO3: Assess the environmental impact of material choices, considering extraction,

processing, usage, and end-of-life options, and select sustainable materials for engineering applications.

CO4: Integrate economic, environmental, and social performance indicators into the design process, creating sustainable engineering solutions.

CO5: Evaluate real-world examples of sustainable engineering practices, identifying key success factors and challenges.

TOTAL: 45 PERIODS

REFERENCES:

1. “Sustainable Engineering Practice: A Life Cycle Approach”, Allen & Shonnard, 3rd Edition, 2020.
2. “Introduction to Life Cycle Assessment”, Hauschild & Huijbregts, 2nd Edition, 2016.
3. “Design for Environment: A Guide to Sustainable Product Development”, Tainter, 3rd Edition, 2017.
4. “The Circular Economy Handbook: Realizing the Circular Advantage”, EMF et al., 2nd Edition, 2019.
5. "Sustainable Development and India", Bimal N. Patel and Ranita Nagar, Oxford University Press, 2018.
6. “Bioinspired Innovation and Design: Materials, Engineering, and Sustainability”, Bar-Cohen, 2019.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	3
2	3	3	3	3	3	3
3	3	2	2	3	3	3
4	3	3	3	3	3	3
5	3	2	2	3	3	3
Avg.	**3**	**2.4**	**2.4**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE07	PROJECT FORMULATION AND IMPLEMENTATION	L	T	P	C
		3	0	0	3

MODULE I PROJECT FORMULATION **9**

An overview of the project cycle – planning process and project planning – search for project ideas – strategies in capital allocation – key elements in project formulation – methods and tools for project formulation – project identification and selection – preparation of feasibility reports as per government policies (amrut/ jnnurm).

MODULE II PROJECT ANALYSIS **9**

Capital cost estimation – market demand analysis – technical analysis – environmental analysis – financial and economic analysis – cash flow generation.

MODULE III PROJECT APPRAISAL **9**

Time and value of money – investment criteria – internal rate of return – net present value, cost benefit analysis, and social cost benefit analysis – project risk analysis – appraisal of marketing strategy – pricing and credit worthiness and management capabilities.

MODULE IV PROJECT FINANCING AND IMPLEMENTATION **9**

Funding options for urban and rural development projects – tender procedure – transparency in government tender rules – organizational aspects in project management – network techniques for project management – resource management - risk management.

MODULE V PROJECT MONITORING AND EVALUATION **9**

Need and techniques for monitoring – service level benchmark performance and process monitoring schedules – penalty and bonus points.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze and apply project planning frameworks and tools to formulate well-defined project proposals.

CO2: Infer capital cost estimation, market and demand analysis, technical, environmental,

financial and economic analysis.

CO3: Assess time and value of money, investment criteria, internal rate of return, cost benefit analysis, project risk analysis and appraisal of marketing strategy.

CO4: Summarize funding options for urban and rural development projects, tender procedure, transparency, resource management & risk management.

CO5: Identify need and techniques for monitoring project performance.

TOTAL: 45 PERIODS

REFERENCES:

1. "Project Management-The Managerial Process", Clifford F Gray, Erik W Larson, Tata Mcgraw-Hill Publishing Co Ltd.
2. "Project Management- A Managerial Approach", Jack Meredith, Samuel J. Mantel Jr. John Wiley And Sons
3. "Detailed Project Report: Preparation Toolkit", sub-mission for urban infrastructure and governance, government of India.
4. "Project Management for Business and Technology", John M Nicholas Prentice hall of India pvt ltd.
5. "Project Management: A Guide to the PMBOK Guide", project management institute (PMI), 6th edition, 2017.
6. "Project Evaluation Tools and Techniques for Decision Making", Cleland & King, 2016.
7. "Managing Projects with Primavera Professional", Fidler, 2020.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	2	2	3	3	3
3	3	3	3	3	3	3
4	3	2	2	3	3	3
5	2	3	3	3	3	3
Avg.	**2.8**	**2.6**	**2.6**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE08	ADVANCED OXIDATION PROCESS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Introduction to AOPs for water and wastewater treatment – mechanism – photooxidation reactions photocatalytic reactions, photo initiated oxidation – UV- H2o2 / ozonation, fenton / photofenton – photocatalysis – light source choice – used in AOPs and their spectral distributions.

MODULE II HOMOGENOUS AOPS **9**

Ozone, electro-chemical oxidation, ultrasonication, UV – photolysis, hydrogen peroxide and ultraviolet radiation (H2o2/UV), fenton and photo fenton's oxidation, chemical and non-chemical AOPs, advantages and disadvantages of homogeneous processes.

MODULE III HETEROGENEOUS PROCESS **9**

Introduction to nano & heterogeneous photo catalysis effect of system composition and process. identification of degradation products, photo reactors (liquid phase/ gas phase) – solar/ artificial light photo reactors – operation of pilot plants – comparing reactor efficiencies – system design – solar collectors – technology issues – slurry, supported catalyst – reuse – novel photo catalysts, synthesis methods – bulk, chemical approaches, physical approaches, nano porous materials – physic chemical methods for characterization of nano materials.

MODULE IV AOPS ENHANCEMENT TECHNIQUES **9**

Non-thermal plasma-electron hydraulic cavitation and sonolysis - super water oxidation – γ rays - electron beams, quantum yield improvement by additional oxidants – hydrogen peroxide persulphate – catalyst modification - case studies and applications semiconductor photolysis - process fundamentals, applications and commercial process.

MODULE V INDUSTRIAL APPLICATIONS AND ECONOMIC ASSESSMENT **9**

Application of AOPs for textile, petroleum, pharmaceutical and petrochemical industries - ground water decontamination – drinking water treatment – pilot & land fill photochemical - cost calculation – economic analysis.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Comprehend the basic principles of advanced water treatment processes, capabilities / constraints of their application in water and wastewater treatment.

CO2: Infer technical knowledge and skills on the design and operation of AOPs for the water and wastewater treatment.

CO3: Design suitable pre-treatment and post treatment schemes, and cleaning protocols for AOPs.

CO4: Evaluate economic assessment on AOPs for water and wastewater treatment.

CO5: Identify appropriate AOPs to solve emerging environmental wastewater issues in the society.

TOTAL: 45 PERIODS

REFERENCES:

1. "Advanced Oxidation Processes", Baeza & Casasnovas, 3rd Edition, 2020.
2. "Handbook of Advanced Water Treatment", Hu & Zhao, 2016.
3. "Photocatalysis: Fundamentals and Applications", Fujishima et al., 2nd Edition, 2017.
4. "Water Treatment Principles and Desi gn", Tchobanoglous et al., 3rd Edition, 2017.
5. "Environmental Applications of Nanomaterials: Recent Advances and Future Trends", Gomis et al., 2018.
6. "Economic Evaluation of Water and Wastewater Treatment Processes", Davis, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	2
2	3	3	3	3	3	2
3	3	3	2	3	3	2
4	3	2	2	3	3	2
5	3	2	2	3	3	2
Avg.	**3**	**2.4**	**2.2**	**3**	**3**	**2**

1-low, 2-medium, 3-high

23MENE09	COMPUTING TECHNIQUES IN ENVIRONMENTAL ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I SOFT COMPUTING PRINCIPLES **9**

Introduction to computing techniques – algorithms and flowcharts, numerical methods - solution to ordinary and partial differential equation using finite difference, finite element and finite volume methods, numerical integration and differentiation.

MODULE II ARTIFICIAL INTELLIGENCE **9**

Knowledge based expert system concepts - principle of Artificial Neural Network (ANN) – perceptron learning rule, neural network structure – neural network operations – ANN Algorithm - Application of ANN Model to environmental field – genetic algorithms.

MODULE III FUZZY LOGIC **9**

Fuzzy logic principles - fuzzy logic and the theory of uncertainty - fuzzy set theory- fuzzy membership function, fuzzy relations, fuzzy rule, and applications of the fuzzy set theory to inference and control, clustering, and image processing.

MODULE IV DIGITAL DATA MANAGEMENT **9**

Data base structure - data acquisition - data warehouse - DBMS - RDBMS - data analysis - network data sharing - Statistical Analysis (SYSTAT) - regression - factor analysis - histogram - scatter diagram - goodness of fit – big data analysis.

MODULE V ENVIRONMENTAL MODELING SOFTWARE **9**

Design of municipal wastewater treatment units-screens- grit chamber-settling tanks- sludge thickening - sludge dewatering systems - sludge drying beds - design of industrial wastewater treatment units - equalization - neutralization - chemical feeding devices – mixers - floatation units - oil skimmer - flowcharts – layouts – hydraulic profile, PID, construction and O&M aspects – case studies, retrofitting - residue management – upgradation of existing plants – recent trends.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Apply computational methods to solve environmental engineering problems and evaluate the accuracy and limitations of these methods.

CO2: Design and implement artificial neural network models for environmental applications, including understanding ANN principles and algorithms.

CO3: Apply fuzzy logic concepts to model and analyze environmental uncertainties and design fuzzy logic-based control systems for environmental processes.

CO4: Manage, analyze, and interpret environmental data using statistical and data management tools, drawing meaningful conclusions and identifying trends.

CO5: Design and evaluate various environmental engineering systems, considering factors like treatment processes, hydraulic profiles, and operational aspects.

TOTAL: 45 PERIODS

REFERENCES:

1. "Soft Computing and its Applications", Aliev R. A, and Aliev Rashad, World Scientific Publications Co. Pte. Ltd. Singapore, 2017.
2. "Numerical Methods for Engineers", Chepra S. C. and Canele R. P., McGraw-Hill, , New York, 6th Edition, 2018
3. "Numerical methods using MATLAB", Mathews J. H. and Fink K.D., Pearson Education 2018.
4. “Data-Driven Modeling: Using MATLAB in Water Resources and Environmental Engineering”, Springer; 2014 edition
5. “Computational Methods in Environmental Engineering and Science”, Seinfeld & Chandra, 3rd Edition, 2019.
6. “Fuzzy Logic with Engineering Applications”, Ross, 5th Edition, 2020.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE10	GEO-ENVIRONMENTAL ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Emergence of Geo-Environmental engineering, Types of Geo-Environmental problems, inorganic and organic toxic chemicals, composition of soils, soil properties, inorganic and organic geochemistry.

MODULE II CONTAMINANT TRANSPORT AND FATE **9**

Transport processes, chemical mass transfer processes, biological processes, contaminant transport and fate modeling, landfill and surface impoundments, in-situ barriers, ground water contamination

MODULE III SUBSURFACE CONTAMINATION AND WASTE CONTAINMENT **9**

Sources and types of contamination, remediation approach, contaminated site characterization, risk assessment and remedial strategy. Vertical and bottom barriers, surface caps, ground water pumping systems, subsurface drains, liner systems.

MODULE IV SOIL REMEDIATION **9**

Soil vapor extraction, soil washing, stabilization and solidification, electrokinetic remediation, thermal desorption, vitrification, bioremediation, phytoremediation, soil fracturing.

MODULE V GROUND WATER REMEDIATION **9**

Pump and treat, In-situ flushing, permeable reactive barriers, in-situ air sparing monitored natural attenuation, bioremediation.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Identify various geo-environmental challenges caused by inorganic and organic contaminants in soil and water systems, understanding their composition and properties.

CO2: Apply principles of contaminant transport and transformation to predict the fate and movement of contaminants in subsurface environments, evaluating different modeling

approaches.

CO3: Develop and evaluate strategies for subsurface contamination remediation and waste containment, considering sources, characterization, risk assessment, and appropriate barrier systems.

CO4: Design suitable soil remediation techniques like SVE, bioremediation, or thermal desorption, based on contaminant type, site conditions, and economic feasibility.

CO5: Recommend and assess groundwater remediation methods including pump-and-treat, in-situ flushing, or biological approaches, considering their effectiveness and long-term impact.

TOTAL: 45 PERIODS

REFERENCES:

1. "Geo environmental Engineering", Bouazza & Dassargues, 2nd Edition, 2019.
2. "Remediation Engineering of Contaminated Soils", Reddy & Chu, 3rd Edition, 2016.
3. "Groundwater Remediation Technologies", Domenico & Schwartz, 2nd Edition, 2017.
4. "Sustainable Remediation of Contaminated Sites", Reddy & Kumar, 2017.
5. "Risk Assessment in Environmental Engineering", Baehr, 2021.
6. "Field Sampling for Environmental Monitoring', Hewitt, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	2
2	3	3	2	3	3	3
3	3	3	3	3	3	3
4	3	2	2	3	3	2
5	3	2	2	3	3	2
Avg.	**3**	**2.4**	**2.2**	**3**	**3**	**2.4**

1-low, 2-medium, 3-high

23MENE11	ENVIRONMENTAL MONITORING INSTRUMENTS	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS **9**

Wet chemistry methods and their limitations-instrumental methods, selection of method-precision and accuracy, error in measuring signals- quality control & assurance- sample preservation, sample preparation and analyte isolation.

MODULE II SPECTROSCOPIC METHODS **9**

Principles, techniques and applications of spectrophotometry, fluorimetry, nephelometry and turbidimetry, Atomic Absorption Spectrometry (Flame, graphite furnace, cold vapor and hydride generation), Atomic Emission Spectrometry (AES), flame photometry and Inducted Coupled Plasma (ICP) – TOC Analyzer.

MODULE III CHROMATOGRAPHIC METHODS **9**

Principles, techniques and applications of GC, GC-MS, high performance liquid chromatography (HPLC) and Ion Chromatography (IC)-hyphenated techniques for environmental contaminant (trace organics) analysis, ICP-MS.

MODULE IV ELECTRO AND RADIO ANALYTICAL METHODS **9**

Principles, techniques and applications of conductometry, potentiometry, coulometry, AOX analyzer. amperometry, polarography, electro-capillary analysis, Neutron activation analysis (NAA), X-ray Fluorescence (XRF) and X-ray diffraction (XRD) methods.

MODULE V CONTINUOUS MONITORING INSTRUMENTS **9**

Principles, techniques and applications of NDIR analyzer for CO, chemiluminescent analyzer for NOx, fluorescent analyzer for SO2- particulates analysis- auto analyzer for water quality using flow injection analysis. LIMS

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Evaluate and select appropriate analytical methods for environmental monitoring, considering limitations, accuracy, and quality control procedures.
CO2: Analyze and interpret data from various spectroscopic techniques for environmental contaminant detection and quantification.
CO3: Understand and apply chromatographic techniques coupled with mass spectrometry or other detectors for trace organic analysis in environmental samples.
CO4: Interpret data from electro analytical and radio analytical techniques like XRF, ICP-MS, and NAA for environmental analysis, considering their principles and limitations.
CO5: Apply appropriate continuous monitoring instruments for real-time environmental data acquisition, understanding their functionalities and limitations.

TOTAL: 45 PERIODS

REFERENCES:

1. "Environmental Monitoring and Assessment", Sharma & Reddy, 2017.
2. "Air Pollution Monitoring Instruments", Harrison & Kershaw, 2019.
3. "Handbook of Water Analysis", Nollet & De Gelder, 3rd Edition, 2017.
4. "Environmental Applications of Analytical Techniques: An Introduction", Morrison & Stewart, 2017.
5. "Environmental Sampling and Analysis: A Practical Guide", Macomber, Second Edition, 2020.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	2
2	3	3	3	3	3	2
3	3	3	3	3	3	2
4	3	3	3	3	3	2
5	3	2	3	3	3	2
Avg.	**3**	**2.6**	**3**	**3**	**3**	**2**

1-low, 2-medium, 3-high

23MENE12	WATER QUALITY MODELLING	L	T	P	C
		3	0	0	3

MODULE I MODELLING INSIGHTS **9**

Engineers and Mathematical models-Water quality models – historical development - different types of models-- steps in model development - importance of model building.- calibration and verification of models- finite element, finite difference and finite volume methods.

MODULE II POLLUTANT TRANSPORT **9**

Transport phenomena – advection, diffusion, dispersion- contamination transport in surface and subsurface water - Simple transport models –steady state and time variable solutions- conservation of mass, momentum and energy balance, governing equation for contaminant fate and transport.

MODULE III SURFACE WATER QUALITY MODELLING **9**

Water quality modeling of streams, lakes and estuaries – water quality– model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelp's model for point and distributed sources - modified streeter Phelp's equations. Tropic status assessment.

MODULE IV GROUNDWATER QUALITY MODELLING **9**

Groundwater flow and mass transport of solutes – groundwater quality modelling using numerical methods - degradation of organic compounds in sub surface - prediction of contaminant transport and particle tracking -seawater intrusion – basic concepts and modelling.

MODULE V WATER QUALITY MODELLING SOFTWARE **9**

Exposure to surface water and groundwater quality modelling software's – MIKE 21, WASP, QUAL2E and MODFLOW – demonstration - case studies.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Evaluate the role and limitations of water quality models in environmental engineering, understanding the different types, development steps, calibration, and verification processes.

CO2: Formulate and solve mathematical models for pollutant transport in surface and subsurface water, considering advection, diffusion, dispersion, and governing equations.

CO3: Apply water quality models to assess and predict different parameters (DO, BOD, pathogens) in streams, lakes, and estuaries, using tools like Streeter-Phelps models and assessing model performance.

CO4: Analyze and model groundwater flow and solute transport, considering degradation, particle tracking, seawater intrusion, and numerical methods

CO5: Use specialized software to simulate and analyze surface and groundwater quality scenarios, interpreting results and applying them to case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. “Surface Water Quality Modelling”, Steven C. Chapra, Tata McGraw-Hill Companies, Inc., New Delhi 2018.
2. “Water Quality Modelling for Rivers and Streams”, Benedini, Marcello, Tsakiris, George, Springer, Netherlands 2017.
3. “Hydrodynamics and Water Quality: Modelling Rivers, Lakes, and Estuaries”, Zhen-Gang Ji, John Wiley & Sons, 2018.
4. “The Analysis and Interpretation of Data”, Hamilton & O'Doherty, 3rd Edition, 2020.
5. “Surface Water Quality Modelling with R and GIS”, Chapman & Dunn, 2nd Edition, 2018.
6. “Applications for Groundwater FLOW and Mass Transport”, Hunt & Doherty, 2015.
7. “Environmental Modelling with R: Spatial and Temporal Analysis”, Hijmans, 2nd Edition, 2020.
8. “The Handbook of Groundwater Engineering”, Driscoll & Istok, 3rd Edition, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MEN13	MARINE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

MODULE I MARINE AND COASTAL ENVIRONMENT **9**

Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology, coastal features – beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes– the oceans and climate, coastal zone regulation in India- national and international treaties.

MODULE II OCEAN HYDRODYNAMICS **9**

Wave theory, waves in shallow waters – refraction, diffraction and shoaling, approximations for deep and shallow water conditions – tidal classification - general circulation of ocean waters - ocean currents - coastal sediment transport - onshore offshore sediment transport - beach formation and coastal processes - Tsunamis, storm surge, El Nino effect.

MODULE III MARINE POLLUTION **9**

Sources of marine pollution – point and nonpoint sources, pollution caused by effluent discharge, oil exploration, dredging, offshore mining, port and harbor activities, power plants, agriculture runoff, plastic waste, marine debris and marine litter - effects of marine pollution on marine water quality and coastal ecosystems.

MODULE IV MARINE POLLUTION MONITORING **9**

Basic measurements - sounding boat, echo sounders – current meters - tide gauge - use of GPS – measurement of coastal water characteristics – sea bed sampling – modelling of pollutant transport and dispersion - oil spill models - ocean monitoring satellites – applications of remote sensing and GIS in monitoring marine pollution – online marine pollution monitoring.

MODULE V MARINE POLLUTION CONTROL MEASURES **9**

Marine discharges and effluent standards, pollution control strategies – marine outfall design-selection of optimal marine outfall locations - Total Maximum Daily Load (TMDL) applications – protocols in marine pollution control– Integrated Coastal Zone Management (ICZM) and sustainable development.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Characterize the marine and coastal environment, understanding its key features, properties, and regulatory mechanisms.

CO2: Analyze hydrodynamic processes in the ocean, including waves, tides, currents, and their influence on coastal sediment transport and coastal processes.

CO3: Evaluate the various sources and impacts of marine pollution, recognizing their effects on water quality and coastal ecosystems.

CO4: Apply various methods for monitoring marine pollution, including sampling techniques, modeling tools, remote sensing, and online monitoring systems.

CO5: Propose strategies for marine pollution control, considering effluent standards, outfall design, TMDL applications, and sustainable development approaches.

TOTAL: 45 PERIODS

REFERENCES:

1. "Marine Pollution", R.B. Clark, C. Frid and M Atttrill, Oxford Science Publications, 5th Edition, 2017.
2. "Marine Pollution: New Research", Tobias N. Hofer, Nova Publishers, 2018,
3. "Marine Pollution", Bryan & Langston, 3rd Edition, 2019.
4. "Oceanography and Marine Biology: An Introduction", Davis Jr., 8th Edition, 2020.
5. "Integrated Coastal Zone Management (ICZM) in Action: Implementing the EU Directives", Healy et al., 2017.
6. "Handbook of Coastal Oceanographic Methods", Lee et al., 2nd Edition, 2017.
7. "Microplastics and Nanoplastics in the Marine Environment: Sources, Distribution, and Impacts", Bergmann et al., 2019.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	2	3	2
2	3	2	2	2	3	2
3	3	2	2	2	3	2
4	3	3	3	2	3	2
5	3	2	2	3	3	2
Avg.	**3**	**2.2**	**2.2**	**2.2**	**3**	**2**

1-low, 2-medium, 3-high

23MENE14	CLIMATE CHANGE AND MODELLING	L	T	P	C
		3	0	0	3

MODULE I CLIMATE CHANGE AND CLIMATE VARIABILITY **9**

Introduction- atmosphere - weather and climate - climate parameters (Temperature, Rainfall, Humidity, Wind etc.,) Equations governing the atmosphere - numerical weather prediction models - introduction to GCMs - applications in climate change projections.

MODULE II IPCC CLIMATE SCENARIOS **9**

Intergovernmental PANEL on Climate Change (IPCC) - an overview - key assumptions – Representative Concentration Pathways (RCP 2.6, 4.5, 6.0, 8.5).

MODULE III GLOBAL CLIMATE MODEL AND REGIONAL CLIMATE MODEL **9**

Climate model – types of model- General Circulation Models (GCM) - Issues with GCMs - Introduction to RCMs and LAMs - RCMs modelers -advantages and disadvantages of GCMs and RCMs.

MODULE IV DOWNSCALING GLOBAL CLIMATE MODEL - AN OVERVIEW **9**

Need for downscaling - selection of GCMs for regional climate change studies - ensemble theory selection of ensembles, model domain (Spatial domain and temporal domain), Resolution and climate variables - lateral boundary conditions - methods of downscaling (Statistical and Dynamical) examples from each and their limitations.

MODULE V ANALYSIS AND POST PROCESSING **9**

Model validation and calibration- evaluating model performance- post processing - introduction to analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS - climate change impact - vulnerability assessment-case studies - Adaptation strategies.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the physical principles of climate and climate variability, analyze the governing equations, and apply numerical weather prediction models to understand climate change projections.

CO2: Evaluate Intergovernmental Panel on Climate Change (IPCC) scenarios, including key assumptions and Representative Concentration Pathways (RCPs), for climate change analysis.

CO3: Compare and contrast global climate models (GCMs) and regional climate models (RCMs), understanding their advantages, disadvantages, and applications in climate research.

CO4: Appropriate downscaling techniques (statistical and dynamical) to translate global climate model data to regional scales, considering data selection, resolution, and limitations.

CO5: Use climate data analysis tools (Ferret, R, Grads, etc.) to validate, calibrate, and post-process climate model outputs, assess climate change impacts, and analyze vulnerability and adaptation strategies.

TOTAL: 45 PERIODS

REFERENCES:

1. "Climate Change Science and Solutions", Shukla et al., 4th Edition, 2019.
2. "An Introduction to Atmospheric Thermodynamics", John Wallace and Peter Hobbs, 2nd Edition, 2017.
3. "Statistical Downscaling: Methodologies and Limitations", Wilks, 2016.
4. "Climate Change Assessment Report Sixth Assessment Report (AR6)", IPCC, 2021.
5. "Regional Climate Modelling", Giorgi, 2020.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	2	2	2	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	2	2	3	3	3
Avg.	**3**	**2.6**	**2.6**	**2.8**	**3**	**3**

1-low, 2-medium, 3-high

23MENE15	OPERATION AND MAINTENANCE OF WATER AND WASTEWATER TREATMENT SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I ELEMENTS OF OPERATION AND MAINTENANCE **9**

Strategy for good operation and maintenance- preventive and corrective maintenance scheduling - operation and maintenance Plan - proper and adequate tools, spare units and parts - training requirements- laboratory control- records and reports- housekeeping – sampling procedure- analytical techniques- code of practice for analytical laboratories- measurement of flows, pressures and Levels -safety in O&M operations - management information system - measures for conservation of energy.

MODULE II OPERATION AND MAINTENANCE OF WATER SUPPLY SYSTEMS **9**

Operational problems, O&M practices and records of operation of reservoir and intakes - causes of failure of wells- rehabilitation of tube wells & bore wells- prevention of incrustation and corrosion - problems in transmission mains- maintenance of pipelines and leakage control- repair method for different types of pipes- preventive and corrective maintenance of water pumps - problems in the water distribution system and remedies- water quality monitoring and surveillance

MODULE III OPERATION AND MAINTENANCE OF SEWERAGE SYSTEMS **9**

Components and functions of sewerage system – maintenance of collection system – operational problems– clogging of pipes – hazards – precautions against gas hazards – precautions against infections – devices for cleaning the conduits – preventive and corrective maintenance of sewage pumps –operation and maintenance of sewage pumping stations- maintenance hazards and operator protection –SOP-case studies

MODULE IV OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENTS **9**

Components and functions of sewerage system – maintenance of collection system – operational problems– clogging of pipes – hazards – precautions against gas hazards – precautions against infections – devices for cleaning the conduits – preventive and corrective maintenance of sewage pumps –operation and maintenance of sewage pumping stations-maintenance hazards and operator protection –SOP-case studies

MODULE V OPERATION AND MAINTENANCE OF BIOLOGICAL TREATMENT UNITS **9**

Construction, operation and maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- startup and shutdown procedures-DO, MLSS and SVI monitoring- trouble shooting guidelines –planning, organizing and controlling of plant operations – capacity building, case studies of retrofitting- SOP-case studies

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Plan and implement effective operation and maintenance strategies for water and wastewater treatment systems, considering preventive and corrective approaches, resource allocation, safety protocols, and data analysis.

CO2: Diagnose and address operational problems in water supply systems, including intake management, pump maintenance, leakage control and water quality monitoring.

CO3: Maintain and troubleshoot sewerage systems, addressing challenges like clogging, gas hazards, and infections, while ensuring operator safety and following standard operating procedures.

CO4: Operate and maintain various physico-chemical treatment units (e.g., sedimentation, filtration, disinfection) with proper startup/shutdown procedures, parameter monitoring, and troubleshooting for optimal performance.

CO5: Manage and maintain biological treatment units (e.g., activated sludge, trickling filters) through process control, monitoring key parameters, troubleshooting, and capacity building.

TOTAL: 45 PERIODS

REFERENCES:

1. “Operation of Water Treatment Plants”, AWWA & WEF, Volume 1, 6th Edition, 2020.
2. “Operation of Wastewater Treatment Plants”, WEF, Volume 1, 6th Edition, 2018.
3. “Waterworks Mechanics Manual’, AWWA, 6th Edition, 2018.
4. “Wastewater engineering, treatment and reuse”, Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Fourth Edition, McGraw-Hill, 2017.
5. “Handbook of Water and Wastewater Treatment Plant Operations”, Cheremisinoff, 3rd Edition, 2017.
6. “Operation and Maintenance of Wastewater Treatment Plants”, WEF, 5th Edition, 2019.
7. “Modern Water Treatment Processes’, Metcalf & Eddy, 5th Edition, 2017.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	3	3	3	3	2

2	3	2	3	3	3	2
3	3	2	3	3	3	2
4	3	2	3	3	3	2
5	2	3	3	3	2	2
Avg.	**2.8**	**2.4**	**3**	**3**	**2.8**	**2**

23MENE16	**AIR QUALITY MODELLING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1-low, 2-medium, 3-high

MODULE I MODELLING AND MODELS **9**

Overview of different types of models-deterministic and stochastic approach- steps in model development - numerical and simulation models - calibration and validation of models - limitations- transport phenomena - mass balance analysis-model development and decision making. Types of air quality models - classification.

MODULE II METEOROLOGY AND DISPERSION **9**

Chemistry of air Pollutants - atmospheric reactions, sinks for air pollution – transport of air pollutants meteorological factors for dispersal of air pollutants – meteorological modelling-developing wind rose and pollutant rose diagrams - vertical structure of temperature and stability, mixing height; tall stacks-transport and diffusion of stack emissions – plume segments–flare stack – plume rise equations-Holland's and Brigg's models.

MODULE III EMISSION AND SOURCE DISPERSION MODELS **9**

Modeling for reactive and nonreactive pollutants, point source-single and multiple sources-area sources, line source models, fixed box models - diffusion models – Gaussian plume derivation - modifications of Gaussian plume equation - Gaussian puff model - emission models - emission factors - long term average-multiple cell model - accuracy and utilization-limitations-air quality mapping.

MODULE IV RECEPTOR MODELS AND INDOOR AIR QUALITY MODELS **9**

Receptor models- source apportionment studies- CMB model- PMF models; environmental wind tunnel models; indoor air pollutants –mass balance-single compartment-multiple

compartments calculation of deposition velocity and Position of Particles-Aerosol-Odours and sick building syndrome-Integrated Models.

MODULE V SOFTWARE PACKAGE APPLICATIONS **9**

Commercial air quality models - ADMS, AERMOD, CALINE, CALPUFF, DEGADIS, HYROAD, INDUSTRIAL SOURCE COMPLEX, SCREEN, HYSPLIT, INDEX

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Evaluate and select appropriate air quality models, understanding the modelling process, types, limitations, and their role in decision-making.

CO2: Analyze and predict the transport and dispersion of air pollutants, considering meteorological factors, vertical structure, plume behavior, and emission characteristics.

CO3: Apply various emission and source dispersion models to estimate pollutant concentrations and map air quality.

CO4: Identify and apply receptor models for source apportionment, and design and analyze indoor air quality models considering pollutant sources and transport.

CO5: Use specialized air quality modeling software to simulate and analyze real-world scenarios, interpreting results and evaluating limitations.

TOTAL: 45 PERIODS

REFERENCES:

1. "Air Pollution Control Engineering", Noel de Nevers, Mc Graw Hill, New York, 2016.
2. “The Analysis and Interpretation of Data”, Hamilton & O'Doherty, 3rd Edition, 2020.
1. “Fundamentals of Air Pollution” Jacobson, 3rd Edition, 2020.
2. “Urban Air Quality Modeling: Methods and Applications with Open-Source Software”, Parra et al., 2017.
3. “Handbook of Environmental Modeling”, R Hijmans, 2nd Edition, 2020.
4. “Air Quality Data Analysis”, Rao et al., 2nd Edition, 2017.
5. “Air Quality Engineering”, Csanady, 2017.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE17	FATE AND REMEDIATION OF EMERGING CONTAMINANTS	L	T	P	C
		3	0	0	3

MODULE I SOURCES, OCCURRENCE AND REGULATORY REQUIREMENTS **9**

Definition - Priority vs. emerging contaminants - recent concerns - major groups - examples - properties - sources - occurrence - distribution in soils, groundwater, industrial and municipal wastewaters, aquaculture effluents, freshwater and marine ecosystems, air, food, plants, animals and human blood - existing global regulatory frameworks and policies.

MODULE II CHARACTERIZATION AND INSTRUMENTATION **9**

Sampling – sample preparation methods – analytical protocols for detection of pharmaceuticals, personal care products, antimicrobials and antibiotics, hormones, phthalate plasticizers and degradation products, surfactants, brominated fire retardants, pesticides and nanoparticles – analytical instruments.

MODULE III ENVIRONMENTAL FATE AND TRANSPORT **9**

Sorption - leaching - runoff - erosion - volatilization - plant/animal uptake - degradation and transformation - human health and ecological risks - environmental fate modelling frameworks - risk assessment tools - challenges - biomonitoring and biosensors.

MODULE IV REMEDIATION TECHNOLOGIES **9**

Incineration - sonolysis - multi-phase extraction - permeable reactive barrier - advanced oxidation processes - membrane based separation - nanofiltration - Reverse osmosis - biosorption - bioaugmentation - combined treatment options - remediation endpoints - challenges – opportunities.

MODULE V CASE STUDIES **9**

Occurrence in different environmental compartments - environmental fate and transport - potential and known risks to human health and the environment - effective technological and policy approaches to prevent, control and remove emerging pollutants in the environment.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Identify the different kinds of emerging contaminants, their sources, occurrence, distribution in different environmental compartments and existing regulations/policies.

CO2: Infer the analytical techniques for the detection of emerging contaminants in environment.

CO3: Assess the environmental fate, behavior, underlying mechanisms, human health and ecological risks of emerging contaminants.

CO4: Select an appropriate single and integrated physical, chemical and/or biological clean-up option for environments contaminated with different classes of emerging pollutants in order to achieve the target remedial endpoints.

CO5: Conduct independent research in the future pertinent to emerging contaminant pollution and remediation.

TOTAL: 45 PERIODS

REFERENCES:

1. "Fate and Transport of Emerging Contaminants in the Environment", Kümmerer et al., 2nd Edition, 2018.
2. "Emerging Contaminants in Wastewater Treatment Plants", Verstraete et al., 2nd Edition, 2017.
3. "Emerging Pollutants: Origin, Structure and Properties", Francisco G, Calvo-Flores, Joaquin Isac-Garcia, Jose A. Dobado, Wiley & Sons, US, 2018.
4. "Emerging Organic Contaminants in Aquifers", Barceló & Petrovic, 2016.
5. "Emerging Contaminants in Wastewater Treatment Plants", Verstraete et al.,2nd Edition, 2017.
6. "Emerging Contaminants in the Environment: Fate, Exposure, and Risk Assessment",Ipeacher et al., 2018.
7. "Risk Assessment of Chemicals: An Introduction", Klaassen, 2020.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	2
2	3	2	3	3	2	2
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	1	3	3	2	1	1
Avg.	**2.6**	**2.6**	**2.8**	**2.8**	**2.4**	**2.2**

23MENE18	ENVIRONMENTAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

1-low, 2-medium, 3-high

MODULE I PRINCIPLES OF REACTION ENGINEERING **9**

Classification of reactions, reaction rate, variables affecting reaction rate, speed of chemical reactions. Reaction engineering principles of chemical treatment – chemical reactions in major treatment technologies, incineration, selective catalytic reduction. Wet- gas scrubbing - H2S.

MODULE II KINETICS OF HOMOGENEOUS REACTIONS **9**

Simple reactor types, the rate equation, concentration dependent term of rate equation. Molecularity and order of reaction. Rate constant k, representation of an elementary and non-elementary reaction. Kinetic models for non-elementary reactions. Testing kinetic models. Temperature dependent term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Activation energy and temperature dependency.

MODULE III REACTOR ANALYSIS **9**

Reactor concepts, ideal reactors, reaction rate measurements, sequencing batch reactor, reactors in series and reactors in recycle. Non.-.ideal reactor behaviour, RTD analysis.

MODULE IV MASS TRANSFER AND ITS APPLICATIONS **9**

Principles of diffusion and mass transfer between phases, gas absorption, humidification operations, leaching and extraction, drying of solids, fixed-bed separation, membrane separation process- adsorption.

MODULE V BIOLOGICAL REACTION ENGINEERING **9**

Kinetics of cell growth and enzymes. Cell growth kinetics; substrate uptake and product formation in microbial growth; enzyme kinetics, Michaelis - Menten rate form - biological kinetics, aerobic processes-anaerobic processes - anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactor. Bio - concentration, bioaccumulation, bio - magnification, bioassay, bio monitoring. Bio - scrubbers, bio trickling filters and their applications. vermi technology, methane production, root zone treatment, membrane technology.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Apply reaction engineering principles to analyze and design chemical treatment processes in environmental contexts.

CO2: Utilize appropriate kinetic models to predict reaction rates and design reactors for environmental applications.

CO3: Analyze the performance of different reactor configurations (ideal, non-ideal, series, recycle) for treating environmental pollutants.

CO4: Apply mass transfer principles to design and optimize various separation processes used in environmental engineering.

CO5: Analyze and design biological treatment processes by understanding microbial growth kinetics and biodegradation principles.

TOTAL: 45 PERIODS

REFERENCES:

1. "Environmental Reaction Engineering", Gumerman, 5th Edition, 2020.
2. "Chemical Reactor Design for Environmental Control", Hsu & Gutierrez, 2nd Edition, 2018.
3. "Biological and Environmental Mass Transfer', Whitman & Acrivos, 2nd Edition, 2017.
4. "Emerging Contaminants in Water Treatment", Verstraete et al., 2nd Edition, 2017.
5. "Design Manual for Municipal Wastewater Treatment Plants', WEF, 5th Edition, 2017.
6. Biological Wastewater Treatment Principles, Modeling and Applications", Henze et al., 2nd Edition, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE19	MEMBRANE SEPARATION FOR WATER AND WASTEWATER TREATMENT	L	T	P	C
		3	0	0	3

MODULE I MEMBRANE FILTRATION PROCESSES **9**

Membrane filtration for solid Liquid separation - cross flow filtration - theory of membrane separation mass transport characteristics - concentration polarization – membrane flux and trans membrane pressure -types and choice of membranes- porous, nonporous, symmetric and asymmetric – membrane structures and materials - plate and frame, spiral wound and hollow fibre membranes – membrane performance factors and considerations - membrane manufacturing process.

MODULE II MEMBRANE SYSTEMS **9**

Membrane module/element designs – membrane system components – design of membrane systems - design of modules, assembly, plant process control and applications - design and applications of low pressure membrane technology systems-microfiltration and ultrafiltration-design and applications of diffusive membrane technologies- nanofiltration and reverse osmosis - – electrodialysis : Ion exchange membranes, process design- design of membrane systems - pump types and pump selection – plant operations – economics of membrane systems.

MODULE III MEMBRANE BIOREACTORS **9**

Historical perspective of MBRs – bio-treatment fundamentals- MBR principles and fundamentals- MBR design principles, design assignment, alternative MBR configurations - commercial technologies- fouling and fouling control- case studies.

MODULE IV PRETREATMENT AND POST TREATMENT SYSTEMS **9**

Membrane fouling – source water quality characterization- particulate membrane foulants - mineral membrane-scaling foulants - natural organic foulants - microbial foulants- parameters and measurement methods - Langlier index, silt density index - combined impacts of various types of foulants- control of fouling -pretreatment methods and strategies –source water screening and conditioning - pretreatment by sand and membrane filtration- monitoring of pretreatment – chemical cleaning systems- biofouling control – post treatment systems.

MODULE V CASE STUDIES **9**

Case studies on the design of membrane based water and wastewater treatment systems – zero liquid effluent discharge plants – desalination of brackish water and seawater – project implementation and project economics – environmental issues –reject management -energy recovery systems.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the various main membrane processes, principles, separation mechanisms, and applications.

CO2: Apply the knowledge of science and engineering fundamentals to analyze the mechanisms of membrane filtration.

CO3: Design of membrane systems involving microfiltration, ultrafiltration, nanofiltration, reverse osmosis, electro dialysis and membrane bioreactor processes.

CO4: Select appropriate membrane technologies for water and wastewater treatment taking into account the impact of the solutions in a sustainability context.

CO5: Conduct research pertinent to membrane technology applications to water and wastewater treatment and communicate effectively to different stakeholders as well as engage in independent life-long learning.

TOTAL: 45 PERIODS

REFERENCES:

1. “Surface Water Quality Modelling”, Steven C. Chapra, Tata McGraw-Hill Companies, Inc., New Delhi, 2018.
2. “Water Quality Modelling for Rivers and Streams”, Benedini, Marcello, Tsakiris, George, Springer Netherlands, 2017.
3. “Hydrodynamics and Water Quality: Modelling Rivers, Lakes, and Estuaries”, Zhen-Gang Ji, John Wiley & Sons, 2018.
4. “Modelling Groundwater Flow and Contaminant Transport”, Jacob Bear, A. H.-D. Cheng, Springer, Science & Business Media, 2010.
5. “Mathematical Modelling of Groundwater Pollution”, Ne-Zheng Sun, Alexander Sun, Springer, New York, 2012.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	3	3	3	3	2

2	3	3	3	3	3	2
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	1	3	3	2	1	1
Avg.	**2.6**	**3**	**3**	**2.8**	**2.6**	**2.2**

23MENE20	**ECOLOGICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1-low, 2-medium, 3-high

MODULE I PERSPECTIVES OF ECOLOGY **9**

Definition, significance, and scope of ecology - Types: aut- and syn-ecologies - Realm of ecology - Eco technology and its relevance to human civilization - Classification of Eco technology - Scope and significance of ecological engineering - Interdependency of urban and rural ecologies - Coupling of two or more ecological systems.

MODULE II ECOSYSTEM PERSPECTIVES **9**

Definition, significance, and scope of ecosystem - Biotic, abiotic - Structure and functions of ecosystems - Law of Thermodynamics -Trophic status - Gross and net production - Energy and material flows - Essential biogeochemical cycles.

MODULE III ECOSYSTEM TYPES **9**

Characteristics and management of agro forest, grassland, wetland, desert ecosystem – Basic concepts of limnology - Forest: Ecological and Economic consequences of deforestation and management - Aquatic Ecosystem: Structure and functional attributes diversity, lentic and lotic habitats, economic importance and management.

MODULE IV BIODIVERSITY CONSERVATION **9**

Definition, significance, and scope of biodiversity - Factors governing biodiversity - Uses of biodiversity - threat to biodiversity - Hot-spots of biodiversity - Indian scenario - Conservation of biodiversity: in-situ and ex-situ approaches - Endemic and Epidemic species in India.

MODULE V URBAN ECOLOGY **9**

Characteristics of urban ecosystem - Population growth and exploitation - Resource exploitation and sustainability – Carrying capacity of the urban region and land - use pattern - Current issues in urban region: water and energy crisis; pollution and waste proposal aspects; and land use aspect.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the scope and significance of ecological engineering in achieving sustainable solutions for human and environmental challenges.

CO2: Explain the structure, function, and energy flow within various ecosystems and assess their importance for environmental well-being.

CO3: Contrast different ecosystem types and explain their management needs and potential risks due to deforestation and exploitation.

CO4: Analyze the importance of biodiversity and threats to its conservation, proposing and evaluating in-situ and ex-situ strategies for safeguarding endangered species.

CO5: Examine the challenges and opportunities associated with urban ecosystems, proposing sustainable solutions for managing resource use, mitigating pollution, and improving environmental quality.

TOTAL: 45 PERIODS

REFERENCES:

1. “Ecological Engineering for Ecosystem Restoration”, Higgs & Harris, 2nd Edition, 2020.
2. “Urban Ecology”, McDonnell & Pickett, 2nd Edition, 2016.
1. “Principles of Ecosystem Conservation”, Molles, 2nd Edition, 2018.
2. “Handbook of Ecological Engineering”, Jorgensen et al., 2nd Edition, 2019.
3. “The Routledge Handbook of Urban Studies”, Douglass et al., 4th Edition, 2017.
4. “Principles, Practices, and Restoration”, Sodhi & Ehrlich, 2nd Edition, 2015.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	3
2	3	2	2	3	3	2
3	3	2	2	3	3	2
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**2.4**	**2.6**	**3**	**3**	**2.6**

1-low, 2-medium, 3-high

23MENE21	WATER TRANSMISSION, WATER DISTRIBUTION AND SEWERAGE SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I GENERAL HYDRAULICS **9**

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor head losses, carrying capacity– flow measurement. Need for transport of water and wastewater and types.

MODULE II WATER TRANSMISSION MAINS **9**

Planning of water system – design of storage reservoirs - water transmission main design- compound gravity and pumping main; selection of pumps and characteristics curve - economics; specials, jointing, laying and maintenance, water hammer analysis.

MODULE III WATER DISTRIBUTION **9**

Service reservoirs - types and design - water distribution pipe networks design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection - plumbing for water supply in high rise buildings.

MODULE IV WASTEWATER COLLECTION AND CONVEYANCE **9**

Planning factors – design of sanitary sewer; partial flow in sewers, economics of sewer design; wastewater pumps and pumping stations - sewer appurtenances; material, construction, inspection and maintenance of sewers; design of sewer outfalls - mixing conditions; conveyance of corrosive wastewaters.

MODULE V STORM WATER DRAINAGE **9**

Necessity- combined and separate system; estimation of storm water runoff - formulation of rainfall intensity duration and frequency relationships- rational methods – storm water harvesting.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Apply fundamental hydraulic principles to analyze and design water and wastewater flow systems.

CO2: Select, design, and analyze water transmission mains, considering economic factors and addressing challenges like water hammer.

CO3: Design and optimize water distribution networks, including service reservoirs, piping systems, and leak detection measures, while ensuring corrosion prevention.

CO4: Plan, design, and analyze wastewater collection systems, considering material selection, construction, maintenance, and potential challenges like corrosive wastewater.

CO5: Design storm water drainage systems considering rainfall patterns and runoff estimation.

TOTAL: 45 PERIODS

REFERENCES:

1. "Water Supply and Wastewater Systems", Feagin, 7th Edition, 2020.
2. "Environmental Engineering", Peavy, Rowe, Tchobanoglous, 5th Edition. McGraw Hill Publishers, New Delhi, 2017.
3. "Water Supply and Sanitary Engineering", Birdie G.S and Birdie J.S, Dhatpat Rai Publishing Company New Delhi, 7th edition, 2013.
4. "Pipe Flow in Hydraulic and Pneumatic Systems', Barkdoll, 2nd Edition, 2017.
5. "Sewerage and Drainage Design and Hydraulics", Bhave, 2nd Edition, 2017.
6. "Handbook of Pumps and Pumping Systems", Pump Handbook Editorial Staff, 3rd Edition, 2018.
7. "Water Works Planning and Analysis", AWWA, 5th Edition, 2018.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high

23MENE22	CARBON MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO CARBON MANAGEMENT **9**

Climate change science and impacts - the carbon cycle and greenhouse gas emissions - introduction to carbon management concepts and terminology- global and national climate change targets and policies.

MODULE II CARBON FOOTPRINTING AND MEASUREMENT **9**

Life cycle assessment and carbon foot printing methodologies - organizational, product, and individual carbon foot printing - data collection and analysis tools - case studies of carbon foot printing in different sectors.

MODULE III CARBON REDUCTION STRATEGIES **9**

Energy efficiency and renewable energy - carbon capture, utilization, and storage (CCUS) - sustainable forestry and land management - technological innovation and mitigation pathways - market-based mechanisms for carbon emissions reduction.

MODULE IV ECONOMICS AND POLICY OF CARBON MANAGEMENT **9**

Economics of climate change and carbon pricing - carbon markets and emissions trading schemes - policy instruments for carbon management: regulations, incentives, and subsidies - the role of business and government in reducing emissions - global climate negotiations and international cooperation.

MODULE V IMPLEMENTATION AND EVALUATION **9**

Developing and implementing carbon management plans - communication and stakeholder engagement - monitoring, evaluation, and verification (MRV) of carbon reduction activities - case studies of successful carbon management projects - future trends and emerging technologies in carbon management.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the science behind climate change and the role of carbon emissions.

CO2: Explore different carbon management strategies and technologies.

CO3: Analyze the economic, social, and political implications of carbon management.

CO4: Develop skills for assessing carbon footprints and implementing reduction strategies.

CO5: Evaluate the effectiveness of carbon management policies and initiatives.

TOTAL: 45 PERIODS

REFERENCES:

1. “Carbon Management in Tourism: Mitigating the Impacts on Climate Change", Stefan Gössling, Paul Peeters, and C. Michael Hall, Routledge, 2011.
2. "Carbon Management, Technologies, and Trends in Mediterranean Ecosystems", Pere Muñoz Odina and Joan Rieradevall i Pons, Elsevier, 2018.
3. "Carbon Management: Implications for R&D in the Chemical Sciences and Technology", Chemical Sciences Roundtable, National Academies Press, 2001.
4. "Handbook of Carbon Offset Programs: Trading Systems, Funds, Protocols and Standards", Anja Kollmuss, Michael Lazarus, and Carrie Lee, Earthscan, 2010.
5. "Carbon Management for Sustainable Development", Mohan Munasinghe and Cutler J. Cleveland, Routledge, 2011.
6. "Carbon Management in Agriculture: Mitigation, Livelihood and Food Security", P. Raja, CRC Press, 2012.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	2
2	3	3	3	3	3	2
3	3	3	3	3	2	2
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**2.8**	**2.8**	**3**	**2.6**	**2.4**

1-low, 2-medium, 3-high

23MENE23	ENVIRONMENTAL SUSTAINABILITY GOVERNANCE MODEL	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO ENVIRONMENTAL GOVERNANCE **9**

Definition and evolution of environmental governance - key principles of good governance in environmental context (transparency, accountability, participation) - challenges and limitations of current environmental governance models - Global, national, and local frameworks for environmental governance.

MODULE II DESIGNING SUSTAINABLE GOVERNANCE MODELS **9**

Stakeholder identification and engagement strategies - multi-level governance and integration across scales - policy instruments for environmental management (regulations, market-based instruments, information instruments) - institutional design for effective environmental governance - tools and frameworks for sustainability assessment.

MODULE III IMPLEMENTATION AND EVALUATION OF GOVERNANCE MODELS **9**

Factors influencing successful implementation (capacity building, communication, enforcement) - monitoring and evaluation frameworks for environmental governance - adapting and adjusting governance models based on feedback and evaluation - role of technology and innovation in enhancing governance effectiveness.

MODULE IV CASE STUDIES IN SUSTAINABLE GOVERNANCE **9**

Analyze diverse case studies across different geographic contexts and environmental issues

(water management, biodiversity conservation, climate change mitigation) - identify best practices and lessons learned from successful cases - evaluate the challenges and shortcomings of existing models - develop recommendations for improvement based on critical analysis.

MODULE V IMPLEMENTATION AND EVALUATION **9**

Future challenges and opportunities in environmental governance - the role of international cooperation and global agreements - emerging trends in technology, finance, and governance innovation - role of international cooperation and agreements in addressing global environmental challenges.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Evaluate existing environmental governance models by analyzing their principles, challenges, and limitations within global, national, and local contexts

CO2: Design, propose, and justify sustainable governance models considering stakeholder engagement, policy instruments, institutional structures, and sustainability assessment tools

CO3: Analyze the factors influencing successful implementation and evaluation of governance models, proposing adaptations based on feedback and leveraging technology for improved effectiveness

CO4: Analyze case studies of successful and unsuccessful environmental governance models across different contexts and issues, identifying best practices, challenges, and potential improvements

CO5: Propose innovative solutions and suggest future directions for environmental governance, considering emerging trends in technology, finance, and international cooperation.

TOTAL: 45 PERIODS

REFERENCES:

1. "Environmental Governance: A Report on the Next Generation of Environmental Policy", Walter F. Baber and Robert V. Bartlett, Yale University Press, 2020.
2. “Environmental Governance for the 21st Century: A Systems Perspective’, David Biggs et al. (2020), Cambridge University Press.
3. "Sustainable Development and Environmental Management: Experiences and Case Studies", Marília Freitas de Campos Tozoni-Reis, Springer, 2022.
4. “Governance for Sustainability: Addressing Environmental Challenge”, Mikael Skou Andersen and Elinor Ostrom, Earthscan, 2010.
5. “The Green Deal: A Guide to Building a Sustainable Economy’, Jeremy Rifkin, Palgrave Macmillan, 2019.
6. "Sustainable Development: Principles, Frameworks, and Case Studies”, Okechukwu Ukaga, CRC Press, 2021.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3

1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**

23MENE24	**ENVIRONMENTAL RISK ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1-low, 2-medium, 3-high

MODULE I INTRODUCTION **9**

Sources of Environmental hazards – Environmental and ecological risks – Environmental risk assessment framework – Regulatory perspectives and requirements – Risk Analysis and Management and historical perspective; Social benefit vs technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines.

MODULE II ELEMENS OF ENVIRONMENTAL RISK ASSESSMENT **9**

Hazard identification and accounting – Fate and behaviour of toxics and persistent substances in the environment – Properties, processes and parameters that control fate and transport of contaminants – Receptor exposure to Environmental Contaminants – Dose Response Evaluation - Exposure Assessment – Exposure Factors, Slope Factors, Dose Response calculations and Dose Conversion Factors – Risk Characterization and consequence determination – Vulnerability assessment – Uncertainty analysis.

MODULE III TOOLS AND METHODS FOR RISK ASSESSMENT **9**

HAZOP and FEMA methods – Cause failure analysis – Event tree and fault tree modeling and analysis – Multimedia and multipath way exposure modeling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products –Estimation of carcinogenic and non – carcinogenic risks to human health – Methods in

Ecological risk assessment – Probabilistic risk assessments – radiation risk assessment – Data sources and evaluation.

MODULE IV RISK MANAGEMENT **9**

Risk communication and Risk Perception – comparative risks – Risk based decision making Risk based environmental standard setting – Risk Cost Benefit optimization and tradeoffs Emergency Preparedness Plans – Emergency planning for chemical agent release – Design of risk management programs – risk based remediation; Risk communication, adaptive management, precaution and stake holder involvement.

MODULE V CASE STUDIES **9**

In-depth analysis of real-world environmental risk assessment projects - Lessons learned from successful and unsuccessful risk management practices - Comparative analysis of environmental risk scenarios. Integration of data analytics, remote sensing, and artificial intelligence in risk assessment - Anticipating and addressing emerging risks, such as climate change impacts. Identification of gaps in existing methodologies and potential areas for improvement.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain the Fundamentals and Regulatory Framework of Environmental Risk Analysis

CO2: Explain risk characterization, including consequence determination, vulnerability assessment, and uncertainty analysis.

CO3: Apply methods in ecological risk assessment and probabilistic risk assessments, including radiation risk assessment.

CO4: Design and optimize risk management programs, including cost-benefit analysis.

CO5: Analyze of real-world environmental risk assessment projects.

TOTAL: 45 PERIODS

REFERENCES:

1. “Environmental and Ecological Risk Assessment”, Ronald L. Beschta and Ronald J. Kazmierczak, 2004
2. “Quantitative Methods for Environmental Risk Assessment”, Gary. M, Petersen, 2014.
3. “Environmental Risk Management Strategies”, James K. Hammitt, 2002.
4. “Environmental Risk and Hazards”, Cutter, S.L., Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. “Global Environmental Risks”, Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., V.N.University Press, New York, 2003.
6. “Risk Assessment in Environmental management”, Kofi Asante Duah, John Wiley and sons, Singapore, 1998.
7. “Risk Assessment and Management Handbook”, Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, McGraw Hill Inc., New York, 1996.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	2	3	1	2	3
1	3	3	3	3	3	2
2	3	3	3	3	3	2
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg.	3	3	3	3	3	3

23MSEOE01	DISASTER MANAGEMENT	L	T	P	C
		3	0	0	3

1-low, 2-medium, 3-high

OPEN ELECTIVE COURSES

MODULE I NATURAL DISASTERS **9**

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche.

MODULE II MAN MADE DISASTERS **9**

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, nuclear disaster- Forest Fire- Oil fire -accident in Mines.

MODULE III GEOSPATIAL TECHNOLOGY **9**

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping.

MODULE IV RISK ASSESSMENT AND MITIGATION **9**

Hazards, Risks and Vulnerabilities - Disasters in India, Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters- Mitigation through capacity building -Preparation of Disaster Management Plans.

MODULE V DISASTER MANAGEMENT **9**

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism - Role of Engineers in Disaster Management.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze and evaluate the causes, impacts, and mitigation strategies for major natural disasters to assess risks.

CO2: Explain in detail about causes and effects of natural and manmade disasters.

CO3: Apply remote sensing, GIS, and GPS technologies to analyze real-time disaster data, generate disaster maps, and develop data-driven solutions for disaster monitoring, prevention, and rehabilitation.

CO4: Identify the factors that give rise to differential vulnerabilities and levels of community resilience and suggest necessary mitigation plans.

CO5: Evaluate the coordination mechanisms between Emergency Support Functions (ESFs) in disaster response, proposing improvements to enhance collaboration and efficiency.

TOTAL: 45 PERIODS

REFERENCES:

1. "Disaster Management", R.Subramanian, Vikas Publishing House Pvt. Ltd, New Delhi, 110055, 2018.
2. "Disaster Science and Management",Tushar Bhattacharya, McGraw Hill India Education Pvt. Ltd., 2017.
3. “Disaster Management - A Systematic Approach”, Singh & Singh, 3rd Edition, 2022.
4. “Geospatial Technologies for Disaster Risk Reduction”, Mondal & Das, 2019.
5. “The Routledge Handbook of Disaster Risk Reduction”, Wisner et al., 2nd Edition, 2020.
6. “Disaster Risk Reduction Approaches in India: A Critical Analysis”, Ghosh & Patel, 2017.
7. “Sendai Framework for Disaster Risk Reduction” 2015-2030.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	2
2	2	2	2	2	2	1
3	3	2	3	3	3	2
4	3	2	3	2	2	1
5	3	2	3	2	2	1
Avg.	**2.8**	**2**	**2.8**	**2.4**	**2.4**	**1.4**

1-low, 2-medium, 3-high

23MSEOE02	ENERGY EFFICIENT BUILDINGS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Conventional versus Energy Efficient buildings - Historical perspective - Water - Energy - IAQ- requirement analysis - Future building design aspects - Criticality of resources and needs of modern living.

MODULE II LANDSCAPE AND BUILDING ENVELOPES **9**

Energy efficient Landscape design - Micro-climates - various methods - Shading, water bodies- Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools.

MODULE III HEATING, VENTILATION AND AIR-CONDITIONING **9**

Natural Ventilation, Passive cooling and heating - Application of wind, water and earth for cooling, evaporative cooling, radiant cooling - Hybrid Methods - Energy Conservation measures, Thermal Storage integration in buildings.

MODULE IV HEAT TRANSMISSION IN BUILDINGS **9**

Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Sol-air temperature; Decrement factor; Phase lag. Design of day lighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

MODULE V PASSIVE COOLING & RENEWABLE ENERGY IN BUILDINGS **9**

Passive cooling concepts : Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air tunnel. Introduction of renewable sources in buildings, solar water heating, small wind turbines, stand-alone PV systems, Hybrid system - Economics.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Compare and contrast conventional and energy-efficient buildings, analyzing the importance of resource conservation and modern living needs in future building design.

CO2: Design energy-efficient landscaping and building envelopes considering microclimates, shading, materials, insulation, and heat transfer characteristics, utilizing design tools and methods.

CO3: Apply natural ventilation and passive cooling strategies such as wind, water, and earth cooling, integrating hybrid methods and energy conservation measures.

CO4: Calculate thermal performance of buildings using heat transfer coefficients, infiltration, and solar factors, employing design tools and considering day lighting strategies.

CO5: Propose and evaluate passive cooling methods and renewable energy integration including solar, wind, and hybrid systems, considering economic feasibility.

TOTAL: 45 PERIODS

REFERENCES:

1. "A Guide to Green Building Practices", Lohrke, 3rd Edition, 2023.
2. "Building Energy Modeling with EQUEST", Crawley et al., 2nd Edition, 2017.
3. "Principles and Practice in Residential Construction", Cole & Cole, 5th Edition, 2019.
4. "A Reference Guide for Building Design, Construction, Operation, and Retrofit', 2nd Edition, ASHRAE, 2016.
5. "Green Building Design and Delivery", Cole, 5th Edition, 2017.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	2
2	3	2	3	3	3	2
3	3	1	2	3	3	2
4	3	2	3	3	3	2
5	3	2	3	3	3	2
Avg.	**3**	**1.8**	**2.8**	**3**	**3**	**2**

1-low, 2-medium, 3-high

23MCMOE01	LANDSCAPE AND ARCHITECTURE	L	T	P	C
		3	0	0	3

MODULE I OVERVIEW OF ARCHITECTURE **9**

Definition of architecture - Introduction to architecture - Elements of architecture - - Need and fulfillment - Architecture design - An analysis - Integration of aesthetic and function - Mass and space, visual and emotional effects of geometric forms and their derivatives - Space - Form - Composition - Dimension - Proportion, scale, Balance, Rhythm, Symmetry, Hierarchy, Pattern and axis with building examples - Concept development.

MODULE II ELEMENTS IN LANDSCAPE DESIGN **9**

Ecology, ecological balance - Hard and soft landscape elements; Plant materials - Classification, Characteristics, use and application in landscape design; Water and landform.

MODULE III GARDEN DESIGN **9**

Landscape and garden design in history - Japanese, Italian Renaissance and Moghul gardens in India, Study of notable examples and spatial development in landscape design.

MODULE IV SITE PLANNING **9**

Organization of spaces - Circulation, built form and open spaces, site planning and micro climate, site planning of neighborhood parks, children's play area and campus development.

MODULE V LANDSCAPING OF FUNCTIONAL AREAS **9**

Urban open spaces and principles of urban landscape; Street landscaping; Landscape

design for waterfront areas and functional areas in urban centers; Green roofs and walls.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the fundamental principles of architecture, including spatial concepts, form, composition, and their emotional impact, applying them to design concepts

CO2: Describe various hard and soft landscape elements, plant materials, and their roles in ecological balance and design applications.

CO3: Compare and contrast historical garden styles and analyze spatial development strategies in landscape design.

CO4: Apply site planning principles to organize spaces, considering circulation, built forms, microclimates, and functional needs for areas like parks, playgrounds, and campuses.

CO5: Propose landscaping solutions for urban spaces, functional areas, and green infrastructure concepts like green roofs and walls.

TOTAL: 45 PERIODS

REFERENCES:

1. “Landscape Architecture: An Introduction”, Simonds, 5th Edition, 2023.
2. “An Introduction to Landscape Architecture”, Marsh, 8th Edition, 2020.
3. “Site Planning and Design Handbook”, Kimm & McLain, 3rd Edition, 2018.
4. “Landscape Graphics: From Drawing to Design”, Loken, 4th Edition, 2019.
5. “The Handbook of Urban Landscape Planning”, Hough, 2nd Edition, 2018.
6. “Planting Design Handbook”, Dunnett & Hitchmough, 5th Edition, 2019.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	2	2	2	2	1
2	2	1	2	2	2	1
3	2	2	2	2	2	1
4	3	2	3	3	2	1
5	3	2	3	3	2	1
Avg.	**2.4**	**1.8**	**2.4**	**2.4**	**2**	**1**

1-low, 2-medium, 3-high

23MENOE01	CLIMATE CHANGE AND ADAPTATION	L	T	P	C
		3	0	0	3

MODULE I EARTH'S CLIMATE SYSTEM **9**

Introduction - weather and climate - Climate in the spotlight-The Earth's Climate Machine - Climate Classification - Global wind systems - Trade Wind Systems - Trade Winds and the Hadley Cell - Cloud formation and Monsoon Rains - Storms, Hurricanes and Tornado - The Hydrological Cycle - Global Ocean Circulation - EI Nino - LA Nino effect - Solar Radiation - The Earth's Natural Green House Effect - Green House Gases and Global Warming.

MODULE II OBSERVED CHANGES AND ITS CAUSES **9**

Observation of Climate Change - Changes in pattern of temperature, precipitation and sea level rise - Observed effects of Climate Changes - Drivers of Climate Change - Climate Sensitivity and Feedbacks - The Montreal Protocol - UNFCCC - IPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India - Climate Change modeling.

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MODULE III IMPACTS OF CLIMATE CHANGE **9**

Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem - Water resources - Human Health - Industry, Settlement and Society - Methods and Scenarios - Projected Impacts for different regions - Uncertainties in the Projected Impacts of Climate Change - Risk of irreversible changes.

MODULE IV CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES **9**

Adaptation Strategy/options in various sectors - Water - Agriculture - Infrastructure and Settlement including coastal zones. Human Health - Tourism - Transport - Energy - Key Mitigation Technologies and practices - Energy supply - Transport – Buildings - Industry - Agriculture - Forestry - Carbon sequestration - Carbon Capture and Storage (CCS) - Waste (MSW & Biowaste, Biomedical, Industrial waste - International and Regional cooperation.

MODULE V CLEAN TECHNOLOGY AND ENERGY **9**

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel - Natural Compost - Eco- friendly Plastic - Alternative Energy - Hydrogen - Biofuels - Solar Energy - Wind - Hydroelectric Power.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Explain earth's climate system and the concept of global warming.

CO2: Infer the causes for climate change on the earth's surface.

CO3: Comprehend the impact of climate change on society.

CO4: Select appropriate adaptation and mitigation measures based on specific climate risks and vulnerabilities.

CO5: Evaluate the role of clean technology in climate change adaptation.

TOTAL: 45 PERIODS

REFERENCES:

1. "Climate Change: The Science of Global Warming and Our Energy Future", Edmond A. Mathez, 2nd Edition, Columbia University Press, 2021.
2. "Introduction to Modern Climate Change", Andrew Dessler, 3rd Edition, Cambridge University Press, 2021
3. "The Climate Crisis: An Introductory Guide to Climate Change", David Archer and Stefan Rahmstorf, 1st Edition, Cambridge University Press, 2010
4. "Global Warming: Understanding the Forecast", David Archer, 2nd Edition, Wiley Publication, 2011.
5. "Climate Change and Society: Sociological Perspectives", Riley E. Dunlap and Robert J. Brulle, 1st Edition, Oxford University Press, 2015
6. "Climate Change Adaptation in Developed Nations: From Theory to Practice", James D. Ford and Lea Berrang-Ford, 1st Edition, Springer, 2011

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	2	2	2	3	2	1
2	3	2	2	3	2	1
3	3	2	2	3	2	1
4	3	3	3	3	3	2

5	3	2	2	3	2	1
Avg.	**2.8**	**2.2**	**2.2**	**3**	**2.2**	**1.2**

23MCOC01	**ENGLISH FOR RESEARCH PAPER WRITING**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

1-low, 2-medium, 3-high

ONE CREDIT COURSES

MODULE I INTRODUCTION TO RESEARCH PAPER WRITING **5**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

MODULE II PRESENTATION SKILLS **5**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

MODULE III WRITING SKILLS **5**

Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills a needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Develop the ability to present their research findings clearly and coherently.

23MCOC02	CONSTITUTION OF INDIA	L	T	P	C
		0	0	2	1

CO2: Demonstrate essential writing skills, including crafting attention-grabbing titles, writing concise and informative abstracts, engaging introductions, thorough literature reviews, methods, results, discussions, and well-supported conclusions.

CO3: Proficient in conducting the final review and proofreading of their research papers, ensuring accuracy, coherence, and adherence to formatting and citation guidelines before submission.

TOTAL: 15 PERIODS

REFERENCES:

1. "Academic Writing for Graduate Students", John M. Swales and Christine B. Feak, 2018.
2. "The Craft of Research", Wayne C. Booth, Gregory Colomb, and Joseph Williams, 2020.
3. "Writing for Social Scientists", Howard Becker, 2017.
4. "Bird by Bird: Some Instructions on Writing and Life", Anne Lamott, 2019.

CO	PO			PSO		
	1	2	3	1	2	3
1	1	3	2	2	1	1
2	1	3	2	2	1	1
3	1	2	2	2	1	1
AVg.	1	2.7	2	2	1	1

CO-PO & PSO MAPPING

1-low, 2-medium, 3-high

MODULE I HISTORY OF MAKING OF THE INDIAN CONSTITUTION **5**

History, Drafting Committee, (Composition & Working), Preamble, Salient Features, Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

MODULE II ORGANS OF GOVERNANCE **5**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

MODULE III LOCAL ADMINISTRATION & ELECTION COMMISSION **5**

District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

COURSE OUTCOMES

23MCOC03	GREEN BUILDINGS	L	T	P	C
		0	0	2	1

At the end of the course, students will be able to

CO1: Demonstrate a comprehensive understanding of the key features and principles enshrined in the Indian Constitution.

CO2: Assess the knowledge of the structure and functions of various organs of governance in India, such as Parliament, Executive, and Judiciary.

CO3: Compare the powers and functions of different levels of local administration, including Municipalities and Panchayati Raj.

TOTAL: 15 PERIODS

REFERENCES:

1. "The Constitution of India, (Bare Act)", Government Publication, 1950.
2. "Indian Constitution Law", M.P. Jain, 7th Edition, Lexis Nexis, 2014.
3. "Framing of Indian Constitution", Dr.S.N.Busi, Dr.B. R.Ambedkar, 1st Edition, 2015.
4. "Introduction to the Constitution of India", D.D. Basu, Lexis Nexis, 2015.

CO	PO			PSO		
	1	2	3	1	2	3
1	2	2	2	1	1	1
2	2	2	2	1	1	1
3	2	2	2	1	1	1
AVg.	2	2	2	1	1	1

CO-PO & PSO MAPPING

1-low, 2-medium, 3-high

MODULE I INTRODUCTION **5**

Life Cycle impacts of materials and products - sustainable design concepts - strategies of design for the Environment -The sun- earth relationship and the energy balance on the earth's surface, climate, wind - Solar radiation and solar temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings - Thermal properties of building materials.

MODULE II ENERGY EFFICIENT BUILDINGS **5**

Passive cooling and day lighting - Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards- Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency Energy audit and energy targeting- Technological options for energy management.

MODULE III INDOOR ENVIRONMENTAL QUALITY MANAGEMENT **5**

Psychometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement-Auditory requirement-Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines - Heat rejection equipment- Energy efficient motors-Insulation.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Interpret the impact of different construction materials and methods on embodied energy and carbon footprint apply different energy analysis methods and standards to assess building performance.

CO2: Develop strategies for managing energy quality in buildings, including efficient systems and user behaviour.

CO3: Design and implement sustainable building solutions that minimize energy use while optimizing occupant comfort and environmental well-being.

TOTAL: 15 PERIODS

REFERENCES

1. "Sustainable Construction: Green Building Design and Delivery", Kibert, C. John Wiley & Sons, 2016.
2. “Building Energy Modeling with EQUEST”, Crawley et al. 2017.
3. “Green Building Design and Delivery”, Cole, 5th Edition, 2017.
4. “Green Building Regulations: An International Comparison”, Feria & Martinez, 2nd Edition, 2018.
5. “A Proven Approach to Energy Efficient Construction”, Bareither et al., 4th Edition, 2019.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	2	1
2	3	2	3	3	2	1
3	2	1	2	3	2	1
Avg.	**2.7**	**1.7**	**2.7**	**3**	**2**	**1**

1-low, 2-medium, 3-high

23MCOC04	PRACTICAL GEOTECHNICAL ENGINEERING	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Soil Exploration and Site Characterization.
2. Assessment of Index Properties of Soil.
3. Assessment of Flow and Consolidation Properties of Soil.
4. Assessment of Shear Strength Parameters of Soil.
5. Assessment of Bearing Capacity of Soil.

TOTAL: 15 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Select the most appropriate method(s) based on the specific site conditions and project requirements.

CO2: Apply knowledge to distinguish between major soil types based on their index properties.

CO3: Interpret strength and settlement characteristics of soils and determine Safe Bearing Capacity of soils and select appropriate foundations.

CO-PO & PSO MAPPING

CO	PO	PSO

	1	2	3	1	2	3
1	2	1	3	3	2	1
2	2	1	2	3	2	1
3	3	1	3	3	2	1
Avg.	**2.3**	**1**	**2.7**	**3**	**2**	**1**

23MCOC05	**GEO INFORMATICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

1-low, 2-medium, 3-high

MODULE I GIS INTRODUCTION **5**

Exploring - GIS functions - features - layers - map scale - connecting to folder - reordering of layers - symbolize layer - identify features - using of identify tool - hyperlink tool - zoom pan tools - map document saving.

MODULE II GIS MAP **5**

Layer attribute table - feature attribute relationship- creating map layout - making map layout in reverse - pinning down geographic data.

MODULE III GEOGRAPHY STUDY **5**

Vector and raster data - geographic data work with item description - query based on attributes and locations - analyze data using buffer and overlay - applying GIS analysis process.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Apply remote sensing and GIS techniques to address diverse industrial requirements.

23MCOC06	SUSTAINABLE ARCHITECTURE	L	T	P	C
		0	0	2	1

Evaluate environmental changes through various methods.

CO2: Evaluate environmental changes through various methods.

CO3: Explain the pivotal role of these techniques in supporting decision-making systems.

TOTAL: 15 PERIODS

REFERENCES:

1. "Mastering ArcGIS Pro", Bishop & Davis, 8th Edition, 2023.
2. "The GIS Handbook", Sheppard & Crighton, 4th Edition, 2021.
3. "Spatial Analysis in Ecology and Agriculture: A Beginner's Guide", Fortin & Dale, 2nd Edition, 2020.
4. "ArcGIS Pro: The Essential Guide for GIS Professionals", Esri Press, 2nd Edition, 2020.
5. "Spatial Analysis Methods for Social and Environmental Sciences", Dorling & Thrift, 2nd Edition, 2021.

CO	PO			PSO		
	1	2	3	1	2	3
1	3	1	2	3	2	1
2	3	1	2	3	2	1
3	3	2	2	3	2	1
Avg.	3	1.3	2	3	2	1

CO-PO & PSO MAPPING

1-low, 2-medium, 3-high

MODULE I SUSTAINABLE CONCEPTS - PEOPLE, ENVIRONMENT AND BUILDING **5**

Introduction -sustainable development goals- Components and factors governing sustainable development- Relationship between people and environment, impact of people on environment and vice versa, extent of the energy and environmental crises facing the world, Need for implementing energy efficiency on an international, national and individual basis in the context of the building industry & environmental issues. Introduction to Indoor environment - spatial environment, Thermal environment, visual environment, sonic environment and olfactory environment.

MODULE II ENERGY AUDIT & ENVIRONMENTAL IMPACT ASSESSMENT **5**

General Aspects of Energy Management & Energy Audit. Energy Efficiency in Thermal Utilities and Energy Efficiency in Electrical Utilities, Energy Performance Assessment for building envelope, fenestration and embodied energy. - Introduction and components such as physical, biological and socio-economical of Environmental impact assessment (EIA) in India based on the Environmental Protection Act (EPA), 1986, Ministry of Environment and Forest (MoEF) January 1994 for Environmental Clearance (EC) known as EIA Notification, 1994.

MODULE III WASTE UTILIZATION & MANAGEMENT, WATER AND BUILT FORMS **5**

The primary goal is to provide a comprehensive understanding of waste management from an environmental public health perspective. Sustainable techniques in municipal solid waste management. Recycling and Reuse. Energy development and Management of urban waste services. - water demand, growing water misuse, pollution, threat to environment, social implications, sustainability of water recourses, ground water management, issues related to urban water supply.

COURSE OUTCOMES

At the end of the course, students will be able to

CO1: Analyze the interdependencies between people, environment, and buildings within the context of sustainable development goals, energy efficiency, and indoor environmental quality.

CO2: Conduct basic energy audits and understand the principles of environmental impact assessment (EIA) within the legal framework of India, applying these concepts to evaluate building energy performance and potential environmental impacts.

CO3: Propose sustainable strategies for waste management and water conservation, considering their impact on built forms and urban environments.

TOTAL: 15 PERIODS

REFERENCES:

1. “Sustainable Architecture with Wood”, Depla & Bahri, 2nd Edition, 2018.
2. “Principles and Practice for a Sustainable Future”, Kibert, 3rd Edition, 2020.
3. “Water in Sustainable Architecture”, Rogers & Kopf, 2nd Edition, 2017.
4. “The Living Building Challenge”, International Living Future Institute, Vol. 3.1 (2020)
5. “Life Cycle Assessment for Building and Construction”, Hauschild & Rossier, 2nd Edition, 2017.

CO-PO & PSO MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	2	1
2	3	2	3	3	2	1
3	3	1	2	3	2	1
Avg.	**3**	**1.7**	**2.7**	**3**	**2**	**1**

1-low, 2-medium, 3-high