Teaching and Examination Schemes with Syllabus

of

Master of Technology (Civil)

in

Environmental Engineering

As per NEP

(Approved by 62nd meeting of Senate dated August 6, 2024)

Department of Civil Engineering
Sardar Vallabhbhai National Institute of Technology, Surat

Teaching Scheme

M.Tech in Environmental Engineering

Semester wise credit

Sr. no	Semester	Credit
1.	First	21
2.	Second	21
3.	Third	21-23
4.	Fourth	20
	Total	83-86

Teaching Scheme

M.Tech in Environmental Engineering

Sr. No.	Subject	Code	Scheme L-T-P	Exam Scheme			Credits (Min.)	Notional hours of Learning (Approx.)
				Th.	T	P		
				Marks	Marks	Marks		
	First Semester							
1	Physico-Chemical Processes	CEEN101	3-1-0	100	25	-	4	70
2	Biological Processes	CEEN103	3-1-0	100	25	-	4	70
3	Environmental Chemistry and Microbiology	CEEN105	4-0-0	100	-	-	4	70
4	Elective -1		3-0-0	100	-	-	3	55
5	Elective – 2		3-0-0	100	-	-	3	55
6.	Environmental Engg. Lab	CEEN107	0-0-4	100	-	-	2	70
7.	Seminar	CEEN109	0-0-2	100	-	-	1	40
8.	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	CEENV191 CEENP191	0-0-10				5	200 (20 x 10)
						Total	**21**	**390**
	Second Semester							
1	Solid and Hazardous Waste Management	CEEN102	3-1-0	100	25	-	4	70
2	Air Pollution and Control	CEEN104	3-1-0	100	25	-	4	70
3	Elective -3		3-0-0	100	-	-	3	55
4	Elective -4		3-0-0	100	-	-	3	55
5	Institute Elective*****		3-0-0	100	-	-	3	55
6	Mini Project		$$##nXX	100	-	-	2	70
7.	Advance Environmental Engg. Lab	CEEN106	0-0-4	100	-	-	2	70
						Total	**21**	**445**
7	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	CEENV192 CEENP192	0-0-10				5	200 (20 x 10)

L: Lecture; T: Tutorial; P: Practical; Th: Theory

*****to be offered to the PG students of other department and other PG Programs with the department.

Subject Code: Core, Electives, Dissertation Preliminary and Dissertation: **$$##nXX;** Vocational Training: **$$##VXX;** Professional Experience: **$$##PXX;**

$$: Department Name; **##**: M.Tech Course Identity; **n**: Year; **XX**: Core (01 to 10), Elective (11 to 70), Institute Elective (71 to 90), Vocational Training (91 to 92), Vocational Training (93 to 94), Dissertation Preliminary (95), Dissertation (96)

XX last digit odd number (for odd semester); XX last digit even number (for even semester)

Calculation of Notional Hours for the subject containing Theory, Tutorial and Practical

Example: 3-1-2: 3*15+1*15+2*15+10 (Exam)= 100

Sr. No.	Subject	Code	Exam Scheme			Credits (Min.)	Notional hours of Learning (Approx.)
			Th.	T	P		
			Marks	Marks	Marks		
	Third Semester						
1	MOOC course – I*	φ	-	-	-	3/4	70/80
2	MOOC course – II*	φ	-	-	-	3/4	70/80
3.	Industrial Training		-	-	-	1	-
4	Dissertation Preliminaries	CEEN295	-	-	350$	14	560
				Total		**21-23**	**700-720**
	Fourth Semester						
1	Dissertation	CEEN296	-	-	600$	20	800

$ **Internal**: 40% and **External**: 60%

*Swayam/NPTEL

φ As per 66th IAAC, Dated 20th March, 2024, Resolution No. 66.34 and 61st Senate resolution No. 4, 25th April, 2024

Elective 1

CEEN111Environmental Legislation and Impact Assessment
CEEN113Environmental Hydraulics
CEEN115 GIS and Remote Sensing in Environmental Engineering

Elective 2

CEEN117 Sustainable Waste Management System
CEEN119 Occupational Health, Safety and Environment
CEEN121Advanced Water and Wastewater Treatment

Elective 3

CEEN112 Industrial Waste Management
CEEN114 Environmental System Modelling
CEEN116 Waste-to-Energy Technologies

Elective 4

CEEN118 Noise, Indoor Air and Odour Pollution
CEEN120 Applied Statistics for Engineers
CEEN122 Cleaner Production and Environmental Management System

Institute elective

CEEN111Environmental Legislation and Impact Assessment
CEEN120 Applied Statistics for Engineers
CEEN119 Occupational Health, Safety and Environment
CEEN116Waste-to-Energy Technologies
CEEN271 AI/ML Based Applications in Civil Engineering

Course-wise Detailed Syllabus

SEMESTER – I

CEEN101PHYSICO-CHEMICAL PROCESSES

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Describe physical and chemical phenomena that form the basis for the design of unit processes.
CO2	Use the theoretical knowledge of corresponding physical and chemical phenomena in the treatment processes.
CO3	Design physico-chemical treatment processes to meet treatment goals for a given pollution scenario.
CO4	Apply advanced treatment processes for treating water and wastewater.
CO5	Develop conceptual schematics for the treatment of water and wastewater.

2. Syllabus

- **INTRODUCTION** **(02 Hours)**

  Physico-chemical processes to control water/wastewater pollution – Flowchart.

- **SEDIMENTATION AND COAGULATION** **(10 Hours)**

  Types of settling and their mathematical analysis – Coagulation: mechanism of coagulation – Colloidal chemistry – Modelling coagulation process – Effect of turbidity and alkalinity – Chemistry of coagulants – Design of coagulation process.

- **FLOW THROUGH BEDS OF SOLIDS** **(12 Hours)**

  Type of filters – Modelling filtration process – Mechanism– Ion exchange units – Contacting towers – Flow through expanded beds – Flow through porous plates and membranes.

- **GAS TRANSFER AND DISINFECTION** **(08 Hours)**

  Mechanism of gas transfer – Film coefficients and equilibrium relationship – Gas disperses – Packed columns – Tray columns – Spray units – Applications in environmental engineering – Disinfection – Mechanisms– Different agents.

- **ADVANCED TREATMENT OPERATIONS** **(13 Hours)**

  Adsorption – Isotherms – Softening – Ion exchange – Removal of specific chemical contaminants such as fluorides, arsenic, nitrates and trace organics. Advanced Oxidation Processes - Membrane processes – Reverse osmosis – Electro-dialysis – Desalination

(TotalLectures:45Hours)

3. References

1. Metcalf, L., & Eddy, H. (2014). Wastewater engineering: Collection, treatment, disposal, and reuse (5th ed.). McGraw-Hill.
2. Wiesmann, U., Choi, I. S., & Dombrowski, E. M. (2018). Fundamentals of biological wastewater treatment (2nd ed.). Wiley.
3. Hendricks, D. (2006). Water treatment unit processes: Physical and chemical. CRC Press.
4. Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2017). Wastewater engineering: Treatment and reuse (7th ed.). Tata McGraw-Hill.

5. Arceivala, S. J., & Asolekar, S. R. (2007). Wastewater treatment for pollution control and reuse (3rd ed.). Tata McGraw-Hill.
6. Sincero, A. P., & Sincero, G. A. (2008). Environmental engineering: A design approach (2nd ed.). Prentice-Hall.

4. **CO-PO-PSO_Mapping**

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	2	0	3	2	2	2
CO2	3	0	3	3	3	2
CO3	3	1	3	3	3	2
CO4	3	1	3	3	3	2
CO5	3	2	3	3	3	2

CEEN103 BIOLOGICAL PROCESSES

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Explain reactions, reactors and biological treatment processes.
CO2	Understand concepts of microbial growth and substrate utilization.
CO3	Differentiate various biological processes.
CO4	Design various biological treatment process units.
CO5	Design nutrient removal through biological processes.

2. Syllabus

- **REACTORS ANDREACTORANALYSIS** **(10 Hours)**
  Reactionsandreactionkinetics–Typesofreactorsandtheiranalysis–Hydrauliccharacteristicsofreactors.
- **KINETICSOFBIOLOGICALGROWTH** **(08 Hours)**
  Nutrition and growth conditions – Effect of environmental conditions–Bacterial growth in terms ofnumbersandmass–Growthcurve–Interpretationofcurve–Substratelimitedgrowth–Monod's expression – Substrate utilization and cell growth – Effect of Endogenous metabolism –Inhibition–Effectoftemperature–Applicationofgrowthandsubstrateremovalkineticstobiological treatment.
- **AEROBICPROCESSES** **(12Hours)**
  Suspended and attached growth systems – Modelling suspended growth – Activated sludgeprocess–Typesandtheirdesignconcepts–Differentattachedgrowthsystemsandtheir designconcepts.–AdvancedBiological Processes like MBR, MBBR, IFAS, Aerobic Granular Sludge Technology.
- **ANAEROBICTREATMENTPROCESSES** **(06Hours)**
  Microbiology–Differenttypes–DesignconsiderationsofUASBandattachedgrowthsystems.
- **NUTRIENTREMOVALANDPONDTREATMENTPROCESSES** **(06 Hours)**
  Biologicalprocessesfornitrogenandphosphorusremoval–NitrificationandDenitrificationprocessesandtheirdesignconcepts–Differentpondtreatmentsystems
- **BIOLOGICALPROCESSESFORSLUDGEPROCESSING** **(03Hours)**
  Anaerobicandaerobicdigestion.

(TotalLectures:45Hours)

3. References

1. Metcalf & Eddy Inc. (2014). Wastewater engineering: Treatment and reuse (5th ed.). Tata McGraw-Hill Education.
2. Benefield, L. D., & Randall, C. W. (2002). Biological process design for wastewater treatment (2nd ed.). Prentice Hall.
3. Qasim, S. R. (2012). Wastewater treatment plants: Planning, design, and operation (3rd ed.). CRC Press.
4. Karia, G. L., & Christian, R. A. (2017). Wastewater treatment: Concepts and design approach (2nd ed.). Prentice Hall.
5. Hendricks, D. (2018). Water treatment unit processes – Physical and chemical (2nd ed.). CRC Press.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	0	2	3	2	2
CO2	2	0	2	3	2	2
CO3	3	0	3	3	2	2
CO4	3	1	3	3	2	3
CO5	3	1	3	3	3	3

CEEN105 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

L	T	P	C
4	0	0	4

1. Course Outcomes (COs)

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

CO1	Identify the suitable treatment processes for water and wastewater.
CO2	Explain use of chemistry and microbiology in water and wastewater treatment processes.
CO3	Evaluate the physico-chemical and microbial characteristics of water and wastewater.
CO4	Understand the significance of bio-kinetics and chemical reactions in environmental engineering
CO5	Apply knowledge of chemistry and microbiology for solving various environmental issues.

2. Syllabus

ENVIRONMENTAL CHEMISTRY (30 Hours)

- **BASIC PRINCIPLES (10 Hours)**
  Physical and chemical properties of water and their significance in environmental engineering –Types of chemical reactions – stoichiometric calculations – solutions - chemical equilibrium. Acid-base equilibria – alkalinity, acidity, buffers and buffer index - Chemical thermodynamics – Oxidation–Reduction.
- **TRANSPORT PROCESSES (08 Hours)**
  Mass transfer and transport of impurities in water and air – diffusion, dispersion – Physical and chemical interactions due to various forces, suspensions and dispersions.
- **ANALYSIS (12 Hours)**
  Basic concepts of quantitative analytical chemistry – Instrumental methods of analysis – Significance of turbidity, colour, pH, acidity, alkalinity, hardness, residual chlorine and chlorine demand, chlorides, dissolved oxygen demand, BOD, COD, nitrogen, solids, iron and manganese, fluoride, sulphate, phosphorous and phosphate, grease, volatile acids, gas analysis – Preparation of standard solutions – Drinking water and wastewater standards – Trace organics and inorganics

ENVIRONMENTAL MICROBIOLOGY (30hours)

- **INTRODUCTION (10 Hours)**
  Microorganisms–Classification, prokaryotic and eukaryotic cells, structure, characteristics, nucleic acids, DNA and RNA, Viruses, their detection and quantification–Microscopy–Measurements and Isolation of Microorganism–Different Cultures–Media and Techniques of Staining.
- **MICROBIAL METABOLISM AND GROWTH (10Hours)**
  Enzyme and enzyme kinetics – Metabolism – Respiration – Fermentation – Glycolysis – Kreb's cycle – Carbohydrate – Protein, lipids, significance of energetic – Chemical composition of cell and nature of organic matter used by microorganisms – Metabolic classification of microorganisms: phototrops, chemotrops, applications in environmental engineering.

- **MICROBIOLOGY OF WATER AND WASTEWATER (10Hours)**
  Distribution of microorganisms in natural water – Indicator organisms – Coliforms – Faecal coliforms – *E.coli, Streptococcus faecalis* – Differentiation of coliforms – Significance – MPN – M.F. techniques – Microbiology of wastewater treatment processes such as activated sludge process – Trickling filter – Anaerobic processes. – Introduction to Microbiology of Soil, Air, Marine and Industrial Microbiology – Microbiology of bioremediation and solid waste treatment.

(TotalLectures:60Hours)

3. References

1. Sawyer C.N., McCarty P.L., and Parkin G.F., "Chemistry for Environmental Engineers", Fifth Edition, McGraw Hill, New Delhi, 2017.
2. Benjamin M. M. "Water Chemistry", Second Edition, Waveland Press Inc, 2014.
3. Rittman B., McCarty P.L. and McCarty P., "Environmental Biotechnology: Principles and Applications", McGraw–Hill, New Delhi, 2000.

4. Pelczar Jr, M.J., Chan E.C.S., Krieg R.N., and Pelczar M.F, "Microbiology", Fifth Edition, Affiliated East West Press, New Delhi, 2023.
5. Maier R.M, Pepper I.L and Gerba C.P., "Environmental Microbiology", Elsevier-AP, New York 2009.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	3	2	2
CO2	1	0	3	3	2	2
CO3	2	1	3	3	2	2
CO4	2	1	3	3	3	3
CO5	3	2	3	3	3	3

CEEN107 ENVIRONMENTAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

1. Course Outcomes (COs)

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

CO1	Understand the sampling methods for water and wastewater.
CO2	Analyze the physico-chemical and biological characteristics of a given sample.
CO3	Select the treatment option based on the sample characteristics.
CO4	Evaluate the impacts of water and wastewater quality on environment.

2. Syllabus

- **CHEMISTRY PRACTICALS** **(30Hours)**

1. Water & wastewater sampling and preservation techniques.
2. Determination of physical characteristics of water and waste water like pH, Turbidity, electrical conductivity, Solids.
3. Determination of Total Hardness, Calcium Hardness, Magnesium Hardness of water sample
4. Determination of Chlorides, Nitrates, Phosphate and Sulphate of water sample.
5. Determination of Residual chlorine of water sample
6. Study of Jar test for different coagulant dose.
7. Determination of DO, BOD and COD of waste water sample
8. Determination of oil and grease of waste water sample
9. Determination of Ammonical Nitrogen, Nitrates and Sulphates of waste water sample
10. Determination of Heavy metals from industrial waste

- **MICROBIOLOGY PRACTICALS** ` **(30 Hours)**

1. Study of Compound and Phase Microscope.
2. Study of staining technique.
3. Study of isolation techniques for bacteria.
4. Determination of Residual chlorine of water sample.
5. Study of MPN test and multiple tube technique.
6. Application of Plate count method for bacterial growth.
7. Effects of pH on growth of bacteria.
8. Effects of Osmotic Pressure on growth of bacteria.

(Total : 60 Hours)

3. References

1. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2017). Chemistry for environmental engineers (5th ed.). McGraw-Hill Education.
2. Benefield, L. D., Judkins, J. F., & Weand, B. L. (2014). Process chemistry for water and wastewater treatment (3rd ed.). Prentice Hall.
3. Rittmann, B. E., & McCarty, P. L. (2018). Environmental biotechnology: Principles and applications (3rd ed.). McGraw-Hill Education.
4. De, A. K. (2019). Environmental chemistry (9th ed.). New Age International Ltd.
5. American Public Health Association. (2017). Standard methods for the examination of water and wastewater (23rd ed.). American Public Health Association.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	2	3	1	3
CO2	2	3	2	3	2	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3

CEEN109SEMINAR

L	T	P	C
0	**0**	**2**	**1**

1. Course Outcomes (COs)

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

CO1	Collect the information on given specific area/topic.
CO2	Update with latest knowledge through exhaustive literature survey
CO3	Collate the information to prepare a report.
CO4	Communicate effectively through skillful presentation.

4. Syllabus:

- Each candidate is required to present one seminar on any chosen topic connected with the field of specialization. The topic shall be chosen in consultation with the concerned faculty. Preparation and Presentation of a seminar is intended to investigate an in–depth review of literature; to prepare a critical review and to develop confidence for making a good presentation. Assessment is based on the presentation and contents of the seminar report prepared. A report has to be submitted in the prescribed format and seminar shall be evaluated by the respective department committee.
- Expert Lectures can be arranged from various Environmental Consultants so that can student can get the exposure to field related problem

5. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	2	3
CO2	3	3	1	1	2	3
CO3	2	3	1	1	2	2
CO4	1	3	1	1	2	2

ELECTIVE – 1

CEEN111 ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT

L	T	P	C
3	0	0	3

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1. Course Outcomes (COs)

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

CO1	Interpret and explain the objectives and scope of EIA.
CO2	Categorize the importance of environmental attributes.
CO3	Describe the legal provisions and statutory requirement of environmental clearance.
CO4	Calculate the identification and prediction of environmental impacts of new/expansion projects.
CO5	Formulate an EIA for any given project.

2. Syllabus

- **IMPACT ASSESSMENT: TYPES AND SIGNIFICANCE** **(03 Hours)**
  Types of impacts, significant impacts, various impact assessments viz. health impact assessment, social impact assessment, disaster impact assessment, strategic environmental assessment.

- **EIA: INTRODUCTION & PLANNING** **(06 Hours)**
  Evolution of EIA; EIA at project; regional and policy levels; EIA legislative and environmental clearance procedures in India; EIA Rules-1994 and subsequent amendments, Rapid and Comprehensive EIA.

- **EIA: METHODOLOGIES AND STRATEGIES** **(14 Hours)**
  Screening, baseline data collection, environmental inventory of physical, biological and socio-economic environment attributes, terms of reference, scoping, identification of impacts, rapid and comprehensiveEIA, monitoring, analysis and report preparation in EIA, impact prediction tools / techniques such as adhocmethod, checklist method, development of environment management plan, post project monitoring.

- **PUBLIC PARTICIPATION** **(03 Hours)**
  Project Affected Persons, significance of public participation in EIA, methods of public consultation – Public Notice and Public Hearing, Resettlement and rehabilitation issues, Land Acquisition, Rehabilitation and Resettlement Act, 2013.

- **EIA CASE STUDIES** **(10 Hours)**
  Case studies / histories for different types of projects like metro rail project, nuclear power project, large hydro-electric power project, pharmaceutical industry, township and area development projects.

- **NATIONAL ACTS & RULES FOR ENVIRONMENTAL PROTECTION** **(09 Hours)**
  Indian environmental legislation and acts such as Water Act-1974, Air Act-1981, Wildlife Protection Act-1972, Forest Conservation Act-1980, Public Liability Insurance Act 1991, Environment Protection Act (EPA) – 1986; Various Rules under EPA-1986 such as Biomedical Waste Rules~~-1998~~ 2016, Coastal Regulation Zone-1999, Municipal Solid Waste rules, Hazardous Waste Rules-2016, Noise Regulation & Control Rules-2000, National Green Tribunal, NGT Act-2010, Case studies of landmark judgements given by NGT and various Courts.

(Total Lectures: 45Hours)

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3. References

1. Canter, L. W. (2018). Environmental impact assessment (3rd ed.). Tata McGraw-Hill Education.

2. Munn, R. E. (2018). Environmental impact assessment (2nd ed.). John Wiley & Sons.
3. Dhameja, S. K. (2014). Environmental engineering and management (2nd ed.). S. K. Kataria & Sons.
4. Central Pollution Control Board (CPCB). (n.d.). General standards. Retrieved from https://cpcb.nic.in/general-standards/
5. Ministry of Environment, Forest and Climate Change (MoEF&CC). (n.d.). Rules and regulations: Environment protection. Retrieved from https://moef.gov.in/en/rules-and-regulations/environment-protection/
6. Central Pollution Control Board (CPCB). (n.d.). Home page. Retrieved from https://cpcb.nic.in/index.php

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	3
CO2	2	3	2	2	1	2
CO3	1	3	1	1	1	1
CO4	3	1	3	3	2	3
CO5	3	3	3	3	3	3

ELECTIVE – 1

CEEN113 ENVIRONMENTAL HYDRAULICS

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understand the concepts of fluid flow analysis.
CO2	Compare different methods of network analysis.
CO3	Analyze water distribution system network with various tools and techniques.
CO4	Design storm water and sewerage network system.
CO5	Develop the hydraulic flow diagram for a treatment plant.

2. Syllabus

- **FUNDAMENTALS** **(06 Hours)**

  Basic equations for fluid flow analyses including Reynolds transport theorem – Basic concepts of flow through pipes.

- **WATER DISTRIBUTION SYSTEM DESIGN** **(10 Hours)**

  General design requirements – Methods of analyses – Control of water hammer in long distance transmission. – Introduction to optimization of water distribution system.

- **URBAN STORM DRAINAGE DESIGN** **(11 Hours)**

  Introduction to drainage problems in difficult climates. – Planning concepts, Rainfall intensity-duration – Frequency curves. – Design of drainage system elements, – Control of storm water pollution.

- **SEWERAGE SYSTEM AND SEWAGE TREATMENT PLANT DESIGN** **(10 Hours)**

  General design principles of sewers, Recent Development in sewerage system design – Application of softwares **-** Hydraulic design of STP**-** CETP design

- **GROUND WATER MANAGEMENT** **(08 Hours)**

  Well development – Artificial recharge – Salinity of ground water – Ground water pollution – Infiltration gallery – Central Ground Water Authority guidelines, 2015 -

(Total Lectures: 45Hours)

3. References

1. Chow, V. T. (2020). Open-channel hydraulics (3rd ed.). McGraw-Hill Education. (Original work published 1959)
2. Ranga Raju, K. G. (2017). Flow through open channels (3rd ed.). Tata McGraw-Hill Education.
3. Bhave, P. R., & Gupta, R. (2020). Analysis of water distribution networks (3rd ed.). Alpha Scientific.
4. Bear, J. (2021). Hydraulics of groundwater (3rd ed.). McGraw-Hill Education.
5. Central Public Health and Environmental Engineering Organisation (CPHEEO). (2023). Water supply and treatment manuals (3rd ed.). CPHEEO.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	0	3	1	2	2
CO2	2	0	3	2	2	2
CO3	2	0	3	2	2	3
CO4	2	1	3	3	2	3
CO5	2	2	3	3	3	3

ELECTIVE – 1

CEEN115 GIS AND REMOTE SENSING IN ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understand the Remote Sensing and GIS system for different data types.
CO2	Execute different techniques of image interpretation and processing.
CO3	Create different types of thematic maps.
CO4	Apply various spatial data analysis techniques.
CO5	Analyze and solve complex environmental engineering problems using GIS and Remote Sensing.

2. Syllabus

- **INTRODUCTION** **(05 Hours)**

  Introduction to GIS and Remote Sensing – Usefulness in Environmental Engineering

- **GEOGRAPHIC INFORMATION SYSTEM** **(10 Hours)**

  Components of GIS – GIS Data – Georeferenced data – Data input and output – Data Models – DBMS

- **FUNDAMENTAL OF REMOTE SENSING** **(10 Hours)**

  Definition – Components of Remote Sensing – Principles of Remote Sensing Energy Sources – Active and Passive Remote Sensing – Electro Magnetic Radiation (EMR) and the Electromagnetic Spectrum – Interaction of EMR with the Earth's Surface – Interactions with the Atmosphere

- **IMAGE INTERPRETATION AND DIGITAL IMAGE PROCESSING** **(10 Hours)**

  Interpretation Procedure – Strategies – Keys – Equipments – Digital Image Processing – Rectification and Restoration

- **GEOSPATIAL ANALYSIS AND APPLICATIONS** **(10 Hours)**

  GIS and image interpretation software – Salient features – Capabilities and Limitations - Methods - Measurements - Analysis – GEO visualization, application of Remote Sensing / GIS in Environmental Engineering – Case studies – Integration of GIS and Remote Sensing – Management and Monitoring of land, air, water pollution – conservation of resources and coastal zone management – Landuse planning.

(Total Lectures: 45Hours)

3. References

1. Lillesand, T. M., & Kiefer, R. W. (2020). Remote sensing and image interpretation (8th ed.). John Wiley & Sons.
2. Burrough, P. A., & McDonnell, R. A. (2015). Principles of geographic information systems (4th ed.). Oxford University Press.
3. Chandra, A. M., & Ghosh, S. K. (2016). Remote sensing and geographical information system (2nd ed.). Narosa Publishing House.
4. Bhatta, B. (2019). Remote sensing and GIS (2nd ed.). Oxford University Press.
5. Aronoff, S. (2016). Geographical information systems (3rd ed.). WDL Publications.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	2	1
CO2	1	1	2	2	2	2
CO3	1	2	2	2	2	2
CO4	2	1	2	3	2	3
CO5	3	2	3	3	3	3

ELECTIVE – 2

CEEN117SUSTAINABLE WASTE MANAGEMENT SYSTEM

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Introduce the concept of sustainability.
CO2	Understand the ecological and natural treatment systems.
CO3	Understand the concept and design of water conservation techniques.
CO4	Design of natural and decentralized treatment systems.
CO5	Design of various systems for waste management.

2. Syllabus

- **INTRODUCTION** **(06 Hours)**

  Concept of sustainability in water and waste management – Ecology, relationship between ecology, environment and waste management - Environmental indices- Bio remediation

- **WATER CONSERVATION AND REUSE** **(12 Hours)**

  Rainwater Harvesting – Roof water harvesting – Technology – Quality – Health issues –Groundwater recharge – Techniques – Greywater – Zero Liquid Discharge - Case studies – Wastewater reuse and reclamation.

- **NATURAL WASTEWATER TREATMENT SYSTEMS** **(10 Hours)**

  Centralized Vs decentralized – Natural and constructed wetlands – Different types – Mechanisms – Performance – Design – Case studies – Land treatment systems.

- **LOW–COST SANITATION** **(08 Hours)**

  Dry sanitation methods – Pit latrines – VIP latrines – Aquaprivy – Septic tank- Waterless urinals

- **SOLID WASTE MANAGEMENT TECHNIQUES** **(09 Hours)**

  Composting/vermicomposting – Liquid fertilizer – Biogas technology – Waste to Energy Technologies - Plasma technology.

(Total Lectures: 45Hours)

3. References

1. Crites, R. W., Middlebrooks, E. J., & Reed, S. C. (2020). Natural wastewater treatment systems (3rd ed.). CRC Press.
2. Cairncross, S., & Feachem, R. (2021). Environmental health engineering in the tropics (2nd ed.). John Wiley & Sons.
3. White, I. D., Mottershead, D. N., & Harrison, S. L. (2006). Environmental systems: An introductory text (2nd ed.). Chapman and Hall.
4. Tchobanoglous, G. (2014). Solid wastes: Engineering principles and management issues (2nd ed.). McGraw-Hill Education.
5. Martin, A. M. (2014). Biological degradation of wastes (2nd ed.). Elsevier.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	1	1	1
CO2	3	1	1	1	2	1
CO3	3	1	2	1	2	2
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3

ELECTIVE – 2

CEEN119 OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENT

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify and explicate the inter-relationship of industries and the government in context to occupational health, environment and safety.
CO2	Understand the statutory requirement of safety and environmental legislation.
CO3	Apply theories and concepts of occupational health and safety for workplace environment.
CO4	Develop and implement safe operating procedures (SOPs) for various industrial activities.
CO5	Execute Health Safety Environment (HSE) policy and Environmental Management Systems.

2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Safety – Safety and Productivity – Role of Government – National Safety Council – National Safety Awards – Housekeeping – Significance of occupation health in industries – Industries and environment protection.

- **OCCUPATIONAL ENVIRONMENT – BASICS & STANDARDS** **(12 Hours)**
  Working environment TYPES – Health impacts in an occupational environment – Effects of environmental factors on human body & mind – Basics of environment design - Improved efficiency and accuracy at work. ISO 14000 introduction – General description of ISO 14001 – Environment Management System (EMS) – Key elements of ISO 14001 and EMS.

- **SAFETY – PLANNING, STANDARDS AND LEGISLATION** (**11 Hours)**
  Safety Standards – HAZOP studies - ILO Model code of safety regulation / legislation – Risk Analysis – Risk Assessment – Indian Factories Act – Boiler Act – Electricity Act – Workman's compensation act - Purpose for planning – planning procedure – Range of plans – Safety policies – Elements and implementation of safety policy – ~~Implementation~~ – Disaster Management – On-site & Off-site emergency plan.

- **OCCUPATIONAL ERGONOMICS** **(07 Hours)**
  Ergonomics – Human-body – Health – Posture – Workplace or office ergonomics – Ergonomics for women at work – physical work and environment – Anthropometry

- **OCCUPATIONAL STRESS AND HEATH** **(10 Hours)**
  Work related stress – Causes of stress – Signs of stress – Measurement of stress – Stress management systems – Prevention – Stress health and productivity – Occupational safety and health Act – Health program – First Aid

(Total Lectures: 45Hours)

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3. References

1. Jain, R. K., & Rao, S. S. (2020). Industrial safety, health, and environment management systems (2nd ed.). Khanna Publishers.
2. Parashar, P., & Bansal, P. (2018). Industrial safety and environment (2nd ed.). S.K. Kataria & Sons.
3. Agrawal, S. K. (2012). Industrial environment assessment and strategy (2nd ed.). APH Publishing Corporation.
4. Slote, L. (2017). Handbook of occupational safety and health (3rd ed.). John Wiley & Sons.

5. National Safety Council. (2015). Safety, health, and working conditions: Training manual (2nd ed.). National Safety Council.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	3
CO2	2	3	2	2	1	2
CO3	1	3	1	1	1	1
CO4	3	1	3	3	2	3
CO5	3	3	3	3	3	3

ELECTIVE – 2

CEEN121ADVANCED WATER AND WASTEWATER TREATMENT

L	T	P	C
3	0	0	3

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1. Course Outcomes (COs)

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

CO1	Design advanced treatment systems for water treayment
CO2	Design advanced systems for w**astewater treatment**
CO3	Design sludge treatment and disposal systems
CO4	Design various systems for nutrient removal and recovery
CO5	Design units for wastewater reuse

2. Syllabus

- **ADVANCED WATER/WASTEWATER TREATMENT PROCESSES (25 Hours)**

  Membrane processes– Desalination – Reverse Osmosis, Electro-dialysis, Ceramic filters, Ion–exchange – Aeration/gas transfer – Precipitation – oxidation-reduction processes – Adsorption, heavy metal removal, evaporators

  Advanced oxidation processes – Bio-electro systems - Air stripping

  Advanced biological processes - modification of activated sludge process- modelling of biological wastewater treatment systems – Nutrient removal and recovery processes - Design of disposal systems

- **SLUDGE TREATMENT AND DISPOSAL (12 Hours)**

  Comparison of different sludge treatment systems – disposal of sludge – advantages and disadvantages – sludge reuse

- **WATER REUSE (8 Hours)**

  Need for wastewater reuse, greywater reuse, different uses - standards, processes for treatment - risks assessment

(Total Lectures: 45Hours)

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3. References

1. Qasim, S. R., Motley, E. M., & Zhu, G. (2017). Water works engineering (2nd ed.). Prentice-Hall India.
2. Montgomery, J. (2021). Water treatment principles and design (3rd ed.). John Wiley & Sons.
3. Metcalf & Eddy. (2014). Wastewater engineering: Treatment and reuse (5th ed.). Tata McGraw-Hill.
4. Central Public Health and Environmental Engineering Organisation (CPHEEO). (2012). Manual on water supply and treatment. Ministry of Urban Development, Government of India.
5. Central Public Health and Environmental Engineering Organisation (CPHEEO). (2005). Manual on sewerage and sewage treatment. Ministry of Urban Development, Government of India.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	3	3	2	2
CO2	2	1	3	3	2	2
CO3	2	1	3	3	3	3
CO4	2	1	3	3	3	3
CO5	2	1	3	3	3	3

Second Semester

CEEN102SOLID AND HAZARDOUS WASTE MANAGEMENT

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Introduce solid and hazardous waste management issues and its legal aspects
CO2	Characterize and quantify solid and hazardous waste..
CO3	Design collection, transportation and processing of waste management system.
CO4	Design disposal and treatment facility for solid and Hazardous waste
CO5	Develop waste management facility for bio medical, plastic ,E-waste, construction waste etc.

2. Syllabus

- **INTRODUCTION (06 Hours)**

  Solid waste sources – Nature and characteristics – Quantities and Qualities – Generation rates – Potential of disease – Nuisance and other problems – Solid Waste Management Rules, 2016 and amendments, Characterization and composition of hazardous waste, Hazardous and other wastes (Management & Transboundary Movement) Rules – 2016.

- **COLLECTION, STORAGE AND TRANSPORT OF SOLID WASTE (10 Hours)**

  Solid waste management – Functional elements of solid waste–on–site storage –Collection and separation – Containers and its location – Collection systems and its example – physical, chemical and microbiological characteristics of waste – Vehicle routing – Route balance – Transfer station – Processing – Recovery and reuse.

- **PROCESSING OF SOLID WASTE (11 Hours)**

  Conveying and compacting waste – Shredding – Types of shredders – Shredders Design–Material separation – Types – Devices for material separation – Thermal processing of municipal solid waste – incinerator and pyrolysis – Refuse Derived fuel – Biological process like composting, vermi-composting and bio-methanation, City compost plant, Waste to Energy plant.

- **DISPOSAL OF SOLID WASTE (06 Hours)**

  Disposal methods – Sanitary land filling – Planning – Site selection – Design – Landfill Process – Monitoring Closure – Post closure monitoring – Other methods like incineration, pyrolysis, and composting, biological digestion.

- **INDUSTRIAL HAZARDOUS WASTE MANAGEMENT (06 Hours)**

  Introduction to hazardous waste – Definition – TCLP test – Storage and transportation of hazardous waste – Labeling of hazardous waste – Physical, Chemical and Biological treatment of hazardous waste – Bioremediation of hazardous waste – Treatment of Bio medical – Nuclear waste and Radio – Active waste – Fly ash management and E-waste management.

- **SPECIALIZED WASTE MANAGEMENT (06 Hours)**

  Construction & demolition waste management - Plastic waste management - Bio-medical waste management – Radioactive waste – Fly ash management – e-Waste management – Cement co-processing – Circular economy.

(Total Lectures: 45Hours)

3. References

1. Rimbers, D. (2016). *Municipal solid waste management: Pollution technologies review* (2nd ed.). Noyes Data Corporation.
2. Wentz, C. A. (2019). *Hazardous waste management* (4th ed.). McGraw-Hill Education.

3. Tchobanoglous, G. (2014). *Solid wastes: Engineering principles and management issues* (2nd ed.). McGraw-Hill Education.
4. LaGrega, M. D., Buckingham, P. L., & Evans, J. C. (2010). *Hazardous waste management* (2nd ed.). McGraw-Hill Education.
5. Central Public Health and Environmental Engineering Organisation (CPHEEO). (2016). *Solid waste management: CPHEEO manual*. CPHEEO.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	2	2
CO2	2	1	2	1	2	2
CO3	2	2	3	2	3	3
CO4	2	2	3	2	3	3
CO5	2	2	3	3	3	3

CEEN104 AIR POLLUTION AND CONTROL

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Identify the air pollutants sources and understand their fate and transport under various meteorological conditions.
CO2	Demonstrate the understanding of basic science of air pollutants propagation and meteorology.
CO3	Analyze the effects and impacts arising from air pollutants.
CO4	Simulate air pollution concentrations using various mathematical, numerical models and softwares.
CO5	Design and apply pollution control devices for different environmental conditions.

2. Syllabus

- **AIR POLLUTION: BASICS AND STANDARDS** **(06 Hours)**

  Air Pollution – Definition – Sources and classification – Air Pollutants: Effects on human health, vegetation, materials and atmosphere –Ambient air quality monitoring and stack emission sampling – Principles of various instruments used in air quality monitoring – Sensor based analysers.

- **AIR QUALITY INDEX AND STANDARDS** **(08 Hours)**

  Source apportionment and emission inventory – Smoke, ozone layer, smog, haze and visibility – Air Quality Index (AQI)– SAFAR - Air quality standards and legislation.

- **METEOROLOGY AND DIFFUSION/DISPERSION MODELS** **(15 Hours)**

  Introduction to air pollution meteorology – Atmospheric motion – Lapse rates – Atmospheric stability – Inversions and its effects on pollutants – Atmospheric diffusion of pollutants – Transport – Transformation and deposition of air contaminants – Removal processes– Maximum Mixing Depths – Plume rise – Types of dispersion models like Gaussian Plume, Box, Line, Area.

- **AIR POLLUTION CONTROL TECHNOLOGIES: PARTICULATES** **(10 Hours)**

  Settling chambers, cyclone separation – Wet collectors – Fabric filters, electrostatic precipitators and other removal methods like absorption – Adsorption and precipitation.

- **AIR POLLUTION CONTROL TECHNOLOGIES: GASEOUS POLLUTANTS** **(06 Hours)**

  Removal of gaseous pollutants by adsorption, absorption, reactions and other methods.

(Total Lectures: 45Hours)

3. References

1. Wark, K., & Warner, C. F. (2022). Air pollution: Its origin and control (4th ed.). Harper & Row Publishers.
2. Rao, C. S. (2020). Environmental pollution control engineering (3rd ed.). New Age International Ltd.
3. De Nevers, H. (2018). Air pollution control engineering (3rd ed.). McGraw-Hill Education.
4. Griffin, R. D. (2019). Principles of air quality management (2nd ed.). CRC Press.
5. Boubel, R. W. (2017). Fundamentals of air pollution (5th ed.). Academic Press.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	2	2
CO2	2	1	2	2	2	2
CO3	2	2	3	3	3	3
CO4	2	2	3	3	3	3
CO5	3	3	3	3	3	3

CEEN106 ADVANCED ENVIRONMENTAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

1. Course Outcomes (COs)

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

CO1	Identify suitable treatment processes for a given water and wastewater.
CO2	Apply physico-chemical and biological processes for water and wastewater treatment.
CO3	Characterize municipal solid wastes.
CO4	Determine air pollutants concentration in ambient air.
CO5	Determine first order and second order kinetics.

2. Syllabus

Practicals:

1. Determination of coagulant dosage.
2. Determination of BOD rate constant
3. Filtration Performance Studies
4. Adsorption kinetics and equilibrium
5. Settling characteristics of solids
6. Removal of heavy metals by precipitation
7. pH Buffers and Buffering capacity
8. Study of Wastewater Disinfection
9. Study of Water Softening Process
10. Aeration and Coefficient of Aeration
11. Study of Activated Sludge Process
12. Analysis of solid wastes – Proximate and ultimate analysis
13. Characterization of wastes from different industries
14. Demonstration of Stack monitoring kit.
15. Analysis and calculation of particulate matter, SO_2 and NO_X for ambient air quality.
16. Demonstration and application of sound level meter

(Total : 60Hours)

3. References

1. Sawyer C.N., McCarty P.L., and Parkin G.F., "Chemistry for Environmental Engineers", 4th Edn. McGraw Hill, New Delhi, 1994.
2. Benefield, Judkins and Weand, "Process Chemistry for Water and Wastewater Treatment", 2nd edition Prentice Hall,New Delhi,1980.
3. Rittman B., McCarty P.L. and McCarty P., "Environmental Biotechnology: Principles and Applications", 2nd edition, McGraw–Hill, 2000.
4. De. A.K., "Environmental Chemistry", New Age International Ltd., New Delhi, 1995.
5. "Standards Methods for the Examination of Water & Waste water", 21st Edition, American Public health Association, Washington. D.C. 2005.

CEENXXXMINI PROJECT

L	T	P	C
0	0	0	2

1. Course Outcomes (COs)

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

CO1	Inculcate the culture of working in group
CO2	Identify a field problem related to environmental issues.
CO3	Compare different methods/solutions through literature review/experiments.
CO4	Design and implement optimum/sustainable solution.

- Students in consultation with the faculty advisor will decide a specific problem and are required to study and analyse the assigned problem. They are required to submit a project report at the end. The faculty adviser and the department committee will internally assess project.

2. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**1**	**1**	**0**	**0**	**3**	**2**
CO2	2	1	2	2	3	2
CO3	2	3	2	2	3	3
CO4	2	3	3	2	3	3

CEEN302 INDUSTRIAL TRAINING

L	T	P	C
0	0	0	2

1. Course Outcomes (COs)

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

CO1	Conduct onsite industrial visit for comprehensive field exposure.
CO2	Obtain practical knowhow about processes, emissions and discharges.
CO3	Understand the work culture and environment of industry.
CO4	Identify the environmental engineering problems related to industry.

- The intention of summer training is to develop the effective skills of the student and to expose them with actual problems faced in the industry. The students have to undergo the summer training during the period of summer vacation after completion of first year. The minimum duration of training is at least 6 weeks.

- Students will identify a suitable industry / consultant firm in consultation with the faculty advisor and study the relevant environmental issues. The student has to submit a training report, with duly signed certificate of the industry / consultant firm, where the training/practical/experimental work has been carried out. The evaluation of the report will be carried out by the department level committee.

2.CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	2	0	1	1
CO2	3	1	3	2	2	2
CO3	3	2	3	1	3	3
CO4	3	2	3	3	3	3

ELECTIVE – 3

CEEN112 INDUSTRIAL WASTE MANAGEMENT

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Explain the sources of industrial pollutants and its impact on environment
CO2	Classify the pollutants for various industry
CO3	Develop plan and strategies using tools and techniques for prevention of pollution in industrial area.
CO4	Select advance control technology for waste minimization programme.
CO5	Develop / formulate Waste Control strategies to minimise industrial pollution.

2. Syllabus

- **INTRODUCTION** **(10 Hours)**

  Sources of wastes – Industrial and domestic – Nature and characteristics of wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater– Quality and quantity of industrial wastes –Evaluation of pollution prevention – physical, chemical and biological process. Prevention vs Control of Industrial Pollution – Benefits and Barriers – Decommissioning of industrial projects.

- **INDUSTRIAL POLLUTION PREVENTION** **(10 Hours)**

  Waste minimization – Source reduction Techniques – waste volume reduction - Waste strength reduction – Neutralization – Removal of suspended and colloidal solids – Removal of inorganic and dissolved solids – reduction of wastewater at point source.

- **ADVANCE WASTEWATER MANAGEMENT** **(12 Hours)**

  Waste Audit – Mass Balance - Toxicity of industrial effluents and Bioassay tests - Individual and common effluent treatment plants – Zero liquid discharge (ZLD) systems – Multiple Effect Evaporator (MEE), Advanced Oxidation, Wet Air Oxidation, Wastewater quality requirements for its reuse. Quantification and characteristics of Sludge – Thickening, conditioning, digestion, dewatering and sludge disposal

- **CASE STUDIES** **(13 Hours)**

  Industrial manufacturing process description – source of wastewater –Wastewater characterization - effect of wastewater on receiving water and sewers –waste treatment flow sheet for Textiles, Tanneries, Pulp and paper, Pharmaceuticals, Sugar, Steel, Fertilizer, Oil and Petrochemicals, Cement.

(Total Lectures: 45Hours)

3. References

1. Smith, P. G., & Scott, J. S. (2022). *Dictionary of water and waste management*. Heinemann.
2. Barton, S. N. (2023). *Industrial waste: Management, assessment, and environmental issues* (2nd ed.). Nova Science Publishers.

3. Patwardhan, A. D. (2019). *Industrial wastewater treatment* (2nd ed.). PHI Learning.
4. Nemerow, N. L. (2018). *Industrial waste treatment* (3rd ed.). Elsevier Butterworth-Heinemann.
5. Rao, M. N., & Datta, A. K. (2022). *Wastewater treatment* (3rd ed.). Oxford & IBH Publishing.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	2
CO2	1	2	2	1	2	2
CO3	2	3	3	2	3	3
CO4	2	3	3	3	3	3
CO5	2	3	3	3	3	3

ELECTIVE – 3

CEEN114 ENVIRONMENTAL SYSTEM MODELLING

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understand mathematical models with system definition and components.
CO2	Identify types of models and their applications
CO3	Select appropriate models for diffusion and dispersion of pollutants.
CO4	Develop simple models for transport and fate of different contaminants
CO5	Apply different soft computing techniques in environmental engineering.

2. Syllabus

- **INTRODUCTION** **(8 Hours)**

  Mathematical modelling and simulation – Defining systems and its components – Types of models and their applications – Evaluation of models – Graphical analysis – Quantitative analysis – Sensitivity analysis – Uncertainty analysis.

- **TRANSPORT AND FATE OF CONTAMINANTS- FUNDAMENTALS** **(10 Hours)**

  Mass and energy balance – Advection – Molecular diffusion and dispersion – Chemical transformations - sorption/desorption - Photochemical transformations and Biological transformations.

- **TRANSPORT AND FATE OF CONTAMINANTS - MODEL APPICATIONS (16 Hours)**

  Modelling approaches - Modelling of rivers-lakes, sediments, wetlands, subsurface flow and transport – Water dispersion models - Air pollution modelling - Modelling of volatilization, Models for activated sludge process – Anaerobic processes.

- **INTRODUCTION TO SOFT COMPUTING TECHNIQUES** **(11 Hours)**

  MCDM techniques - Analytic hierarchy process –Fuzzy set theory - Neural networks - Applications in environmental engineering.

(Total Lectures: 45Hours)

3. References

1. Ramaswami A., Milford J.B., Small M.J., "Integrated Environmental Modeling – Pollutant Transport, Fate, and Risk in the Environment", John Wiley & Sons, 2005.
2. NirmalaKhandan, "Modeling Tools for Environmental Engineers and Scientists", CRC Press, 2020.
3. Snape J.B., Dunn I.J., Ingham J. and Prenosil J., "Dynamics of Environmental Bioprocesses, Modelling and Simulation", Weinheim: VCH, 1995.
4. International Water Association, "Activated sludge modelling", ASM1 and ASM2
5. Chapra S.C., "Surface Water Quality Modeling", McGraw–Hil, Inc., New York, 1997.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	2	0	3	2	1	2
CO2	2	0	3	2	2	2
CO3	3	2	3	2	2	3
CO4	3	2	3	2	3	3
CO5	3	2	3	3	3	3

ELECTIVE – 3

CEEN116WASTE-TO-ENERGY TECHNOLOGIES

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify waste characteristics with respect to waste- to-energy technologies.
CO2	Compare different waste-to-energy technologies with respect to its applicability.
CO3	Evaluate waste-to-energy technologies with respect to sustainability perspective.
CO4	Design biological waste-to-energy systems.
CO5	Design thermal waste-to-energy systems.

2. Syllabus

- **CHARACTERIZATION OF SOLID WASTES (10 hours)**
  Wastes and their classification, Important quality parameters, Wastes suitable for energy production, Municipal solid wastes and their availability in India, Characterisation of solid wastes, proximate and ultimate analysis, leaching properties, Energy content and heating value – Energy balance
- **INCINERATION AND GASIFICATION (13 hours)**
  Incineration scope and application, Mechanism, air requirements, Performance factors, Feedstock characteristics, Incinerator working, Environmental impacts and issues, Basics of gasification, gasification products, syngas, gasifier types, Gasifiers for biomass and wastes, Comparison between incineration and gasification, Syngas utilization
- **PYROLYSIS, GAS PURIFICATION (09 hours)**
  Mechanism, types, operating conditions, end products, properties of bio-oil, Densification of solids, efficiency improvement of power plant and energy production from waste plastics. Properties of gas produced through different routes, Gas clean up, removal of particulates
- **ANAEROBIC PROCESSES (09 hours)**
  Anaerobic processes fundamentals, microbiology, pathways, pre-treatment, types and operation of anaerobic digester, Design of anaerobic digesters, Introduction to microbial fuel cells. Energy production from wastes through fermentation

- **ALGAL BIOMASS AND ENERGY PRODUCTION (04 hours)**
  Characteristics of algal biomass, Cultivation and growth of algae, Reactor systems and harvesting, Bio fuel production from algal biomass, Conversion processes, Factors affecting yield, homogeneous and heterogeneous catalyst.

(Total Lectures: 45Hours)

3. References

1. Rogoff, M. J., & Screve, F. (2024). Waste-to-energy: Technologies and project implementation (2nd ed.). Elsevier.
2. Young, G. C. (2019). Municipal solid waste to energy conversion processes (2nd ed.). John Wiley & Sons.
3. Harker, J. H., & Backhurst, J. R. (2019). Fuel and energy (2nd ed.). Academic Press.
4. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2018). Environmental engineering (2nd ed.). McGraw-Hill Education.
5. Tchobanoglous, G., & Kreith, F. (2014). Handbook of solid waste management (2nd ed.). McGraw-Hill Education.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	2
CO2	2	1	2	1	2	2
CO3	2	2	3	2	3	3
CO4	2	2	3	2	3	3
CO5	2	2	3	3	3	3

CEEN118NOISE, INDOOR AIR AND ODOURPOLLUTION

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Interpret the legal provisions and statutory requirements of noise, air and odour pollution.
CO2	Demonstrate the understanding of basic science of noise and indoor air propagation.
CO3	Analyze the effects and impacts arising from noise, indoor air and odour pollution.
CO4	Compare and select methods of improving indoor environmental quality systems.
CO5	Design of noise maps and mitigation measures using mathematical models and softwares.

2. Syllabus

- **INDOOR AIR POLLUTION: BASICS** **(03 Hours)**

  Indoor air quality, indoor air pollution sources, health effects of various indoor air pollutants, household pollutants, principles & types of ventilation, various types of air conditioning systems. Instruments for indoor air quality parameters like PM_{10}, $PM_{2.5}$, CO_2, VOCs, Bio-aerosols.

- **INDOOR AIR POLLUTION: IMPACTS & CONTROL TECHNIQUES** **(06 Hours)**

  Impact of aerosol properties on indoorair quality, construction materials and indoor air quality, impact of PM_{10}, $PM_{2.5}$, Formaldehyde, Carbon Monoxide, VOCs on human health, Sick Building Syndrome, strategies for indoor air pollution control.

- **SOUND AND NOISE: BASICSAND LEGISLATION** **(08 Hours)**

  Sound, noise, physiology of hearing, frequency, wavelength, speed,loudness of sound, sound pressure and sound pressure level, equivalent noise level, noise indices, frequency and octave bands, A and C weighted frequencies, charts for addition and subtraction of sound pressure levels, Noise Pollution (Regulation and Control) Rules 2000.

- **NOISE POLLUTION: SOURCES & IMPACTS** **(10 Hours)**

  Noise pollution sources, effects of noise pollution, auditory and non-auditory effects, calculation of hearing handicap, CPCB ambient noise standards, OSHA noise standards for work place, WHO hearing loss standards.

- **NOISE CONTROL TECHNIQUES AND MODELLING** **(12 Hours)**

  Mitigation of noise at source - use of PPEs - noise barrier design - use of softwares' like SOUNDPLAN, CADNA, LIMA – application of mathematical noise prediction models like FHWA, CoRTN, RLS-90 - use of neuro-fuzzy, genetic algorithm optimization, neural networks in noise modelling.

- **ODOUR POLLUTION** **(06 Hours)**

  Chemicals and processes responsible, elements of odour, odour threshold and character, strategies for odour pollution control.

(Total Lectures: 45Hours)

3. References

1. Wang, L. K., Pereira, N. C., & Hung, Y. (2022). *Advanced air and noise pollution control* (2nd ed.). Humana Press.
2. Bugliarello, G., Alexander, A., Barnes, J., & Wakstein, C. (2020). *The impact of noise pollution: A socio-technological introduction* (2nd ed.). Pergamon Press Inc.
3. Central Pollution Control Board (CPCB). (2020). *Manual on guidelines on odour pollution and its control*. CPCB.
4. Central Pollution Control Board (CPCB). (n.d.). *Home page*. Retrieved from https://cpcb.nic.in/index.php

5. Ministry of Environment, Forest and Climate Change (MoEF&CC). (n.d.). *Rules and regulations: Environment protection*. Retrieved from https://moef.gov.in/en/rules-and-regulations/environment-protection/
6. Central Pollution Control Board (CPCB). (n.d.). *General standards*. Retrieved from https://cpcb.nic.in/general-standards/

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	2	2
CO2	2	1	2	1	2	2
CO3	2	2	3	2	3	3
CO4	2	2	3	2	3	3
CO5	2	2	3	3	3	3

ELECTIVE – 4

CEEN120 APPLIED STATISTICS FOR ENGINEERS

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Analyze and interpret engineering data.
CO2	Apply different sampling distributions to engineering data.
CO3	Use hypothesis testing for various cases.
CO4	Develop simple linear regression models and correlation.
CO5	Design statistical experiments.

2. Syllabus

- **INTRODUCTION** **(07 Hours)**

  Graphical presentation of data: dot and scatter plots – Frequency distribution and histogram – Box plot and time plots – Numerical distribution of data: Measures of Central tendency – Dispersion – Skewness and kurtosis – Measuring association – Grouped data.

- **SAMPLING DISTRIBUTIONS** **(10 Hours)**

  Random variables and expectation – Discrete and continuous random variables – Sampling distributions – Important discrete distributions – Binomial – Poisson and geometric distributions – Normal distribution – Central limit theorem.

- **PARAMETER ESTIMATION** **(06 Hours)**

  Point estimation – Confidence interval estimation.

- **TESTS OF HYPOTHESIS** **(08 Hours)**

  Tests of hypothesis on single sample and two samples – Goodness of fit – Tests based on Normal – t – Chi–square – F distributions.

- **SIMPLE LINEAR REGRESSION AND CORRELATION** **(06 Hours)**

  One way and two way classification.

- **DESIGN OF EXPERIMENTS** **(08 Hours)**

  Completely randomized single factor experiment – Analysis of variance – Randomized block design – Latin square design – 2^2 factorial design.

(Total Lectures: 45Hours)

3. References:

1. Box G.E.P, Hunter J.S. and Hunter W.G., “Statistics for Experimenters”, John Wiley and Sons, 2005
2. Berthouex P.M and Brown L.C., “Statistics for Environmental Engineers”, CRC Press, 2002.
3. Freund J.E. and Miller I.R., “Probability and Statistics for Engineers”, Eighth Edition, Prentice–Hall of India, 2011.

4. Walpole R.E. Myers R.H., Myers S.L. and Ye K., “Probability and Statistics for Engineers and Scientists”, Pearson Education, New Delhi, 2002.
5. Johnson D. E., “Applied Multivariate Methods for Data Analysis”, Thomson & Duxbburg Press, Singapore, 2002.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	3	3	2	2
CO2	1	1	3	3	2	2
CO3	2	2	3	3	3	3
CO4	2	2	3	3	3	3
CO5	2	2	3	3	2	3

ELECTIVE – 4

CEEN122CLEANER PRODUCTION AND ENVIRONMENTAL MANAGEMENT

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understand the concept of sustainable development.
CO2	Create the Env management plan for industry.
CO3	Encourage the industry for pollution prevention and cleaner production.
CO4	Develop the life cycle assessment of the product of industry.
CO5	Analyze the product in terms of environmental economics.

2. Syllabus

- **ENVIRONMENT AND SUSTAINABLE MANAGEMENT (08 Hours)**
  Concepts of Sustainable Development – Indicators of Sustainability – Sustainability Strategies, Barriers to Sustainability – Resource degradation – Industrialization and Sustainable development – Socio economic policies for sustainable development
- **CLEANER PRODUCTION (08 Hours)**
  Clean development mechanism, cleaner Production (CP) in Achieving Sustainability – Principles and concepts of Cleaner Production – Role of Industry, Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches
- **ENVIRONMENTAL MANAGEMENT SYSTEM IN INDUSTRY (10 Hours)**
  Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Preparing for the Site visits – Data and Information collection –Process Flow Diagram – Material Balance – CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives – Total Cost Analysis – Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement – Green house gases and carbon credit – Carbon sequestration – Sustainable development through trade – carbon trading.
- **ENVIRONMENTAL MANAGEMENT TECHNIQUES (13 Hours)**
  Elements of Life Cycle Assessment (LCA) – Life Cycle Costing – Eco Labeling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit, Green building & green energy concepts and management – Industrial applications of CP, LCA, EMS and Environmental Audits – Green energy and green process management in Pharmaceutical, Construction, Textiles, Petroleum Refineries, Iron and Steel
- **ENVIRONMENTAL ECONOMICS (06 Hours)**
  Introduction – economic tools for evaluation – Economic development and social welfare consideration in socio economic developmental policies and planning.

(Total Lectures: 45Hours)

3. References

1. Bishop, P. L. (2019). Pollution prevention: Fundamentals and practice (2nd ed.). McGraw-Hill Education.
2. World Bank Group. (2018). Pollution prevention and abatement handbook: Towards cleaner production (2nd ed.). World Bank and UNEP.
3. Modak, P., Visvanathan, C., & Parasnis, M. (2018). Cleaner production audit (2nd ed.). Environmental System Reviews, Asian Institute of Technology.
4. Kirkby, J. O., Keefe, P., & Timberlake, L. (2018). Sustainable development (2nd ed.). Earthscan Publications.
5. Purohit, S. S. (2021). Green technology: An approach for sustainable environment (2nd ed.). Agrobios.

4. CO-PO-PSO_Mapping

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	2	1	2
CO2	1	1	3	2	1	2
CO3	2	1	3	2	2	2
CO4	2	1	3	2	3	3
CO5	2	2	3	3	3	3

INSTITUTIVE ELECTIVE

CEEC 271AI/ML BASED APPPLICATIONS IN CIVIL ENGINEERING

1. Course Outcomes (COs)

At the end of the Course the students will be able to:

CO1	Comprehend the basic principles of artificial intelligence (AI) and machine learning (ML) algorithms.
CO2	Understanding Data collection & management tools & techniques for AI/ML application to Civil Engineering.
CO3	Derive the need and benefits of using AI/ML algorithms for developing applications in Civil Engineering using big-data analysis.
CO4	Solve the real-life problems in Civil Engineering using real-time data collection and big-data analysis involving AI/ML tools.
CO5	Evaluate the performance of different AI/ML algorithms towards a given application in civil engineering.

2. Syllabus

- **INTRODUCTION TO MACHINE LEARNING** **(8 hours)**

Machine Learning Basics: Data Collection, Data Management, Big data, taxonomy of machine learning algorithms, **Supervised Learning:** Classification – Bayesian Classifier, K-nearest Neighbours, Regression- Linear Regression, Multivariate Regression, Logistic regression. Support Vector Machine (SVM) Algorithm. **Unsupervised Learning:** Clustering- K-means clustering algorithm and Hierarchical clustering algorithm. **Reinforcement Learning:** Q-Learning algorithm.

- **DATA COLLECTION APPARATUSES** **(8 hours)**

Type of data sources, Types of data, Types of sensors, Edge-devices, Introduction to microcontrollers, data communication protocols, Cloud storage and cloud computing, Local server setup, Cloud server setup, Introduction to Python, Introduction to Django server, Database setup.

- **APPLICATIONS IN CIVIL ENGINEERING** **(15 hours)**

Intelligent Transportation systems, smart mobility, shared mobility, Mobility as a Service (MaaS), Real-time data monitoring, Structural health monitoring, Fire resistance evaluation of structures, automation in water resource management, Water quality monitoring, water distribution system monitoring, air and noise pollution monitoring, Rainfall-runoff modelling, Climate change monitoring, Soil liquefaction, Forecasting foundation related parameters, Building occupancy modelling, Building information modelling, Energy demand prediction, Predictive maintenance of equipment, roads and buildings

- **APPLICATION PART I: DATA COLLECTION AND MANAGEMENT** **(7 hours)**

Image processing for real time applications in Civil Engineering**,** Description of available database across specialisations**,** Selection of sensors and microcontroller, Integration of sensors with Edge-device, Programming of Edge-devices, Programming of server in Django framework, Collection of sensor data and storing to Database, Cloud computing

- **APPLICATION PART II: BIG DATA ANALYSIS** **(7 hours)**

Selecting the appropriate ML algorithm for analysis, Data Processing, Analysing the importance of each variable in decision making,andAnalysis of processed data.

(Total Lecture : 45 Hours)

3. References:

1. Pradhan, M., & Kumar, U. D. (2023). Machine learning using Python (2nd ed.). Wiley.
2. Deka, P. C. (2022). Primer on machine learning applications in civil engineering (2nd ed.). Taylor & Francis.
3. Farrar, C. R., & Worden, K. (2021). Structural health monitoring: A machine learning perspective (2nd ed.). Wiley.
4. Soldatos, J. (2022). Building blocks for IoT analytics. River Publishers.
5. Natri, S. (2023). Django - The easy way (2nd ed.). [Publisher information not provided].
6. Holovaty, A., & Kaplan-Moss, J. (2022). The Django book (Release 2.0) (2nd ed.). [Publisher information not provided].
7. Benjamin, J. R., & Cornell, C. A. (2020). Probability, statistics, and decision for civil engineers (4th ed.). McGraw-Hill Education.
8. Washington, S. P., Karlaftis, M. G., & Mannering, F. L. (2019). Statistical and econometric methods for transportation data analysis (3rd ed.). CRC Press.
9. Johnson, R. A., & Wichern, D. W. (2022). Applied multivariate statistical analysis (7th ed.). Pearson.

4. Other Material:

1. Arduino-ESP32 (Release 2.0.2), Espressif, 2022.

5. CO-PO-PSO Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3
CO2	3	2	3	3	2	2
CO3	3	3	3	3	3	3
CO4	3	3	3	3	2	3
CO5	3	2	3	3	3	3

SEMESTER – III

CEEN295 DISSERTATION PRELIMINARY

L	T	P	C
0	0	28	14

1. Course Outcomes (COs)

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

CO1	Identify and investigate problems related to environmental issues.
CO2	Conduct the comprehensive literature review.
CO3	Propose the methodology for the identified problem.
CO4	Collate the information to prepare a report.

- Dissertation will be taken up by the student after the completion of the second semester. This is aimed at training the students to analyze independently problem assigned to them. The work may be analytical, experimental, design or combination of these.

- The dissertation preliminary report is expected to display clarity of thought, critical appreciation of the existing literature and analytical and / or experimental or design skill.

2. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	3
CO2	3	3	3	2	1	3
CO3	2	2	3	3	3	3
CO4	2	3	3	2	3	3

SEMESTER – IV

CEEN296 DISSERTATION

L	T	P	C
0	0	40	20

1. Course Outcomes (COs)

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

CO1	Analyze the preliminary results and if required, modify the proposed methodology.
CO2	Conduct extensive analytical / modelling / experimental / field work.
CO3	Propose effective sustainable solution for the identified problem.
CO4	Prepare a comprehensive report and communicate through a skilful presentation.

- It is the continuation of the Dissertation preliminary. The Dissertation report is to be submitted at the end of the fourth semester.
- The main objective of dissertation work is to provide scope for original and independent study/research, to develop a theme and to demonstrate ability of using analytical approach independently. The theme or topic of dissertation should be within the framework of the environmental engineering M.Tech. programme.
- Dissertation report will be prepared by each student under the supervision of the faculty advisor and will be submitted within the specified time. The evaluation of dissertation will be based on continuous internal and external assessment comprising of presentation of the work and viva-voce examination.

2. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	1	3	2	2
CO2	3	2	2	3	2	3
CO3	3	2	3	3	2	2
CO4	1	3	3	3	1	3