PONDICHERRY UNIVERSITY

CENTRE FOR POLLUTION CONTROL AND ENVIRONMENTAL ENGINEERING

Curriculum and Syllabus
for

Master of Technology
Environmental Engineering and Management

Regulations 2025-2026 onwards

PONDICHERRY UNIVERSITY

CENTRE FOR POLLUTION CONTROL AND ENVIRONMENTAL ENGINEERING

Master of Technology
(Environmental Engineering and Management)

UNIQUE FEATURES OF THE CENTRE

- This Centre has developed a vigorous culture of applied environmental research, teaching, and industrial consultancy.
- Several dynamic PhDs and MTechs, trained in frontier research areas, in India and abroad, contribute to the pool of manpower expertise of the Centre.
- The Centre has thus far published over 700 papers, with most in high impact- factor international journals.
- The Centre has also been providing expert advice to government departments, industry, and academia.

VISION

To integrate social responsibility, sustainable existence, novelty, innovativeness, rigour and sophistication in all the activities of the Centre

MISSION

Development and deployment of cleaner, greener, sustainable pollution control technologies.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: To provide graduates the knowledge to identify, formulate the environmental protection needs of society and provide solutions that are technically sound, economically feasible, socially acceptable and sustainable.

PEO 2: To address the real-life environmental engineering problems related to water, air, solid waste management, industrial pollution prevention and control by applying the concept of SDGs in the design and technology for environmental management

PEO 3: To enable the graduates to have a career and develop independent and lifelong learning skills for continuous professional development.

PEO 4: To practice professional ethics and social responsibility towards environmental protection and preservation.

PROGRAMME OUTCOMES (POs)

PO1: To identify, understand, analyse, formulate, evaluate, and solve environmental engineering problems using the techniques, skills, and engineering tools necessary for environmental engineering and management practice

PO2: To design optimal systems, processes, and equipment for control and remediation of water, air, noise and soil quality best suited for public health, considering cultural, societal, and economic factors

PO3: To design and conduct experiments independently, with an ability to write as well as interpret data and communicate effectively and present a substantial technical report/document

PO4: To gear-up for professional level employment as Environmental Engineers or pursue higher studies; as well as understand the importance of ethical and professional responsibility

PO5: To gain knowledge of contemporary environmental issues and demonstrate a degree of mastery in the field of environmental engineering and management

ELIGIBILITY CRITERIA

- **B.E./B.Tech.** in Agriculture / Agricultural and Irrigation Engineering / Biotechnology / Biochemical Engineering / Civil / Chemical / Chemical and allied Engineering / Environmental Engineering / Energy / Energy and Environment / Geo-informatics / Geo-technology/ Industrial engineering / Industrial biotechnology with at least 55% in the qualifying examination.
- **M.Sc.** in Atmospheric sciences / Biotechnology / Chemistry / Climate Sciences / Climate Change and Sustainability / Earth Sciences / Environmental Science / Ecology and Environment / Geology / Life sciences / Physics with at least 55% in the qualifying examination.

PONDICHERRY UNIVERSITY

CENTRE FOR POLLUTION CONTROL AND ENVIRONMENTAL ENGINEERING

Master of Technology

Environmental Engineering and Management

CURRICULUM
2025-2026 ONWARDS

CODE	NAME OF THE COURSE	CREDITS	PAGE NO.
SEMESTER I			
	Core courses (Hard)		
CPET 611	Fundamentals of Environmental Sampling and Analysis	4	7
CPET 612	Physico-Chemical Treatment of Water and Wastewater	4	9
CPET 613	Air and Noise Pollution and Control	4	11
CPET 614	Solid and Hazardous Waste Management	4	13
	Core courses (Soft)		
CPET 615	Ecology and Environmental Biotechnology	3	15
CPET 616	Research Methodology and IPR	3	17
CPET 617	Environmental Analysis Laboratory	2	19
	Total credits	**24**	
SEMESTER II			
	Core courses (Hard)		
CPET 621	Biological Treatment of Wastewater	4	20
CPET 622	Environmental Impact Assessment and Management	4	22
	Core courses (Soft)		
CPET 623	Environmental Sustainability and Circular Economy	3	24
	Elective 1	3	
	Elective 2	3	
	Elective 3	3	
	Total credits	**20**	
SEMESTER III			
	Core courses (Hard)		
CPET 711	Summer Training	2	26
CPET 712	Air and Surface Water Quality Modelling	4	27
CPET 713	Project Phase 1	8	29
	Core courses (Soft)		
	Elective 4	3	
	Total credits	**17**	
SEMESTER IV			
CPET 721	Project Phase 2	**12**	30

Total credits for Hard core courses= 50
Total credits for soft core courses=23
Total credits=73

LIST OF ELECTIVES

SEMESTER I

HARD CORE COURSES

CPET 611 ENVIRONMENTAL SAMPLING AND ANALYSIS

(Credits: 4; Lectures: 60 contact hours)

Objectives:

To understand the concept of representative sampling techniques, analytical methods, basic monitoring equipment and instrument calibration, sample preservation procedures, data analysis and quality control

Unit 1: General Considerations (10)

Qualitative and quantitative analysis; characterization of data: accuracy and precision, errors and uncertainty, repeatability and reproducibility; detection of outliers; significant figures; different expressions of concentration and their equivalence. primary and secondary standards; measuring glassware and clean/good laboratory practice.

Unit 2: Sampling Techniques (12)

General sampling strategies; techniques for the collection of grab/pooled samples of water, air soil, and solid waste; sampling of micro and macro flora and fauna; preservation and storage of samples; maximum holding time; chain of custody of records

Unit 3: Analysis of Water and Wastewater (12)

pH, EC, acidity, alkalinity, hardness, chloride, phosphorous, nitrogen, sulphate, turbidity, iron, DO, BOD and COD, solids, coliforms, emerging contaminants, heavy metals, microplastics; BIS standards ISO10500:2012 for drinking water

Unit 4: Analysis of Air, Noise, Soil, and Solid Wastes (12)

SPM, NOx, SOx, CO, ozone, dioxin; noise pollution monitoring; major/minor elements in soil; proximate and ultimate analysis of solid waste.

Unit 5: Analytical Instruments (14)

Principle and functioning of Conductivity meter, pH meter, thermal analysis, spectrophotometer – molecular and atomic spectroscopy; absorption, emission and fluorescence spectrophotometers – UV-Vis spectrophotometers, FTIR, XRF; Chromatography: types, chromatogram, resolution, column chromatography: types of column, Gas Chromatography – principle, functioning, types of detectors

Reference Books/ Sources:

- Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 24th Edition, Water Works Association, Water Environment Federation, , 2022.
- E. Popek, Sampling and Analysis of Environmental Chemical Pollutants: A Complete Guide, 2nd Edition Elsevier, , 2017
- Z. Chunlong, Fundamentals of Environmental Sampling and Analysis, John Wiley & Sons, , 2024.
- Anshul Nigam, Rupal Gupta, Environmental Analysis Laboratory Handbook, 1st Edition, Scrivener Publishing LLC, 2020
- Jr. James P. Lodge, Methods of Air Sampling and Analysis, , CRC Press, 2020.
- C.S. Rao, Environmental Pollution Control Engineering, 4th Edition New Age International Publishers, , 2021.

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand the basics of analytical chemistry in environmental analysis.
2. Apply the concept of data quality objectives for data analysis.
3. Identify methods and techniques for sampling different environmental matrices such as water, air, soil, flora and fauna.
4. Understand the analytical methods of environmental contaminants in water, air and soil.
5. Understand the theory, and principle and functioning of instruments and its application in environmental analysis.

COs	PO				
	1	2	3	4	5
1	0	1	1	3	3
2	1	2	2	3	3
3	2	3	3	3	3
4	1	2	2	3	3
5	2	3	3	3	3

CPET 612: PHYSICO-CHEMICAL TREATMENT OF WATER AND WASTEWATER

(Credits: 4; Lectures: 60 contact hours)

Objectives

To learn about the physico-chemical treatment of water and wastewater. To make the students to understand the applications of physico-chemical treatment of water and wastewater.

Unit 1: Introduction (10)

Overview of unit operations and unit processes associated with water and wastewater treatment. Schematic flow diagrams. Flow equalization. Screening: types of screens, estimation of head loss due to flow-through screens. Treatment requirements and standards.

Unit 2: Aeration, Sedimentation and Floatation (12)

Aeration: two film theory, oxygen transfer rates, factors affecting transfer rates, application of correction factors, aerator performance. Sedimentation: types of settling (Types 1-4), computation of settling velocities, performance of sedimentation tanks. Design of sedimentation tanks. Dissolved air floatation.

Unit 3: Filtration (12)

Sand filtration: rapid sand and slow sand filters, filter operation, Darcy's equation, Carmen-Kozeny equation-computation of head loss, backwash hydraulics. Membrane filtration: membrane process classification, membrane operation, recovery rate, membrane area calculation. Adsorption: activated carbon filtration, adsorption isotherms.

Unit 4: Coagulation, Flocculation, Precipitation and Disinfection (14)

Coagulation: destabilization of colloids, types of coagulants. Flocculation. Precipitation: solubility product and nucleation. Disinfection: characteristics of an ideal disinfectant, types of chemical disinfectants. Disinfection with chlorine: breakpoint chlorination. Dechlorination.

Unit 5: Advanced Oxidation Process (12)

Advanced oxidation process (AOP): mechanism of AOPs for water and wastewater treatment. Photo induced AOP. Solar and UV Photolysis of H_2O_2. Ozonation. UV/O_3 processes. Fenton processes. Ultrasound processes. Electrochemical processes.

Reference Books/ Sources

- Metcalf & Eddy, Inc., Revised by G. Tchobanoglous, F. L. Burton, and H. D. Stensel, Wastewater Engineering – Treatment and Reuse, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
- T. D. Reynolds, P. Richards, Unit Operations and Processes in Environmental Engineering, 2nd edition, PWS Series in Engineering, Boston, 1996.
- A. P. Sincero, G. A. Sincero, Physical–Chemical Treatment of Water and Wastewater, IWA Publishing, Boca Raton, CRC Press, 2003.
- V. Belgiorno, V. Naddeo, L. Rizzo, Water, Wastewater and Soil Treatment by Advanced Oxidation Processes (AOP), Lulu Enterprises, 2011.
- S. Parsons, Advanced Oxidation Processes for Water and Wastewater Treatment, IWA Publishing, 2004.
- T. Oppenlander, Photochemical Purification of Water and Air: Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts, Wiley-VCH Publishing, 2003.

Course Outcomes (CO):

On successful completion of this course, students will be able to:

1. Apply the concepts of unit operations and unit processes for water and wastewater treatment based on the standards.
2. Analyze the aeration, primary sedimentation tank and flotation unit for wastewater treatment.
3. Examine the various filtration methods in water and wastewater treatment.
4. Examine the coagulation/flocculation, precipitation and disinfection methods in water and wastewater treatment.
5. Analyze the various advanced oxidation processes for water and wastewater treatment.

COs	PO				
	1	2	3	4	5
1	1	2	2	3	3
2	2	3	3	3	3
3	2	3	3	3	3
4	2	3	3	3	3
5	1	2	2	3	3

CPET 613: AIR AND NOISE POLLUTION AND CONTROL

(Credits: 4; Lectures: 60 contact hours)

Objectives:

To illustrate the major problems in air and noise pollution and control. To describe the air and noise pollution control measures and devices.

Unit 1: Air Pollution and Its Effects (8)

Air Pollutants: Sources, classification, effect on animal health, vegetation, materials, and atmosphere; Chemical and photochemical reactions in the atmosphere and their effects: smoke, smog, acid rain and ozone layer depletion; Greenhouse gases, global warming and its implications; Global atmospheric and climate change; Air pollution legislation and standards; Issues of indoor air quality.

Unit 2: Air Pollution Dispersion and Modeling (15)

Meteorology and air pollution: atmospheric stability and inversions, behavior of air pollutant plumes as effected by nature of source, meteorology, obstacles and terrain, maximum mixing depth; Effluent dispersion theories: models for point and line sources based on Gaussian plume dispersion and their limitations; Box model for area sources; Prediction of effective stack height: Holland's and Briggs equations.

Unit 3: Particulate Emission and Its Controls (14)

Reduction in the generation of particulate matter by process modification, good housekeeping, and other means; Control of SPM: concepts and the design elements of gravitational settlers, centrifugal collectors, wet collectors, electrostatic precipitators, fabric filters, condensers.

Unit 4: Gaseous Emissions and Its Control (15)

Sources of air pollution from fossil fuels and industrial processes; Prevention and reduction of emissions, cleaner production; Air pollution control by absorption, adsorption, condensation, incineration, bioscrubbers, biofilters, etc; Design and performance equations; Case studies.

Unit 5: Noise Pollution and Its Control (8)

Generation and propagation of sound; sound power, sound intensity and sound pressure levels, sources; outdoor and indoor noise propagation; psycho-acoustics and noise criteria; Noise problem analysis- OSHA regulations, Annoyance rating schemes; noise standards and limit values; Effects of noise on health; Noise pollution measuring instrumentation and monitoring procedure.

References Books / Sources:

- N. de Nevers, Air Pollution Control Engineering, 2nd Edition, McGraw Hill, Singapore, 2000.
- Louis Theodore, Air pollution control equipments, , Wiley Publication. 2008.
- US EPA https://www.epa.gov/air-research/air-quality-modeling.
- Urban emission info: https://urbanemissions.info/
- AP-42: Compilation of Air Emissions Factors from Stationary Sources. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources
- Portal for Regulation of Air Pollution in Non-Attainment Cities https://prana.cpcb.gov.in/#/home.

Course outcomes:

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

1. Summarize the air quality, properties, sources and effects of the atmospheric pollutants
2. Examine the meteorology and air pollution modeling
3. Analyze the particulate pollutants and control
4. Understand the gaseous pollutants and control
5. Illustrate the noise pollution, measurement and control

COs	PO				
	1	**2**	**3**	**4**	**5**
1	3	3	1	2	2
2	3	3	1	1	2
3	3	3	2	1	1
4	3	3	2	1	1
5	3	3	1	1	1

CPET 614: SOLID AND HAZARDOUS WASTE MANAGEMENT

(Credits: 4; Lectures: 60 contact hours)

Objectives

To provide comprehensive overview of sources of solid and hazardous wastes. To provide knowledge on solid and hazardous waste disposal.

Unit 1: Introduction (6)

Solid and hazardous wastes; definition, types, sources, and impact on environmental health. Elements of integrated waste management, Legislations on management and handling of solid wastes, construction waste, biomedical wastes, E-waste, Plastic waste, and other hazardous wastes. Swatch Bharat Mission.

Unit 2: Characterization and Source Reduction (14)

Waste generation rates- characteristics- physical, chemical, biological properties, Concepts of waste reduction, recycling and reuse; Markets and product for recycled material , Public participation and the role of NGOs-Waste exchange programmes – Extended Producer Responsibility; Case studies on awareness programmes related to 3Rs .

Unit 3: Storage, Collection and Transport (14)

Handling and segregation of waste at source - Storage and collection of municipal solid wastes- Analysis of collection systems- Needs for transfer and transport- Development and implementation of material recovery facility- Storage, Labelling, handling and transport of hazardous waste- Case studies on storage, collection and transport of urban and rural systems.

Unit 4: Waste Treatment Methods (14)

Material separation and processing technologies , Mechanical biological treatment methods and chemical conversion methods, Composting system, Odour management. Vermicomposting, - Waste to energy recovery options; Incineration; Solidification and stabilization of hazardous wastes Treatment of biomedical wastes- Health and environmental considerations of operation facilities. Refuse derived fuels.

Unit 5: Waste Disposal (12)

Waste Disposal options, Concepts of waste disposal ; NIMBY, NIABY NIMTO, LULU, BANANA. ALARA, YIMBY Disposal in landfills- Landfill classification; Site selection; design and operation of sanitary landfills, secure landfills and landfill bioreactors- Leachate and landfill gas management-landfill closure and environmental monitoring- Rehabilitation of open dumps-landfill remediation. Legacy waste mangement. Fly ash management.

References Books / Sources:

- *Handbook of Solid Waste Management,* F. Kreith, G. Tchobanoglous, 2nd edition.The McGraw-Hill Companies, Inc
- CPHEEO, (Part I, II, III, Overview, Manual and compendium) *Municipal Solid waste management Manual, Central Public Health and Environmental Engineering Organization*, Government of India, New Delhi, 2016.
- *Hazardous Waste Management,* M. D. LaGrega, P. L Buckingham, J. C. Evans, 2nd edition. McGraw-Hill, 2000.
- SBM technical advisories: https://sbmurban.org/technical-advisories

- Ministry of Housing and Urban affair. http://www.moud.in/
- Solid waste management practices in urban India, A compendium 2019, National Institute Of Urban Affairs, Delhi. https://niua.in/innovation/home/solution/3.

Course outcomes:

On successful completion of this course, the student will be able to

1. Describe the various sources, types and handling of solid wastes.
2. Describe the characterization and source reduction of solid waste
3. Analyze the waste collection and transportation systems.
4. Discuss the various solid waste treatment technologies to recover energy.
5. Apply the various techniques for effective solid waste disposal.

COs	PO				
	1	2	3	4	5
1	3	1	1	2	2
2	3	3	1	1	2
3	3	3	2	1	1
4	3	3	2	1	1
5	2	3	1	1	3

SOFT CORE COURSES

CPET 615: ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To learn about ecological systems and the environment, which would help in applications to the prevalent problems in the society. To impart understanding of living organisms, microorganisms and their relation to the environment. To impart knowledge on the pollution control methods based on biotechnology.

Unit 1: Ecology (9)

Biotic and abiotic components in the environment and their interaction; Ecosystem; Energy flow and material cycling; Food chain, food web and ecological pyramids; Biogeochemical cycles; Ecological succession; Ecological efficiency; Ecological engineering: concepts and limiting factors.

Unit 2: Biology and Microbiology (8)

Types of cells: prokaryotes and eukaryotes; Membrane transport; Classifications of living organisms and micro-organisms; Microbial world: diversity, growth and processes; Microorganisms in air, soil, water, wastewater and sludge; Concepts of Genetic engineering.

Unit 3: Microbial Treatment Processes (9)

Biosorption, bioleaching, biohydrometallurgy and bioaccumulation processes; Bio-Desulphurization of coal and oil; Indicator organisms and their quantification; Algae in water supplies: problems and control; Algal effluent treatment systems and their limitations.

Unit 4: Plant and Animal-based Treatment Processes (9)

Phytoremediation: Organic and inorganic; Macrophyte-based wastewater treatment systems; Composting, vermicomposting and termigradation.

UNIT 5: Bioremediation and Bio-subtitution (10)

Bioremediation: principle, types, contaminant availability; Microbial catabolism of organic pollutants; Short-term and long-term monitoring of remedial sites; Bio-substitution: fuels, oils, polymers, construction materials, fertilizers and pesticides.

References Books / Sources:

- Fundamentals of Ecology, Eugene Odum, 5th Edition, Cengage India Private Limited, 2017.
- Biotechnology in Environmental Remediation, Jaspal Singh, Rajesh Bajpai, Ravi Kumar Gangwar, 1st edition, Wiley, 2023.
- Soil Microbiology, Robert L. Tate III, 3rd Edition, Wiley-Blackwell, 2020.
- Environmental Microbiology and Microbial Ecology, Larry L. Barton, Robert J. C. McLean, Wiley-Blackwell, 2019.
- Sustainable Solutions for Environmental Pollution, Volume 2: Air, Water, and Soil Reclamation, Nour Shafik El-Gendy, 1st Edition, Wiley, 2022.
- Biotechnology for Environmental Protection, Rangabhashiyam Selvasembian, Eric D. van Hullebusch, Joyabrata Mal, Springer, 2022.

Course outcomes:

On successful completion of this course, students will be able to:

1. Summarize the fundamentals of ecological systems and their relation with engineering and environment.
2. Summarize the nature of living organisms and micro-organisms.
3. Apply the concept of environmental biotechnology and the different types of microbes used.
4. Analyze the different pollutants and identify the appropriate control strategy.
5. Examine the nature of pollutants and recognize their remediation through environmental biotechnology techniques.

COs	**PO**				
	1	**2**	**3**	**4**	**5**
1	1	1	1	3	3
2	1	1	1	3	3
3	1	2	2	3	3
4	2	3	3	3	3
5	2	3	3	3	3

CPET 616: RESEARCH METHODOLOGY AND IPR

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To gain insights on how scientific research is conducted; to understand how to do critical review of literature for identifying research problem statement and research gap; to gain knowledge on scientific communication such as technical paper writing/presentation.

Unit 1: Perception of Research (9)

Meaning, definition, characteristics, objectives, classification and kinds; assortment of problem: reflective and scientific thinking; identification and evaluation of problem; research proposal/synopsis; appraisal of related literature

Unit 2: Conducting State-of-the-Art Surveys (9)

The pivotal role of the knowledge of prior art in research - organizing a state-of-the-art survey – databases for literature search (SCOPUS, Web of knowledge, Google scholar, Science Direct Shodhganga, INFLIBNET, Web of Science, ORCID etc.) - perils, pitfalls, and safeguards.

Unit 3: Collection of Data (9)

Sources of data – primary, secondary and tertiary; methods of data collection: surveys, interviews, observation, field investigations, direct studies, report/records, experiments. Design of experiments.

Unit 4: Basics of Data Analysis (10)

Accuracy, precision; repeatability and reproducibility; outliers – tests to identify outliers: z-test, 4d rule, Dixon's test, Grubb's test; descriptive and inferential statistical analysis; measures of central tendency and variance; regression analysis, entropy analysis, error estimations, hypothesis testing, tests of significance – 't' test, f-test, ANOVA, chi-square.

Unit 5: Ethical Issues (8)

Copyright, royalty, intellectual property rights and patent law, reproducibility and accountability, reproduction of published material - plagiarism, citation and acknowledgement.

References Books / Sources:

- C.R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International Publishers, New Delhi, 2019.
- Donald H McBurney, Research Methods, 5th Edition, Thomson Learning, 2006.
- Dipankar Deb, Rajeeb Dey, Valentina E. Balas, Engineering Research Methodology: A Practical Insight for Researchers, 1st Edition, Springer Verlag, 2019.
- G.B. Reddy, Intellectual Property Rights and The Law (Copyright Law, Patent Law, Designs Law, Trademarks Law, Farmers Rights Law, Biological Diversity Law, Information Technology Law Etc.), , Gogia law Agency, Hyderabad, 2020.
- Ranjith Kumar, Research Methodology; A step by step guide or beginners,, Sage Publications Pvt. Ltd, 4th Edition, 2024.
- Indian national Science Academy (INSA), Ethics in Science Education, Research and Governance, 2019, http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Course outcomes:

On successful completion of this course, the student will be able to

1. Identify, formulate research problem
2. Develop hypothesis and methodology of research
3. To communicate scientific results following research integrity and ethics
4. To apply basic statistics involved in data analysis and presentation
5. To understand the significance of IPR and filing patents

CO	PO				
	1	2	3	4	5
1	0	1	1	3	3
2	2	3	3	3	3
3	1	2	2	3	3
4	1	2	2	3	3
5	0	1	1	3	3

CPET 617: ENVIRONMENTAL ANALYSIS LABORATORY

(Credits: 2; Practical)

Objectives:

To give hands on experience on characteristics of water and wastewater, to measure the particulate and gaseous pollutant concentration in ambient air, to characterize soil samples and solid wastes, to sample flora and fauna.

Experiments:

- Determination of pH, EC, acidity, alkalinity, turbidity, hardness, sulphate, BOD, COD, solids and metals in wastewater.
- Determination of SPM, NOx, and SOx of ambient air.
- Analysis of soil for moisture content, pH, EC, carbon, nitrogen, phosphorous and potassium.
- Analysis of solid wastes- proximate analysis: moisture content, volatile matter, fixed carbon, ash; ultimate analysis: carbon, hydrogen, nitrogen, oxygen and sulfur.

- Sampling of terrestrial flora and fauna by quadrat and transect methods.

References Books / Sources:

- Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Water Works Association, Water Environment Federation, 24th Edition, 2022.
- , M. Radojevic and V.N.Bashkin, Practical Environmental Analysis, 2nd Edition, RSC Publishing, 2015.
- E. Popek, Sampling and Analysis of Environmental Chemical Pollutants: A Complete Guide, 2nd Edition, Elsevier, , 2017
- Anshul Nigam, Rupal Gupta, Environmental Analysis Laboratory Handbook, 1st Edition, Scrivener Publishing LLC, 2020
- Official Methods of Analysis, 22nd Edition, , AOAC International, 2023
- Jr. James P. Lodge, Methods of Air Sampling and Analysis, CRC Press, 2020.

Course outcomes:

On successful completion of this course, students will be able to:

1. Apply the analytical techniques for identifying and understanding physical and chemical parameters of water and wastewater.
2. Evaluate methods and techniques for sampling and analysis of particulates and gaseous pollutants in air.
3. Apply the procedures of analyzing soil and solid wastes.
4. Evaluate methods of sampling flora and fauna to understand species richness, diversity and evenness.
5. Understand the functioning of instruments essential in environmental analysis.

COs	PO				
	1	2	3	4	5
1	1	2	2	3	3
2	1	2	2	3	3
3	1	2	2	3	3
4	1	2	2	3	3
5	1	2	2	3	3

SEMESTER II

HARD CORE COURSES

CPET 621 BIOLOGICAL TREATMENT OF WASTEWATER

(Credits: 4; Lectures: 60 contact hours)

Objectives:

To educate the students on the principles and process designs of various biological treatment systems for wastewater and students should gain competency in the process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process.

Unit 1: Classification and Kinetics (10)

Aerobic and anaerobic fermentation. Suspended and attached growth systems. Rates of substrate utilization and biomass growth in suspended and attached growth systems. Kinetics of biological growth. Types of reactors. Process selection.

Unit 2: Aerobic Wastewater Treatment (12)

Aerobic suspended growth processes: activated sludge process and its variants sequencing batch reactors. Modeling and design of activated sludge processes. Aerobic attached growth process: trickling filters, rotating biological contactors. Combined aerobic treatment processes.

Unit 3: Anaerobic Wastewater Treatment (14)

Anaerobic suspended growth processes: complete mix process, anaerobic contact process, anaerobic sequencing batch reactors. Anaerobic attached growth processes: up flow and down flow attached growth processes, expanded-bed reactor, fluidized bed-reactor Anaerobic sludge blanket reactors. Facultative ponds and lagoons.

Unit 4: Biological Nutrient Removal (12)

Biological nitrogen removal: nitrogen cycle, nitrification, denitrification, stoichiometry, kinetics, environmental factors. Biological phosphorus removal: microbiology, mechanism, kinetics, environmental factors.

Unit 5: Biological Sludge Treatment (12)

Sludge thickening: design of gravity thickening beds. Sludge drying beds: bed area and bed layers dimensions. Filter (belt) press. Anaerobic sludge digestion: low and high rate digestion.

Reference Books/ Sources:

- Manual on Sewerage and Sewage Treatment CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013
- Metcalf & Eddy, Inc., Revised by G. Tchobanoglous, F. L. Burton, and H. D. Stensel, Wastewater Engineering - Treatment and Reuse, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
- C.P.L. Grady, G. Daigger, H.C. Lim, Biological Wastewater Treatment, 2nd Edition, Marcel Dekker, 1999.
- F.R. Spellman, Handbook of Water and Wastewater Treatment Plant operations, CRC Press, New York 2009.

- S.R. Qasim, Wastewater Treatment Plant, Planning, Design & Operation, CRC Press, New York, 2017.
- Larry D. Benefield, Clifford W. Randall, Biological Process Design for Wastewater Treatment, Prentice Hall, Inc., Englewood Cliffs, NJ 07632, 1980.

Course outcomes:

On successful completion of this course, students will be able to:

1. Summarize the concepts and fundamentals of various biological processes used in wastewater treatment.
2. Analyze the design of aerobic wastewater treatment units.
3. Examine the design of anaerobic wastewater treatment units.
4. Analyze the methods for biological nutrient removal.
5. Examine the design of sludge management facilities.

COs	PO				
	1	2	3	4	5
1	0	1	1	3	3
2	2	3	3	3	3
3	2	3	3	3	3
4	2	3	3	3	3
5	1	2	2	3	3

CPET 622 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

(Credits: 4; Lectures: 60 contact hours)

Objectives:

To understand the importance of environment impact of various proposed developmental activity and post operational activity for better decision making.

Unit 1: Overview (6)

Definition and purpose of EIA, Evolution of EIA, Legal and policy framework of EIA in India (including EIA Notification 2006 and amendments), Role of EIA in sustainable development, Case studies of successful and failed EIA projects.

Unit 2: Components and methods of EIA (16)

Components: Screening, setting, analysis, prediction of impacts, mitigation. Importance assessment techniques ;Adhoc, Delphi, Matrices, Networks, Checklists. Cost benefit analysis, Analysis of alternatives , Term of reference , Public Participation in environmental decision making: public hearings.

Unit 3: Impact Identification, Prediction & Assessment (10)

Methods for Prediction and assessment of impacts; Air ,Water , Soil , Noise, Biological, Cultural, Social, Economic Environments.

Unit 4: Quality control, documentation and monitoring of EIA (12)

Trends in EIA practice and evaluation criteria - Capacity building for quality assurance. Accreditation EIA Consultant Organization, Expert System in EIA - Use of regulations- Document planning - Collection and organization of relevant information - Use of visual display materials,Team writing, Reminder checklists, Preparation of environmental Management Plan.

Unit 5: Environmental management systems and industrial ecology (16)

Introduction to environmental management system (EMS); Definition and concept, Benefits of implementing EMS. International standards: ISO 14001; Planning, Implementing and Operating, Checking the Performance, Management Review.

Industrial metabolism; Dematerialization and decarbonization, Eco design, Life cycle planning, design and assessment. Product stewardship; Product oriented environmental policy, Eco-efficiency.

Reference Books/ Sources:

- L. W. Canter, Environmental Impact Assessment, McGraw Hill, New York, 1996.
- R. B. Clements. Simon & Schuster*, Complete Guide to ISO 14000,* 1996.
- T.E Gradel and B.R. AllenIndustrial Ecology and Sustainable Engineering. Pearson Publication, 2015.
- Project categorization framework for strengthening environmental impact assessment, CSE publication, 2018. https://www.cseindia.org/project-categorization-framework-8922
- EIA guidance Manual, PARIVESH, MoEF&CC, Government of India. https://environmentclearance.nic.in/report/User_eia_manuals.aspx).
- Environmental notifications, 2006 and subsequent amendments.https://environmentclearance.nic.in/report/EIA_Notifications.aspx

Course outcomes:
On successful completion of this course, students will be able to:

1. Perceive the importance of Environmental Impact Assessment and the issues in EIA
2. Outline the component and methods of EIA.
3. Summarize the EIA document and monitoring methods.
4. Describe the environmental management system.
5. Outline the industrial ecology.

COs	PO				
	1	2	3	4	5
1	3	1	.1	3	3
2	3	3	1	1	2
3	3	3	1	1	1
4	3	3	1	1	1
5	3	3	1	1	3

CPET 623: ENVIRONMENTAL SUSTAINABILITY AND CIRCULAR ECONOMY

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To understand the principles of sustainability and circular economy, explore methods to reduce resource use and environmental impact, analyze circularity's role in addressing climate change and pollution, study best practices, and develop strategies for integrating these principles into business and policy-making.

Unit 1: Fundamentals of Sustainability (8)

Introduction to Sustainability- Definition, pillars (environmental, economic, social), and history- Global Challenges - Climate change, resource depletion, biodiversity loss, and inequality- Sustainability Metrics - Ecological footprint, carbon footprint, and SDGs, Sustainable Development Goals (SDGs)- Overview, progress, and integration into policies.

Unit 2: Principles of Circular Economy (9)

Understanding Circular Economy (CE): Definition, principles (reduce, reuse, recycle)-Linear vs. Circular Systems: Comparison and critique- Frameworks and Models: Cradle-to-cradle design, biomimicry, and regenerative systems- Role of Technology: Digitization, Industry 4.0.

Unit 3: Strategies for Circularity (9)

Design for Sustainability- Product life-cycle thinking and eco-design. Waste Management- Hierarchy of waste management, low-value plastics, and e-waste, Business Models for CE- Sharing economy, product-as-a-service, and reverse logistics. Role of Policy- Extended producer responsibility (EPR), green taxation, and circular procurement.

Unit 4: Applications and Best Practices (10)

Sectoral Applications -Manufacturing and Industry, Agriculture, Circular bio-economy and agro-waste management. Business models, Solid Waste Management, Wastewater, Plastics: A case study, EPR: Polluters pay principle, Industrial symbiosis/ Eco-parks.

Unit 5: Future Directions and Innovations (9)

Emerging Trends: Circular cities, carbon-neutral economies, and zero-waste strategies. Role of Innovation: Advanced recycling technologies, bioplastics, and AI in resource optimization. Cross-Sector Collaboration: Public-private partnerships, community involvement, and global cooperation.

Reference Books/ Sources:

- Charles E. Bamford, Alan N. Hoffman, ,Strategic Management and Business Policy *Globalization, Innovation and Sustainability,* 16th Edition, Pearson 2024
- Robert , Vaibhav Bhamoriya, Introduction to Sustainability, An Indian Adaptation, 2nd Edition, Wiley India Private Limited, 2024
- Walter R Stahel, The Circular Economy A User's Guide, 1st Edition, Routledge, 2019
- Shalini Goyal Bhalla, Circular Economy: (Re) Emerging Movement, Invincible Publisher, 2021.
- Peter Lacy, Jessica Long, Wesley Spindler Peter Lacy, Jessica Long, Wesley Spindler Palgrave, The Circular Economy Handbook: Realizing The Circular Advantage, Macmillan UK, 2020.

- Circular economy in municipal solid and liquid waste, Ministry of housing and urban affairs, 2021, https://mohua.gov.in/pdf/627b8318adf18Circular-Economy-in-waste-management-FINAL.pdf

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand sustainability and circular economy principles to address global challenges.
2. Analyze environmental, social, and economic impacts of linear and circular systems.
3. Develop innovative strategies for sustainable practices and resource efficiency.
4. Evaluate policies and technologies driving circularity and sustainability transitions.
5. Communicate and collaborate effectively to implement impactful solutions.

COs	PO				
	1	2	3	4	5
1	3	1	1	3	3
2	3	1	3	3	3
3	3	1	3	3	3
4	3	1	3	3	3
5	3	1	2	3	3

SEMESTER III
HARD CORE COURSES

CPET 711: SUMMER TRAINING

(Credits: 2)

Objectives:

To provide industrial exposure to student to the real time problems related to environmental engineering and management and policy & regulations. Enable the students to work on short industry projects and come up with the solutions commensurate with the assigned problem to the students. To impart skills in preparing detailed report describing the project and results/findings. To identify gap in existing knowledge to help develop a specialization.

The course offers thorough problem-based learning approach, guided by realistic and challenging industry requirements. The course includes 24 working days of on-job training on current industry-relevant problem through supervised self-learning approach. The students shall apply their classroom learning for identification of problem, execute analysis based on available literature, data& reports and present the output.

The students will identify the problems on thematic area in consultation with the host industry/organization perform literature review, interaction with industry experts, define objective and relevant tasks to be performed and define the methods to be followed and tools to be used and finally write synopsis.

Course outcomes:

On successful completion of this course, students will be able to:

- Construct the company profile by compiling the brief history, management structure, products / services offered, key achievements and market performance for his / her organization of internship.
- Assess its Strengths, Weaknesses, Opportunities and Threats (SWOT) of the organization.
- Determine the challenges and future potential for his / her internship organization in particular and the sector in general.
- Test the theoretical learning in practical situations by accomplishing the tasks assigned during the internship period.
- Apply various soft skills such as time management, positive attitude and communication skills during performance of the tasks assigned in internship organization.

COs	PO				
	1	**2**	**3**	**4**	**5**
1	2	3	3	3	3
2	2	3	3	3	3
3	3	3	3	3	3
4	3	3	3	3	3
5	2	3	3	3	3

CPET 712: AIR AND SURFACE WATER QUALITY MODELING

(Credits: 4; Lectures: 60 contact hours)

Objectives:

To understand the basics of model construction. To understand various air and surface water quality models.

Unit 1: Fundamentals of Mass and Energy Balance (10)

Mass and energy: laws of conservation of mass and energy. Steady state systems and non-steady state systems. Mass balance: mass-balance principle. Advection, diffusion and dispersion. Setting up mass balance equations. Energy balances.

Unit 2: Reaction Kinetics and Reactors (10)

Reactions: Reaction rates, reaction rate coefficients. Ideal reactors: Batch reactor, ideal flow in complete mix reactors, plug flow reactors, performance equations. Non-ideal reactors: Causes for non-ideal flow, tracer studies, modeling non-ideal flows. Process kinetics modeling.

Unit 3: Surface Water Quality Modeling (14)

River water quality modelling: The Streeter-Phelps equation and its limitations. Lake water quality modelling.

Unit 4: Air Quality Modeling (14)

Models for point and line sources based on Gaussian plume dispersion. Area source models. Indoor air quality modeling.

Unit 5: Software (12)

Environmental systems modeling with various tools: QUAL, SUTRA, DGADIS, HEGADIS, etc.

Reference Books/ Sources:

- M. J. Barnsley, Environmental Modeling: A Practical Introduction, CRC Press, 1st Edition, 2007.
- S. C. Chapra, Surface Water Quality Modeling, McGraw-Hill, New York, 1997.
- B. Halling-Sorensen, S. N. Nielsen, S. E. Jorgensen, Handbook of Environmental and Ecological Modelling, Lewis Publishers Inc, 1995.
- M. Z. Jacobson, Fundamentals of Atmospheric Modelling, Kluwer Academic Press, 2002.
- Metcalf & Eddy, Inc., Revised by G. Tchobanoglous, F. L. Burton, H. D. Stensel, Wastewater Engineering - Treatment and Reuse, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
- G. M. Masters, W. P. Ela, Introduction to Environmental Engineering and Science, Prentice Hall India Learning Private Limited, 3rd Edition, 2008.

Course outcomes:

On successful completion of this course, students will be able to:

1. Outline the fundamentals of mass and energy balance in modeling.
2. Apply the various models for different reactors.
3. Analyze the surface water quality modeling.
4. Analyze the air quality modeling.
5. Examine the environmental systems modeling with various software tools.

COs	PO				
	1	2	3	4	5
1	0	1	1	3	3
2	1	2	2	3	3
3	2	3	3	3	3
4	2	3	3	3	3
5	2	3	3	3	3

CPET 713: PROJECT WORK: PHASE I

(Credits: 8)

Objectives:

To identify a specific problem related to environment and collecting information related to the same through detailed literature review. To identify a methodology to carry out the project. To prepare the project reports and for conference/journal publications. To present their findings in reviews and viva-voce examination.

In this course the student is assigned topics for carrying out research. He/she would put forth his/her own plans of work, consolidate the set of objectives, hypothesis and methodology and commence preliminary studies. The student may either opt for the work done in this semester as Mini project and start another research work in the next semester or continue the same research in the next semester in CPET 721

Course outcomes:

On successful completion of this course, students will be able to:

1. Examine the literature survey for any type of environmental problems.
2. Analyze the problem statement clearly.
3. Select the methodology.
4. Interpret the research results.
5. Analyze the report preparation, presentation and publication.

COs	PO				
	1	2	3	4	5
1	2	3	3	3	3
2	2	3	3	3	3
3	3	3	3	3	3
4	3	3	3	3	3
5	2	3	3	3	3

SEMESTER IV
HARD CORE COURSE

CPET 721: PROJECT WORK: PHASE II
(Credits: 12)

Objectives:

To carry out experiments to solve the identified problem based on the identified methodology. To develop skills to analyze and discuss the results obtained and make conclusions.

In this course the student may continue the research work commenced in the previous semester or start a new research work if opted for mini project in the previous semester CPET 713 course. Besides continuous assessment made throughout, at the end of the semester, the student submits a dissertation based on the research output which he/she has carried out, followed by extensive Viva-Voce.

Course outcomes:

On successful completion of this course, students will be able to:

1. Analyze the procedures to carry out the project work.
2. Interpret the research results.
3. Analyze the report preparation, presentation and publication.
4. Design the pilot plant system based on the observed research results.
5. Examine the cause and solutions to any environmental pollution related problems.

COs	PO				
	1	2	3	4	5
1	2	3	3	3	3
2	3	3	3	3	3
3	2	3	3	3	3
4	3	3	3	3	3
5	2	3	3	3	3

ELECTIVES
SOFT CORE COURSES

CPET 624: ENVIRONMENTAL TOXICOLOGY AND RISK ASSESSMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To understand the source, uptake and distribution of environmental pollutants in an organism and how pollutants can affect molecular, cellular and organismal processes.

Unit 1: Introduction to Environmental Toxicology (8)

Types of toxic substances in the environment; degradation and non-degradation; factors influencing toxicity; sources, entry routes, cycles and residence time of toxic substances, transport through food chain – bioaccumulation and biomagnification

Unit 2: Evaluation of Toxicity and Toxicity Indicators (9)

Methods used to assess toxicity; concepts of bioassays; threshold limit values, LC 50, LD 50, lethal, sublethal and chronic tests; dose response curves; monitoring approaches – indicator populations and indicator species; biomonitoring and bioindicators; molecular markers to toxicants – metabolites as indicators, protein induction, cytochrome P450 enzymes, stress proteins, metalothioneins

Unit 3: Metabolism and Detoxification of Toxicants (9)

Toxicokinetics and toxicodynamics; Phase I and Phase II reactions; detoxification in human body; detoxification mechanisms; organs of detoxification

Unit 4: Occupational Hazards and Safety (9)

Environmental and occupational safety, occupational exposure, occupational hazards and diseases; control of toxic materials and protection measures; toxicity of biohazard; occupational health and safety policy

Unit 5: Risk Assessment (10)

Epidemiological diseases due to pollution; health effect of cosmetics and drugs; health risk assessment of toxic chemicals; ecological risk assessment in environmental management; human health risk assessment; risk assessment of antimicrobial resistance in environmental reservoirs; education and training in health hygiene

References Books / Sources:

- J.M.Pacyna ., E.G. Pacyna, Environmental determinants of human health: molecular and integrative toxicology, Springer International Publishing, Switzerland, 2016.
- MD. Ahmad, Irshad, Mohammad Mahamood, Mehjbeen Javed, Saleh S. Alhewairini, Toxicology and Human Health: Environmental Exposures and Biomarkers, , Springer Nature, 2024.
- Morton Lippmann, George D. Leikauf, Environmental Toxicants: Human Exposures and Their Health Effects, 4th Edition, Wiley, 2020
- Prabhat Kumar Srivastava, Vijay Pratap Singh, Anita Singh, Durgesh Kumar Tripathi, Samiksha Singh, Sheo Mohan Prasad, Devendra Kumar Chauhan, Bioaccumulation of Pesticides and Its Impact on Biological Systems, Wiley, 2020

- Dennis J. Paustenbach, Human and Ecological Risk Assessment: Theory and Practice, 3rd Edition, Wiley, 2024
- T. Simon, Environmental risk assessment: a toxicological approach, CRC Press, 2016

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand the entry routes, fate of pollutants in the environment and inside the organism
2. Gain knowledge on the bioassays and tests and understand the effect of the toxic substances on organisms
3. Evaluate what the body does to the toxicant on its entry and what the toxicant does to the body
4. Analyse the exposure to toxicants and health effects caused in different occupational sectors
5. Apply risk assessment studies to understand the toxicity of the pollutants on the organisms and the environment

COs	PO				
	1	2	3	4	5
1	3	1	1	3	3
2	3	1	3	3	3
3	3	1	3	3	3
4	3	1	3	3	3
5	3	1	2	3	3

CPET 625: CLIMATE CHANGE: CAUSES, IMPACTS AND SOLUTIONS

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To impart knowledge and understanding of climate change and its causes. To learn the impacts caused by Climate change in various sectors. To introduce the emerging concepts and methods on adaptation and mitigation measures to curb climate change.

Unit 1: Climate, Climate Change, models (10)

Weather and climate; Climate parameters; Climate classifications; Three basic climate groups; Greenhouse effect; Global warming; Climate change; Geological history of climate change; Other causes of climate change; Intergovernmental panel on Climate Change (IPCC); Action plans: national and state level; Models: General circulation model (GCM), Regional circulation models, Regional climate models (RCM).

Unit 2: Greenhouse Gases (8)

Greenhouse gases (GHG): sources, sinks, radiative forcing, global warming potential, biogeochemical cycles, effects, quantification methods; GHG emission: current scenario, calculation, wastewater treatment plants and landfills; Kyoto protocol; Paris agreement.

Unit 3: Impacts of Climate Change (9)

Impacts of climate change on various sectors: water resources, agriculture and food production, economic sectors and services, Human health, Human security and livelihood, Forestry and Ecosystem; Projected impacts for different regions; Gender assessment.

Unit 4: Adaptation Measures (8)

Adaptation strategies in various sectors: water, agriculture, infrastructure and settlements, human health, tourism, transport and energy; Adaptation funding; Case studies.

Unit 5: Mitigation Measures (10)

Energy conservation, efficiency and sustainable energies; Clean development mechanism; Technologies for the reduction of GHG emissions; Carbon storage and monitoring technologies; CO_2 transport; Carbon: trading and foot print; Case studies.

References Books / Sources:

- IPCC sixth Assessment Report, Cambridge University Press, 2023.
- Climate Change Impacts in India, 1st edition, Chaitanya B. Pande, Kanak N. Moharir, Abdelazim Negm, Springer Int Publishing Ag, 2023.
- Handbook of Climate Change Mitigation and Adaptation, 3rd Edition, Maximilian Lackner, Baharak Sajjadi, Wei-Yin Chen, Springer Int Publishing Ag, 2022.
- Climate Change Science, 1st Edition, David S-K. Ting, Jacqueline A. Stagner, Elsevier, 2021.
- Extreme Events and Climate Change: A Multidisciplinary Approach, Federico Castillo, Michael Wehner and Dáithí A. Stone, John Wiley & Sons, Inc, 2021.
- The Climate Modelling Primer, 4th edition, Kendal McGuffie and Ann Henderson-Sellers, John Wiley & Sons, Inc, 2014.

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand the basics of climate change and its causes.
2. Identify and analyze the different GHGs.
3. Analyze impacts of climate change in various sectors.
4. Develop appropriate adaptative strategy in various sectors to combat climate change.
5. Develop suitable measures to control GHG emissions.

COs	**PO**				
	1	**2**	**3**	**4**	**5**
1	0	1	1	3	3
2	1	2	2	3	3
3	2	3	3	3	3
4	1	2	2	3	3
5	1	2	2	3	3

CPET 626: INDUSTRIAL WASTE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To provide knowledge on sources and characteristics of industrial wastes, techniques and approaches for minimizing the generation of wastes. Application of physio-chemical and biological treatment methods for recovery, reuse and disposal supported with case studies under Indian situations.

Unit 1: Overview (8)

Major industries (dairy, distillery, sugar, textile, tannery, pulp & paper, metal finishing petroleum refining, pharmaceutical and fertilizer, thermal power), their water requirements, and the typical quantities and characteristics of waste generated. Environmental consequences of wastewater discharge and the regulatory requirements for treatment and disposal. Treatment costs.

Unit 2: Source Reduction, Recycling, and Reuse (9)

Waste minimization with process modification and cleaner production techniques. Benefit-cost optimization with common effluent treatment plants. Recycling, reuse, and recovery strategies. Process optimization for waste minimization. Flowsheet analysis. Energy and resource audits for efficient usage and conservation. Waste audits, emission inventories, and waste management hierarchy. Case studies of re-engineering for waste minimization. Concept of zero liquid discharge.

Unit 3: Industrial Wastewater Treatment (9)

Effluent mixing, equalization, neutralization. Separation of oil and grease. Removal of pollutants by screening, flotation, coagulation/flocculation, sedimentation, precipitation, adsorption, ion exchange, membrane filtration. Biosorption and biodegradation techniques.

Unit 4: Industrial Sludge Management (7)

Sludge management: characterization, thickening, conditioning, digestion, dewatering and disposal.

Unit 5: Case Studies on Waste Treatment from Various Industries (12)

Case studies of waste generation from various industries and their treatment: dairy, distillery, sugar, textile, tannery, pulp and paper, metal finishing, iron and steel, petroleum refining, pharmaceutical, fertilizer and thermal power generation

Reference Books/ Sources

- W.W. Eckenfelder, Industrial Water Pollution Control, Mc-Graw Hill, 1999.
- S. J. Arceivala, Wastewater Treatment for Pollution Control, Tata McGraw Hill, 1998.
- Pollution Prevention and Abatement Handbook – Towards Cleaner Production, World Bank Group, World Bank and UNEP, Washington D.C, 1998.
- L. K. Wang, Y-T Hung, H. H. Lo C. Yapijakis, Waste Treatment in the Process Industries, CRC Press, Taylor and Francis Group, Boca Raton, 2006.
- N. L. Nemerow, Industrial Waste Treatment: Contemporary Practice and Vision for the Future, Elsevier Science & Technology Books, 2006.
- Industrial Wastewater Management, Treatment, and Disposal, WEF Manual of Practice No. FD-3, 3rd Edition, 2008.

Course outcomes:

On successful completion of this course, students will be able to:

1. Summarize the overview of major industries water requirements, typical characteristics of wastes and regulatory requirements for treatment and disposal.
2. Apply the source reduction, recycling and reuse principles in industrial waste management activities.
3. Apply the various treatment methods to manage the industrial wastewater.
4. Outline the various methods to manage the industrial sludge.
5. Analyze the case studies of waste generation from various industries and their treatment.

COs	**PO**				
	1	**2**	**3**	**4**	**5**
1	0	1	1	3	3
2	1	2	2	3	3
3	2	3	3	3	3
4	1	2	2	3	3
5	1	2	2	3	3

CPET 627: TRANSPORT OF WATER AND WASTEWATER

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To understand the basic concept of fluid flow, to design the water transmission, waste collection and conveyance, storm water drainage and special systems.

Unit 1: Fluid Flow (10)

Fluid flow: continuity, energy and momentum principles; frictional head losses in free and pressure flow, major and minor head losses and their estimation. Pumping of fluids and selection of pumps. Flow measurement.

Unit 2: Water Transmission and Distribution (10)

Urban and rural water supply, emergency responses, Planning factors. Water transmission main design. Pipe material and economics; water distribution pipe networks, and methods for their analysis and optimization. Laying and maintenance of pipelines; in situ: lining, appurtenances and corrosion prevention. Application of softwares.

Unit 3: Wastewater Collection and Conveyance (11)

Design of sanitary sewer; partial flow in sewers, economics of sewer design; sewer appurtenances; material, construction, inspection and maintenance of sewers; design of sewer outfalls: mixing conditions; conveyance of corrosive wastewaters.

Unit 4: Storm Water Drainage and Water Reservoir Management (8)

Run-off estimation, rainfall data analysis, storm water drain design. Rainwater harvesting. Planning, maintenance, design, storage and restoration techniques of water reservoir, Traditional knowledge on managements of water resources, Role of public and government. Case studies.

Unit 5: Special Water Supply and Sanitary Systems (6)

Emergency sanitary system, Immediate and short-term long-term sanitation in emergencies- Basic types of toilets- Low cost toilets- Selections of toilets - Public gathering- Gender based toilets in buildings- Source diversion, challenges in transportation systems- Shit flow diagrams

Reference Books/ Sources

- National building code, 2016, Volume 2, Part 9, plumbing services. Bureau of Indian standards.
- SP 35 (1987, Handbook of water supply and drainage (With special emphasis on plumbing (CED 24 Public Health Engineering.) Bureau of Indian standards
- International Plumbing code, 2018, International code council, INC
- Manual on water supply and treatment systems (drink from tap) , CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2013, December 2023, https://mohua.gov.in || https://cpheeo.gov.in
- Manual on Sewerage and Sewage treatment system (Part A, B, C). CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2013, https://mohua.gov.in || https://cpheeo.gov.in.
- Manual on storm water drainage systems. Part I &II, CPHEEO, Ministry of Urban Development, GOI, New Delhi.2019, https://mohua.gov.in/publication/manual-on-storm-water-drainage-systems--2019.php

Course outcomes:

On successful completion of this course, students will be able to:

1. To understand the basic of fluid flow
2. To design the water transmission and distribution system.
3. To design the wastewater collection and conveyance.
4. To design the Storm water drainage.
5. To outline the special system of water and sanitation.

COs	PO				
	1	2	3	4	5
1	3	3	1	1	1
2	3	3	3	1	2
3	3	3	3	1	1
4	3	3	3	3	1
5	3	3	2	3	3

CPET 628: CITIZEN SCIENCE FOR ENVIRONMENTAL AND SOCIAL INNOVATION

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To provide a comprehensive understanding of Citizen Science as a participatory research approach, engaging the public in scientific inquiry and fostering environmental and social innovation.

Unit 1: Introduction to Citizen Science (8)

Definition and Scope of Citizen Science; History and Evolution of Citizen Science Initiatives; Role of Citizens in Scientific Research; Ethical Considerations and Data Credibility; Case Studies of Global and Indian Citizen Science Projects.

Unit 2: Methods and Tools in Citizen Science (10)

Participatory Research and Community-Based Monitoring; Data Collection Techniques: Surveys, Remote Sensing, Sensor-Based Monitoring; Digital Platforms and Mobile Apps for Citizen Science (e.g., iNaturalist, eBird); GIS and Mapping Tools; Citizen Science Data Validation and Interpretation.

Unit 3: Applications in Environmental and Social Sciences (10)

Biodiversity Monitoring and Conservation; Air and Water Quality Monitoring; Climate Change Observations and Disaster Preparedness; Waste Management and Plastic Pollution Tracking; Public Health and Epidemiological Studies.

Unit 4: Community Engagement and Policy Impact (10)

Mobilizing and Training Citizen Scientists; Engaging Schools, NGOs, and Local Communities; Role of Citizen Science in Policy Advocacy; Open Science and Data Sharing; Challenges and Limitations.

Unit 5: Future of Citizen Science and Hands-On Projects (7)

Emerging Trends: AI, Machine Learning, and Big Data in Citizen Science; Citizen Science in Sustainable Development Goals (SDGs); Crowdsourcing Scientific Innovations; Designing and Implementing a Citizen Science Project.

References Books / Sources:

- The Science of Citizen Science, Katrin Vohland · Anne Land-Zandstra Luigi Ceccaroni · Rob Lemmens Josep Perelló · Marisa Ponti Roeland Samson · Katherin Wagenknecht . Springer publication https://doi.org/10.1007/978-3-030-58278-4 , 2021.
- Data and citizen science in India, A practitioner's ToolKit, Vattakaven, Thomas, Vijay Barve, Geetha Ramaswami, Priya Singh, Suneha Jagannathan, and Balasubramanian Dhandapani. 2022. CitSci India Conference.https://citsci-india.org/wp-content/uploads/2023/05/Data-and-CS-in-India.pdf,
- Learning Through Citizen Science: Enhancing Opportunities by Design. National Academies of Sciences, Engineering, and Medicine. 2018. Washington, DC: The National Academies Press. https://nap.nationalacademies.org/catalog/25183/learning-through-citizen-science-enhancing-opportunities-by-design, https://doi.org/10.17226/25183.

- Citizen Science: Public Participation in Environmental Research, Janis Dickinson et al., Comstock Publishing, 2012.
- CitSci India, Citizen Science for Biodiversity, https://citsci-india.org/citizen-science-projects/
- Science NASA: Web Resource. https://science.nasa.gov/citizen-science/

Course Outcomes:

On successful completion of this course, students will be able to:

1. Understand the fundamental principles and ethical considerations of Citizen Science.
2. Learn methodologies for data collection, analysis, and visualization.
3. Investigate Citizen Science applications in various domains.
4. Recognize the importance of community involvement in scientific endeavors.
5. Analyze the influence of Citizen Science on policymaking and governance.

COs	PO				
	1	2	3	4	5
1	3	3	1	2	2
2	3	3	1	1	2
3	3	3	2	1	1
4	3	3	2	1	1
5	3	3	1	1	1

CPET 629: BIOFUELS AND BIOREFINERY

(Credits: 3; Lectures: 45 contact hours)

Objectives

To provide fundamental knowledge on biofuels production and biorefinery concepts, including biomass conversion technologies, process design, and sustainability aspects.

Unit 1: Introduction to Biofuels and Biomass (7)

Global energy scenario and renewable energy; Types of biofuels: First, second, and third generation; Biomass composition and characteristics; Feedstock selection and preparation; Biomass storage and handling; Resource assessment and availability.

Unit 2: Biochemical Conversion Processes (10)

Microbial metabolism and fermentation; Enzymatic hydrolysis; Bioethanol production; Biogas production; Anaerobic digestion; Process parameters and optimization; Product recovery and purification.

Unit 3: Thermochemical Conversion Processes (10)

Pyrolysis and bio-oil production; Gasification and syngas; Torrefaction; Hydrothermal processes; Fischer-Tropsch synthesis; Biodiesel production; Product upgrading technologies.

Unit 4: Biorefinery Concepts and Integration (10)

Biorefinery classifications and types; Process integration principles; Material and energy balance; Heat integration techniques; Water integration and management; Waste minimization strategies; Co-product development.

Unit 5: Economics and Sustainability (8)

Techno-economic analysis; Life cycle assessment; Environmental impact assessment; Social implications; Policy and regulations; Market analysis; Future trends and challenges.

References Books / Sources:

- Dominik Rutz, Sustainable Bioenergy: Advances and Impacts, , Springer, 2018.
- David M. Mousdale, Biofuels: Biotechnology, Chemistry, and Sustainable Development, , CRC Press, 2022.
- Pandey & Hofer, Handbook of Biorefinery Research and Technology, , Elsevier, 2020.
- Production of Biodiesel from Non-Edible Sources -Technological Updates , A. Arumugam, 2022, Elsevier Publications,ISBN 978-0-12-824295-7.
- 2.Biorefineries,Carlos Ariel Cardona Alzate (Author), Jonathan Moncada Botero (Author), Valentina Aristizábal Marulanda (Author), 1st edition , 2020,CRC Press.
- 3.Handbook of Biorefinery Research and Technology: Production of Biofuels and Biochemicals, Virendra Bisaria, 2024, Springer Nature Singapore,https://doi.org/10.1007/978-981-97-7586-6

Course Outcomes:

On successful completion of this course, students will be able to:

1. Understand different types of biomass feedstocks and their characteristics.
2. Analyze various biofuel production technologies.
3. Design basic biorefinery processes.

4. Evaluate economic and environmental aspects of biofuel production.
5. Apply biorefinery integration concepts.

COs	PO				
	1	2	3	4	5
1	3	3	1	2	2
2	3	3	1	1	2
3	3	3	2	1	1
4	3	3	2	1	1
5	3	3	1	1	1

CPET 630: ENVIRONMENTAL REACTION ENGINEERING

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To gain the knowledge on the different kinds of reactors for specific reactions. To learn the design of different kinds of reactors.

Unit 1: Basic Concepts (9)

Reaction engineering principles with applications to environmental systems. General reaction mechanisms. Rate Relationships: Concepts and applications to homogeneous systems and heterogeneous systems with respect to chemical and biological reactions.

Unit 2: Ideal Reactors (9)

Ideal systems modeling and design. Reactor concepts. Ideal reactors. Reaction rate measurements. Hybrid system modeling and design. Sequencing batch reactor. Reactors in series and reactors with recycle.

Unit 3: Non-Ideal Reactors (9)

Non ideal system modeling and design. Non-ideal reactor behavior. RTD analysis. PFDR model.

Unit 4: Heterogeneous Reactions (9)

Reactive interphase mass transfer. Fluid–solid surface reactions. Gas-liquid bulk phase reactions. Adsorption in porous solids. Fluid solid processes and gas-liquid processes.

Unit 5: Biological Reaction Engineering (9)

Biological kinetics: Enzyme kinetics, Michaelis-Menten equation, simple microbial kinetics. Bioreactor: Concepts, modeling, batch operation, semi continuous operation, fed batch operation, continuous operation, and its environmental applications.

Reference Books:

- A.A. Martin, P.H. Robert, Reaction Engineering for Pollution Prevention, Elsevier Science B.V., The Netherlands, 2000.
- I.J. Dunn, E. Heinzle, J.P. Ingham, J.E. Enosil, Biological Reaction Engineering, Wiley inter science, 2005.
- A.K. Coker, Modeling of Chemical Kinetics and Reactor Design, Gulf Professional Publications, 2001.
- Jeff Kuo, Chemistry, Thermodynamics, and Reaction Kinetics for Environmental Engineers, CRC Press, 2025.
- James G. Speight, Reaction Mechanisms in Environmental Engineering, Elsevier, Butterworth-Heinemann, 2018.
- W.J. Weber, F.A. Di Giano, Process Dynamics in Environmental Systems, John Wiley Sons Inc, 1996.
- C.G. Hill, Introduction to Chemical Engineering Kinetics and Reactor Design, Wiley Publications, 1977.

Course outcomes:

On successful completion of this course, students will be able to:

1. Summarize the fundamentals of reaction engineering principles related to environmental systems.
2. Examine the various ideal reactors for environmental engineering applications.
3. Analyze the design and modeling of non-ideal reactors.
4. Analyze the mass transfer combined with reaction in various heterogeneous reactions.
5. Analyze the kinetics of biological reaction and design of bioreactors.

COs	PO				
	1	2	3	4	5
1	0	1	1	3	3
2	2	3	3	3	3
3	2	3	3	3	3
4	2	3	3	3	3
5	2	3	3	3	3

CPET 714: CARBON CAPTURE SCIENCE AND TECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To impart knowledge and understanding of science involved in carbon capture technologies. To introduce the emerging concepts and methods on carbon capture storage and utilization to curb climate change.

Unit 1: Introduction (8)

Need for Carbon capture and storage (CCS); Methods for CCS – pre-combustion, Post-combustion and Oxy-fuel combustion, chemical looping combustion systems, calcium looping; Current status of CCS technologies; Barriers to CCS; Government initiatives.

Unit 2: Physical/Chemical Methods (10)

Process, description and advancements: Absorption, adsorption, membranes, cryogenic and distillation; Solvent generation/CO_2 stripping technology.

Unit 3: Biological Methods (9)

Carbon sequestration in soils; Algae based systems; Carbon immobilization of plants; enzymatic sequestration; Biomimetic carbon sequestration.

Unit 4: Carbon Negative Technologies (9)

Biomass Energy with Carbon Capture and Storage (BECCS); Direct air capture; Hydrogen production with CCS; Carbon mineralization.

Unit 5: CO_2 Utilization (9)

Polymers from CO_2; CO_2 based solvents; CO_2 to oxygenated organics; Conversion into higher carbon fuels; High temperature catalysis; Carbon capture utilization and storage.

References Books / Sources:

- IPCC Special Report on Carbon Dioxide Capture and Storage, Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2005.
- Materials and Processes for CO_2 Capture Conversion and Sequestration, Lan Li, Winnie Wong-Ng, Kevin Huang, Lawrence P. Cook, Wiley, 2018.
- Climate Change and Green Chemistry of CO_2 Sequestration, 1st edition, Malti Goel, T. Satyanarayana, Maruthadu Sudhakar, D. P. Agrawal, Springer Singapore, 2021.
- Carbon Capture, Utilization and Storage (CCUS), Atanu Mukherjee and Saurav Chatterjee, NITI Aayog, Government of India, 2022.
- Sustainable Utilization of Carbon Dioxide, 1st edition, Mohammad Jawaid and Anish Khan, Springer Singapore, 2023.
- Carbon Capture-Utilization and Storage: Climate Change Mitigation, Jayarama Reddy Puthalpet, BS Publications, 2024.

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand the basics and necessity of carbon capture processes.
2. Analyze the various carbon capture technologies.
3. Develop appropriate CCS methods in various sectors.
4. Examine the various carbon negative technologies.
5. Develop suitable measures to utilize CO_2.

COs	POs				
	1	**2**	**3**	**4**	**5**
1	0	1	1	3	3
2	2	3	3	3	3
3	1	2	2	3	3
4	2	3	3	3	3
5	1	2	2	3	3

CPET 715: ENVIRONMENTAL LAW

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To provides an overview of environmental laws, focusing on pollution control, waste management, biodiversity conservation, and sustainable development. To explores key legal frameworks and their applications in protecting natural resources and promoting equitable growth

Unit 1: Foundations of Environmental Law (8)

Evolution of Environmental Law- Constitutional Provisions- Principles of Environmental Law: Polluter Pays Principle, Precautionary Principle, Public Trust Doctrine, Sustainable Development. Environmental Impact Assessment (EIA): Legal framework, process, and public participation. National green tribunal (NGT), Public Interest Litigation (PIL).

Unit 2: Air and Noise Pollution Control (9)

The Air (Prevention and Control of Pollution) Act, 1981: Noise Pollution (Regulation and Control) Rules, 2000: National Clean air programme, Case studies from air pollution issues- Global Governance of Climate Change- international agreements and institutions.

Unit 3: Water Pollution Control and Coastal Zone Management (10)

The Water (Prevention and Control of Pollution) Act, 1974: Water Quality Standards: Central Pollution Control Board (CPCB) standards, drinking water standards. Wastewater Treatment and Disposal: Sewage treatment plants, effluent discharge standards, and solid waste disposal. Coastal Zone Regulation (CRZ) Notification: Coastal zone classification, regulation of activities, and coastal zone management plans.

Unit 4: Solid Waste and Hazardous Waste Management (9)

The Solid Waste Management Rules, 2016: Hazardous Waste Management Rules, 2016: Biomedical Waste Management Rules, 2016: Plastic waste management rules 2016, E-waste management rules, Construction and Demolition Waste Management Rules, 2016

Unit 5: Forest Conservation, Wildlife Protection, and land acquisition. (9)

The Indian Forest Act, 1927: The Forest (Conservation) Act, 1980: The Wildlife Protection Act, 1972: The Biodiversity Act, 2002: The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013

References Books / Sources:

- P. Leelakrishnan, Environmental Law in India, Lexis Nexis Butterworth India, 2018
- David Hunter, Environmental Law: Cases and Materials, , University Press of America
- Law, Philippe Sands , Jacqueline Peel , Adriana Fabra Ruth MacKenzie, Principles of International Environmental, 4th edition, Cambridge University Press; 2018.
- Environmental Law and Policy in India Cases and Materials- Shyam Divan, Armin Rosencranz, 3rd edition ,Oxford Univ Press, 2023
- ECOLEX (information service on environmental law,) https://www.ecolex.org/
- EIA notifications, Government of India

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand the principles and evolution of environmental law in India.
2. Understand the air and noise pollution control legislatures.
3. Explore laws governing water, waste management and biodiversity conservation.
4. Evaluate coastal zone, forest, and wildlife protection regulations.
5. Examine land acquisition laws for equitable and sustainable development

COs	PO				
	1	2	3	4	5
1	3	1	1	3	3
2	3	1	1	3	3
3	3	1	1	3	3
4	3	1	1	3	3
5	3	1	1	3	3

CPET 716: SEPARATION PROCESSES IN ENVIRONMENTAL APPLICATIONS

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To learn about the different separation processes available.

To make the students to understand the fundamental mathematical concepts behind the various separation processes.

Unit 1: Overview (8)

Pollution sources. Environmental separations. Historic perspective of environmental pollution. Separation mechanisms. Equilibrium-based processes. Rate-based processes. Productivity and selectivity. Separating agents, Magnetic separation and other miscellaneous operations.

Unit 2: Distillation (9)

Macroscopic and microscopic balances. Degrees of freedom analysis. Phase equilibrium. Minimum number of stages. Batch and continuous distillation. McCabe–Thiele analysis.

Unit 3: Extraction and Absorption (10)

Extraction: Environmental applications, triangular diagram, leaching processes, counter current extraction, minimum and total reflux. Absorption and stripping: McCabe-Thiele analysis, packed columns, HTU-NTU method.

Unit 4: Adsorption and Ion Exchange (10)

Adsorption: Adsorbent selection, breakthrough curve analysis, regeneration methods, process design factors, design of fixed-bed adsorber. Ion exchange: Environmental applications, types of ion exchange resins, selectivity coefficients, mechanisms, equipment and design procedures.

Unit 5: Membrane Technology (8)

Membranes: Environmental applications, membrane processes, merits and demerits, membrane materials, membrane modules, separation mechanisms.

References Books / Sources:

- R.D. Noble, P.A. Terry, Principles of Chemical Separations with Environmental Applications, Cambridge University Press, 2004.
- J.D. Seader, E.J. Henley, Separation Processes Principles, 3 rd Edition, John Wiley & Sons, 2011.
- H. Kister, Distillation Operation, McGraw-Hill Professional Publication, 1990.
- Ronald W. Rousseau, Handbook of Separation Process Technology, Wiley-Interscience, 1987.
- Treybal, R.E. Mass Transfer Operations, McGraw Hill 2017.
- Frank, C.T. Perry's Chemical Engineer's Handbook, McGraw-Hill Professional Publication, 2007.

Course outcomes:

On successful completion of this course, students will be able to:

- Examine the various pollution sources and the different types of separation processes for environmental applications.
- Assess the various types of distillation processes and its analysis.
- Analyze the extraction and absorption processes for environmental applications.
- Analyze the adsorption and ion exchange processes for environmental applications and its design considerations.
- Outline the various membrane processes for environmental applications.

	PO				
COs	**1**	**2**	**3**	**4**	**5**
1	**2**	**3**	**3**	**3**	**3**
2	**3**	**3**	**3**	**3**	**3**
3	**2**	**3**	**3**	**3**	**3**
4	**2**	**3**	**3**	**3**	**3**
5	**0**	**1**	**1**	**3**	**3**

CPET 717: E-WASTE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To provide comprehensive knowledge about electronic waste management, including collection, processing, recycling, and disposal methods. The course also covers environmental impacts, regulatory frameworks, and sustainable practices in managing electronic waste.

Unit 1: Fundamentals of E-waste (7)

Definition and classification of e-waste; Global e-waste statistics and trends; Composition of electronic products; Hazardous materials in electronics; Environmental and health impacts; Value chain analysis in e-waste.

Unit 2: Regulatory Framework and Policy (10)

International conventions (Basel Convention); Regional regulations (EU WEEE Directive); National policies and legislation; Extended Producer Responsibility (EPR); Documentation and compliance requirements; Corporate responsibilities and obligations.

Unit 3: Collection and Transportation Systems (10)

Collection models and infrastructure; Reverse logistics management; Storage requirements and protocols; Transportation guidelines and safety; Tracking and documentation systems; Public awareness and collection programs.

Unit 4: Processing and Treatment Technologies (10)

Manual dismantling techniques; Mechanical processing methods; Metallurgical recovery processes; Chemical treatment technologies; Precious metals recovery; Plastics recycling and recovery; Quality control in recycling.

Unit 5: Sustainable Management and Future Trends (8)

Circular economy principles; Design for recycling and reuse; Green electronics manufacturing; Life cycle assessment; Emerging technologies in e-waste management; Business models in e-waste recycling; Future challenges and opportunities.

References Books / Sources:

- Electronic Waste Management and Treatment Technology, Majeti Narasimha Vara Prasad, Elsevier, 2019.
- Sustainable Electronic Waste Management and Recycling Technology, Giannis M. Tsoulfas, CRC Press, 2021.
- Handbook of Electronic Waste Management, Majeti Narasimha Vara Prasad, 2020.
- Basel Convention official website: https://www.basel.int
- WEEE Directive information: https://ec.europa.eu/environment/topics/waste-and-recycling/weee-directive_en
- EPA E-waste resources: https://www.epa.gov/international-cooperation/electronic-waste

Course Outcomes:

On successful completion of this course, students will be able to:

1. Understand the global e-waste crisis and its environmental implications.
2. Identify different categories of e-waste and their components.
3. Apply proper e-waste collection and handling techniques.
4. Analyze various recycling and recovery methods.
5. Evaluate existing policies and regulations.

COs	PO				
	1	2	3	4	5
1	3	3	1	2	2
2	3	3	1	1	2
3	3	3	2	1	1
4	3	3	2	1	1
5	3	3	1	1	1

CPET 718: PLASTIC WASTE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To impart knowledge and understanding of various types of plastic waste and their impact to the environment. To learn about the different recycling methods available.

Unit 1: Introduction (8)

Overview of plastic waste generation and impacts; Types of plastics and their uses; Plastic waste management hierarchy (reduce, reuse, recycle, recover, dispose); Generation rate.

Unit 2: Sources and Impacts of Plastic Waste (8)

Land-based sources of plastic waste (urban, industrial, agricultural); Marine litter: sources, impacts, and mitigation strategies; Water based plastic pollution in marine ecosystems: sources, fate, and impacts; Health impacts of plastic waste: toxic chemicals, exposure routes, and health effects.

Unit 3: Formal and Informal Sector Roles in Plastic Waste Management (10)

Formal sector: municipal waste management systems, private sector initiatives; Informal sector: waste pickers, kabadiwalas, scrap dealers; Role of informal sector in plastic waste collection, sorting, and recycling; Challenges and opportunities for integrating informal sector into formal waste management systems.

Unit 4: Extended Producer Responsibility (EPR) and Waste Management Strategies (10)

EPR: principles and implementation; Waste reduction strategies: minimizing plastic packaging, product design for recyclability; Recycling methods: mechanical recycling, chemical recycling, biodegradation; Limitations of recycling: contamination, economic viability, technological constraints.

Unit 5: Assessment and Future Directions (9)

Assessment methods: waste audits, waste characterization, monitoring programs; Policy and regulatory frameworks: national, state, and local laws and regulations; Role of stakeholders: government, private sector, civil society, informal sector; Future directions: circular economy, innovative technologies, and sustainable waste management practices.

Reference Books / Sources:

- Plastic waste management and Extended Producer responsibility rules https://cpcb.nic.in/rules-4/
- Manual for Gram Panchayat: Plastic waste management, Ministry of jalshakthi. Government of India, 2021, https://sbmurban.org/storage/app/media/pdf/SBM%20Plastic%20Waste%20Book.pdf
- Niti AAYOG - UNDP Handbook on Sustainable urban plastic waste management, 2021 https://www.niti.gov.in/sites/default/files/202110/Final_Handbook_PWM_10112021.pdf
- Plastic recycling decoded https://csestore.cse.org.in/default/plastic-recycling-decoded.html

- Advisory on material recovery Facility for municipal solid waste https://www.niti.gov.in/sites/default/files/2021-11/Promoting-Behaviour-Change-for-StrengtheningWasteSegregationatSource-PolicyGuidelines.pdf
- Integration of Informal Sector in Solid Waste Management, CSE PUBLICATIONS, 2021, https://www.cseindia.org/integration-of-informal-sector-in-solid-waste-management-10886

Course outcomes:

On successful completion of this course, students will be able to:

1. Understand the basic of plastic waste management
2. Analyze the various types of sources.
3. Understand the role of formal and informal sector in PWM.
4. Summarize the various management strategies.
5. Predict the future of plastic waste management.

COs	PO				
	1	**2**	**3**	**4**	**5**
1	2	3	3	3	3
2	2	3	3	3	3
3	2	3	3	3	3
4	0	1	1	3	3
5	0	1	1	3	3