ACADEMIC CURRICULA

POST GRADUATE DEGREE PROGRAMMES

Master of Technology

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 26
Syllabi for Civil Engineering and Nanotechnology Programmes

Professional Core and Elective Courses

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

ACADEMIC CURRICULA

Civil Engineering

Common Professional Elective Course

Regulations 2021

SRM INSTITUTE OF SCIENCE & TECHNOLOGY
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SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21MAE501T	Course Name	ADVANCED MATHEMATICAL TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mathematics*	**Data Book / Codes/Standards**		*Statistical table*	

Course Learning Rationale (CLR)	***The purpose of learning this course is to:***
CLR-1:	*learn the concept of one dimensional wave equations and diffusion equation*
CLR-2:	*understand the concepts of Euler's equations*
CLR-3:	*learn concepts of Fredholm and Volterra integral equations*
CLR-4:	*study the sampling techniques to real world applications*
CLR-5:	*learn the concept of design of experiment and control charts*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	**2**	**3**
CO-1:	*solve one dimensional wave equations and diffusion equation by using Laplace and Fourier transform techniques*	*3*	*3*	-
CO-2:	*familiar with solving Euler's equations*	*3*	*3*	-
CO-3:	*solve Fredholm and Volterra integral equations*	*3*	*3*	-
CO-4:	*transfer the knowledge to model the sampling techniques*	*3*	*3*	-
CO-5:	*construct design of experiments and control charts*	*3*	*3*	-

Module 1: Transform Techniques	***9 Hour***
Laplace transform - Fourier transform - One-dimensional wave equation using Laplace transform methods - Displacements in long string - Longitudinal vibration of an elastic bar - One-dimensional diffusion equation using Fourier transform methods – One-dimensional diffusion equation using Fourier sine transform methods – One-dimensional diffusion equation using Fourier cosine transform methods.	
Module 2: Variational and Isoperimetric Problems	***9 Hour***
Euler's Equations - Functional involving x, y, y` - Functional on higher order derivatives - Functional dependent on functions of independent variables - Geodesics – Ritz method.	
Module 3: Integral Equations	***9 Hour***
Fredholm integral equations - Volterra integral equations - Integro- differential equation - Green's function - Fredholm equations with separable kernel - Iterative methods.	
Module 4: Testing of Hypothesis	***9 Hour***
Sampling distribution, Null hypothesis, Alternate hypothesis - One-tailed test, two-tailed test - Level of significance, Critical region - Large samples test - Student - t test - single Proportion - Two Sample proportions - Large sample test, Single Mean - Difference of Means - Paired `t` test - Applications of Difference of Means - small samples - F-test problems - Differences between two population variances - Differences between two Normal population variances - Applications of paired - t-test. - Chi-Square goodness of fit - Chi-square test - Independent Attributes.	
Module 5: Design of Experiments and Statistical Quality Control	***9 Hour***
Design of Experiments – Completely Randomized Design – Randomized Block Design – Latin Square Design - Control theory - Control charts for X and R - Control charts for X and S.	

Learning Resources	1. *Gupta, S.C., & Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, Edition 2018* 2. *Dr.B.S.Grewal., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2019* 3. *M. B. K. Moorthy, "Advanced Mathematical Methods", Yesdee Publication, 2nd Edition, 2019.*	4. *B .V. Ramana, "Higher Engineering Mathematics", McGraw Hill Publication, 2017.* 5. *Vijay K. Rohatgi., A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 2nd Edition, Wiley, 2008.* 6. *R.A.Johnson and C.B Gupta, " Miller & Freund`s Probability and Statistics for Engineers", Pearson Eduction, Asia, 7th Edition, 2007.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*15%*	-	*15%*	-	*15%*	-
Level 2	*Understand*	*15%*	-	*15%*	-	*15%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*15%*	-	*15%*	-	*15%*	-
Level 6	*Create*	*15%*	-	*15%*	-	*15%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. *Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in*	1. *Dr. V. Subburayan, SRMIST*
	2. *Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in*	2. *Dr. G. Arul Joseph, SRMIST*

ACADEMIC CURRICULA

Environmental Engineering

Professional Core Courses

Regulations 2021

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CEC561T	Course Name	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study the importance of environment, ecosystem and sustainability*
CLR-2:	*know the current issues related to environment*
CLR-3:	*realize the measurement tool for impacts on environment*
CLR-4:	*explore the concepts about sustainability in material resources*
CLR-5:	*understand the sustainable strategies and policies*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*apply the acquired knowledge on values of environment, ecosystem and sustainability theory.*	2	2	2
CO-2:	*understand the various environmental issues and current treatment/ disposal methods*	2	2	3
CO-3:	*learn the impacts caused by humans on environment and their measurement tools*	3	2	3
CO-4:	*know the changes in material resources and sustainable traps*	2	3	2
CO-5:	*explore the sustainable strategies and policies for practical applications*	2	3	2

Module-1 - Environmental Chemistry: Principles and Application	***9 Hour***
Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product-Heavy metal precipitation, amphoteric hydroxides-CO_2 solubility in water and species distribution – Chemical kinetics, First order and second order-Principles of green chemistry- Concepts of acids, bases and salts, strengths of acids and bases, buffers, acid-base indicators, choice of indicators- Concept of chemical equilibrium, solubility and solubility product, activity, Le Chatelier principle.	
Module-2 - Environmental Chemistry of Aquatic Environment	***9 Hour***
Water quality parameters- Environmental significance and determination-Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation- Degradation of synthetic chemicals, metals, complex formation, oxidation and reduction-redox zones, sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation - Radioactivity and nuclear chemistry - Nitrogen chemistry and chlorination- Chemical speciation- Metals chemicals - Pesticides, Dioxins and Endocrine - PCBs, PAHs - Disruptors and their toxicity, Nanomaterials - CNT, Titania- Composites, environmental applications - Environmental Fate and Transport Modeling - Emerging Contaminants – Ecotoxicology - Sustainable Water Treatment Technologies - Environmental Monitoring and Assessment.	
Module-3 - Ecosystem Chemistry: Aquatic, Atmospheric, and Soil Interaction	***9 Hour***
Atmospheric structure –-Chemical and photochemical reactions – Photochemical smog- Ozone layer depletion – Greenhouse gases and global warming-CO_2 capture and sequestration – Acid rain- origin and composition of particulates- Air quality parameters-effects and determination. - Reaction mechanism, rate determining step, catalysts, activation energy- Nature and composition of soil-clays,cation exchange capacity-acid base and ion- exchange reactions in soil-Agricultural chemicals in soil-Reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation-Soil Microbiology-Soil Erosion and Conservation - Soil Contamination and Remediation- Soil-Plant Interactions- Soil Carbon Sequestration.	

Module-4 - Microbial Biology and Growth Kinetics	***9 Hour***
Classification of microorganisms- Prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology. -Cell chemistry, biology and microscopy, Recombinant DNA – Distribution/Diversity of micro-organisms, Symbiotic relationship - Kinetics of biological growth - Microbial metabolisms- Carbon source, Energy source and Nutrient requirements. Microbial Metabolism - Attached growth systems and their functions - Suspended growth process and their functions - Anaerobic microorganisms-their environment - Factors affecting the growth of micro-organisms processes.	
Module-5 -Microbial Ecology and Nutrient Cycling in Environmental Process	***9 Hour***
Microbial Growth and Control- Distribution of microorganisms – Distribution / diversity of microorganisms, fresh and marine, terrestrial –Microbes in surface soil, Air – Outdoor and Indoor, aerosols, bio safety in Laboratory – Extreme Environment –Significance in water supplies – problems and control-Transmissible diseases, biogeochemical cycles-Hydrological, Nitrogen, Carbon, Phosphorus, Sulphur, Cycles-Role of Microorganism in nutrient cycle- Microbial Bioremediation - Microbial Biosensors - Microbial Fuel Cells - Microbial Genomics - Microbial Biofilms.	

Learning Resources	1. *Dutt PK, Dutt PK (2000) General & Inorganic Chemistry, Calcutta* 2. *Sawyer CN, McCarty PL, Parkin GF (2010) Chemistry for Environmental Engineering and Science, Tata McGraw Hill, New Delhi* 3. *Tortora GJ, Funke BR, and Case CL (2014) Microbiology: An Introduction. Pearson Education (Singapore), Inc.*	4. *Sawyer, C.N. and McCarty, P.L., and Parkin, G.F. "Chemistry for Environmental Engineers", 4th edition, McGraw Hill New Delhi,2018.* 5. *De. A.K." Environmental Chemistry", NewageInternationalLtd., NewDelhi,2017* 6. *Standard Methods for the Examination of water and wastewater", 21st edition. American PublicHealthAssociation,Washington. D.C. 2019*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1.Dr. E. S. M Suresh, NITTTR Taramani Chennai, esmsuresh@gmail.com*	*1. Dr. D. Justus Reymond, SRMIST*
2.Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2.Dr. G. Dhinagaran, Assistant Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. K.C. Vinuprakash, SRMIST*

Course Code	21CEC562J	Course Name	SOLID AND HAZARDOUS WASTE MANAGEMENT	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the source, type and characteristics of solid and hazardous waste*
CLR-2:	*classify and collect the solid and hazardous waste for practice*
CLR-3:	*utilize resource recovered from the solid waste*
CLR-4:	*design the recycling and reutilizing treatment units for segregation of solid waste*
CLR-5:	*design the solid waste processing unit based on their characteristics*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify the various sources of solid waste and its quality*	3	2	3
CO-2:	*design collection mechanism and handling process of solid and hazardous waste*	2	2	3
CO-3:	*identify the conveyance and segregation of solid and hazardous waste*	2	2	2
CO-4:	*design of treatment units for organic solid waste and process mechanism for inorganic sold and hazardous solid waste*	3	3	3
CO-5:	*evaluate the concept of reducing, reuse, recycling in solid waste management*	2	3	3

Module-1 – Overview of Solid and Hazardous Waste	***12 Hour***
Objective of Solid and Hazardous waste management- Characteristics of waste- Physical, chemical and biological- Solid waste composition- Per capita generation of solid waste- Salient features of Indian legislation on management and handling of municipal solid waste- Public health issues and effects of improper management of solid and hazardous waste - Sampling of solid waste- Handling regulation of solid and hazardous waste management- Safety procedure and equipment used for solid and hazardous waste management- Elements of integrated solid and hazardous waste management-Public awareness-Practices adopted in local bodies-Case studies.	
Module-2 - Integrated Onsite Waste Management	***12 Hour***
Onsite solid waste management and it's practices- Practices in household waste management-Onsite collection process-Onsite segregation and resource recovery-Source reduction- Recycling- Economics in recycling and their market- Plastic recycling efficiency- Resource recovery- Sampling techniques- Hands-on practices in waste sample and characterization.	
Module-3 - Optimizing Solid Waste Infrastructure	***12 Hour***
Collection system of waste- Types of waste collection system- Refuse collection system, commercial system, Stationery collection system, Hauled collection system- Collection crew safety and monitoring- Collection routing- Transfer station- Types of transfer station- Sizing of transfer station- Transport vehicles for solid and hazardous waste- Financing and contracting of MSW and HW- Strategies for waste minimization- Developing waste minimization plans using software- Hands-on recycling and sorting activities in municipalities and other local bodies.	
Module-4 - Advanced Offsite Waste Processing Technologies	***12 Hour***
Offsite waste management- Unit operation and material recovery facilities- Size reduction and their equipment- Density separation and its process, autoclaving, microwaving- Smart techniques- Unit process for solid and hazardous waste- Biodegradation- Composting and anaerobic digestion- Energy recovery- Biomedical waste and their process- Hazardous waste and their process- Byproduct recovery after treatment process-Practice on Case studies in municipalities.	

Module-5 - Effective Waste Disposal Methods	***12 Hour***
Waste disposal- Solidification and stabilization of solid and hazardous waste- Landfill- Types of landfills- Landfill gas management- Leachate treatment- Landfill remediation- Emergency response and spill containment of hazardous waste management- Developing waste management plans using standard tools and software.	

Learning Resources	*1. George Tchobanoglous, Hilary Theisen, Samuel Vigil, Integrated Solid Waste Management, McGraw Hill, 2014* *2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans, Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York,2010*	*3. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2020.* *4. NPTEL Course-Municipal solid waste management. https://nptel.ac.in/courses/120108005/* *5. NPTEL Course-Solid and Hazardous waste management. https://nptel.ac.in/courses/105106056/*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1.Dr. E. S. M Suresh, NITTT, Taramani, Chennai, esmsuresh@gmail.com*	*1.Dr. D. Justus Reymond, SRMIST*
2.Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2.Dr. Harish Gupta, Osmania University, Hyderabad, harishgupta78@gmail.com*	*2.Dr. K.C Vinu Prakash, SRMIST*

Course Code	21CEC563J	Course Name	TRANSPORT OF WATER AND WASTEWATER	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study the various sources of water and develop concept about transport of water*
CLR-2:	*study the various sources of wastewater and to develop concept about transport of wastewater*
CLR-3:	*realize insights to the storage, collection and transport of water and wastewater*
CLR-4:	*initiate the students in detailed design concepts related to water distribution system*
CLR-5:	*acquaint the students with software to design sewer network*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the various sources of water and wastewater*	*3*	*3*	*3*
CO-2:	*draft a management plan for water estimation and distributions.*	*2*	*2*	*2*
CO-3:	*apply the concept of water usage minimization and safe wastewater collection*	*3*	*3*	*3*
CO-4:	*recognize the effect of sewage on the environment*	*3*	*3*	*3*
CO-5:	*understand the benefits of sustainable rainwater harvesting techniques.*	*2*	*2*	*2*

Module-1 - Types of Fluids and Its Properties of Flow	***12 Hour***
Fluid properties, fluid flow, head losses, major loss, minor loss, water storage and transmission - Storage requirements, impounding reservoirs, intakes, pressure conduits-Hydraulics, pumps and pumping units-Capacity and selection of water pumps, economic design of pumps and economic design of gravity and pumping mains-Use of computer software in water transmission.	
Module-2 - Water Estimation and its Factors	***12 Hour***
Forecasting of population - Arithmetic Increase - Geometrical Increase - Incremental Increase - Graphical Methods - Logistic Curve Method – Per capita consumption - Design period - Variation in demand – Factors affecting per capita consumption-Use of programming language to estimate forecasting population.	
Module-3 - Water Distribution and Analysis	***12 Hour***
Water transmission main design - pipe materials - economics – water- distribution pipe networks - methods for analysis and optimization – Laying and maintenance, in-situ lining – appurtenances, Use of computer software in water distribution.	
Module-4- Sewage Distribution and Conveyance	***12 Hour***
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 wastewater- Use of computer software in sewer design.	
Module-5 – Stormwater Estimation and Sustainable Rainwater Harvesting Techniques	***12 Hour***
Rainwater harvesting – Rural and urban planning, run-off estimation, rainfall data analysis, storm water drain design-Use of computer software in stormwater design.	

Learning Resources	1. *Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, NewD elhi, 2019.* 2. *Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Shimla, 2013*	*3. CPHEEO Manual on Sewerage and Sewage Treatment Systems Part A, B & C, Ministry of Urban Development, Government of India, New Delhi, 2013* *4. M.J.Hammer, "Water and Wastewater Technology", Regents / Prentice Hall, New Jercy, 2021*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. E. S. M Suresh, NITTT Taramani, Chennai esmsuresh@gmail.com*	*1. Dr. S. Dhanasekar, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. K. Prasanna, SRMIST*

Course Code	21CEC564J	Course Name	UNIT OPERATION AND PROCESSES IN WATER AND WASTEWATER	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*identify the treatment method for water and waste treatment*
CLR-2:	*analyze the suitable efficient method for water wastewater treatment*
CLR-3:	*design the recycling and reutilizing treatment units for polluted water*
CLR-4:	*analyze the effect of disinfection process in wastewater treatment*
CLR-5:	*sustainable bioremediation practice for effective wastewater handling and treatment*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*study various methods of treatment of water and wastewater treatment*	*3*	*2*	*3*
CO-2:	*learn importance of contamination reduction mechanisms in waste*	*3*	*2*	*3*
CO-3:	*characterize various parameter of water pollution*	*2*	*2*	*2*
CO-4:	*recognize the effect of disinfection process.*	*2*	*2*	*2*
CO-5:	*understand the benefits of sustainable bioremediation process.*	*3*	*2*	*3*

Module-1 - Overview of Unit Operations and Processes	***12 Hour***
Unit operations and processes -Type of reactors and its principles-Flow measurement -Screening-Flow Equalization-Mixing - Coagulation and Flocculation, Physical characteristics of water and wastewater-pH, TDS, Conductivity, Turbidity, Jar test for optimization of coagulants.	
Module-2 – Sediment and Analysis of Settling Processes	***12 Hour***
Sedimentation -Type of settling - Discrete, Flocculant, Hindered and Compression Settling - Flotation - Dissolved air flotation, chemical characteristics of water and wastewater Hardness, Alkalinity, Chlorides.	
Module-3 - Filtration and its Types	***12 Hour***
Filtration - Type of filters-Surface filters, depth filters and its types-Head loss through filters, membrane filters, membrane classification, membrane process, membrane bioreactors-Heavy metal Analysis-Copper, iron, chromium and selected organic pollutants.	
Module-4 - Role of Unit Processes in Wastewater Treatment	***12 Hour***
Adsorption and its types, activated carbon and its production mechanisms-Disinfection objectives - Different types of chlorinators- Bleaching powder - Ozone treatment - UV Irradiation - Types of chlorination - Breakpoint chlorination -De-chlorination- Determination of breakpoint chlorination-Dissolved oxygen-BOD.	
Module-5 – Role of Biological Treatment in Wastewater	***12 Hour***
Suspended and attached growth processes - Aerobic and anaerobic - Determination of kinetic coefficients, organic pollutants- COD, TOC, MPN analysis.	

Learning Resources	1. . METCALF & EDDY, INC. "Wastewater Engineering - Treatment, Disposal, and Reuse", Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2015., 2. CASEY. T. J. "Unit Treatment Processes in Water and Wastewater Engineering", John Wiley&Sons, England 2013.	3. G.S. Birdie J.S. Birdie, "Water Supply & Sanitary Engineering", Dhanpatr Rai Publishing COMPANY Pvt Ltd., New Delhi. 4. IS 3025:1988: Methods of sampling and test (physical and chemical) for water and wastewater.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	10%	-	-	10%	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	1. Dr. E. S. M Suresh, NITTT Taramani, Chennai esmsuresh@gmail.com	1. Dr. S. Dhanasekar, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	2. Dr. G. Dhinagaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com	2. Dr. K. Prasanna, SRMIST

Course Code	21CEC565J	Course Name	DESIGN AND OPERATION OF WATER AND WASTEWATER TREATMENT UNITS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*address concepts related to design of water treatment for domestic supplies*
CLR-2:	*address concepts related to design of wastewater treatment plant for cities and industries*
CLR-3:	*create insights to the anaerobic treatment process*
CLR-4:	*address concepts related to sludge treatment and disposal*
CLR-5:	*address concepts related to advanced wastewater treatment*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*design the water treatment plant for domestic purposes*	3	2	3
CO-2:	*design the wastewater treatment plant for cities and industries*	3	2	3
CO-3:	*gain knowledge in anaerobic treatment process*	2	2	2
CO-4:	*manage treatment and disposal of sludge*	2	2	2
CO-5:	*understand the need of advanced treatment for reuse of wastewater*	2	2	3

Module-1 - Design of Conventional Water Treatment Units	***12 Hour***
Design of conventional water treatment units- Introduction- Selection of treatment units- Aeration, types- Sedimentation tanks, design of rectangular and circular tanks- Chemical dosing tanks-Flash mixers, Flocculators, design-Coagulation and flocculation tanks- Tube settlers-design- Filtration-Rapid sand and slow sand filters, pressure filters- disinfection units- Calculation and design of disinfection units Advanced techniques- Adsorption- Reverse Osmosis- Residue management- Hydraulic profile and layout of conventional treatment units- Operation and maintenance.	
Module-2 - Design of Wastewater Treatment Units	***12 Hour***
Flow chart of wastewater treatment units- Screen chamber types and design- Grit chamber design-Sedimentation tank- Design- Biological process fundamentals – attached and suspended growth process- Aerobic and anaerobic process- Trickling filters , types and design- Rotating biological contactor- Activated Sludge process, design-Aerated lagoons, waste stabilization ponds, design- Recent advances- Constructed wet lands- Sequencing Batch Reactor- Sequencing Batch Biofilm Reactor- Membrane Bio Reactor - Moving Bed Bio reactor- Disinfection.	
Module-3 - Anaerobic Treatment of Wastewater	***12 Hour***
Anaerobic treatment of waste water process- Factors affecting anaerobic process- Sulfide production- Ammonia toxicity- Types of anaerobic units- High rate and highbred reactors- Complete mix process- Anaerobic contact process- Anaerobic sequencing batch reactor- Upflow packed bed attached growth reactor- Expanded bed reactor- Fluidized bed reactor- Downflow attached growth process- Anaerobic Lagoon process- Upflow anaerobic Sludge Blanket Reactor- Design of UASB- Septic tank- Disposal of Septic tank effluent- methods, design problem- Recent trends.	
Module-4 – Sewage Treatment	***12 Hour***
Methods of sludge treatment and disposal, sludge sources, characteristics- Importance of moisture content- Sludge management flow chart- Thickening methods- Gravity thickening- Digestion methods- Aerobic digestion, Anaerobic digestion- Process fundamentals- Design of anaerobic digestion tank- Methane production- Dewatering methods- Centrifugation, Vacuum filtering- Sludge drying beds- Design of drying beds- Indian conditions- Heat drying- Flash drying- Incineration-Application of biosolids on land- Sludge hygiene- Ultimate residue disposal.	
Module-5 - Advanced Tertiary Treatment	***12 Hour***

Denitrification- Nitrification- Ammonia stripping- Phosphorous removal- Gas stripping- Adsorption- Advanced oxidation process- Distillation- Membrane filtration process- Operational problems in treatment units- Odor management- Odor control methods- Operational changes that can improve plant performance- Need for upgrading treatment plant performance- Process optimization- Histograms, computer models- Upgrading to meet new requirements- Methods to improve plant performance- Planning, operation and controlling of plant operation- Automatic process control- Process disturbances- Case study on Sewage treatment plants.

Learning Resources	1. *Metcalf and Eddy, Wastewater Engineering- Treatment and Reuse. Tata McGraw Hill, New Delhi 2005* 2. *S.K.Garg, Water Supply Engineering. Khanna Publishers, New Delhi, 2017* 3. *S.K.Garg, Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi, 2017* 4. *CPHEEO Manual on Water Supply and Treatment, Ministry of Drinking water and Sanitation, New Delhi, 2015.*	5. *Qasim, S. R. Wastewater Treatment Plant, Planning, Design & Operation. 2nd edition, CRC press, New York, 2010* 6. *Arceivala S.J., and Asolekar S.R , Wastewater Treatment for Pollution Control and reuse. Tata McGraw Hill , 3rd Edition, New Delhi, 2007.* 7. *CPHEEO Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, New Delhi, 2010*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (45%)		*Life-Long Learning CLA-2 (15%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	-	*20%*	*20%*	-
Level 2	*Understand*	*20%*	-	-	*20%*	*20%*	-
Level 3	*Apply*	*20%*	-	-	*20%*	*20%*	-
Level 4	*Analyze*	*20%*	-	-	*20%*	*20%*	-
Level 5	*Evaluate*	*10%*	-	-	*10%*	*10%*	-
Level 6	*Create*	*10%*	-	-	*10%*	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Suyash Misra, Arcadis, Bangalore, suyash.misra@gmail.com	*1. Dr. Harish Gupta, Osmania University, Hyderabad, harishgupta78@gmail.com*	*1. Dr. D. Justus Reymond, SRMIST*
2. Dr. Rajkumar, Director, HECS, Chennai. rajkumar@hecs.in	*2. Dr. E.S.M Suresh, Professor & Head, NITTTR, Chennai, esmsuresh@gmail.com*	*2. Mr. S. Ramesh, SRMIST*

ACADEMIC CURRICULA

Environmental Engineering

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CEE561T	Course Name	OCCUPATIONAL HEALTH AND SAFETY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*educate the students on the importance of environmental monitoring in industries.*
CLR-2:	*impart knowledge on the various techniques and measures taken to maintain safety.*
CLR-3:	*train the students on the document preparation for maintaining health and safety in industry*
CLR-4:	*understand role of management in providing safety*
CLR-5:	*train the students on the document preparation for maintaining health and safety in industry and imparting the necessary education to maintain the safety.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*possess knowledge thorough which safety is ensured in the organization.*	2	2	3
CO-2:	*understand the various source and imparting the effects*	2	2	3
CO-3:	*take precautions in chemical storage and handling*	2	2	3
CO-4:	*suggest and make others in the plant about emergency management plans*	3	2	3
CO-5:	*classify and identify hazards in chemical industries*	3	2	3

Module-1 - Occupational Health and Hygiene	***9 Hour***
Concept and spectrum of health- Functional units and activities of occupational health services-Need for developing Environment in workplace -Occupational and work-related diseases- Levels of prevention of diseases- Notifiable occupational diseases, their effects and prevention. Ergonomics and workplace-Industrial Toxicology-Local and systemic effects. chronic and acute effects-Chemical hazards, dusts, fumes, gases-Recognition of chemical hazards-Methods of controlling work environment- Personal protective clothing.	
Module-2 - Categories of Health Hazard	***9 Hour***
Physical Hazards-Noise and vibration, types, surveying procedure, permissible levels, health effects, control measures- Radiation hazards; different types of radiation hazards, its source -Effects of radiation and its control measures- OSHA standard non-ionizing radiations-Lighting and illumination, measurement, artificial lighting, quality and quantity of illumination-Fire hazard and chemical hazard.	
Module-3 - Workplace Safety and Safety Systems	***9 Hour***
Features on satisfactory design, work premises-Exposure pathways to hazardous and toxic substances - Human responses to hazardous and toxic substances - Hierarchy of control measures-Significance of human factors in the establishment-Effectiveness of safe systems - Safe systems of work -annual handling operations-Contingency arrangements for events serious and imminent danger.	
Module-4 - Computer Aided Risk Analysis	***9 Hour***
Introduction, factors influencing the selection of hazard evaluation techniques- Decision making process- Hazard review for management changes combined hazard review- hazard evaluation - Risk issues-Hazard evaluation techniques-Non-scenario based:- Checklist analysis, safety review, relative ranking, preliminary hazard analysis (PHA), fire explosion and toxicity index (FETI)- Scenario Based:- Fault tree analysis, event tree analysis– Analysis/checklist - Hazard operability studies (HAZOP) -Hazard analysis (HAZAN) - Failure Mode and Effect Analysis (FMEA).	
Module-5 - Education and Training	***9 Hour***
Instruction, training and supervision-Principles of effective training- Factors to be considered in the development of effective training programs-Methods of effective training- Evaluation mechanism -	

Feedback Mechanism- Plant layout, inherent safety and design- Precautionary measures necessary when handling hazardous substances

Learning Resources	*1. Lewis J. Cralley & Lester V. Cralley, Patty's Industrial Hygiene and Toxicology, Volume III, Second edition, John Wiley & Sons, New York, 2015.* *2. Barbara A. Plog and Patricia J. Quinlan, Fundamentals of Industrial Hygiene by, 6 th Edition, National Safety Council, USA, 2012.* *3. D.H. Anna (Editor). The Occupational Environment - Its Evaluation, Control, and Management.. AIHA, Fairfax, Virginia, 2011*	*4. Bridger, RS: Introduction to Ergonomics, 2nd Edition, Taylor &Francis, 2013.* *5. Gayle Woodside & Dianna Kocurek, Environmental, Safety and Health Engineering, John Wiley & Sons, New York, 2017.* *6. ILO, Encyclopedia of Occupational Health and Safety, Vol.I and II, International Labour Office*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. Suyash Misra, Arcadis, Bangalore, suyash.misra@gmail.com	*1. Dr. Vivekanand, MNIT Jaipur, vivekanand.cee@mnit.ac.in*	*1. Dr. K.C. Vinu Prakash, SRMIST*
2. Dr. Rajkumar, Director, HECS, Chennai. rajkumar@hecs.in	*2. Dr. Harish Gupta, Osmania University, Hyderabad, harishgupta78@gmail.com*	*2. Mr. S. Ramesh, SRMIST*

Course Code	21CEE562T	Course Name	INSTRUMENTAL MONITORING OF ENVIRONMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*introduction of instrumental methods*
CLR-2:	*understand the techniques of spectrometry*
CLR-3:	*study the different chromatography techniques*
CLR-4:	*learn the principles of XRD and XRF*
CLR-5:	*analyze air and water quality*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the principles of spectrometry*	2	3	3
CO-2:	*possess knowledge for the selection of instruments for components*	2	3	3
CO-3:	*understand the gas and ion chromatography (GC)*	2	2	2
CO-4:	*be well versed in instrumental methods*	2	2	3
CO-5:	*explain the concept of neutron activation analysis (NAA)*	2	2	3

Module-1 – Introduction	***9 Hour***
Data in Quantitative Analysis-Accuracy, precision, standard deviation-Types of errors, minimization of error, significant figure-Criteria for rejection of data-Principles of instrumentation-Selection of method. Sample preservation	
Module-2 - Instrumental Methods	***9 Hour***
Electromagnetic radiation, matter radiation interactions-Colorimetry and spectrophotometry, fluorimetry, nephelometry and turbidimetry, flame photometry, Colorimetry (principle, working and uses)-Atomic Absorption Spectrometry, Atomic Emission Spectrometry -Mass spectrometry, principles and applications.	
Module-3 - Classical Methods	***9 Hour***
Classical methods, Column, Paper and thin layer chromatography (TLC)- Techniques and application of Gas Chromatography (GC), GC-MS, High performance liquid chromatography (HPLC) and Ion chromatography (IC).	
Module-4 - Electrochemical Methods	***9 Hour***
Principles, applications, usages, limitations, electrochemical method- Pulse polarography, cyclic voltammetry, anode stripping voltammetry, electrophoresis-Principles of Neutron Activation Analysis, Principles of X-ray Fluorescence (XRF), X-ray Diffraction (XRD), applications.	
Module-5 - Chromatography	***9 Hour***
Principles, applications, advantage, limitations of following chromatographic methods-Adsorption, Partition, Column chromatography, permeation devices, Particulates analysis, Applications of Auto analyzer for water	

Learning Resources	1. *Instrumental Methods of analysis, Willard H H& Dean LL, John Willey, 2016.* 2. *Modern Methods of chemical analysis Recsok RL, & Shields LD, John Willey & sons, Inc 2020.* 3. *Instrumental Methods of chemical analysis, Ewing GW, McGrw Hill Book Company, Inc.2015.*	4. *Fundamental of molecules spectroscophy. Banwell CN, McGraw Hill, NY, 2020.* 5. *Vogels textbook of Quantitative chemical analysis, Third Ed.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. E. S. M Suresh,NITTT Taramani, Chennai , esmsuresh@gmail.com*	*1. Dr. D. Justus Reymond, SRMIST*
2.Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. Harish Gupta, Osmania University, Hyderabad, harishgupta78@gmail.com*	*2. Mr. S.Ramesh, SRMIST*

Course Code	21CEE563T	Course Name	INDUSTRIAL WASTEWATER TREATMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*develop a basic knowledge about industrial wastewater treatment*
CLR-2:	*address concepts related to treatment of industrial wastewater*
CLR-3:	*create insights to the industrial pollution prevention*
CLR-4:	*address concepts related to real time difficulties in treating wastewater from industries*
CLR-5:	*address concepts industrial wastewater management*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the various sources of industrial wastewater*	*3*	*2*	*3*
CO-2:	*draft a management plan for treatment plants*	*3*	*3*	*3*
CO-3:	*knowledge on industrial pollution and its control*	*3*	*2*	*3*
CO-4:	*recognize the effect of industrial wastewater on the environment*	*3*	*3*	*3*
CO-5:	*apply the concept of waste minimization*	*3*	*2*	*3*

Module-1 – Industries and Development	***9 Hour***
Industrial scenario in India - Industrial activity and Environment - Uses of Water by industry - Sources and types of industrial wastewater - Industrial wastewater and environmental Impacts - Regulatory requirements for treatment of industrial wastewater - Industrial waste survey - Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and bioassay tests.	
Module-2 – Pollution Prevention in Industries	***9 Hour***
Prevention Versus Control of Industrial Pollution - Benefits and barriers - Source reduction techniques - Waste audit - Evaluation of pollution prevention options - Environmental statement as a tool for pollution prevention - Waste minimization circles.	
Module-3 – Treatment of Industrial Wastewater	***9 Hour***
Equalization - Neutralization - Oil separation - Flotation - Precipitation - Heavy metal Removal - Refractory organics separation by adsorption - Aerobic and anaerobic biological treatment - Sequencing batch reactors – High-Rate reactors - Chemical oxidation - Ozonation - Photocatalysis - Wet Air Oxidation - Evaporation - Ion Exchange - Membrane Technologies - Nutrient removal.	
Module-4 – Management Of Treatment Plants	***9 Hour***
Individual and Common Effluent Treatment Plants - Joint treatment of industrial wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse - Industrial reuse - Disposal on water and land - Residuals of industrial wastewater treatment – Quantification and characteristics of sludge – Thickening, digestion, conditioning, dewatering, and disposal of sludge – Management of RO Rejects-Case study on zero effluent discharge system in treatment plant.	
Module-5 – Practical Application in Industries	***9 Hour***
Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles - Tanneries - Pulp and paper - Petroleum Refining - Pharmaceuticals - Sugar and Distilleries – Food Processing - Fertilizers - Thermal Power Plants and Industrial Estates.	

Learning Resources	1. *Water and wastewater Engineering – NPTEL* 2. *Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hill, 2021.* 3. *Arceivala, S.J., "Wastewater Treatment for Pollution Control", Tata McGraw-Hill, 2018.* 4. *Frank Woodard, "Industrial waste treatment Handbook", Butterworth Heinemann, New Delhi, 2020*	5. *Metcalf & Eddy/ AECOM, "Water reuse Issues, Technologies and Applications", The McGraw- Hill companies,2007.* 6. *Nelson Leonard Nemerow, "Industrial waste Treatment", Elsevier, 2007.* 7. *Paul L. Bishop, "Pollution Prevention: - Fundamentals and Practice", Mc-Graw Hill International, Boston,2020.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Mr. Suyash Misra, Arcadis, Bangalore, suyash.misra@gmail.com*	1. *Dr. Harish Gupta, Osmania University, Hyderabad,* harishgupta78@gmail.com	1. *Dr. K. Prasanna, SRMIST*
2. *Dr. Rajkumar, Director, HECS, Chennai. rajkumar@hecs.in*	2. *Dr. E.S.M Suresh, Professor & Head, NITTTR, Chennai, esmsuresh@gmail.com*	2. *Dr. P. Purushothaman, SRMIST*

Course Code	21CEE564T	Course Name	RESOURCE ENERGY AND RECOVERY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*provide information on various methods of waste management*
CLR-2:	*familiarize students with recent energy generation techniques*
CLR-3:	*understand on the recent technologies of waste disposal*
CLR-4:	*know about the disposal of hazardous wastes*
CLR-5:	*attain knowledge to recover the waste in efficient ways*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand waste characterization, segregation, disposal will be made known*	2	2	2
CO-2:	*understand the impact of various types of wastes*	2	2	2
CO-3:	*employ technologies that are available for effective waste disposal along with pros / cons will become cleaner to students*	3	3	3
CO-4:	*gain knowledge about efficient recovery of waste.*	2	2	3
CO-5:	*apply modern technology in conversion of waste to energy*	3	2	3

Module-1 - Energy Balance	***9 Hour***
Earth –Atmosphere System. Solar and Terrestrial Radiation. Absorption of Radiation by gases- Energy balance, solar variability and Earth's energy balance-Various renewable and non-renewable resources- Energy concepts for a sustainable world.	
Module-2 - Energy Scenario	***9 Hour***
Indian Energy Scenario – Types, forms of energy – An overview of energy consumption and its effects -Reasons to save energy (financial and environmental) - Energy Conservation Acts and related policies– Schemes of Bureau of Energy Efficiency (BEE)	
Module-3 - Resource Assessment	***9 Hour***
Wind Characteristics-Measurement of wind using anemometers and other remote wind speed sensing techniques-Average wind speed calculation-Statistical models for wind data analysis (Weibull and Rayleigh distribution), solar radiation relations – Radiation on horizontal and tilted surfaces – Extraterrestrial radiation - Estimation of clear sky radiation – Total radiation on fixed sloped surfaces	
Module-4 - Alternate Fuels	***9 Hour***
Hydrogen, properties, production and storage methods-Safety aspects, use in SI and CI engines- Performance and emissions. Biodiesel- Composition and properties; Challenges of use in CI engines, solutions - preheating, blending-Transesterification-Performance and emissions; Oils from waste, cooking oil, wood, rubber, plastic.	
Module-5 - Energy Management	***9 Hour***
Project Preparation – Feasibility study – Detailed project report - Project appraisal – Social-cost benefit analysis - Project cost estimation – Project risk analysis - Project Financing – Financial Evaluation.	

Learning Resources	1. *S.K. Agarwal, Kul Bhushan Nangia, "Wealth from Waste", APH Publishing Corporation, New Delhi,* 2. *Parker, Colin and Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 2015.*	3. *Tchobanoglous, Theisen and Vigil, Integrated Solid Waste Management, 2nd Ed. McGraw Hill, New York,2014* 4. *Howard S. Peavy et al, Environmental Engineering, McGraw Hill International Edition, 2015.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. Suyash Misra, Arcadis, Bangalore, suyash.misra@gmail.com	*1. Dr. Harish Gupta, Osmania University, Hyderabad, harishgupta78@gmail.com*	*1. Mr. S. Ramesh, SRMIST*
2. Dr. Rajkumar, Director, HECS, Chennai. rajkumar@hecs.in	*2. Dr. E.S.M Suresh, Professor & Head, NITTTR, Chennai, esmsuresh@gmail.com*	*2. Dr. Vinu Prakash, SRMIST*

Course Code	21CEE565T	Course Name	ENVIRONMENTAL SANITATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*develop a conceptual understanding on key issues related to environment and sanitation*
CLR-2:	*apply the concept sanitations and its role in environment*
CLR-3:	*state the mode of transmission of a disease and its prevention.*
CLR-4:	*recognize major classes of industrial and waste management*
CLR-5:	*discuss the sanitary aspects in institutions and rural areas.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*study the water, hygiene, and sanitation systems*	*2*	*2*	*3*
CO-2:	*develop the skills in basic sanitation concepts and its application.*	*2*	*2*	*3*
CO-3:	*aware about the communal disease due to unhygienic practices.*	*2*	*2*	*3*
CO-4:	*identify the problems in industrial hygiene in sanitation,*	*2*	*2*	*3*
CO-5:	*understand the institutional and rural sanitation.*	*2*	*2*	*3*

Module-1 - Water, Sanitation and Hygiene	***9 Hour***
Environment and ecology, meaning, concepts, principles, and components-Environmental pollution and health hazards-Water, Sanitation and Hygiene (WASH), concept, meaning-Principles, and Practices, Sustainable Development Goals pertaining to environmental issues.	
Module-2 - Sanitation – Concept and Applications	***9 Hour***
Sanitation, meaning, concept and applications-Institutional Sanitation-Waste Management-Types and its applications.	
Module-3 - Communicable Diseases-Unsanitary Conditions	***9 Hour***
Modes of transmission of diseases – Diseases spreading by intestinal discharges – Diseases communicated by nose and throat discharges–Arthropod borne diseases – Diseases of animals transmitted to human– Miscellaneous diseases – Immunization – Control of epidemics	
Module-4- Industrial Hygiene and Waste Management	***9 Hour***
Industrial hygiene-Industrial safety-Industrial waste and its classification-Toxicology; particulate matter, aerosol, hazardous chemicals-Occupational hazards-Noise exposure, noise sampling, ventilation, personal productive equipment- Waste management and disposal.	
Module-5 – Institutional and Rural Sanitation	***9 Hour***
Institutional sanitation-roles, responsibility-Health Management- Education- Hygiene – Safety – Fist Aid-Fire hazards – Accidents Control- Rural areas, Population habits and environmental conditions, Rural sanitation improvement schemes-Concept of environment and scope of, sanitation in rural areas-Methods of disposal of waste in rural areas	

Learning Resources	1. *Victor Ehalers & Earnest W Steel, Municipal and Rural sanitation. McGraw Hill Company, 3rd Ed., 2017* 2. *2. Bhatia H. S., A Textbook Of Environmental Pollution and Control, Galgotia Publication Pvt. Ltd., New Delhi.* 3. *Wright F.B., Rural water supply and sanitation, Robert E. Krieger Publishing Co., 2017* 4. *Ministry of Drinking Water and Sanitation: https://mdws.gov.in/* 5. *Joseph A Salvato, "Environmental Engineering and Sanitation", 4th Edition, Wiley- Inter science, 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Dr. E. S. M Suresh, NITTT Taramani, Chennai esmsuresh@gmail.com*	*1. Dr. S. Dhanasekar, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. K. Prasanna, SRMIST*

Course Code	21CEE566T	Course Name	MARINE POLLUTION MONITORING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**	*Nil*		

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*Develop a basic knowledge about the marine pollution monitoring and apply the same in the field application*
CLR-2:	*Address concepts related to Wave Characteristics*
CLR-3:	*Create insights to the marine resources and its behaviour*
CLR-4:	*Address concepts related to types of surveying*
CLR-5:	*Address concepts to physiochemical characteristics of seawater*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*Understand the various sources of Marine Pollution*	2	2	3
CO-2:	*Able to draft behavior of types of waves*	2	2	2
CO-3:	*Knowledge on resources of marine environment*	2	2	3
CO-4:	*Able to recognize the suitable monitoring technique*	3	2	3
CO-5:	*Apply the concept of coastal zone management*	3	2	3

Module-1 - Introduction to Oceanography	***9 Hour***
General features of ocean- Conservation laws - Wave characteristics and theories - Seas and oceans, continental area - Sediment transport, tides - Coastal zone, properties of sea water - Principles of marine, geology- Ocean currents - Thermocline circulation - General circulation of ocean waters - coastal features -Tsunamis - Storm surge – Beaches – Estuaries – Lagoons -Principles of Marine geology - The oceans and climate - Marine Biodiversity - Ocean Acidification - Marine Renewable Energy - Marine Spatial Planning - Ocean Governance.	
Module-2 – Coastal Processes and Resources Management	***9 Hour***
Wave Theory - Waves in shallow waters – Refraction - Diffraction and Shoaling - Approximations for deep and shallow water conditions - coral reefs – mangroves - sea grass – seaweeds - Fishery potential - nonliving resources - manganese nodules, heavy minerals - Tidal Classification - Shoreline change - General circulation of ocean waters - Coastal sediment transport - Onshore offshore sediment transport - Beach formation and coastal processes - Wave Energy Conversion - Marine Protected Areas - Climate Change Impacts on Coastal Systems - Coastal Erosion and Management - Blue Carbon Ecosystems	
Module-3 - Environmental Monitoring of Marine Ecosystem	***9 Hour***
Marine Pollution sources and their Effects - Sources of Marine Pollution - Point and non-point sources - Pollution caused by Oil Exploration – Dredging - Offshore Structures - Agriculture Impacts of pollution water quality and coastal ecosystems - Marine discharges, effluent standards - Marine Surveying - Sea surveying planning - Oceanographic instrumentation - Hydrographic Surveying - Underwater surveying - Measurement of physical properties of ocean water - sea bed sampling - Microplastics Pollution - Harmful Algal Blooms (HABs) - Emerging Contaminants - Citizen Science in Marine Pollution Monitoring - Legal and Policy Frameworks for Marine Pollution Management.	
Module-4 - Marine Pollution Management Technologies	***9 Hour***

Marine Pollution Monitoring - Basic measurements - Sounding boat - lead lines, echo sounders - current meters - tide gauge - Use of GPS - Measurement of coastal water characteristics - Modeling of Pollutant transport and dispersion - Oil Spill Models - Ocean Monitoring satellites - Applications of Remote Sensing and GIS in monitoring marine pollution - Oil exploration and their effects - Marine outfalls - Impacts of ports and harbour on marine water quality - Human intervention in estuarine ecosystem - Physical modeling in Coastal Engineering - Applications of Remote sensing and GIS in marine studies -Autonomous Underwater Vehicles (AUVs) for Marine Pollution Monitoring - Bioremediation Techniques for Marine Pollution - Integrated Coastal Zone Management (ICZM) - Green Infrastructure for Coastal Resilience-Community Engagement in Marine Pollution Monitoring.
Module-5 – Coastal Zone Management and Pollution Control ***9 Hour***
Coastal Management - Pollution Control strategies - Selection of optimal Outfall locations - National and International Treaties - Coastal Zone Regulation - Total Maximum Daily Load applications - Protocols in Marine Pollution - ICZM and Sustainable Development - protocols in marine pollution - Exclusive Economic Zone - Sustainable development. - Challenges in marine pollution - Banned of throwing of plastic litters - Diminish discharge of untreated sewage - Control chemical and industrial pollution - Strengthen laws of marine litter - Increase funding for marine pollution and control - Coastal Habitat Restoration - Climate Change Adaptation in Coastal Management - Blue Economy Development - Indigenous Knowledge and Traditional Coastal Management - Innovative Technologies for Coastal Monitoring and Management.

Learning Resources	1. *Kennish, M.J., "Pollution impacts on Marine Biotic Communities", CRC press New York, 2018.* 2. *Newman, M.C., Roberts Jr. M.H., Male R.C. (Editors), "Coastal and Estuarine Risk Assessment", Lewis Publishers, Washington, D.C., 2012*	3. *U.S. Army Corps of Engineers, "Shore Protection Manual", Washington D.C., 2012.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in*	1. *Dr. E. S. M Suresh, NITTTR Taramani Chennai, esmsuresh@gmail.com*	*1. Dr. D. Justus Reymond,, SRMIST*
2. *Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com.*	2. *Dr. G. Dhinagaran, Assistant Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr.K. C. Vinuprakash, SRMIST*

Course Code	21CEE567T	Course Name	ENVIRONMENTAL IMPACT ASSESSMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*know the characteristics of the environment and the impact of human activities on environment*
CLR-2:	*understand the importance of EIA, its evolution through rules and regulations*
CLR-3:	*study the principles and methods of environmental analysis of different components of the environment*
CLR-4:	*identify the methodologies used for environmental impact assessment*
CLR-5:	*comprehend the application of EIA studies in various sectors through case studies*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify the need of environmental impact assessment and types of EIA*	2	2	3
CO-2:	*recognize the importance of various rules & regulation in EIA and the concept of environmental management*	2	2	3
CO-3:	*apply the analytical methods to study the effect on different environmental compartments*	2	2	3
CO-4:	*implement various techniques in impact assessment studies*	3	3	3
CO-5:	*interpret and analyze the EIA case studies of different projects and industries*	3	3	3

Module-1 – Introduction	***9 Hour***
Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA –EIA process- screening – scoping - setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA-EIA Consultant Accreditation-Geographic Information System (GIS) - Ecosystem and ecological footprints -Global Footprint Network (GFN) Tools - Definition and concepts of EIA, ethics and environment, EIA for civil engineers - Case study on EIA.	
Module-2 –Impact Identification and Prediction	***9 Hour***
Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts, air, water, soil, noise, biological - Cumulative Impact Assessment-Various amendments of rules and regulations (MOEFCC website)-CPCB and State PCBs – roles and responsibilities-Remote Sensing- risk- Environmental management-Principles, problems and strategies; Review of political, ecological and remedial actions.-Discussion With Activity :Eco Web Desk-Environmental audit	
Module-3 –Social Impact Assessment and EIA documentation	***9 Hour***
Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials-LiDAR -Drones- Biosphere (macro, micro)- Introduction to hazard exposure levels for biota -Discussion using a case study - Components of the environment: Socio- economic-Activity, discussion using a case study	
Module-4 –Environmental Management Plan	***9 Hour***
EIA Report preparation. Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring	

programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies-SITES for sustainable landscape design - AQUATOX-Case study involving matrix methods-discussion: Aldo Leopold's environmental ethics-Network methods-decision tree, expert systems.
Module-5 –Environment Risk Assessment and Management ***9 Hour***
Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modeling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.

Learning Resources	*1. L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 2017.* *2. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2010* *3. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2015.*	*4. Y. Anjaneyalu, ValliManickam, Environmental Impact Assessment Methodologies, 2nd Ed., BS Publications, 2017* *5.Environnemental Management- NPTEL- https://nptel.ac.in/courses/120108004/16#* *6.Environmental Impact Assessment- NPTEL- https://nptel.ac.in/syllabus/105103024/*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. SuyashMisra, Technical Discipline Leader,Arcadis Consulting India Private Limited Bangaloresuyash.misra@gmail.com	*1.Dr. Vivekanand, Assistant Professor MNIT Jaipu, vivekanand.cee@mnit.ac.in*	*1. Dr. P. Purushothaman, SRMIST*
2. Dr.Rajkumar, Director-Hubert Envirocare Systems, Chennai. rajkumar@hecs.in	*2. Dr. Harish Gupta, Assistant Professor, University College of Engineering, Osmania University, Hyderabad. harishgupta78@gmail.com*	*2. Dr. K. Prasanna, SRMIST*

Course Code	21CEE568T	Course Name	GROUNDWATER CONTAMINATION AND TRANSPORT MODELING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	***Civil Engineering***	**Data Book / Codes/Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*provide an understanding about the source of ground water and its properties*
CLR-2:	*provide an understanding of water movement in subsurface environment*
CLR-3:	*study the concept applied in chemical equilibria and kinetics*
CLR-4:	*study the fate and transport of contaminants through porous media*
CLR-5:	*enumerate various model input parameters for transport of contaminants in subsurface water*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	**2**	**3**
CO-1:	*describe various sources of groundwater and data acquisition techniques*	*2*	*2*	*3*
CO-2:	*examine the contaminant transport mechanism by applying various models*	*3*	*3*	*3*
CO-3:	*evaluate various factors controlling transport of contaminants in groundwater*	*3*	*2*	*2*
CO-4:	*differentiate various numerical techniques for solving flow and transport equations*	*2*	*2*	*2*
CO-5:	*apply the software packages to develop contaminant transport model for field condition*	*3*	*2*	*3*

Module-1- Introduction	***9 Hour***
Hydrological Cycle- Water Movement in the Subsurface- Types of aquifers - Sources of contamination – Data collection methods- Introduction, geological data acquisition, and hydrologic data acquisition, acquisition of soil and ground water quality data- Case studies.	
Module-2 -Contaminant Transport Mechanisms	***9 Hour***
Introduction, advection processes, diffusion and dispersion processes, Mass- transport equations, one dimensional model-Governing flow and transport equation in two dimensions, semi-analytical methods, test for dispersivity, Natural gradient field test for dispersion- Case studies on application of models and estimation of mass transport process.	
Module-3-Sorption and other Chemical Reactions	***9 Hour***
Introduction, the concept of sorption, factor influencing sorption, sorption Isotherm, Hydrophobic theory for organic contaminants, sorption effects on fate and transport of pollutants, Estimation of sorption, Redox reaction, Hydrolysis, volatilization, acid-base reaction, Ion exchange, dissolution and precipitation of solids, complication reaction, models incorporating chemical reactions; Estimation of various process using models-Case study in India.	
Module-4-Saturated Flow	***9 Hour***
Continuity equation-Darcy's Law-Equation of flow-Analytical solutions and numerical modeling-Unsaturated flow - soil-water characteristics curves, unsaturated hydraulic conductivity, governing equation for unsaturated flow, measurement of soil properties- Case study on application of numerical modelling	
Module-5-Transport of Contaminants	***9 Hour***
Transport of contaminants - Transport equation - Dispersion and diffusion in porous media - Reaction terms - Adsorption and surface complexation models – Soil Chemical Kinetics -Reaction and transport of trace metals, Ligands and Non-polar organic solutes - Model input parameters - Initial and boundary conditions - Calibration - Sensitivity Analysis - Groundwater transport modelling-Case study- software for groundwater transport models	

Learning Resources	1. *Randall J. Charbeneau, "Ground water Hydraulics and Pollutant transport", Prentice Hall, Upper Saddle River, 2019.* 2. *Todd David Keith, "Ground water Hydrology", Second edition, John Wiley and Sons, New York, 2020.* 3. *Allen Freeze, R. and John A. Cherry, "Ground Water", Prentice Hall, Inc., 2019.*	4. *Horst D. Schulz and Georg Teutsch (Eds.), Conceptual Models for Reactive Transport in Soil and Groundwater, Wiley, 2012* 5. *Rushton K.R., Groundwater Hydrology - Conceptual and Computational Models, Wiley, 2013*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	20%	-	20%	-	20%	-
Level 2	*Understand*	20%	-	20%	-	20%	-
Level 3	*Apply*	20%	-	20%	-	20%	-
Level 4	*Analyze*	20%	-	20%	-	20%	-
Level 5	*Evaluate*	10%	-	10%	-	10%	-
Level 6	*Create*	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in.*	1. *Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	1. *Dr. P. Purushothaman, SRMIST*
2. *Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com*	2. *Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	2. *Dr. K. Prasanna, SRMIST*

Course Code	21CEE569T	Course Name	GEOINFORMATICS FOR ENVIRONMENTAL ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand geoinformatics techniques*
CLR-2:	*understand various types of geospatial data and their extraction using modern tools*
CLR-3:	*understand geospatial techniques in atmosphere and hydrosphere*
CLR-4:	*understand geospatial techniques in earth materials and vegetation*
CLR-5:	*understand the geospatial technology and its applications in various environmental problems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*explain principles of EMR, GIS and GNSS*	*3*	*2*	*2*
CO-2:	*analyse and extract data using geospatial Techniques*	*3*	*2*	*2*
CO-3:	*identify various components of atmosphere and hydrosphere using GIS and GNSS*	*3*	*2*	*2*
CO-4:	*extract information about earth materials and vegetation using Geospatial Technology*	*3*	*2*	*2*
CO-5:	*apply Geospatial technology in real time environmental problems*	*3*	*2*	*2*

Module-1-Introduction	***9 Hour***
Definition of Geoinformatics; Surveying techniques; Photogrammetry techniques; Remote sensing and GIS; Remote sensing- Resolution, Remote sensing data analysis- Analog data, Digital data; Electro-Magnetic Radiation (EMR), EMR Spectrum, Visible, Infra-Red (IR), Near IR, Middle IR, Thermal IR, Hyperspectral and Microwave, GNSS.	
Module-2-Data Acquisition and Extraction	***9 Hour***
Introduction to GIS, Components of GIS, Spatial and Non-Spatial, Maps- Types of Maps, Projections; Data Input, Digitizer, Scanner, Editing; Raster and Vector data structures- Comparison, Spatial Analysis; Retrieval, Reclassification, Overlaying, Buffering, Non-Spatial Analysis- Data Output, Printers and Plotters; Open-source software- Application & Case study	
Module-3-Geospatial Technology for Atmosphere and Hydrosphere Applications	***9 Hour***
Atmosphere characteristics, Scattering of EMR- Raleigh, Mie, Non-Selective and Raman Scattering; EMR Interaction with water vapour and ozone, Atmosphere Windows, Significance of Atmospheric Windows EMR interaction with Water- Radiance, Irradiance, Incident, Reflected, Absorbed and Transmitted Energy, Reflectance, Specular and Diffuse Reflection Surfaces, Spectral Signature, Spectral Signature curves, EMR interaction with water- GIS and GPS applications- Case Study	
Module-4-Geo Information for Sensing Earth Materials, Vegetation	***9 Hour***
Spectral response of Minerals, Rocks; Soil and altitude, Soil and aspect, Soil and slopes, Soil landscapes, Soil erosion modeling; Estimation of Vegetation Cove: Spectral Indices -Vegetation indices and vegetation descriptors; Microwave vegetation indices- estimation of vegetation using Lidar. Detection and diagnosis of plant stress; Precision agriculture and crop management; Ecosystems and Forestry Management- GIS and GPS applications- Case Study	
Module-5-Applications on Environmental Problems	***9 Hour***
Spatial analysis in GIS- interpolation, overlay, Proximity, Weighted Linear Combination, Analytical hierarchical process, Artificial neural network, Multi criteria decision making analysis, GIS customization; Graphical user Interface development- Web based GIS, Integration with QGIS-Application of GIS in Ecosystem Analysis, Environmental impact analysis and monitoring, Ecosystem modeling; Wetland mapping; Urban growth	

studies; Municipal solid waste studies; Land use land cover change detection studies; Spatial Models of Ecological Systems and Process- Case Study on various applications

Learning Resources	1. *M. Anji Reddy, Textbook of Remote sensing and GIS by, BSP Publications, Hyderabad, 2021.* 2. *K Tempfli, G.C. Huurneman et al. Principles of Remote sensing: An introductory Textbook. The international institute for Geo Information sciences and Earth Observation (ITC), 2019.* 3. *Anil K. Maini, Varsha Agrawal. Satellite Technology: Principles and Applications, 2nd Edition, ISBN: 978-1-119-95727-0694 pages, June 2011.*	4. *Burrough, P.A and McDonnel, R.A., Principles of Geographic Information Systems, Oxford university press,2018* 5. *Chang, K.T., Introduction to Geographic Information Systems, Tata McGraw – Hill ,2016*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in.*	1. *Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	1. *Dr. R. Sivakumar, SRMIST*
2. *Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com*	2. *Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	2. *Dr. P. Purushothaman, SRMIST*

Course Code	21CEE570T	Course Name	AIR AND NOISE POLLUTION CONTROL	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*know the various sources of air and noise pollution*
CLR-2:	*know the air pollution monitoring and modelling*
CLR-3:	*explore the air and noise pollution monitoring techniques*
CLR-4:	*study the concepts related to reduce air pollution*
CLR-5:	*realize the concepts related to reduce noise pollution*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify the various sources of air and noise pollution*	2	2	3
CO-2:	*analyze air quality parameters and its impact*	2	2	3
CO-3:	*recognize the pollution measurement methods*	2	2	3
CO-4:	*identify the techniques to reduce air pollution*	2	2	3
CO-5:	*apply the concept of reducing air and noise pollution*	2	2	3

Module-1 - Introduction	***9 Hour***
Structure and composition of Atmosphere – Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation and animals, Materials structures – Effects of air pollutants on the atmosphere, soil and water bodies – Long term effects on the planet – Global climate change, Ozone holes – Ambient air quality and emission standards – Air pollution indices – Emission inventories. - Greenhouse effect–Major contributions of air pollutant-Noise Pollution-Sources, classification-Monitoring techniques for noise pollution-Legislation and regulations - Noise quality management in India	
Module-2 –Air Pollution Monitoring and Modelling	***9 Hour***
Ambient and stack sampling- Analysis of particulate and gaseous pollutants -Effects of meteorology on Air pollution - Fundamentals, atmospheric stability, inversion-Wind profiles and stack plume patterns-Transport and dispersion of Air pollutants – Modeling techniques – Air pollution climatology-Ambient noise quality and emission standards-Noise pollution indices.-Manmade sources - Types of noise pollutant - effects on human health.	
Module-3 –Control of Particulate Contaminants	***9 Hour***
Factors affecting selection of control equipment – Gas particle interaction – Working principle, design and performance equations of gravity separators, cyclones-Fabric filters-Particulate scrubbers-Electrostatic precipitators – Operational considerations - Process control and monitoring – Costing of APC equipment – Case studies for stationary and mobile sources - Active personal particulate monitor-Monitoring stations in India - Temperature lapse rate and stability - Adiabatic lapse rate - Wind Rose, Inversion - Wind velocity and turbulence - Plume behavior - Carbon emission-Data logging sound level meters- Pollution measurement methods, - Occupational noise monitoring - Monitoring-case studies.	
Module-4 –Control of Gaseous Contaminants	***9 Hour***
Factors affecting selection of control equipment – Working principle, design and performance equations of absorption, adsorption, condensation- Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations - Case studies for stationary and mobile sources- Air pollution control measures - Basics of pollution control- Particulate control methods - Settling chambers, - cyclone separation, - Wet collectors-fabric filters-electrostatic precipitators-Removal of gaseous pollutants by adsorption, absorption,-Biological air pollution control technologies,-Indoor air quality-control	

principles -Case studies on gaseous contaminants.
Module-5 - Automobile and Noise Pollution ***9 Hour***
Vehicular Pollution, automobile emission- Types of emissions- Exhaust emissions, evaporative emissions, crank-case emissions- Prevention and control of vehicular pollution-Noise Pollution-Sources and Effects of Noise Pollution - Measurement - Standards -Control and Preventive measures- Sources types and control of indoor air pollutants, sick building syndrome types-Case studies on Air pollution.

Learning Resources	*1.C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2020.* *2.M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 2013* *3.Dr. Y. Anjaneyulu, "Air Pollution and Control Technologies", Allied publishers Pvt. Ltd., 2012.* *4.Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition* *5.Peterson and E.Gross Jr., "Hand Book of Noise Measurement", 5 th Edition, 2013*	*6. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 2016* *7. Antony Milne, "Noise Pollution: Impact and Counter Measures", David & Charles PLC, 2019.* *8. Kenneth wark, Cecil F.Warner, "Air Pollution its Origin and Control", Harper and Row Publishers* *9.NPTELOnline Course - Noise Management and Control :https://swayam.gov.in/nd1_noc19_me72/*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Mr. Elvis Dsouza, EDPC Polymer Industries, Maharashtraelvisdsouza11@gmail.com	*1.Dr. Rehana Shaik, Assistant Professor, Dept of Civil Engineering, IIIT Hyderabad rehanaiisc@gmail.com*	*1. Mr. S. Ramesh, SRMIST*
2.Dr.Rajkumar Director Hubert Envirocare Systems, Chennai rajkumar@hecs.in	*2.Dr. E.S.M Suresh Professor & Head Department of Civil Engineering NITTTR, Chennaiesmsuresh@gmail.com*	*2. Dr. K. C. Vinu Prakash, SRMIST*

Course Code	21CEE571T	Course Name	ENVIRONMENTAL POLICIES AND LEGISLATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study the importance of environment, ecosystem and sustainability*
CLR-2:	*know the current issues related to environment*
CLR-3:	*realize the measurement tool for impacts on environment*
CLR-4:	*explore the concepts about sustainability in material resources*
CLR-5:	*understand the sustainable strategies and policies*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*apply the acquired knowledge on values of environment, ecosystem and sustainability theory.*	2	2	2
CO-2:	*understand the various environmental issues and current treatment/ disposal methods*	2	2	2
CO-3:	*learn the impacts caused by humans on environment and their measurement tools*	2	2	2
CO-4:	*know the changes in material resources and sustainable traps*	2	2	2
CO-5:	*explore the sustainable strategies and policies for practical applications*	2	2	2

Module-1 - Introduction to Environment and Law	***9 Hour***
Indian constitution and environmental protection – National environmental policies – Precautionary principle and polluter pays principle – Concept of absolute liability – Multilateral environmental agreements and Protocols – Montreal protocol, Kyoto agreement, Rio declaration – Environmental Protection Act 1986, Water Act 1974, Air Act 1981 – Institutional framework-Environment, Nature and Ecosystem– Origin of Environmental Law Ecology and the environment - - Concept of Law and Policy – Environment and Governance– Sustainable Development and Environment – Understanding climate change and its processes – CDP, CDMs and Carbon off setting -Case study.	
Module-2 - International Environmental Law and Policy	***9 Hour***
Power and functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory-Appellate Authority-Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation- Right to Environment as Human Right- International Humanitarian Law and Environment -Environment and Conflict Management- UNFCCC and Kyoto Protocol- Treaty on Antarctic and Polar Regions- UN Convention of Law of the Sea and Regional Seas Convention– Law on International Watercourses.	
Module-3 - National Environmental Law and Policy	***9 Hour***
Power and functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures-State air laboratory- Appellate authority-Penalties for violation of consent conditions-Provisions for closure/directions in apprehended pollution situation.— Environmental Law and the Indian Constitution– Other Laws and Environment- Law and Policy Frameworks related to forest and wildlife– Scheduled Tribes and other traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and Forest Conservation Act 1980– Panchayats Extension to Scheduled Areas (PESA) Act 1996 – Wildlife Protection Act, 1972 – Coastal Regulation Zone & Coastal Regulation Management- introduction to various expert system (software/ models widely used)	
Module-4 - Environment (Protection) Act 1986	***9 Hour***
Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for	

Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards- Land Acquisition Act, 1894 - Tenure & Property Rights and Community Rights II – Environment Impact & Policy : Introduction to Environmental Impact Assessment– EIA – Infrastructure Projects-Environment – Introduction to Environmental Public Hearing (EPH) & Processes – Introduction to displacement and rehabilitation – Displacement and Environmental Concerns
Module-5 - Environment Protection Mechanisms ***9 Hour***
Environment Management– Air, Water and Land Management– Forest Management– Urban Development Policy– Municipal Solid Waste- E- waste management– Judicial trends -Public Interest Initiatives – Introduction to Public Interest Litigation – Forest Cases Responses (Case Laws) – Right to Information Act – Tribunals committees – Introduction to Environment Tribunals – The National Green Tribunal Act, 2010

Learning Resources	1. *F. Douglas Muschett, Principles of Sustainable Development, CRC Press, 2019* 2. *Bhavik R. Bakshi, Sustainable Engineering Principles and Practice, Cambridge University Press, 2019.*	3. *Catherine Mulligan, Sustainable Engineering: Principles and Implementation, CRC Press, 2019* 4. *Kauffman, Joanne, LEE, Kun Mo, Handbook of Sustainable Engineering, Springer 2013.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in*	1. *Dr. E. S. M Suresh, NITTTR Taramani Chennai, esmsuresh@gmail.com*	*1. Dr. D. Justus Reymond, SRMIST*
2. *Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com.*	2. *Dr. G. Dhinagaran, Assistant Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. K. C. Vinuprakash, SRMIST*

Course Code	21CEE572T	Course Name	CLEANER PRODUCTION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*give students an understanding about the concept of cleaner production*
CLR-2:	*understand in detail, the methodologies involved*
CLR-3:	*financial evaluation of cleaner production technologies*
CLR-4:	*study the practical applications of cleaner production technologies*
CLR-5:	*educate the students on complete management principles related to cleaner production*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the concept and principles of cleaner production*	3	2	3
CO-2:	*suggest different unit operations in industrial production process to minimize pollutants*	3	2	3
CO-3:	*plan good housekeeping practices for industry*	3	2	3
CO-4:	*suggest basic methods and techniques of pollution prevention during production*	3	2	3
CO-5:	*suggest cleaner production methods for a given situation which will also lead to cost reduction in long run*	3	2	3

Module-1 – Sustainable Development	***9 Hour***
Sustainable development-Indicators of sustainability- Sustainable strategies-Barriers to sustainability-Industrial activity and environment-Industrialization and sustainable development- Industrial ecology-Cleaner Production (CP) in achieving sustainability-Prevention versus control of Industrial pollution – Environmental Policies and Legislation-Regulations to encourage pollution prevention-Cleaner Production- Regulatory versus market based approaches.	
Module-2 – Pollution Prevention	***9 Hour***
Definition-Importance-Historical Evolution-Benefits-Promotion-Barriers-Role Industry, Government and Institutions - Environmental management hierarchy - Source reduction techniques-Process and equipment optimization reuse, recovery, recycle, raw material substitution-Internet information and other CP Resources-Case study on recovery process in industries.	
Module-3 – Concept of Cleaner Production	***9 Hour***
Overview of CP assessment steps and skills, preparing for the site visit-Information gathering and process flow diagram, material balance-CP Option, technical and environmental feasibility analysis-Economic valuation of alternatives-total cost analysis-CP Financing-Establishing a program-Organizing a program-preparing a program plan-Measuring progress-pollution prevention and cleaner production-Awareness plan -Waste Audit-Environmental Statement.	
Module-4 – Life Cycle Assessment	***9 Hour***
Elements of LCA-Concepts in LCA- stages of life cycle assessment-Life cycle inventory methods – Life cycle impact assessment - Life Cycle Costing -Eco Labelling-Design for the Environment- International Environmental Standards-ISO 14001-Enironmental audit.	
Module-5 – Industrial Applications of Cleaner Production	***9 Hour***
Industrial application of cleaner production-Life cycle assessment-Environmental Management System-and Environmental Audits in selected major industries-Case studies.	

Learning Resources	1. *Paul L Bishop, "Pollution Prevention Fundamental and Practice", McGraw-Hill International, 2020* 2. *World Bank Group, "Pollution Prevention and Abatement Handbook-Towards Cleaner Production", World Bank and UNEP, Washington D.C, 2015.* 3. *Prasad modak, C. Visvanathan and Mandarparasnis "Cleaner Production Audit", Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok, 2015*	4. *S Chaltegger, S., Bennett, M., Burritt, R.L., Jasch, C.M. (Eds.), Environmental Management Accounting for Cleaner Production, Springer, 2018* 5. *Krishna B Misra, Clean Production: Environmental and Economic Perspectives, Springer- Verlag, 2016.* 6. *Rajiv K Sinha, Sunil Heart, Cleaner Production: Greening of Industries for Sustainable Development, Pointer Publishers, 2005*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Suyash Misra, Arcadis, Bangalore, suyash.misra@gmail.com*	1. *Dr. Harish Gupta, Osmania University, Hyderabad,* harishgupta78@gmail.com	1. *Dr. K. Prasanna, SRMIST*
2. *Dr. Rajkumar, Director, HECS, Chennai. rajkumar@hecs.in*	2. *Dr. E.S.M Suresh, Professor & Head, NITTTR, Chennai, esmsuresh@gmail.com*	2. *Dr. D. Justus Reymond, SRMIST*

Course Code	21CEE573T	Course Name	ENVIRONMENTAL MANAGEMENT SYSTEM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	***Civil Engineering***	**Data Book / Codes/Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*understand the significance of EMS*
CLR-2:	*understand ISO 14000 certification process*
CLR-3:	*understand Auditing process in EMS*
CLR-4:	*explain environmental ethics*
CLR-5:	*understand LCA and Explain ISO14040*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*identify the importance of Management System and the process*	*3*	*2*	*3*
CO-2:	*evaluate the necessity in applying ISO certification*	*3*	*2*	*3*
CO-3:	*apply the Environmental auditing process*	*3*	*2*	*2*
CO-4:	*examine the ethics followed in understanding environmental systems*	*3*	*2*	*2*
CO-5:	*evaluate the Life cycle of various processes*	*3*	*2*	*2*

Module-1-Introduction	***9 Hour***
Environmental management system - Principles, problems and strategies-Review of political, ecological and remedial actions-EMS global scenario-Evolution of environmental management standard- ISO 9000 and ISO 14000 series, origin, objective, scope and applicability of ISO 14000-Case Study- EMS in India.	
Module-2-ISO and ISO 14000 Series	***9 Hour***
Necessity of ISO certification-Introduction to ISO and ISO 14001-2004, 2015, ISO 9001-2015-EMAS regulations-Wider application of system-based approach-ISO 14001 requirements-Steps in ISO 14001 certification-ISO 14001 and sustainable development-Integration with other systems, ISO 9000, TQM, Six Sigma- Benefits of integration-Case study- Application of software.	
Module-3-ISO 14010: EMS Audit	***9 Hour***
Environmental management system audits as per ISO 19011- Definitions and concepts, Scope and Objectives, Types of audits,-Accounts audit-Environmental audit statement-Qualities of environment auditor; types and guidelines of environmental auditing process. Registration process for implementing ISO 14000; ISO 14024: Eco-labelling communication to the public; Case study- Application of software- Auditing.	
Module-4-Environmental Ethics	***9 Hour***
Ethics in society-Environmental Consequences-Responsibility for environmental degradation-Ethical theories and codes of Ethics-Changing attitudes. ISO 14031-Evaluating the organization environmental performance. ISO 14020: Guidelines, standards on environmental claims, declarations-Case study- Application of ISO14031 & 14020.	
Module-5-Life Cycle Assessment	***9 Hour***
ISO 14040: Guidelines standards for a company's management system-General principle of conducting life cycle assessment, definition, stages and scope of LCA and LCA inventory-Case Study on LCA	

Learning Resources	1. *"Environmental Auditing", Published by CPCB. New Dehli.* 2. *A.K. Mhaskar "Environmental Audit", , .Media Enviro Publications, 2002.* 3. *Khanna, P. Environmental Management, Dhaya Publishing house, 2013* 4. *Soyre. D.: Inside ISO 14000. Installing Environmental management Systems – a step by step guide. 2001*	5. *C. Sheldon and M. Yoxon, Environmental Management. Earthscan Publications Ltd, London, 1999* 6. *ISO 14001/14004, ISO 9001, ISO 19011: Environmental management standards, International Organisation for Standardisation. https://www.epa.gov/ems.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in.*	1. *Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	1. *Dr. P. Purushothaman, SRMIST*
2. *Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com*	2. *Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	2. *Dr. R. Sivakumar, SRMIST*

Course Code	21CEE574T	Course Name	INDUSTRIAL POLLUTION PREVENTION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*impart knowledge on the concept and application of Industrial pollution prevention.*
CLR-2:	*know about industrial wastewater treatment methods.*
CLR-3:	*understand types of air pollutants, impact of air pollution*
CLR-4:	*identify the best applicable waste reduction technologies for wastewater and air pollutants.*
CLR-5:	*know the manufacturing processes carried out in various industries.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*gain knowledge on principles of pollution prevention and mechanism of various processes.*	*3*	*2*	*3*
CO-2:	*understand the suitable methodologies for the treatment of wastewater based on industries.*	*3*	*2*	*3*
CO-3:	*characterize and analyze the air pollutants.*	*3*	*2*	*3*
CO-4:	*knowledge on waste reduction techniques.*	*3*	*2*	*3*
CO-5:	*knowledge on real time industrial applications of pollution prevention techniques.*	*3*	*2*	*3*

Module-1 – Introduction	***9 Hour***
Sources and types of industrial emissions- Nature and origin of pollutants - Industrial wastewater and environmental impacts – Environment legislation – Characterization of effluent streams – Oxygen demand and its determination- self-purification of running streams-characteristics of pollutants in fertilizer, thermal power plant, textile, electroplating, sugar mill, paper mill, petroleum and tannery industries.	
Module-2 – Treatment Methods	***9 Hour***
Screening, sedimentation, flotation- Neutralization, carbon absorption – ion exchange, reverse osmosis- filtration, chlorination -biological treatment-bacterial growth curve-aerobic processes-suspended and attached growth processes-lagoons, ponds, trickling filter, rotary drum filters	
Module-3 – Air Pollution and Control Methods	***9 Hour***
Air pollution sampling and measurement – types of pollutant – ambient air sampling- collection of gaseous air particulates – stack sampling -air pollution control methods and equipment – source collection method-raw material changes, process changes, equipment modification – control equipment; gravitational settling chambers, cyclone separators, ESP, absorption equipment. Case study on working of air pollution control equipment.	
Module-4 – Waste Reduction Techniques	***9 Hour***
Waste Minimization Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Implementing and promoting- Pollution prevention programs in industries- solids; recycling, bio conversion-source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining–Pharmaceuticals–Sugar and distilleries.	
Module-5 – Industrial studies on pollution prevention	***9 Hour***
Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, pulp and paper, sugar and alcohol industries, metal finishing industries.	

Learning Resources	*1. "Industrial wastewater management, treatment & disposal, Water Environment" Federation Alexandria Virginia, Third Edition, 2018.* *2. Lawrance K.Wang, Yung. Tse Hung, Howard H.Lo and Constantine Yapijakis, "handlook of Industrial and Hazardous waste Treatment", Second Edition, 2014.* *3. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw-Hill companies, 2017.* *4. Nelson Leonard Nemerow, "Industrial waste Treatment", Elsevier, 2017.*	*5. Wesley Eckenfelder W., "Industrial Water Pollution Control", Second Edition, Mc Graw Hill, 2019..* *6. Paul L. Bishop, „Pollution Prevention: - Fundamentals and Practice", Mc-Graw Hill International, Boston, 2020.* *7. Waste water Treatment for pollution control and reuse by soil J.Arceivala, Shyam.R.Asolekar, Tata Mcgraw Hill, 2017.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Mr. Suyash Misra, Arcadis, Bangalore, suyash.misra@gmail.com*	1. *Dr. Harish Gupta, Osmania University, Hyderabad, harishgupta78@gmail.com*	1. *Dr. K. Prasanna, SRM IST*
2. *Dr. Rajkumar, Director, HECS, Chennai. rajkumar@hecs.in*	2. *Dr. E.S.M Suresh, Professor & Head, NITTTR, Chennai, esmsuresh@gmail.com*	2. *Dr. P. Purushothaman, SRM IST*

Course Code	21CEE575T	Course Name	REMOTE SENSING AND GIS APPLICATION IN ENVIRONMENTAL ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*conversant with basic of remote sensing and its principles*
CLR-2:	*posses knowledge in various types of remote sensing platforms and sensors and their applications*
CLR-3:	*posses knowledge on satellite image processing and data acquisition*
CLR-4:	*understanding GIS and its applications*
CLR-5:	*various applications of Remote sensing and GIS in environmental related problems*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*describe basics of remote sensing and application of EMR spectrum in RS studies*	*3*	*2*	*2*
CO-2:	*apply knowledge on various sensor and their usage for environmental problems*	*3*	*2*	*2*
CO-3:	*extract and interpret satellite data using image processing techniques*	*3*	*2*	*2*
CO-4:	*apply GIS techniques in extracting and processing RS data*	*3*	*2*	*2*
CO-5:	*analyse various environmental problems using RS and GIS technique*	*3*	*2*	*2*

Module-1-Introduction to Remote Sensing	***9 Hour***
Definition, Physics of Remote Sensing, Remote Sensing observations and platforms-Electromagnetic Radiation and its interactions with atmosphere-Spectral reflectance of earth features, -Resolution- Spectral, Spatial, Temporal and Radiometric-Remote Sensing types, optical-Thermal-Microwave and Hyperspectral-Case studies.	
Module-2-Sensors In Remote Sensing	***9 Hour***
Remote sensing Platforms; Various satellites in orbit; Resolution; Imaging Sensors- Optical Infrared (OIR) Imagers- Optical Sensors- Thermal Sensors- Microwave Sensors- Active Microwave Sensors.	
Module-3-Visual and Digital Image Processing	***9 Hour***
Remote sensing Data analysis; Digital and Visual Image Interpretation- Basics, Types, Elements, Techniques; Introduction to Digital Image Processing- Image Rectification and Registration- Geometric Correction- Image Enhancement Techniques; Image Classification - Unsupervised and Supervised; Data Merging and Fusion; Case studies on image processing and its application	
Module-4-Geographical Information System	***9 Hour***
Introduction, Components of GIS; GIS data types, Data acquisition, Data Input and Data Processing; Maps- Types, Preparation of thematic maps, map projection-Coordinate system -GIS components-Hardware, software, and management including topology DEM/ DTM generation-Spatial Analysis- Techniques and applications.	
Module-5-Remote Sensing and GIS for Environmental Applications	***9 Hour***
Remote sensing techniques for Air quality monitoring; water quality monitoring, geological-Forestry, Bio-diversity, Environment, Soil resource management, Disaster studies, public utilities, water distribution, sewerage, solid waste management- Case studies on applications of Remote Sensing and GIS in various environmental components.	

Learning Resources	*1. Lilliesand, T.M. and Kiefer, R, W., "Remote Sensing and Image Interpretation", John Wily and sons, 2014.* *2. Burrough, P.A. and, McDonnell, R.A., "Principles of Geographical Information Systems", Oxford University Press, 2019.* *3. Lintz, J. and Simonet, "Remote Sensing of Environment", Addison Wesley Publishing Company, 2014.* *4. E.C. Barrett & L.F Curtis "Introduction to Environmental Remote Sensing" , Chapman and Hall, London, Springer; 3rd edition 2021*	*5. John A. Jensen , "Remote sensing of the environment an earth resource perspective" Pearson new international edition 2014* *6. QihaoWeng "Advances in Environmental Remote sensing Sensonrs, Algorithms and applications" Taylor and Francis series, CRC press, 2011* *7. NPTEL courses: NOC: Remote sensing and GIS* *8. NPTEL courses: NOC: Digital image processing of remote sensing data* *9.NPTEL courses: NOC: Environmental quality monitoring & analysis*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 3	*Apply*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 4	*Analyze*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 5	*Evaluate*	*10%*	*-*	*10%*	*-*	*10%*	*-*
Level 6	*Create*	*10%*	*-*	*10%*	*-*	*10%*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in.	*1. Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	*1. Dr. R. Sivakumar, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	*2. Dr. P. Purushothaman, SRMIST*

Course Code	21CEE576T	Course Name	RESEARCH METHODS IN CIVIL ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	***Civil Engineering***	Data Book / Codes/Standards		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*describe the research problem using a proper methodology and ethics*
CLR-2:	*understand the significance of sampling in designing a research problem*
CLR-3:	*identify the suitable processing and statistical method for data analysis*
CLR-4:	*prepare a research report and publications*
CLR-5:	*understand the significance of intellectual property rights*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*apply research methodology in formulating the research problem in civil engineering*	*3*	*3*	*3*
CO-2:	*identify suitable sampling technique for a research problem in civil engineering*	*3*	*3*	*3*
CO-3:	*apply and extract the information using statistical tools and relevant methods*	*3*	*3*	*3*
CO-4:	*describe the research problem and its output through research report and publications in civil engineering*	*3*	*3*	*3*
CO-5:	*apply IPR knowledge in patenting the research work in civil engineering*	*3*	*2*	*3*

Module-1- Introduction and Opportunities	***9 Hour***
Fields of research in Civil Engineering-Domain aspects of Structural Engineering-Construction Management-Environmental Engineering-Water Resources-Geotechnical-Transportation-Remote sensing-publics sectors-private sectors – research and development in industries- Institution and industry collaboration activities in India-Opportunities-Justification Criteria Characteristics of a good research-Errors in selecting a research problem-Techniques involved in defining a problem.	
Module-2-Research Design	***9 Hour***
Need for research design-Basic principles of experimental designs-Sampling design followed in Civil Engineering-Types of sampling design-Sampling Fundamentals-Sample size Determination, Random sampling; Case studies on various specialization of Civil Engineering	
Module-3-Data Collection and Analysis	***9 Hour***
Collection of Primary, Secondary and Tertiary Data-Selection of appropriate method with respect to specialization in Civil Engineering-Data Processing Operations, Elements of Analysis-Statistics in Civil Engineering Research, Tests for Hypotheses I and II, Important Parameters-Case studies on application of statistical software- Application of statistical analysis.	
Module-4-Report Preparation	***9 Hour***
Effective literature studies approach-Plagiarism Check-Effective technical writing, report writing-Research paper- Indexing, developing a research proposal- Format of research proposal-Case studies on various specialization of Civil Engineering-Submission-reviews-Overcome the issues.	
Module-5-Intellectual Property Rights	***9 Hour***
Patents-Designs-Trade and Copyright- Materials used in the field of concrete, road work, soil stabilization-Adsorbents used in the field of wastewater treatment-Novelty of the materials-Process of Patenting and Development: technological research, innovation, patenting, development; International and national Scenario: International cooperation on Intellectual Property-Patent Rights-Licensing and transfer of technology-Geographical Indications-Procedure for grants of patents-New Developments in IPR-Case studies and examples from various specialization of Civil Engineering	

Learning Resources	1. *Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students, 2017* 2. *Ranjit Kumar, , "Research Methodology: A Step by Step Guide for beginners" 2nd Edition, SAGE publications, 2016*	3. *Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2017.* 4. *Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age",2016.* 5. *T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2018*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in.*	1. *Dr. S. Madhava Kumar, IIT Madras, mathav@iitm.ac.in*	1. *Dr. R. Sivakumar, SRMIST*
2. *Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com*	2. *Dr. G. Dhinagaran, Anna University, Chennai, dhinagaran@annauniv.edu*	2. *Dr. P. Purushothaman, SRMIST*

Course Code	21CEE577T	Course Name	BIOREMEDIATION-PRINCIPLES AND APPLICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study the practical applications of bioremediation.*
CLR-2:	*study the microorganisms and plants, to detoxify and restore contaminated environments.*
CLR-3:	*realize insights to the contaminant types and degradation pathways*
CLR-4:	*initiate the students to tackle environmental challenges through sustainable and innovative methods.*
CLR-5:	*analyzing real-world bioremediation projects to understand practical challenges and solutions.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*study the biological and environmental engineering for application in biological systems*	*2*	*2*	*2*
CO-2:	*develop the skills in basic and applied fields of microbial and environmental principles*	*2*	*2*	*2*
CO-3:	*ability to contribute towards the advancement of biotechnology in the fields of research and management*	*3*	*2*	*3*
CO-4:	*identify different types of environmental contaminants and understand their chemical properties and degradation pathways.*	*2*	*2*	*3*
CO-5:	*understand the concepts of sustainable bioremediation process.*	*2*	*2*	*3*

Module-1 - Introduction to Bioremediation	***11 Hour***
Process of bioremediation-Historical development of environmental bioremediation-Requirements for bioremediation-Constraints and priorities of bioremediation-Applications of bioremediation technologies- Xenobiotic compounds, their structure and persistence in environment, Oil spills, Oil products in environment-Biodegradation- principles and microbiology- Micro conversions of xenobiotics	
Module-2 - Bioremediation of Wastewater	***11Hour***
Biotransformation of pesticides and hydrocarbons-Biodegradation Kinetics-Bioavailability-Biomineralization-Testing for biodegradability-Numerical modelling of biodegradation-Biological processing of wastewater-Bioreactors, designs used for treatment of sludge and removal of metals from waste water-Biodegradable plastic- Biodegradation of PAH in environment.	
Module-3 – Bioremediation and its Techniques	***11 Hour***
Bioremediation strategies, bio stimulation and bioaugmentation-Bioremediation techniques in-situ and ex-situ-Bioremediation of organic and metal contaminated environments-Metal toxicity and bioavailability. Biosorption and precipitation-Bioremediation technologies for heavy metal and radionuclides removal-Phytoremediation and its processes, role of photoheating-Applications of genetic engineering in phytoremediation-Algal and fungal based bioremediation.	
Module-4- Bioremediation- Treatment and its Methods	***12 Hour***
Gaseous bioremediation, biofilms, bio scrubbers, bioventing-Soil Vapor Extraction (SVE)-Water recirculation systems-Air sparging-Bio barriers, composting, phytoremediation for air technologies-Role of biosensors in bioremediation technologies-Biofilms and their applications.	

Learning Resources	1. *Chaudhury, G.R. "Biological degradation and Bioremediation of toxic chemicals", Dioscorides Press, Oregon, 2014.* 2. *Martin. A.M, "Biological degradation of wastes", Elsevier Applied Science, London, 2021*	3. *Bioremediation and Natural Attenuation: Process Fundamentals and Mathematical Models" by Pedro J. Alvarez and Walter A. Illman.* 4. *Handbook of Environmental Engineering: Volume 8: Bioremediation and Sustainability: Research and Applications" edited by S.N. Singh, R.D. Tripathi, and O.P. Ward. "*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in*	*1. Dr. E. S. M Suresh, NITTT Taramani, Chennai esmsuresh@gmail.com*	*1. Dr. S. Dhanasekar, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. K. Prasanna, SRMIST*

Course Code	21CEE578T	Course Name	ENVIRONMENTAL CHANGE AND SUSTAINABLE DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*study the importance of environment, ecosystem and sustainability*
CLR-2:	*know the current issues related to environment*
CLR-3:	*realize the measurement tool for impacts on environment*
CLR-4:	*explore the concepts about sustainability in material resources*
CLR-5:	*understand the sustainable strategies and policies*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*apply the acquired knowledge on values of environment, ecosystem and sustainability theory.*	2	2	3
CO-2:	*understand the various environmental issues and current treatment/ disposal methods.*	2	2	3
CO-3:	*learn the impacts caused by humans on environment and their measurement tools*	2	2	3
CO-4:	*know the changes in material resources and sustainable traps*	2	2	2
CO-5:	*explore the sustainable strategies and policies for practical applications*	2	2	3

Module-1 - Challenges in Sustainability and Development	***9 Hour***
Definition of sustainability – Environmental, Economic and Social dimensions of sustainability - Sustainable development models – Strong and weak sustainability – Defining development- Millennium development goals – Mindsets for sustainability-Global, Regional and local environmental issues – Social insecurity - Resource degradation – Core problems and cross- cutting issues of the 21st century – Strategies to end rural and urban poverty and hunger.	
Module-2 - Environmental Concerns – Present and Future	***9 Hour***
Climate Change – Air Issues (Ozone depletion, smog, other air pollutants) – Water issues (Eutrophication, water quality/access, Pollution) – Land use changes – Waste (quantity generated, Treatment/ disposal methods, E-waste – Human health – Diversity of life on the plant (population stresses and ecology, Failure at large scale.	
Module-3 - Assessing Progress and Future Development	***9 Hour***
Sustainability in global, regional and national context - Change in materials used (history) & critical materials - Energy and fossil fuel consumption -Buildings - Food systems - Transportation - Businesses and service organizations - ISO and other standards - Systems engineering – material flow analysis; lean/6S (certification potential) - Environmental Product Declarations - Carbon Foot printing - Life Cycle Assessment using software– certification potential handprints - Trade-offs in Impacts and Decision-Making from Data.	
Module-4 - Cross – Discipline Considerations	***9 Hour***
Issues in developing countries, sanitation and public health, changes in material resources without corresponding changes in treatment options - Ethical issues, links between environmental emissions and poverty - Sustainability traps, failed policies to address consumption in one-child, forced sterilization and other social issues.	
Module-5 -Sustainable Socio-Economic Systems	***9 Hour***

Corporate / Organizational responsibility on sustainability strategy development, management tools, sustainable/ethical investment accounts, silos and open access-Product development and design - Policies for sustainability COP commitments, UK and other national directives, US approaches to sustainability policies - Sustainability in Individual Lives in behavioral changes, activism and group networking- Future of the planet - Careers in sustainability.

Learning Resources	1. *F. Douglas Muschett, Principles of Sustainable Development, CRC Press, 2019* 2. *Bhavik R. Bakshi, Sustainable Engineering Principles and Practice, Cambridge University Press, 2019.*	3. *Catherine Mulligan, Sustainable Engineering: Principles and Implementation, CRC Press, 2019* 4. *Kauffman, Joanne, LEE, Kun Mo, Handbook of Sustainable Engineering, Springer 2013.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	-
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	-
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	-
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	-
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	*1. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com.*	*1. Dr. D. Justus Reymond, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com.	*2. Dr. G. Dhinagaran, Assistant Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. C. Vinu Prakash, SRMIST*

Course Code	21CEE579T	Course Name	ENVIRONMENTAL BIOTECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*develop the fundamental concepts and applications of biotechnology*
CLR-2:	*apply the concept bioremediation and biodegradation principles, processes*
CLR-3:	*design the bioreactors and its factors involving the remediation processes.*
CLR-4:	*analyze the concept of microbial population for pollutant removal mechanism*
CLR-5:	*detection and diagnostics of biotechnological methods.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*study the biological and environmental engineering for application in biological systems*	*2*	*2*	*2*
CO-2:	*develop the skills in basic and applied fields of biotechnology leading to professionalism and leadership*	*2*	*2*	*2*
CO-3:	*ability to contribute towards the advancement of biotechnology in the fields of research and management*	*3*	*2*	*3*
CO-4:	*identify the materials of construction and control and monitor the process*	*2*	*2*	*2*
CO-5:	*understand the concepts of sustainable bioremediation process.*	*2*	*2*	*3*

Module-1 - Concept of Environmental Biotechnology	***9 Hour***
Environmental biotechnology and sustainability-Scope and applications of the bioprocess- Basics of ecosystem structure and function-Principles, and concepts of environmental biotechnology, usefulness to mankind, current status.	
Module-2 - Toxic Pollutants	***9 Hour***
Degradation of high concentrated toxic pollutants, halogenated, nonhalogenated, petroleum hydrocarbons, metals-Mechanisms of detoxification oxidation, dehalogenation, biotransformation of metals, biodegradation of solid wastes.	
Module-3 - Remedial Measures	***9 Hour***
Biotechnological remedies for environmental pollution - decontamination of groundwater systems, subsurface environment - reclamation concepts bioremediation. Production of proteins - biofertilizers. Physical, chemical and microbiological factors of composting - health risk - pathogens- odor management.	
Module-4- Concept of DNA Technology	***9 Hour***
Biomarkers- biochemical indicators, immunochemistry, genetic indicators-Toxicity testing using biological material-Concept of DNA technology - expression vectors - cloning of DNA - mutation - construction of microbial strain, recombinant DNA technology and proteomics, radioactive probes, protoplast fusion technology - applications.	
Module-5 – Biotechnological Methods to Control Pollution	***9 Hour***
Biofilters, Bioremediation, Biotransformation and Biodegradation-In situ and Ex situ bioremediation-Evaluating Bioremediation-Bioremediation of VOCs-Factors affecting process of biodegradation; methods in determining biodegradability-Contaminant availability for biodegradation-Use of microbes (bacteria and fungi) and plants in biodegradation and biotransformation-Phytoremediation -waste water treatment using aquatic plants and microalgal treatment.	

Learning Resources	1. *Chaudhury, G.R. "Biological degradation and Bioremediation of toxic chemicals", Dioscorides Press, Oregon, 2014.* 2. *Martin. A.M, "Biological degradation of wastes", Elsevier Applied Science, London, 2021*	3. *Environmental Biotechnology, Principles and Applications by Bruce E Rittman and Perry L McCarty, McGrawhill Higher education..* 4. *Environmental Biotechnology Edited by Hans-Joachim Jördening and J Winter, WILEY-VCH Verlag Gmbh & Co. "*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	-	*20%*	-	*20%*	
Level 2	*Understand*	*20%*	-	*20%*	-	*20%*	
Level 3	*Apply*	*20%*	-	*20%*	-	*20%*	
Level 4	*Analyze*	*20%*	-	*20%*	-	*20%*	
Level 5	*Evaluate*	*10%*	-	*10%*	-	*10%*	-
Level 6	*Create*	*10%*	-	*10%*	-	*10%*	-
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. *Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in*	*1. Dr. E. S. M Suresh, NITTT Taramani, Chennai esmsuresh@gmail.com*	*1. Dr. S. Dhanasekar, SRMIST*
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	*2. Dr. G. Dhinagaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com*	*2. Dr. K. Prasanna, SRMIST*

Course Code	21CEE580T	Course Name	WATERSHED MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	*Nil*	Co- requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Civil Engineering*	**Data Book / Codes / Standards**		*Nil*	

Course Learning Rationale (CLR):	***The purpose of learning this course is to:***
CLR-1:	*enhance awareness on the connection between watershed management, hydrological equations and water budget.*
CLR-2:	*describe the concepts of soil erosion, estimating quantity and control measures.*
CLR-3:	*demonstrate different water harvesting structures.*
CLR-4:	*understand the impacts and feedbacks of land management practices on water bodies.*
CLR-5:	*brief understanding about the role of ecosystem in watershed management.*

Course Outcomes (CO):	***At the end of this course, learners will be able to:***	***Programme Outcomes (PO)***		
		1	***2***	***3***
CO-1:	*understand the concepts of hydrology, including the water budget, water flow and stream flow analysis.*	*2*	*2*	*3*
CO-2:	*attain knowledge on soil erosion and erosion control measures.*	*2*	*2*	*3*
CO-3:	*gain knowledge on the methods of water harvesting and various structures.*	*2*	*2*	*3*
CO-4:	*understand the land use management, agriculture and forest management.*	*2*	*2*	*3*
CO-5:	*knowledge about role of ecosystem and watershed management.*	*2*	*2*	*3*

Module-1 – Introduction	***9 Hour***
Concept of watershed development- Objectives of watershed development- Need for watershed development in India- Integrated and multi-disciplinary approach for watershed management – Characteristics of watershed, size, shape, physiography, slope, climate, drainage, land use, vegetation - geology and soils - hydrology and hydrogeology - socioeconomic characteristics - basic data on watersheds.	
Module-2 – Erosion and its Control	***9 Hour***
Types of erosion - factors affecting erosion - effects of erosion on land fertility and land capability - estimation of soil loss due to erosion - Universal soil loss equation - Measures to control erosion: Contour techniques, ploughing - furrowing, trenching, bunding, terracing, gully control, rock fill dams, brushwood dam, Gabion.	
Module-3 – Water Harvesting	***9 Hour***
Rainwater Harvesting- surface runoff- groundwater recharge - system setup, components-methods of harvesting- statistics and benefits - catchment harvesting - catchment area - watershed harvesting - harvesting structures - soil moisture conservation - check dams - artificial recharge- methods- farm ponds - percolation tanks-Case study on rainwater harvesting system in institutions, industries.	
Module-4 – Land Management	***9 Hour***
Land use, land cover and land capability classification-Contour bunding and trenching-Land planning and management – Land use change and causes- Management of forest, forestry - agricultural, nutrient pollution - aquatic ecology- grassland and wild land - Reclamation of saline and alkaline soils – sustainable land management.	
Module-5 – Ecosystem and Watershed Management	***9 Hour***
Role of Ecosystem, crop husbandry - Soil enrichment, inter, mixed and strip cropping - cropping pattern- sustainable agriculture - Bio-mass management, dry land agriculture - Horticulture, social forestry and afforestation. Watershed management, planning of activities, people's participation - Preparation of action plan, administrative requirements.	

Learning Resources	*1. J. V. S. Murty, "Watershed Management", 2ndEdition, New Age International Publishers, 2013.* *2. R.A. Wurbs and WP James, "Water Resource Engineering", 3rdEdition Prentice Hall of India, 2002* *3. V.V.N. Murthy and Madan K Jha. "Land and Water Management", 6thEdition, Kalyani Publishers, 2015.* *4. D.K. Majumdar, "Irrigation Water Management", 3rdEdition, Prentice Hall of India, 200\14*	*5. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.* *6. Hydrology and Soil Conservation Engineering: Including Watershed Management. Ghanshyam Das, 2008. Prentice-Hall of India Learning Pvt. Ltd., New Delhi.*

Learning Assessment

	Bloom's Level of Thinking	*Continuous Learning Assessment (CLA)*				*Summative Final Examination (40% weightage)*	
		Formative CLA-1 Average of unit test (50%)		*Life-Long Learning CLA-2 (10%)*			
		Theory	*Practice*	*Theory*	*Practice*	*Theory*	*Practice*
Level 1	*Remember*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 2	*Understand*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 3	*Apply*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 4	*Analyze*	*20%*	*-*	*20%*	*-*	*20%*	*-*
Level 5	*Evaluate*	*10%*	*-*	*10%*	*-*	*10%*	*-*
Level 6	*Create*	*10%*	*-*	*10%*	*-*	*10%*	*-*
	Total	*100 %*		*100 %*		*100 %*	

Course Designers

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