Walchand College of Engineering

Vishrambag, SANGLI-416415

(Government Aided Autonomous Institute)

Syllabus

M. Tech. Civil (Environmental Engineering)

With Effect From

Academic Year

2022-23 (F. Y. M. Tech.)

2023-24 (S. Y. M. Tech.)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV501
Course Name	Research Methodology
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 2			

Course Objectives

1	To prepare students to undertake research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2	To enable students to investigate the problem, interpret the results, propose theories, suggest possible/alternative solutions, solve and prove the solution adapted–logically and analytically, conclude the research findings.
3	To impart knowledge to review the literature and publish research in conference and journals.
4	To expose students to research ethics, IPR and patents.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Analyze*** research and its significance in economic, social and legal aspects.	Analyze
CO2	***Evaluate*** research problem and its design for solution logically and critically.	Evaluate
CO3	***Produce*** research solution, publication, Dissertation, IPR and patent.	Create

Module	**Module Contents**	**Hours**
I	**Engineering Research Process** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	5
II	**Research Methodology Tools** Problem statement formulation, resources identification for solution, Experimental and Analytical modelling, Numerical and Statistical methods in engineering research, Software tools like spread sheets.	5
III	**Research Ethics** Effective literature studies approaches, critical analysis, Plagiarism, Research ethics,	3
IV	**Report Writing** Effective technical writing, how to write report, Research Paper. Presentation of paper/report/seminar.	3
V	**Intellectual Property Rights (IPR)** Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. New developments	5

	in IPR; IPR of Biological Systems, Traditional knowledge Case Studies	
VI	**Patents** Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Administration of Patent System.	5

Textbooks	
1	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", 2nd Ed.-2004, Juta and Company Ltd.
2	Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 4th Ed.-2014, SAGE Publications.
3	Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science & Engineering Students", 2000 , Juta and Company Ltd.
4	C. R. Kothari and Gaurav Garg, "Research Methodology: Methods and Techniques," 4th Edition, 2019, New Age International Publishers.
References	
1	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2	Mayall, "Industrial Design", McGraw Hill, 1992.
3	Niebel, "Product Design", McGraw Hill, 1974.
4	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3				1	
CO2	3			2		
CO3	3	3		2		

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV502
Course Name	Physico-Chemical Methods for Water and Wastewater Treatment
Desired Requisites:	Water and Wastewater Treatment

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide in-depth knowledge of unit operations and processes for the treatment of water and wastewater.
2	To impart technical competency for analysis, evaluation and design of physical and chemical treatment systems for water and wastewater.
3	To inculcate aptitude for research, and consultancy.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** and **apply** the concepts of unit operations and processes for physical and chemical treatment of water and wastewater.	Understanding Applying
CO2	***Analyze*** and ***evaluate*** the physical and chemical treatment systems used in water and wastewater.	Analyzing Evaluating
CO3	***Design*** physical and chemical treatment systems for water and wastewater.	Creating

Module	**Module Contents**	**Hours**
I	**Transport phenomena and Reaction kinetics** Review of conventional unit operations and processes in water and wastewater treatment, Transport processes, Kinetics and Reaction rates, System material balance, Hydraulic transport flow regimes, Reactor Engineering (CMBR, CMFR, CMFRS, PFR, PFRD), Processes and rates of gas transfer	7
II	**Aeration, mixing and Settling** Types of aerator, Design of gravity aerators Coagulation and flocculation, Stability and destabilization of colloids, Transport of colloidal particles, Design of rapid and slow mix units Types of settling, Design of sedimentation tanks, Tube settler, Grit chamber (horizontal flow and aerated)	8
III	**Filtration** Gravity and pressure filtration, filter hydraulics, Analysis of filtration process, Backwash hydraulics, Rate control patterns and methods, Design of dual media and pressure filter	5
IV	**Adsorption and Ion exchange** Causes and Types of adsorption, Adsorption equilibria and adsorption isotherm, Process, Analysis and design of batch and continuous flow activated carbon adsorber Ion Exchange process, Exchange materials and capacity, Exchange reactions, Design and operation of softener for hardness and TDS removal	8

V	**Membrane filtration** Membrane separation processes, Design and operation of Reverse osmosis, Ultrafiltration, and Electrodialysis. Membrane fouling: Causes, and Control.	7
VI	**Disinfection** Kinetics of disinfection Ozone disinfection: Chemistry, System components, Modeling. UV disinfection: Source, System components, Estimation of UV dose. Principles and theories of Chemical oxidation.	5

Textbooks	
1	Peavy H, S, Rowe D, R, and Tchobanoglous G, *"Environmental Engineering",* McGraw-Hill Book Company, Indian edition 2017.
2	Metcalf and Eddy *"Wastewater Engineering Treatment and Reuse",* Tata McGraw Hill Publication, Indian Edition 2017.
3	Davis, M, L, and Cornwell, D, A, *"Introduction to Environmental Engineering",* Tata McGraw Hill Publishing Company, Special Indian Edition, 2010.
4	Unit Operations and Processes in Environmental Engineering, 2nd Edition, by Tom D. Reynolds and Paul A. Richards, PWS Publishing Company, 1995.

References	
1	Droste, Ronald L *"Theory and Practice of Water and Wastewater Treatment",* Wiley student Edition, 2009.
2	Weber W, J, "*Physico-Chemical Processes of Water quality control",* Wiley-Interscience, 1994.
3	Sincero A, P and Sincero G, A, *"Environmental Engineering A Design approach",* PHI learning private limited, 2004.
4	Quasim, S. R., Motley E, M, and Zhu G, *"Water works engineering",* PHI learning private limited, 2000.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3						3

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV503
Course Name	Municipal Solid Waste Management
Desired Requisites	A graduate level course in Environmental Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	Provide knowledge on functional elements of MSWM.
2	Impart basic skills for design and operation of MSWM systems.
3	Have overview of MSW rules and Government initiatives.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Recognize*** fundamental elements of MSW and ***summarize*** practices for effective MSW management.	Remember Understand
CO2	***Apply*** the fundamental elements of MSWM to ***analyze*** collection, transportation, and processing of MSW.	Apply Analyze
CO3	***Evaluate*** processing and disposal system; and to ***devise*** suitable plans for rehabilitation of existing MSWM	Evaluate

Module	**Module Contents**	**Hours**
I	**Municipal Solid Waste Sources and Characterization** Sources, Types, Composition, Physical, Chemical and Biological properties. Solid Waste Management: Objectives, Functional elements, Environmental impact of mismanagement, Present scenario of municipal solid waste management in India	7
II	**Solid Waste Generation Rate & Transfer Station** Solid Waste Generation Rate: Definition, Typical values for Indian cities, Factors affecting. Storage and collection: General considerations for waste storage at source, Collection components, Types of collection systems and its design, Transportation of solid waste: Means and methods, Routing of vehicles. Transfer station: Need, Types, factors affecting Capacity, Location and economic Viability.	6
III	**Waste Processing Techniques & Material Recovery and Recycling** Waste Processing Techniques: Purpose, Mechanical volume and size reduction, component separation techniques. Material Recovery and Recycling: Objectives, Recycling program elements, Commonly recycled materials and processes. Energy recovery from solid waste: Parameters affecting, Fundamentals of thermal processing, Pyrolysis, Incineration, Refuse derived fuels, Energy recovery, case studies under Indian conditions.	7
IV	**Recovery of Biological Conversion Products: Compost and Biogas**	6

	Composting: Benefits, Processes, Stages, Technologies, Factors affecting properties of compost. Vermicomposting, Mechanical composting, In-vessel composting and Bio-methanation.	
V	**Landfills** Dumpsites: Problems associated with dumpsites, Management, Dumpsite rehabilitation, Bio-mining of dumpsites. Sanitary Landfills: Site selection, Types, Principle, Processes, Land filling methods, Design of a landfill facility, Landfill Liners, Leachate and landfill gas management, closure, post-closure plans.	7
VI	**Overview of Municipal Solid Waste Rules and Government Initiatives** Waste Management legislation in India, MSWM Rules 2016, Role of CPCB and SPCB in management of solid waste. Biomedical and Construction and Demolition Waste Management: Generation, Sources, Classification, Management technologies, Legislation.	7

Textbooks	
1	Bhide. A. D. and Sundaresan. B. B., "Solid Waste Management", Indian National Scientific Documentation Centre, 1st Edition, 1983.
2	CPHEEO, "Manual on Municipal Solid waste management", Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000
3	Tchobanoglous G., "Integrated Solid Waste Management", Tata McGraw-Hill Publishing Company Limited, 1st Edition, 1993.
References	
1	Vesilind, Worrell and Reinhart, "Solid Waste Engineering", Cengage Learning India Pvt. Ltd.,
2	Masters G., "Introduction to Environmental Engineering and Science", Pearson Education, 2004
3	Peavy, Rowe and Tchobanoglous, "Environmental Engineering", Tata McGraw-Hill Publishing Company Limited, 1st Edition, 1985.
4	"MSW Rules 2016", Swachh Bharat Mission and Smart Cities Program of India.

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		3
CO3				3		

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV504
Course Name	Hydraulics of Transport Systems in Environmental Engineering
Desired Requisites:	Basic courses on hydraulics, water supply and sewerage

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	Provide in-depth knowledge of hydraulics for analysis and evaluation of transport systems in Environmental Engineering
2	Enhance the technical competency and apply the acquired knowledge for research and development, industry, and consultancy activities.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** and ***apply*** hydraulics of environmental facilities	Understand Apply
CO2	***Analyze*** the distribution and collection systems	Analyze
CO3	***Design*** the distribution, collection and treatment facilities in environmental systems	Create

Module	**Module Contents**	**Hours**
I	**Pumped and Gravity Water Mains and Service Reservoirs** *Review of closed conduit hydraulics:* Continuity and Energy equation, Head loss calculations. *Sizing water mains:* Classification of problems, Design flow, Design of pumped and gravity system of water mains, Concept of Optimal design, Economic design of pumped and gravity water mains. *Pumping system:* Design of water pumping system. *Hydraulic design of Service Reservoirs:* Necessity, Components, Location, Capacity requirements	6
II	**Water Distribution System (WDS)** *Water Distribution System (WDS):* Types of network, Water demand allocation, Types of problem, Network hydraulics, Types of simulation, Flow, node and loop equations *Analysis and Design of WDS:* Hardy-Cross method, Linear theory, and Newton-Raphson methods, *WDS testing:* Fundamentals, Pressure and flow measurement. *Calibration:* Concept, Parameters, Approaches. *Pipe breaks and water loss:* Causes, Leak detection, Loss of carrying capacity of pipes, Appurtenances in WDS	10
III	**Sanitary Sewerage System** *Review of sewer hydraulics:* Velocity of flow, Hydraulic formulae, Gradient, types of sewer.	6

	Design of sanitary sewerage system: Estimation of design flow, Design considerations, Procedure, Design of sanitary sewer system.	
IV	**Storm water Drainage System** Need and design objectives of storm water conveyance system, System components and design process, Peak flow estimation by rational and SCS method, Hydraulic analysis of roadway gutter and inlets, Design of storm sewer system.	6
V	**Plumbing System** Terminology, Principles of water supply and drainage system in buildings, Design of water supply and drainage system in multi-storeyed building.	6
VI	**Rainwater harvesting** Need and concept of rainwater harvesting, Systems of rainwater harvesting, Roof top harvesting of rainwater, Components, Estimation of water collection potential, Design considerations, Design of a roof top harvesting system.	6

Textbooks	
1	Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.
2	Hammer M, J and Hammer M, J, "Water and Wastewater Technology", PHI learning private limited, 6th Edition, 2008.
3	Walski, Chase and Savic, "Water Distribution Modeling", Haestad Press, First edition, 2007.

References	
1	"Manual on Water Supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.
2	"Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2013.
3	"Manual on Storm Water Drainage Systems", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2019.
4	Haestad-Durrans, "Storm water conveyance modeling and design", Haestad Press, 1st edition, 2003.

Useful Links	
1	https://www.youtube.com/channel/UCbFIgNot42PRCi-05X8aF_A

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2			
CO2				3		
CO3				2		3

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV511
Course Name	Professional Elective 1: Water Quality Modeling
Desired Requisites:	Basics of hydraulics and water quality

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	Impart in-depth knowledge of modelling /simulation of water quality in surface, and sub-surface sources.
2	Enhance technical competency to deal with water quality issues in real life cases through modeling.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** and ***apply*** concepts of simulation/modeling for pollutant transport in surface and sub-surface sources of water.	Understand Apply
CO2	***Analyze*** the processes contributing to water quality variations.	Analyze
CO3	***Apply*** the knowledge of water quality for rejuvenation of lakes and streams	Apply

Module	**Module Contents**	**Hours**
I	**Fundamentals of Water Quality Modeling** Fundamentals: Concept of modeling, Model development, Types of models, Model sensitivity, Assessment of model performance, Movement of the contaminants in the environment Water quality in distribution system, Causes of variation, transport of constituents in pipe, chemical reactions, water quality simulations for source trace and water age.	6
II	**Streams/Rivers and Estuaries** Streams/Rivers and Estuaries: Dispersion and Mixing of pollutants, Estuary transport, Point and non-point/distributed sources of pollution, Application plug and mixed flow reactors (MFR) to streams with point and distributed sources, Spill models for plug and mixed flow system, Application of MFR model to estuaries.	6
III	**Process of Water Quality Modeling** Water quality modeling process, Modeling of organic pollution of stream, Streeter-Phelps equation for point, multiple point and distributed sources, Calibration, Modified/Total Streeter-Phelps equation, Anaerobic condition, Estuary Streeter-Phelps equation.	8
IV	**Groundwater Pollution and Control** Sources of groundwater pollution, Groundwater movement, Cone of Depression, Capture zone curve, Immiscible compounds, Processes in solute migration through porous media, Solute transport equation, Chemical reaction during transport, Sorption and retardation, Dupuit - Forchheimer theory of free surface flow, Control measures for contaminant plume, Hydrodynamic, physical, conventional pump and	8

	treat system, Soil vapour extraction with and without air sparging, In-situ bioremediation.	
V	**Lakes** Eutrophication problem in lakes and flowing water, Role of Carbon, Nitrogen and phosphorous, Phosphorus loading concept, Thermal stratification, Stratification and dissolved oxygen, Hydraulic behaviour of lakes, Effects of physical processes on water quality.	7
VI	**Rejuvenation of Lakes and Streams** Water Balance Study, Control of pollution in lakes, Methods of weed control, Bathymetry studies, Lake water quality monitoring. Methods of stream rejuvenation	5

Textbooks	
1	Tchobanoglous G. and Schroeder E. D., "Water Quality: Characteristics, Modeling and Modifications", Addison-Wesley publishing company, Reprint 1987.
2	Chapra S., "Surface Water Quality Modeling", Tata Mc-Graw Hill, 1997.
3	Walski, Chase and Savic, "Water Distribution Modeling", Haestad Press, First edition, 2007.
References	
1	Lee C. C and Lin S. D., "Handbook of environmental engineering calculations", McGraw Hill Publication, 2nd Edition 2007.
2	Todd D. K., "Groundwater Hydrology", John Wiley & Sons, Second Edition, 2007.
3	Metcalf and Eddy, "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003.
Useful Links	
1	https://youtu.be/vvgqcDJLHUo

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2						3
CO3			3			

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information	
Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV512
Course Name	Professional Elective 1: Energy Efficient Buildings
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To introduce the scientific and engineering principles of energy.
2	To impart the integration of new materials and traditional techniques to bring about energy efficiency, cost effectiveness and environmental friendly technologies in construction industry.
3	Imparting the objective of environmental friendly, active and passive concepts during the construction and operational phases of building life cycle.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Grasp the language of energy in context to energy policies and interpret the relevance of environment and energy efficiency in context to non-renewable and renewable energy resources.	Applying
CO2	examine the energy contribution of various materials and components in buildings and develop an ability to justify appropriate/environmental friendly/energy efficient building systems	Analyzing
CO3	apply the concept of heat exchange in buildings and adopt passive and active design strategies to maximize human comfort in buildings for tropical regions	Applying

Module	**Module Contents**	**Hours**
I	**Introduction to Energy** Global warming, causes, energy considerations, energy conservation and energy efficiency, energy systems and spatial structures, Classification of energy, primary and secondary energy, commercial and non-commercial energy, renewable and nonrenewable energy, Global primary energy reserves and consumption, energy distribution, Units of Energy with examples	7
II	**Conventional Materials and Techniques in Buildings** Constraints in Choice of building systems, Pre & post construction performance, Properties of materials, Types of Physical, Mechanical, Chemical and Thermal characteristics, Introduction to structural and physical aspects of buildings, Conventional materials used in construction, Case studies of various building materials, Energy consumption in various building materials, Sustainability considerations	6
III	**Energy and Environmental issues in Buildings** General facts, energy resources and their impacts on environment, energy in context to built-environment, Sustainable buildings, sustainability and objectives of Green buildings, Rating of Buildings- LEED & Griha, planning aspects of sustainable buildings, energy consumption and efficiency in buildings, Design	6

	strategies, Material strategies, Parametric assessment, Env. Issues related to buildings materials.	
IV	**Sustainable Materials and Techniques for Masonry** Felt requirements and real objectives of Green towns, Energy scenario in pre and post independent India, Need and approach to sustainability, Green building materials, Design constraints. Appropriate materials and techniques in construction: Relevance of building blocks, mortars. Stabilized mud blocks, FAL-G blocks, Hollow concrete blocks, Calcium silicate bricks for masonry, Energy consumption and comparison in building blocks, energy estimates in masonry components.	7
V	**Roofing Alternatives in Green Buildings** Structural inefficiencies in Conventional roofing systems, Concepts in roofing alternatives, Thatch roofs, Filler slab roofs, Filler materials, Composite beam-panel roofs / floors, hollow hourdi/concrete block roofs / floors, Ferrocement roofing systems, Masonry Domes and Vaults, Rain water harvesting, Energy consumption in different roofing systems. Overall embodied energy comparisons in buildings.	7
VI	**Energy systems in Building Maintenance** Elements of climate, Factors influencing climate, Climate and human comfort, Orientation of buildings, Comfort criteria, Heat exchange in buildings, Concepts of Active and Passive Energy systems in Buildings, Use of modern gadgets leading to energy efficiency.	7

Textbooks	
1	Alternative Building materials and Technologies by K.S. Jagadish, B.V.Venkatarama Reddy, K. S. Nanjunda Rao.
2	Sustainable Building Technologies, Editor :K S. Jagadish, Published by BMTPC, I.K. International Publishing House Pvt. Ltd.
3	Manual of tropical Housing and Building- Climatic Design by Koenigsberger, Ingersoll, Mayhew, Szokolay.

References	
1	Renewable Energy: Power for Sustainable Future, Ed. By Godfrey Boyle, Oxford Univ. Press, Third Edition.
2	World Energy Investment Outlook- Special Report, International Energy Agency, London, 2014.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2			
CO2	2			2		
CO3	2					

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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AY 2022-23

Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV551
Course Name	Environmental Chemistry and Microbiology Laboratory
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	1 Hr./ Week	30	30	40	100
		Credits: 2			

Course Objectives

1	To provide basic knowledge of environmental chemistry and microbiology for the treatment of water, wastewater and solid waste.
2	To provide hands-on practice for analyzing the water and wastewater by physical, chemical and instrumental methods.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** the basic concepts of environmental chemistry and microbiology of water and wastewater and ***summarize*** environmental significance of organic compounds.	Understand
CO2	***Apply*** physical, bio-chemical and advanced instrumental methods for water and wastewater analysis.	Apply
CO3	***Analyze*** data acquired from the experiments.	Analyze

List of Experiments / Lab Activities/Topics

List of Topics

Module	Course Contents	Hours
I	**Introduction to General, Organic and Biochemistry** General chemistry: Nomenclature, Valency, Oxidation-reduction equations, Ionization, Solubility Product, Common ion effect. Organic Chemistry: Environmental significance of different organic compounds Biochemistry: Biochemistry of carbohydrates and Proteins, Enzymes and their regulation.	4
II	**Instrumental Methods** UV- visible, Atomic Absorption Spectroscopy (AAS), Flame Photometry, Mass Spectroscopy, Gas Chromatography (GC) with reference to principle, instrumentation, calibration, working and applications in environmental analysis.	5
III	**Introduction to Environmental Microbiology** Groups of microorganisms, Major characteristics of microorganisms, Microbial classification, Nomenclature and identification, Cell and its composition, Prokaryotic cell division.	4

List of Lab Experiments:

I. Physical and bio-chemical analysis of water:

a. Review of basic experiments:
   pH, Acidity and Alkalinity, Electrical conductivity, Hardness, Chlorides
b. Solids
c. Dissolved organic matter by BOD and COD
d. Total Kjeldahl Nitrogen (TKN)

e. Nitrate and Sulphate
f. Fluoride
g. Iron and Manganese (Spectrophotometer)
h. Most Probable Number (MPN)

II. Instrumental Methods:

Study and use of

i. Atomic Absorption Spectrophotometer
j. Flame photometer
k. Spectrophotometer

Demonstration of

a. TOC Analyzer
b. Gas Chromatograph
c. Zeta meter
d. CHNS Analyzer

Textbooks	
1	Sawyer C.N. and McCarty P.L., "Chemistry for Environmental Engineers", Tata McGraw-Hill Publishing Company Limited, 5th Edition, 2003.
2	Mohapatra P. K., "Textbook of Environmental Microbiology", I. K. International Publishing House Pvt. Ltd., Reprint 2013.
3	Peavy H. S., Rowe D. R. and Tchobanoglous G, "Environmental Engineering", McGraw-Hill book company, 1st Edition, 2013.

References	
1	VanLoon G. W. and Duffy S. J., "Environmental Chemistry: A Global Perspective", Oxford University Press, Indian Edition, Reprint 2011.
2	Pelczar Jr., M. J. E. C. S. Krieg, R. Noel., and Pelczar M. F., "Microbiology", Tata McGraw Hill Publishing Company Limited, Reprint 2012.
3	American Public Health Association (APHA), "Standard Methods for the Examination of Water and Wastewater", 23rd Edition, 2017.
4	Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2			
CO2			2	3		
CO3			2	2		

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV552
Course Name	Water Treatability Studies Laboratory
Desired Requisites:	Physico-Chemical Methods for Water and Wastewater Treatment

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To provide exposure to the techniques and tools for the design and conduct of the experiments.
2	To provide an opportunity to contribute individually/ in groups to the development of experimental set ups by applying the acquired technological knowledge.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Design*** experiments by applying the acquired knowledge on techniques and tools.	Create
CO2	***Carry out*** experimental studies for characterization, parameter estimation, and performance evaluation independently and in teams.	Apply
CO3	***Analyze, critique,*** and ***interpret*** experimental results through application of modern engineering tools and ***conclude*** based on the results.	Analyze Evaluate

List of Experiments / Lab Activities/Topics

List of Lab Experiments:

1. Determination of order and rate of reaction/mass transfer parameter using CMBR
2. Flow measurement by ultrasonic flow meter
3. Use of natural and chemical coagulant/s for the turbidity, and colour removal
4. Settling column studies for discrete and flocculent dilute suspensions
5. Physical and chemical characteristics of sand as filter media
6. Determination of head loss in depth filter
7. Development of adsorption isotherm with activated carbon
8. Determination of exchange capacity of resin
9. Use of resin for hardness removal
10. Chlorination study on raw, filtered and distributed water

Textbooks

1	Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, International edition, 1985.
2	Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint, 2003.

3	"Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.
References	
1	Sincero A, P and Sincero G, A, "Environmental Engineering A Design approach", PHI learning private limited, 2004.
2	Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, 5th Edition, 2003.
3	Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
4	Quasim, S. R., "Water treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010
Useful Links	
1	https://www.youtube.com/watch?v=tA2nbDeueng
2	https://cwaterservices.com/treatment-plant-design-construction/water-treatability-studies/
3	http://www.environmentclearance.nic.in/writereaddata/online/EC/01042017OGDANQ0QTreatabiltyReport.pdf

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I
Course Code	6EV553
Course Name	Modeling and Simulation Laboratory
Desired Requisites:	Hydraulics of Transport Systems in Environmental Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	Simulate/analyze/ Model complex environmental systems using Modern tools.
2	Design water and wastewater treatment, water distribution, drainage, storm water drainage systems using modern tools/software

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Analyze*** environmental engineering related problems/systems by using Software and spreadsheets.	Analyze
CO2	***Design*** water and wastewater treatment, water distribution, drainage, storm water drainage systems using modern tools and software	Create

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. Study and application of at least two software for simple case studies
   a. Q-GIS
   b. EPANET/WaterGEMS
   c. SewerGEMS
   d. HEC-RAS, HEC-HMS
   e. AERMOD/HYSPLIT/UrbAirIndia
   f. iNODE WTP
2. Development of simulation/analysis/design modules for at least one of following using spread sheet/C programming/MATLAB/VB
   a. Water and wastewater treatment systems
   b. Solid waste processing units
   c. Air quality modeling, Emission inventory
   d. Energy Efficient Buildings

Textbooks

1	Walski, Chase and Savic, "Water Distribution Modeling", Haestad Press, First edition, 2007.
2	Haestad-Durrans, "Storm water conveyance modeling and design", Haestad Press, 1st edition, 2003.
3	Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.

References

1	User manuals of EPANET/WaterGEMS and SewerGEMS
2	User manuals of HEC-RAS, HEC-HMS
3	User manuals of AERMOD/HYSPLIT/UrbAirIndia
4	User manual of iNODE WTP
Useful Links	
1	https://www.youtube.com/@HalHartQGIS
2	https://www.youtube.com/@bentleysystems
3	https://www.youtube.com/@HEC-RAS
4	https://www.youtube.com/@AERMODTraining

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1				2		2
CO2				2		2

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

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Course Information	
Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV521
Course Name	Project Management
Desired Requisites:	Nil

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To develop a holistic, integrated approach to manage projects, exploring both technical and managerial challenges in civil engineering projects.
2	To inculcate leadership and ethical qualities in dealing with real life project environment and develop positive attitude towards individual responsibility in project execution.
3	To induce the art of documentation and oral communication in research and industry.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	Explain critically the project characteristics, project management principles and to apply them within the context of practical projects.	Understanding
CO2	Construct and solve projects in context of scheduling and controlling with time and cost as constraints using knowledge of network scheduling techniques and applications.	Applying
CO3	Engage in effective oral/written communication and apply leadership skills to successfully manage in a project environment and ethically accomplish project objectives.	Applying

Module	**Module Contents**	**Hours**
I	**Project Management Concepts** Factors Governing Modern Business, Effective Project Management, definition of project, Attributes of Project, Strategic Planning, Project Life Cycle, considerations for RFP, Project Process, Project Balancing, Project Environment, Programme and Portfolio, Reasons for project failures	6
II	**Project Planning and Schedule** Work Breakdown Structure, Responsibility matrix, Development of non-network and network schedules, Deterministic and Stochastic models and Problem solving in scheduling, Activity duration estimates, Schedule calculations, Probability considerations.	7
III	**Schedule Control** Project control process Updating schedule, Approaches to schedule control, Resource considerations Resource smoothening, Resource limited scheduling, Problem solving on Resource constrained planning.	7
IV	**Project Cost : Planning and Performance** Project cost estimation, budgeting, Techniques for cost estimation, Direct and	8

	Indirect costs, Fixed variable costs, Least-cost schedules, Problem solving on Schedule compression, Project Cost Management, Earned Value Management system, Planned Value, Earned Value, Actual Cost, Schedule variance, Cost Variance, Schedule performance index, Cost performance index, Limitations of EVM.	
V	**Leadership, Project Manager and Project Team** Understanding Leadership, Responsibilities and skills, Delegation, Managing Change, Development and effectiveness of project team, Ethics, Conflicts on Projects, Time Management, SWOT Analysis	7
VI	**Communication and Documentation** Types of Project organizations- their merits and demerits, Personal communication, Effective listening, Meeting, Presentations and Report preparation.	5

Textbooks	
1	A Guide to Project Management Body of Knowledge, 7th edition, 2021, Project Management Institute. (Free download)
2	Jack Gido, James P Clements, Project Management, Cengage Learning India Pvt. Ltd., 2nd Reprint 2011, ©2007
3	B.C. Punmia and Khandelwal, Project Planning and Control with PERT and CPM, Lakshmi Publications Pvt. Ltd., 4th Edition, 2008

References	
1	John Adair, Strategic Leadership, Kogan Page Ltd., 1st ed. 2010.
2	Project Management, Achieving Competitive Advantage, Jeffrey K. Pinto, Dorling Kindersley India Pvt. Ltd. Ed. 2009.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1					2	
CO2				2	2	
CO3		2				

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV522
Course Name	Biological Methods for Wastewater Treatment
Desired Requisites:	Wastewater Treatment

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide conceptual and field knowledge for the analysis, design and evaluation of biological processes of wastewater treatment.
2	To enhance the technical competency to conduct research and address the problems of industry/society related to wastewater treatment.
3	To inculcate aptitude for research, and consultancy.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** and ***apply*** the acquired knowledge on biological wastewater treatment.	Understanding Applying
CO2	***Analyze*** and ***evaluate*** the suspended and attached growth, aerobic and anaerobic biological wastewater treatment systems at secondary and tertiary levels.	Analyzing Evaluating
CO3	***Design*** wastewater treatment and sludge processing facilities.	Creating

Module	**Module Contents**	**Hours**
I	**Fundamentals of Biological Treatment** Fundamentals: Measurement of organic pollutant, Biochemical transformation, Bioreactor configuration, Aerobic, Anoxic and Anaerobic Biochemical operations Kinetics of Bio-chemical operations: Biomass growth, Substrate utilization, Yield Kinetics of (Aerobic/Anoxic, Anaerobic) biomass growth	6
II	**Aerobic Suspended and Attached Growth Processes** Review of conventional activated sludge process (ASP), aerated lagoon and waste stabilization ponds Modelling aerobic suspended growth in complete-mix and plug flow reactor with and without recycle Design and operation of sequential batch/cyclic ASP and membrane bioreactor Biological filtration, Eckenfelder model for performance of packed tower with and without recirculation Design and operation of rotating biological contactor	9
III	**Biological Nitrification and Denitrification** Biological nitrogen and phosphorous removal, Kinetics of nitrification and denitrification Process design of ASP, SBR and RBC for carbon oxidation – nitrification and denitrification	5
IV	**Sludge Processing**	9

	Design and operation of Upflow Anaerobic Sludge Blanket system Sludge processing: Sludge mass-volume relationship, Process fundamentals of Thickening, Stabilization, Conditioning, and Dewatering Design and operation of gravity thickener, dissolved air flotation tank, anaerobic digester, belt press and sludge drying bed	
V	**Decentralized Wastewater Treatment** Design and operation of decentralized wastewater treatment systems Moving Bed Bio-reactor, Anaerobic filter, Modified septic tank Constructed Wetland (CW): Classification and application, Design and operation of horizontal flow subsurface, Vertical flow systems Emerging concepts in CW, Sludge treatment constructed wetland Design and operation of Water hyacinth system	7
VI	**Land application and Treatment** Land application treatment systems: Processes, Removal mechanisms, Design and operation of slow rate, rapid infiltration and overland flow systems	4

Textbooks	
1	Peavy H, S, Rowe D, R, and Tchobanoglous G, *"Environmental Engineering",* McGraw-Hill Book Company, Indian edition 2017.
2	Metcalf and Eddy *"Wastewater Engineering Treatment and Reuse",* Tata McGraw Hill Publication, Indian Edition 2017.
3	Karia, G, L, and Christian R, A, "*Wastewater treatment*", PHI learning private limited, 2008.
4	Tom D. Reynolds and Paul A. Richards, "*Unit Operations and Processes in Environmental Engineering*", 2nd Edition, PWS Publishing Company, 1995.

References	
1	Droste, Ronald L *"Theory and Practice of Water and Wastewater Treatment",* Wiley student Edition, 2009.
2	Crites Ron and Tchobanoglous George, "*Small and Decentralized Wastewater Management Systems*", McGraw-Hill Book Company, International edition, 1998.
3	Sincero A, P and Sincero G, A, *"Environmental Engineering A Design approach",* PHI learning private limited, 2004.
4	Quasim, S. R., "*Wastewater treatment plants planning, design and operation*", CRC Press, 2nd Edition, 2010.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3						3

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV523
Course Name	Air Pollution and Control
Desired Requisites	A graduate level course in Environmental Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide knowledge on physics of atmosphere, meteorology and its relation to air pollution, different types of air pollution control equipment.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Recognize*** and ***summarize*** scientific and engineering principles for air pollution studies	Remember Understand
CO2	***Apply*** appropriate dispersion models ***estimate*** air pollutant concentrations	Apply Evaluate
CO3	***Analyze*** situations leading to air pollution and ***design*** air pollution control strategies with due consideration to technical, environmental, health, safety and social considerations	Analyze Evaluate

Module	**Module Contents**	**Hours**
I	**Air pollution: A retrospective** Air pollution: sources and types and effects on biosphere, National and international air emission standards; air pollution emission inventory; emission factor; air quality index; Strategy for effective control of air pollution in India, Introduction to air pollution control act, and international agreements for mitigating global air pollution effects.	7
II	**Meteorology** Physics of atmosphere, Solar radiation, Wind circulation, Lapse rate, Inversion, Stability conditions, Pasquil stability model, Maximum mixing depth, Wind rose, Plume behaviour, Global effects of air pollution: Green house effects, acid rain and ozone layer depletion, Heat island effect, Visibility, Photochemical reaction	7
III	**Dispersion of pollutants in the atmosphere** Eddy diffusion model, the Gaussian dispersion model, Point source, Line source, Maximum ground level concentration, Determination of stack height, Sampling time corrections, Effects of inversion trap Definition, Distribution and source of different particulate matter, Terminal settling velocity, Basics of hood and duct design for particulate collection	7
IV	**Control of Air Pollution** Control Equipment for Particulate Matter: Operation design and component detailing of Settling chamber, Cyclone, Wet collectors, Fabric filter, and	7

	Electrostatic precipitator	
V	**General control of Gaseous pollutants** Principles of absorption, Adsorption, Basic design of absorption and adsorption units, Incineration and after burner, Control of SO2, NOx, SPM, RSPM, Biological Matter	6
VI	**Motor Vehicle Emissions** Automobile Source Emission of pollutants from automobiles, Photochemical smog, Reduction of emissions by different methods, Alternative fuels and their utilizations	6

Textbooks	
1	Wark and Warner, "Air Pollution", C.F., H.R. Publication, 1st Edition, 1978.
2	Nevers N., "Air Pollution Control Engineering" McGraw-Hill, New York, 2nd edition, 1995.
3	Martin Crawford, "Air Pollution and Control", Tata McGraw Hill Publication, 1st Edition, 1976.

References	
1	Richard W. Boubel and Bruce Turner, "Fundamentals of Air Pollution", Academic Press, New York, Third edition, 1994.
2	Stern A. C., "Air Pollution Vol. I and II", Allied Publishers Limited, 1st Edition, 1994.
3	Rao H.V.N. and Rao M. N., "Air Pollution", Tata McGraw Hill, 1st Edition, 1989.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			3
CO3				3		3

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester I/II
Course Code	6EV531
Course Name	Professional Elective 2: Industrial Wastewater Pollution and Control
Desired Requisites:	A course on Wastewater Treatment at graduate level and Physico-Chemical Methods for Water and Wastewater Treatment

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To provide conceptual and field knowledge for the analysis, design and evaluation of biological processes of wastewater treatment.
2	To enhance the technical competency to conduct research and address the problems of industry/society related to wastewater treatment.
3	To inculcate the qualities of critical thinking.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	**Explain** and **apply** concepts of industrial wastewater treatment.	Understanding Applying
CO2	**Analyze** and **evaluate** the physical and chemical treatment systems used in water and wastewater.	Analyzing Evaluating
CO3	**Design** physical and chemical treatment systems for water and wastewater.	Creating

Module	**Module Contents**	**Hours**
I	**Classification of Industries and Cooling Tower** Classification of Industries, General water requirements in industry, Industrial water reuse, Cooling tower make up water, Water and salt balances in cooling tower, Common water quality problems in cooling water tower systems, Estimation of blow-down water composition, Analysis of scaling potential by Langlier and Ryzner indices.	4
II	**Waste Minimization Techniques** Waste audit, Concept of waste minimization and Techniques of volume and strength reduction. Equalization: Process, Flow and quality, Location, Volume requirement and Design considerations. Reuse and recycling concepts, Process description, Objectives and Methods of Neutralization and Proportioning	5

III	**Agro Based Industries** Manufacturing processes, Water usage, Sources, Quantities and characteristics of effluents (process stream and combined), Pollution effects, Waste Reduction/ Reclamation/Byproduct recovery, Utilization, Alternative methods of treatment and disposal for Agro-based industries: Sugar, Distillery, Dairy, Pulp and paper mill and Textile	12
IV	**Chemical and Engineering Industries** Manufacturing processes, Water usage, Sources, Quantities and characteristics of effluents (process stream and combined), Pollution effects, Waste Reduction /Reclamation/Byproduct recovery, Utilization, Alternative methods of treatment and disposal for a. Chemical industries: Pharmaceutical, Petroleum and refineries, Fertilizer and Tannery b. Engineering industries: Steel, Electroplating and Battery Manufacturing c. Thermal power plants.	12
V	**Common Effluent Treatment Plant** Concept, Objectives, Methodology, Cost benefit analysis, Design, Operation and maintenance	4
VI	**Detailed Project Report for Waste Treatment Facilities** Project report preparation for waste treatment and disposal system of industries, Pre-feasibility, feasibility and detailed project reports, Project financial appraisal.	3
Textbooks		
1	Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.	
2	Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, Indian Edition 2017.	
3	Unit Operations and Processes in Environmental Engineering, 2nd Edition, by Tom D. Reynolds and Paul A. Richards, PWS Publishing Company, 1995.	
References		
1	Droste, Ronald L "Theory and Practice of Water and Wastewater Treatment", Wiley student Edition, 2009.	
2	Crites Ron and Tchobanoglous George, "*Small and Decentralized Wastewater Management Systems*", McGraw-Hill Book Company, International edition, 1998.	
3	Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.	
Useful Links		
1	https://www.youtube.com/watch?v=fHRxhuMQQnE&list=PLbRMhDVUMngdeOSgQOe399aBKqdxkxNCp	
2	https://pubs.rsc.org/en/content/chapterhtml/2021/bk9781839162794-00001?isbn=978-1-83916-279-4&sercode=bk	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2			
CO2				3		
CO3				2		3

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV532
Course Name	Professional Elective 2: Operation and Maintenance of Environmental Facilities
Desired Requisites:	Courses on Water and Wastewater Treatment, Air pollution, Solid Waste Management

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	Provide in-depth knowledge of operation and maintenance of infrastructural facilities in environmental engineering.
2	To enhance the technical competency and apply the acquired knowledge for research and development, industry, and consultancy activities.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** concepts of operation and maintenance for environmental facilities.	Understand
CO2	***Apply*** the imparted knowledge to effectively operate the system.	Apply
CO3	***Assess*** operation and maintenance problems associated with real life environmental facility.	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction** Need of Operation and Maintenance (O & M), Basic principles, corrective and preventive maintenance, Detailed plans, drawings, operation manuals, computer usage in O and M.	7
II	**Water Supply System** Intakes, pumps, transmission pipes, water treatment process control, Quantity and quality monitoring.	6
III	**Water Distribution and Sewerage System** *Water distribution system*: Loss of carrying capacity of pipes, pipe breaks and leakages, leak detection, record keeping, O and M of Appurtenances, Use of network models in O and M, Corrosion control. *Sewerage system*: Maintenance, Inspection methods, Manual and television, Cleaning and rehabilitation, Safety in sewer inspection.	7
IV	**Wastewater Treatment Plant** Wastewater treatment plant: O and M of wastewater treatment plant, Monitoring and operational problems, Corrective measures. Performance: Plant performance, Need for up gradation, Process reliability, Odour management.	7
V	**Air Pollution Control Facilities** Air pollution control facilities: Regular inspection of devices, SPM control equipment, Gravity settlers, Cyclone separators, Bag filters, Scrubbers, Electrostatic precipitator, Gaseous control devices, incinerators and their	7

	troubleshooting.	
VI	**Planning and Management** Organizational structure, work planning, preparation and scheduling, Cost estimates.	6
Textbooks		
1	Quasim S. R., Motley E. M. and Zhu G., "Water works engineering", PHI learning private limited, 2000.	
2	Wark K. And Warner C.F., "Air Pollution", H.R. Publication, 1st Edition, 1978.	
References		
1	"Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Govt. ofIndia, New Delhi, 1999.	
2	"Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Govt. of India, New Delhi, 1993.	
Useful Links		
1	https://www.youtube.com/watch?v=Kc9u3I0tyeg	
2	https://www.suezwaterhandbook.com/processes-and-technologies/instrumentation-control-regulation/deferred-plant-control-system/water-treatment-plant-maintenance	
3	https://www.epa.gov/sites/production/files/2018-07/documents/uss-midwest-revised-om-pmpp-manual-submitted-20180626-184pp.pdf	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3						2

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV533
Course Name	Professional Elective 3: Environmental Management Systems
Desired Requisites:	Environmental Engineering Course at Graduate Level

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide knowledge of ecological aspects.
2	To provide knowledge of Environmental Ethics and Environmental Legislation.
3	To provide necessary knowledge of managerial tools required for assessing, analyzing and solving problems in the field of environmental management.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Explain*** ecological imbalance due to various types of pollution and perceive environmental ethics and legislation.	Understand
CO2	***Choose*** appropriate methodology for EIA and auditing and assess the impacts.	Apply
CO3	***Justify*** EMS and Environmental Management Plan for infrastructural facilities.	Evaluate

Module	**Module Contents**	**Hours**
I	**Ecological Aspects and Noise Pollution** Ecological aspects: Salient features of major Eco Systems, Energy Transfer, Population Dynamics, Ecological imbalance, Preservation of Biodiversity. Land Pollution, Water Pollution due to sewage, industrial effluents and leachate, Pollution due to Nuclear Power Plants, Radioactive Waste, Thermal pollution, causes and control. Noise Pollution: Decibel Levels, Monitoring, Hazards, Control measures.	6
II	**Environmental Ethics and Legislation** Environmental Ethics: Ethics in society, Environmental consequences, Responsibility for environmental degradation, Ethical theories and codes of Ethics, Changing attitudes, Sustainable development. Environmental Legislation: Water (prevention and control of pollution) act 1974, The environmental act 1986, The Noise Pollution (Regulation and Control) Rules, 2000. Environmental economics.	7
III	**Environmental Impact Assessment (EIA)** Definitions and Concept, Scope, Objectives, Types of impacts, Elements of EIA, Baseline studies. Methodologies of EIA, Prediction of impacts and its methodology, Uncertainties in EIA, Status of EIAs in India.	7
IV	**Environmental Auditing** Definitions and concepts, Scope and Objectives, Types of audit, Accounts audit, Environmental audit statement, Qualities of environment auditor. Environmental	7

	Impact Statement (EIS).	
V	**ISO Standards** ISO and ISO 14000 Series: Introduction, Areas covered in the series of standards, Necessity of ISO certification. Environmental management system: Evolution, Need, Elements, Benefits, 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.	7
VI	**Environmental Management Plan** Definition, Importance, Development, Structuring, Monitoring, Cost aspects. Strategy for siting of Industries, Environmental Labeling, Life-Cycle Assessment.	6

Textbooks	
1	Canter, L. W., Environmental Impact Assessment, McGraw-Hill, 2nd Edition, 1997.
2	Agarwal, N. P., Environmental Reporting and Auditing, Raj Pub., 1st Edition, 2002.
3	Judith, P. and Eduljee, G., Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1st Edition, 1994.

References	
1	"Environmental Auditing", Published by CPCB, Govt. of India Publication, New Delhi
2	Mhaskar, A.K., Environmental Audit", Media Enviro Publications, 2002.
3	K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997.

Useful Links	
1	https://www.youtube.com/watch?v=wEqrMCdNjX4
2	https://www.youtube.com/watch?v=hfLGI73N_iA
3	https://www.youtube.com/watch?v=MpR6YiSiHrs

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2					3	
CO3			3			

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV534
Course Name	Professional Elective 3: Geo-Environmental Engineering
Desired Requisites:	Soil Mechanics, Foundation Engineering, Environmental Engineering : UG Level

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

This course is intended to acquaint M. Tech Environmental Engineering students with concepts of Geo-environmental engineering, and planning and design of waste in landfills, ash ponds and tailing ponds.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Describe*** and ***Differentiate*** various engineering properties of soils, available geo synthetic materials, their properties and suitability.	Understanding Analyzing
CO2	***Calculate*** area requirement of landfill site and ***Evaluate*** compaction quality using field tests.	Analyzing Evaluating
CO3	***Analyze*** stability of landfill embankments, liners and covers.	Analyzing

Module	**Module Contents**	**Hours**
I	**Introduction to Geo-environmental Engineering** Introduction, overview of pollution, control and remediation, Case histories on Geo-environmental Engineering, Soils- Soil as 'Phased System', Soil classification, Various Soil Types with important engineering properties, their suitability for intended purpose, Clay Mineralogy.	7
II	**Contaminant Transport in Soil** Soil-water-contaminant interaction; Contaminant Transport, Geochemical Attenuation and attenuation capacity of soils. Zones of contaminant plume. Introduction to Detection of polluted zones and Monitoring designed system.	5
III	**Introduction to Geo-synthetic Materials** Various forms of Geo-synthetic material (GM, GT, GN, GG, GCL, GP, Geo-foam), Their general applications for various engineering functions. Various Geo-synthetic material properties. Use of Geo-synthetic material in waste containment. Concerns about use.	6
IV	**Solid Waste Containment** Site selection, Typical cross sections of landfills, merits and demerits. Area calculation of landfill site. EPA (MoEF and CPCB) Guidelines. CCL, GCL and composite liners. Compaction quality control for CC liners. Stability analysis of Landfills: Conventional Slope Stability analysis by method of slices, stability number concept. Stability against sliding of geo-membrane over clay (liner stability) and sliding of soil over geo-membrane (Cover stability). Assessment of anchorage requirement of GM.	12

V	**Slurry Waste Containment** *Slurry Waste Containment:* Slurry transported wastes, pond layouts, components of pond, embankment construction, staged raising of embankment, Design aspects, environmental impact and control. *Vertical Barriers for Containment:* Various types of Cutoff Walls, Requirements of good vertical barriers, Slurry trench walls using Bentonite and Cement-bentonite slurry, material and construction aspects.	5
VI	**Geotechnical Reuse of Waste Material** Waste reduction, use of waste in geotechnical construction, Waste characteristics for soil replacement, Transport considerations, and engineering properties of waste.	5

Textbooks	
1	G L Sivakumar Babu, "Soil Reinforcement and Geosynthetics", Universities Press (India) Pvt. Ltd. Hyderabad, 2006.
2	Reddi L.N. and Inyang, H. I., "Geoenvironmental Engineering, Principles and Applications" Marcel Dekker Inc. New York, 2000.
3	Bagchi, A., "Design of landfills and integrated solid waste management" John Wiley & Sons, Inc., USA, 2004.

References	
1	Donald Coduto, "Geotechnical Engineering Principles and Practices Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
2	Daniel, D. E, "Geotechnical Practice for Waste Disposal", Chapman and Hall, 1993.
3	Rowe R.K., "Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000.

Useful Links	
1	https://cpcb.nic.in/rules/
2	https://nptel.ac.in/courses/105103025
3	https://onlinecourses.nptel.ac.in/noc19_ce37/preview

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2			
CO2			3			1
CO3			3	2		2

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information	
Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV535
Course Name	Professional Elective 3: Emerging Technologies in Water and Wastewater Treatment
Desired Requisites:	A course on Water and Wastewater Treatment at graduate level and Physico-Chemical Methods for Water and Wastewater Treatment

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Provide in-depth knowledge of emergent technologies in water and wastewater engineering.
2	To enhance the technical competency and apply the acquired knowledge for research and development, industry, and consultancy activities.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	***Explain*** and ***apply*** the concepts of emerging/advanced physical, chemical and biological processes for the treatment of water and wastewater.	Understanding Applying
CO2	***Analyze*** and ***evaluate*** the emerging/advanced physical, chemical and biological systems for the treatment of water and wastewater.	Analyzing Evaluating
CO3	***Design*** the emerging/advanced physical, chemical and biological water and wastewater treatment facilities.	Creating

Module	**Module Contents**	**Hours**
I	**Solids Separation** High rate clarification, Enhanced particle flocculation, Analysis of ballasted flocculation and settling, Dense-sludge process, Swirl and vortex separation, Enhanced coagulation, Applications in water and wastewater treatment	5
II	**Organic and Inorganic Matter Removal** *Organic matter removal:* Chemical oxidation for BOD, COD, ammonia and non-biodegradable organic compounds, Advanced oxidation processes. *Inorganics removal:* Biological removal of phosphorus, heavy metals, toxic and recalcitrant organic compounds, Biological-Chemical Phosphorus and Nitrogen Removal (BCFS) Process Gas Stripping for ammonia and VOC removal, analysis, design of stripping towers	5
III	**Hybrid Treatment** Biological treatment with membrane separation, Combined aerobic treatment processes, Integrated Fixed-film Activated Sludge (IFAS) Systems, Aerobic granular biomass wastewater treatment, Submerged attached growth processes, Denitrification with attached growth systems, Moving bed bioreactor, Combination natural and mechanized treatment systems, Vertical flow constructed wetland, Aerated constructed wetland	10

IV	**Decentralized and Sustainable Wastewater Treatment** *Sustainable wastewater treatment:* Limitations of conventional centralized wastewater systems, Concept of sustainability in wastewater treatment. *Decentralized treatment:* Concept, significance, applications and elements of decentralized wastewater treatment, Technologies for Decentralized wastewater treatment, On-site treatment systems, Greywater treatment.	8
V	**Vermin Technology** Vermin technology: Concept, Worm species, Worm action. *Applications of vermin technology:* Vermifilter and Vegetated vermifilter in biological treatment of wastewater, Vermi-stabilization of sludge, Vermin composting.	6
VI	**Introduction to Automation and Nano Technology** Introduction to automatic process control, Energy efficiency in wastewater treatment, Upgrading wastewater treatment plant performance. *Nano technology in treatment:* Introduction to Nano technology in water and wastewater treatment, Drinking water decontamination using Nano technology, Application of Nano TiO2 catalyst in wastewater treatment, Disinfection by Nano particles.	6

Textbooks	
1	Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.
2	Hammer M. J. and Hammer M. J., "Water and Wastewater Technology", PHI learning private limited, 6th Edition, 2008.
3	Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint, 2003.
References	
1	Sincero A. P. and Sincero G. A., "Environmental Engineering A Design approach", PHI learning private limited, 2004.
2	Nazaroff W. W. and Alvarwz-Cohen, "Environmental Engineering Science", John Wiley & Sons Publication, 2011.
3	Ram M. K., Andreescu S. and Ding H., "Nanotechnology for Environmental decontamination", McGraw Hill, 2011.
Useful Links	
1	https://www.epa.gov/sites/production/files/2019-02/documents/emerging-tech-wastewater-treatment-management.pdf
2	https://www.intechopen.com/online-first/emerging-trends-in-wastewater-treatment-technologies-the-current-perspective

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3						3

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV571
Course Name	MSW Characterization and Air Quality Monitoring Laboratory
Desired Requisites:	Solid Waste Management & Air Pollution and Control

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To provide hands-on practice to analyze the quality of ambient air, noise levels, stack emissions and MSW.
2	To provide knowledge to analyze environmental condition.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Recognize and explain use of instrumentation for air, and noise monitoring and MSW Characterization.	Remembering Understanding
CO2	Use instrumentation for air, and noise monitoring and MSW Characterization.	Applying
CO3	Assess environmental conditions by using results obtained through experimentation.	Evaluating

List of Experiments / Lab Activities/Topics

List of Topics(Applicable for Interaction mode):

1. Sampling of Municipal Solid Waste (MSW)
2. Proximate analysis of Municipal Solid Waste (MSW).
3. Ultimate analysis of Municipal Solid Waste (MSW).
4. Study of air samplers for ambient air quality monitoring.
5. Study of air samplers for indoor air quality monitoring.
6. Study of stack monitoring kit.
7. Study of automobile exhaust analyzer.
8. Study of weather monitoring station.
9. Study of noise level meter and ambient noise level measurements.

List of Lab Activities:

1. Mini Project 1: Municipal Solid Waste Management for small locality/society/colony/village.
2. Mini Project 2: Indoor/Outdoor air quality monitoring of enclosed/open area.

Textbooks

1	Wayne T. D., Air Pollution Engineering Manual, John Wiley & Sons, 2000.
2	Rao C. S., Environmental Pollution Control Engineering, New Age Int. Pubs, 2005.
3	"Manual for wet and dry depositing", CPCB Methods, Central Lab test methods, 2001.

References

1	Sincero A. P. and Sincero G, A, "Environmental Engineering A Design approach", PHI

	learning Private limited, 2004.
2	Nathanson J. A. “Basic Environmental technology for water supply, waste management and Pollution control”, PHI Publishing Company, 5th Edition, 2009.
3	Wark K. and Warner C.F., “Air Pollution”, C.F., H.R. Publication, 1st Edition, 1978.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			2	3		
CO2				3		2
CO3				3		2

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

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Course Information	
Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV572
Course Name	Wastewater Treatability Studies Laboratory
Desired Requisites:	Physico-Chemical Methods for Water and Wastewater Treatment and Biological Methods for Wastewater Treatment.

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To provide hands-on practice to plan, design and conduct experiments.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Design*** and ***conduct*** experiments using appropriate techniques and tools to demonstrate research skill individually/groups.	Creating
CO2	***Analyze, critique,*** and ***interpret*** results of experimental studies on performance evaluation and characterization studies.	Analyzing Evaluating

List of Experiments / Lab Activities/Topics

List of Experiments:

1. Determination of BOD rate constant for domestic and industrial wastewater
2. Development of laboratory scale Activated Sludge Process (ASP) and Determination of MLSS, MLVSS, sludge volume index and sludge density index
3. Evaluation of bio-kinetic parameters for aerobic treatment
4. Performance evaluation of aerobic sequential batch reactor for treating domestic wastewater
5. Study on characterization of raw and processed (thickened/stabilized/dewatered) sludge
6. Development and operation of anaerobic reactor for wastewater/sludge treatment
7. Evaluation of effluent quality for land application
8. Evaluation of impact of effluent disposal on soil
9. Study of Activated Sludge Models (ASM)

Textbooks

1	Metcalf and Eddy, "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint 2003.
2	Lee C. C. and Lin S. D., "Hand book of environmental engineering calculations", McGraw Hill Publication, 2nd Edition, 2007.
3	Hammer M, J and Hammer M, J, "Water and Wastewater Technology", PHI learning private limited, 6th Edition, 2008.

References

1	Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

2	Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
3	Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

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Course Information

Programme	M. Tech. Civil (Environmental Engineering)
Class, Semester	First Year M. Tech., Semester II
Course Code	6EV573
Course Name	Pre-dissertation work and seminar
Desired Requisites:	Hydraulics of Transport Systems in Environmental Engineering, Unit Operations and Processes in Environmental Engineering– I, II and Air Pollution and Control.

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	Encourage students to explore new research from a range of academic disciplines which shed light on environmental issues.
2	Create awareness amongst students about the cutting edge technical/industrial research projects that can be undertaken for their dissertation works.
3	Develop the attribute of effective communication (written and oral) through effective presentations

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	***Examine*** the confirming and opposing evidence from research papers in order to draw conclusions consistent with the topic.	Analyzing
CO2	***Summarize*** gaps in the research areas related to environmental engineering based on a thorough literature review of research papers from recognized authors/journals and prepare project proposals.	Understanding
CO3	***Demonstrate*** effective written and oral communication, giving appropriate consideration to audience, context, format and textual evidence.	Applying

List of Experiments / Lab Activities/Topics

Part A: List of Topics(Applicable for Interaction mode):

The students shall collect information on the probable topic of his/her dissertation by referring to research articles from journals and conferences.

Students should deliver minimum of three presentations on chosen topic with a view of enhancing their presentation skills on technical presentation.

A detailed report based on three presentations is to be prepared and submitted.

Textbooks

1	Metcalf and Eddy, "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint 2003.
2	Lee C. C. and Lin S. D., "Hand book of environmental engineering calculations", McGraw Hill Publication, 2nd Edition, 2007.

References	
1	Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.
2	National and International journals in Environmental Engineering [A. Journal of Indian water works association, b. Journal of environmental science and engineering (NEERI), c. Journal of environmental engineering (ASCE), d. Water research, e. Water science and technology, f. Journal of Water supply: Research and technology-AQUA, g. Journal of environmental management, h. Journal of waste management, i. Water science and technology –Water supply, j. Journal of Water Reuse and Desalination, k. Journal of American water works association. L. Building and Energy (Elsevier)]

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2			2	1	
CO2	2			2	2	
CO3		3			2	

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40