1st Semester Syllabus

Department	**Environmental Engineering**						
Course Code	**22PEV110**	*Total Credits*	*4*	*Course Type*	**Professional Core Course**		
Course Title	**Applied Environmental Chemistry And Microbiology**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**42**	**4**		**CIE**	**SEE**	**Total**
	Tutorial	**10**		*Weightage*	*40 %*	*60 %*	*100 %*
	Practical			*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**52**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PRE-REQUISITE: Basics of Chemistry and Biology

COURSE OBJECTIVE: The course is an applied science course dealing with relevant aspects of chemistry and microbiology. The chemistry provides an in depth knowledge of basics of chemistry, variety of reactions and introduces equilibrium chemistry. The course also lays foundation of electrochemistry, colloidal and surface chemistry. It encompasses water and wastewater analytical and instrumental methods of analysis.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Name and distinguish a variety of chemical reactions and their importance. Review equilibrium chemistry and perform dimensional analysis. Apply le-chateliers principle to find feasibility of reaction.	L3
CO2	List and describe types of electrodes and electrode potential. Classify colloids, discuss their properties and their environmental significance. Reproduce the two-film theory and identify the salient features.	L2
CO3	Describe various analytical techniques for measuring water quality parameters and wastewater characteristics. Explain the concepts of buffering capacity in water/river. Discuss the need for microbiology and identify different flora and fauna of importance in water, air and soil media.	L3
CO4	Draw and identify bacterial cell structure and morphological features. Solve numerical problems on generation time, specific growth rate and decay rate. Analyze single & multiple substrate utilization rates. Apply various growth models and determine biokinetic coefficients.	L3
CO5	Distinguish between fungi and virus. Classify and characterize using different methods. Formulate enzymatic relationships using kinetics. Apply the knowledge of using microbes in pollution control activities. Review emerging microbial contaminants.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**Introduction** Importance of Environmental Chemistry as applied to Environmental Engineering,Modes of expression for molarity, normality, molality, ppm, numerical problems.	**12**	**02**

	Types of reactions. Concepts of equivalent mass in relation to acids, bases, salts and oxidizing and reducing agents. Chemical equilibrium – redox and ionic Equations, Le-chateliers principle, Gibs free energy and numerical problems on finding the feasibility of reaction.		
2	Electrochemistry Electrolytes, types of conductance. Method of determining the specific conductance of water/wastewater and its correlation with dissolved salts. Electrode, types of electrodes, electrode potential, etc. Measurement of emf and pH electrode potential, etc. Buffers and buffer index. **Colloidal Chemistry** Colloids – Types, properties and environmental significance. Colloidal dispersionsin water, air and emulsions. Theory of colloids – double layer theory, zeta potential, destabilization of colloids (Schulze – Hardy rule) as applied to coagulation process.	**08**	**02**
3	**Water and wastewater analysis** Acidity, alkalinity, and hardness. Color, Fluoridation and defluoridation – significance and determination. Chlorination – residual chlorine and break point chlorination.Biochemical oxygen demand (BOD) – dissolved oxygen (DO determination andenvironmental significance). Types and measurement of BOD. Rate of biochemical oxygen demand and theoretical oxygen demand. Chemical oxygendemand (COD) – determination and its application in wastewater treatment	**06**	**02**
4	**Applied Microbiology** Microscopic flora and fauna and their importance in environmental protection, microorganisms of importance in air, water and soil environment. Microbial enumeration techniques. **Microbial Metabolism** : Metabolic activity, anabolism and catabolism, influencing parameters, microbial metabolism of toxic chemicals and trace organics, bio concentration and bio magnification. **Bacteria**: Morphology, spore formation, typical bacterial growth curve, Nutritional requirements, Growth Models specific growth rate and generation time,numerical problems.	**10**	**02**
5	**Fungi:** Classification, characteristics and environmental applications **Virus:** Types, characteristics and enumeration methods. **Enzymes** : Classification, kinetics of enzymatic reactions, Michaelis - Menton equation, factors influencing enzyme reactions, problems. **Recent trends** - Use of microbial consortia in water and wastewater treatment,Emerging Microbial Contaminants- chemical and antibiotic resistant microbes	**06**	**02**

Text Books:

- Pelzer, Chan and Ried (1998), "Microbiology", Tata McGraw Hill Publishers
- Sawyer C.N. and McCarty, P.L., (2003), "Chemistry for Environmental Engineering and Science", 5th Edition, TATA Mc Graw Hill Publishing Co.Ltd., New Delhi

Reference Books:

- Gaudy and Gaudy (1980), "Microbiology for Environmental Scientists and Engineers", McGraw Hill.
- Mall C.A.S & Day J.W., "Ecosystem Modelling in Theory and Practice: An Introduction with Case Histories", John Wiley Publications
- APHA, (2002), "Standard Methods for Examination of Water and Wastewater"; 21st Edition.
- Chakraborthy P, (2005), "Textbook of Microbiology", 2nd Edition, New Central Book Agency Pvt. Ltd.,

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **http://www.oficyna.pwr.edu.pl/wp-content/media/Ko%C5%82wzan-B.-Adamiak-W.-Grabas-K.-Pawe%C5%82czyk-A.-Introduction-to-environmental-microbiology.pdf**

SWAYAM/NPTEL:

- Anjali Pal, Sudha Goel 'Environmental Chemistry and Microbiology' IIT Kharagpur **https://onlinecourses.nptel.ac.in/noc21_bt22/preview**

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Drawing structure of compound and chemical reactions	Chem draw	Visualization of chemical structure/Software exposure

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects –**
3. **Any others –**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	3	-	3				
CO2	3	1	3	3	3	3				
CO3	3	-	2	3	3	3				
CO4	3	3	3	3	-	3				
CO5	3	3	3	3	3	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV120	Total Credits	4	Course Type	Professional Core Course		
Course Title	Physico-Chemical Processes for Water Treatment						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Environmental Chemistry and Microbiology

COURSE OBJECTIVE: The course emphasizes on unit operations and processes of Water treatment facilities and its design considerations.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Interpret the inter-relationship between water quality parameters and design hydraulics flow diagram.	L3
CO2	Design intake structures. Understand aeration, sedimentation, coagulation and flocculation processes. Apply settling equations. Tube settlers and pulsators.	L3
CO3	Evaluate performance of filter units along with filter backwash and to know the kinetics of disinfection.	L5
CO4	Highlighting about various miscellaneous treatment processes such as softening, fluoridation/ DE fluoridation and know the importance of removal of trace organics.	L3
CO5	Relate generation of chemical sludge and its management. Describe the norms and different rural water supply schemes. Exemplify the need for industrial water quality requirements.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	Basic Considerations – Water – (Surface & Ground) quality characteristics, Drinking Water Quality Standards, guidelines, inter-relationship between water quality characteristics. Urban and rural water treatment facilities – norms and schemes Hydraulic profile of Water Treatment and Distribution Systems Water Supply Facilities- Intakes – types & design considerations, Pressure conduits - Rising main. Water distribution systems-Valves, Fittings and Hydrants, Pumps and Pumping station - design considerations.	10
2	Water Treatment Facilities: Screening – design considerations. Aeration, – Principle, Theory, Gas Laws, types, Design Considerations and Numerical Problems Sedimentation tanks– Principle, theory, types of settling, settling velocity Laws (Stoke's, Hazen William's law & Newton's law); - Design Considerations & Numerical Problems.	18

	Coagulation and Flocculation – Principle, Theory, types of coagulants and their best pH range, design Considerations and Numerical Problems	
3	Filtration – Principle, Theory, Mechanism, types, Design Considerations and Numerical Problems Disinfection – Principle, Theory, kinetics of Disinfection, disinfection methods, influencing factors; Numerical Problems	**14**
4	Miscellaneous Water Treatment Facilities: Water Softening Process – Principle, Theory, Types and Numerical Problems Removal of Iron and Manganese; Fluoridation and defluoridation	**12**
5	Water Treatment Plant Residues – Collection, Conveyance, Treatment and Disposal 5 R Technologies –reduce, reuse, recycle, reclaim and recovery, Industrial Water treatment & Supply Facilities - Quality aspects of industrial water,	**10**

Text Books:

- Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control".
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering" McGraw Hill.
- Santhosh Kumar Garg, "Water Supply Engineering", Khanna Publishers (Recent Edition).
- B. S. N. Raju, "Water Supply and Wastewater Engineering"

Reference Books:

- AWWA, (1971), "Water Quality and Treatment McGraw Hill.
- CPHEEO Manual, (1991), "Water Supply and Treatment", GOI Publications.
- Fair, G.M., Geyer J.C and Okun, (1969) "Water and Wastewater Engineering" Vol II, John Wiley Publications.
- APHA, 2005, Standard methods for examination of water and wastewater, 21st Edition.
- Design data handbook by IW

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **https://ocw.mit.edu/courses/1-85-water-and-wastewater-treatment-engineering-spring-2006/pages/lecture-notes/**

SWAYAM/NPTEL:

- **https://archive.nptel.ac.in/courses/105/105/105105201/**

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**
3. **Any others**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3				
CO2	3	-	3	3	3	-				
CO3	3	3	3	3	3	3				
CO4	3	-	3	3	3	3				
CO5	3	3	3	3	3	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV130	Total Credits	4	Course Type	Professional Core Course		
Course Title	Design Of Wastewater Treatment Systems						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	32	4		CIE	SEE	Total
	Tutorial	20	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Environmental Chemistry, Environmental Microbiology and Ecology

COURSE OBJECTIVE: The course emphasizes on design criteria, design equations, kinetics, hydraulic diagrams for the design of unit operations and processes for wastewater treatment systems. It also deals with sludge handling and treatment and discusses the importance of rural sanitation systems.

COURSE OUTCOMES(COs):

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the need for wastewater treatment, categorize the wastewater, kinetics and fundamental scientific and engineering processes of UGD design and operation maintenance.	L3 & L4
CO2	Design and explain the concept of a unit operation	L3 & L4
CO3	Design and explain the concept of a unit process	L3 & L4
CO4	Design and explain the concept of Sludge Processing units	L3 & L4
CO5	Illustrate wastewater treatment systems for rural areas and draw the hydraulic profile for drainage network	L3 & L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Domestic Wastewater** characteristics, flow fluctuations, types of reactors and mass balance approach. Simple problems. **Kinetics of biological wastewater treatment syst**ems – biokinetic constants and their determination, batch and continuous system. **Design of Sewers:** Types of sewerage systems, Design of sanitary sewer: partial flow in sewers, economics of sewer design; sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.	06	02
2	**Design principles and design of unit operation systems** - Objectives, process flow sheets based on characterization. Screens, equalization, grit chamber, oil and grease removal, primary sedimentation tank. Secondary sedimentation tank - design criteria and examples.	06	05

3	**Design Criteria and design of unit processes -** Aerobic, Anoxic and Anaerobic systems, Suspended and attached growth systems, activated sludge process and modifications, sequencing batch reactor - design criteria and examples. **Biological Sludge separation**, conditioning and volume reduction, toxicity assays	08	06
4	**Design of Sludge Processing units** – Chemical and biological sludge – sources and generation, Quantification and characterization, sludge volume index (SVI), alternate uses of sludge and disposal options. Sludge Digestion- aerobic and anaerobic, Sludge Drying Bed, Sludge Thickeners, sludge filter press, design criteria and examples.	06	03
5	**Wastewater treatment systems for small communities** – septic tanks, soak pits, two-pit latrines, eco-toilet. Natural and constructed wetlands. **Wastewater Treatment**: Hydraulic Profile and Pumps and Use of computer software in sewer networks.	06	04

Text Books:

1. Metcalf and Eddy, "Wastewater Engineering, Treatment and Reuse", 4th Edition, Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2014.
2. Karia, G. L., and Christian, R. A., "Wastewater Treatment: Concepts and Design Approach", Prentice – Hall of India, 2018.

Reference Books:

1. Qasim Syed R., (2009), "Wastewater treatment plants: planning, design, and operation" - 2nd edition, CRC Press LLC
2. Peavy, H. S., Rowe, D. R., and Tchobanoglous, G., (2015), "Environmental Engineering", McGraw Hill Book Co.
3. Benefield R. D., and Randal C. W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.
4. Ronand L., and Droste, (1997)," Theory and Practice of Water and Wastewater Treatment", John Wiley and Sons Inc.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **http://cpheeo.gov.in/**
- **https://cpcb.nic.in/**

SWAYAM/NPTEL:

- **https://onlinecourses.nptel.ac.in/noc21_ce25/preview**
- **https://onlinecourses.nptel.ac.in/noc23_ch17/preview**
- **https://onlinecourses.nptel.ac.in/noc23_ch30/preview**

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Design of sanitary sewer: partial flow in sewers, economics of sewer design	Demo version of Sewer cad	Software skill
2	Design of Treatment Plant	Excel spread sheet	Software skill

Self-Learning Exercises:

1. **Case Study Projects**
2. **Mini Projects**
3. **Assignments**
4. **Poster Presentation**

Course Articulation:

COURSE OUTCOMES	PROGRAM SPECIFIC OUTCOMES						PROGRAM SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	3	3	3				
CO2	-	-	-	-	-	-				
CO3	-	-	-	-	-	-				
CO4	3	-	-	3	3	3				
CO5	3	-	-	3	3	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV140	Total Credits	4	Course Type	Professional Core Course		
Course Title	Industrial Pollution and its Prevention						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	32	4		CIE	SEE	Total
	Tutorial	20	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Wastewater Treatment, Solid Waste Management

COURSE OBJECTIVE: Conceptualize the importance of implementing pollution prevention methods in industries and encourage sustainable development.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Categorize industries based on pollution potential and relate pollution control norms.	L2
CO2	Illustrate general industrial process flow with waste generation points and summarize on fundamental principles and technologies for industrial pollution prevention.	L3
CO3	Select and evaluate feasibility of industrial pollution prevention plans.	L4
CO4	Design monitoring programs for pollution prevention and explain governmental and corporate responsibilities in industrial pollution prevention and sustainable development.	L3
CO5	Suggest suitable pollution prevention strategies for a given industry	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Lecture Hours
1	**Fundamentals of environmental pollution and prevention** Necessity of pollution prevention. Industrial pollution and management strategies. Types and categories of industries, rules for consent for establishment and operation, discharge standards, industrial hubs and pollution control norms. Mass load calculations at source and discharge points- simple numerical problems	08
2	**Industrial processes and waste streams** Typical industrial process flow diagrams, type and volume of waste generation, characterization – conventional and emerging contaminants – effects on environment, dual, triple and hybrid treatment technologies **Pollution prevention technologies or Waste Minimization/waste prevention Techniques** Change in Plant operations, retrofit modification, 5R concepts, process, material substitution/separation, cleaner technologies, water pinch analysis, zero liquid discharge	12
3	**Pollution prevention feasibility and plan.** Environmental, technical, economic & institutional feasibility analysis. Identifying pollution prevention opportunities and its implementation. Facility environmental auditing, Environmental management audit.	08

4	**Monitoring industrial pollution prevention programs** Product- Life Cycle Analysis and Assessment (LCA), Life Cycle Engineering (LCE), Prevention of Significant Deterioration (PSD) for industrial areas. **Governmental & Corporate responsibilities** Policies & strategies, Regulations & standards, Community actions, Environmental programs, sustainable development initiatives, partnerships and international programs.	**12**
5	**Industry specific pollution prevention strategies** Study on sources/processes of waste generation and its prevention in Printing, Textile, Pulp & Paper, Electronics and pharmaceutical industry and other industries of concern. **Case studies on industrial pollution prevention** The DOW chemical company, ARAMCO pollution prevention program, five leaf rating industries, Responsible Care Program, The World Environmental Centre Program, ISO certified industries.	**12**

Text Books:

- S.C. Bhatia, Pramod Kumar and Sarvesh Devaraj Industrial Pollution and Its Control (Volume I & II). Wood head Publishing India Pvt. Ltd., 2017.
- Harry Freeman Industrial Pollution Prevention Handbook (1st Edition). MacGraw Hill Inc., 1994.
- Ryan Dupont, Kumar Ganesan and Louis Theodore Pollution Prevention: Sustainability, Industrial Ecology and Green Engineering (2nd Edition). CRC Press. 2016.
- S.C. Bhatia Managing Industrial Pollution (1st Edition). Macmillan, 2003.
- H. Panda. "The Complete Guide on Industrial Pollution Control", (1st Edition). Asia Pacific Business Press Inc., 2011.
- Ireneusz Zbicinski, Product Design and Life Cycle Assessment (1st Edition) Baltic University Press, 2006.

Reference Books

- S. P. Mahajan Pollution Control in Process Industries (22nd reprint). Tata McGraw Hill Education, 2008.
- Nancy J. Sell Industrial Pollution control – Issues and Techniques (2nd Edition). John Wiley & Sons, 1992.
- Nelson Leonard Nemerow, Industrial Water Pollution: origins, characteristics, treatment (1st Edition) Addison-Wesley Educational Publishers Inc., 1978.
- Nelson L. Nemerow, Zero Pollution for Industry (1st Edition), Wiley-Interscience, 1995.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- Videos on YouTube
- Coursera
- https://css.umich.edu/sites/default/files/publication/CSS95-01.pdf
- https://www.taylorfrancis.com/books/mono/10.1201/9781315368436/pollution-prevention-ryan-dupont-kumar-ganesan-louis-theodore
- https://www.niir.org/books/book/complete-guide-on-industrial-pollution-control/isbn-9788178331409/zb,,183,a,0,0,a/index.html
- https://www.diva-portal.org/smash/get/diva2:604277/FULLTEXT01.pdf
- https://corporate.dow.com/en-us/about/legal/issues/dioxin/reducing-emissions.html
- https://www.aramco.com/-/media/publications/enviro-news/2018-28.pdf

- https://www.aramco.com/-/media/publications/enviro-news/2020-31.pdf

SWAYAM/NPTEL:

- Electrochemical Technology in Pollution Control, IISc Bangalore, Prof. J. R. Mudakavi, https://nptel.ac.in/courses/103108162
- Basic Environmental Engineering and Pollution Abatement, Prof. P. Mondal, IIT Roorkee, https://nptel.ac.in/courses/103107215
- Fundamentals of Environmental Pollution and Control, Prof. J. Bhattacharyya, IIT Kharagpur, https://nptel.ac.in/courses/123105001

Self-Learning Exercises:

1. **Case Study bibliography**

Course Articulation:

	PROGRAM OUTCOMES					
COURSE OUTCOMES ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	1	2	1
CO2	1	-	1	3	3	2
CO3	1	2	-	2	2	3
CO4	-	-	-	-	-	2
CO5	1	1	1	2	2	3

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV151	Total Credits	4	Course Type	Professional Core Course		
Course Title	Advanced Computational Methods And Optimization						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: UG Environmental System Optimization and Numerical Methods

COURSE OBJECTIVE: The course introduces both numerical methods and analysis along with optimization and statistics.The student will be gaining knowledge of partial differential equations, their analytical solutions. Optimization deals with both problems with constraints and without constraints. The course lays the base for statistical methods and their applications for environmental data analysis and interpretation.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Apply the partial differential equations using Newton-Raphson and Finite Element methods and arrive at solutions.	L3
CO2	Demonstrate the application of optimization problem to solve LPP.	L3
CO3	Apply simplex method for linear and numerical search method for the solution of nonlinear problems	L3
CO4	Describe and apply concepts of probability, central tendency and distribution methods to analyze the environmental data**.**	L3
CO5	Formulate null hypothesis and apply regression analysis for a given set of data.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Numerical Methods** Newton – Raphson method for solution of simultaneous equations, Numerical solutions ofpartial differential equations, finite difference, finite element method, explicit and implicitmethods to solve simple parabolic differential equations.	**12**
2	**Optimization** Classification of optimization problems. Importance in Environmental Studies. Single and multivariable optimization without and with constraints. Linear programming – standard form of problems – pivotal reduction of equations.	**10**
3	**Solution for LPP** Simplex method and two-phase method. Solutions of linear programming problems. **Numerical search methods** Dichotomous, Fibonacci and Golden section methods. Quadratic and cubic interpolation methods.	**10**
4	**Statistics and Probability** Frequency Distribution – Characteristics of Distributions: Central tendency and	**10**

	dispersion. Concepts of Probability – Binomial, Poisson and Normal distribution – applications,ofregression analysis problems.	
5	**Regression analysis** Methods of least square and regression, multiple regression, Chi-squared test, F test, t-test. Analysis of Variance – Tolerance and control charts. Solutions of regression analysis problems.	**10**

Text Books:

- Rao, S.S., (1996), **"**Optimization: Theory and applications**"** - Wiley Eastern Ltd. Publications
- Shanthakumar M., (1987), "Computer Based Numerical Analysis", Khanna Publishers
- Levin R I., (2008), "Statistics for Management", Pearson Education India

Reference Books:

- Anthony Ralston, and Philip Rabinowitz, (2001), "A First Course in Numerical Analysis"- Second Edition, Published by Dover Publications
- Desai, C.S., and John F Abel, (1972), "Introduction to the Finite Element Method:Numerical Method for Engineering Analysis" -Van Nostrand Reinhold, New York
- Taha, H.A., (2008), "Operations Research – An Introduction, 8th edition, PearsonEducation India

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

http://web.tecnico.ulisboa.pt/mcasquilho/compute/com/,Fibonacci/pdfHXu_ch1.pdf

http://www.universalteacherpublications.com/univ/ebooks/or/Ch3/twophase.htm

https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SPRA5301.pdf

SWAYAM/NPTEL:

- Optimization from fundamentals By Prof. Ankur A. Kulkarni | IIT Bombay
- Optimization, IIT Kharagpur by Prof. A. Goswami, Dr. Debjani Chakraborty **https://onlinecourses.nptel.ac.in/noc23_ma30/preview**

Self-Learning Exercises:

- **Case Study projects**
- **Mini Projects**
- **Any others**

Course Articulation:

	Program Outcomes						**PROGRAM SPECIFIC OUTCOMES**		
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	3	-	3
CO2	3	3	-	3	2	-	3	3	-
CO3	3	3	1	3	-	2	3	3	3
CO4	3	-	-	3	-	-	3	3	-
CO5	3	-	-	3	2	2	3	3	3

Department	Environmental Engineering						
Course Code	22PEV152	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Solid Waste Engineering and Management						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

High – 3, Medium – 2, Low – 1

COURSE PRE-REQUISITE: Elements of Environmental Engineering, Environmental Chemistry

COURSE OBJECTIVE: The student will have a thorough understanding of key functional elements in municipal solid waste management including waste minimization concepts. And also designing of engineered land fill sites for the disposal of wastes.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Identify improper practices of solid waste disposal and their environmental implications. Know the basic engineering principles of solid waste management and waste generation rate.	L3
CO2	Explain the various types of collection systems ,segregation and transportation of solid waste means.	L3
CO3	Identify the conventional and advanced treatment options of solid waste management and Interpret the concept of 4R.	L3
CO4	Describe the different disposal methods of solid waste and operational aspects of solid waste	L3
CO5	Explain the recent development in solid waste reuse and role of various organization in solid waste management	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Introduction** Sources of solid waste, engineering classification, characterization, quantification; functional elements of solid waste management system– Environmental implications of open dumping, Construction debris – management & handling. **Waste Generation:** Rate of generation, frequency, storage and refuse collection, Physical and chemical composition, quantity of waste, engineering properties of waste E-Waste Management, Bio-medical waste management.	12
2	**Collection, Segregation and Transport:** Handling and segregation of wastes at source, Collection (primary &secondary) and storage of municipal solid wastes, collection Equipment, transfer stations, collection route optimization and economics, regional concepts. System dynamics,	10
3	**Treatment Methods**: Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: Composting, vermin composting, vermin gradation, fermentation. Incineration and Pyrolysis of solid wastes. **Waste Minimization:** 4R: reduce, recover, recycle and reuse, case study,	10

	guidelines	
4	**Disposal Methods:** Impacts of open dumping, site investigation and selection, sanitary Land Filling-Types, geotechnical considerations, design criteria and design, Liners-earthen, geo membrane, geo synthetics and geo textiles. **Operational aspects of MSW Landfills**: Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems–Design, leachate treatment. Landfill post-closure environmental monitoring; land fill remediation.	**12**
5	**Recent Developments in Solid Wastes Reuse and Disposal**: Power Generation, Blending with construction materials and Best Management Practices (BMP). Community based waste management, Waste as a Resource concept, Public private Partnership (PPP) **Role of various organizations in Solid Waste Management**: Governmental, Non-Governmental, Citizen Forums	**08**

Text Books:

- Tchobanoglous G.,Theissen H., and EIiassenR., "Solid Waste Engineering Principles and Management Issues", Mc Graw Hill, NewYork.
- Pavoni J.L.,"Hand book of Solid Waste Disposal".
- Peavy, Rowe and Tchobanoglous, "Environmental Engineering",McGrawHill.
- Mantell C.L., (1975), "Solid Waste Management",JohnWiley.

Reference Books:

- CPHEEO Manual on Solid Waste Management.
- WHO Manual on Solid Waste Management.
- Vesiland A., "Solid Waste Engineering", Thompson Books.
- Flintoff F.,(1976),"Management of Solid Wastes in Developing Countries", WHO Regional Publications, South East Asia, NewDelhi

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCIA4002.pdf**

SWAYAM/NPTEL:

- **https://nptel.ac.in/courses/105103205**

Self-Learning Exercises:

- **Case Study projects**
- **Mini Projects**
- **Any others**

Course Articulation:

	Program Outcomes						**PROGRAM SPECIFIC OUTCOMES**		
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	3	-	3
CO2	3	2	-	3	2	-	2	3	-
CO3	3	3	1	2	-	2	3	3	3
CO4	3	-	-	3	-	-	2	2	-
CO5	3	-	-	3	2	2	3	3	3

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV153	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Ecology And Environmental Statistics						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE OBJECTIVE: The course introduces both ecology and statistics for environmental engineers. It explains different ecosystems and their interactions through symbiotic and synergic relationships, reviews ecologicalindices and modes. It describes trophic levels of lakes, influence of nutrient loading and control measures for eutrophication. The course also provides an in depth knowledge of basic statistics, statistical methods used for data processing, analysis and interpretation. It describes distribution methods, variance, correlation and regression and testing of hypotheses.

COURSE OUTCOMES (Cos)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Classify and discuss the structure and function of ecosystems, describe symbiotic andsynergic relationships, Illustrate the need for bio- geo- cycles, apply ecosystem models.	L1
CO2	Describe various trophic status of lakes, stratification and mixing of lakes, apply Leibig's and Shelford's law, explain the importance of biodiversity and its protective measures.	L2
CO3	Discuss the need for statistical methods for environmental data processing and analysis. Describe and perform frequency analysis and grouping of data.	L4
CO4	Review basic statistical data analysis and probability concepts. Distinguish betweennormal, Poisson's and binomial distribution. Solve numerical examples	L4
CO5	Describe correlation and regression methods of data analysis. Estimate the regression coefficient using different methods. Solve numerical problems. Perform different methods of null hypotheses on a given set of data. Solve numerical examples to understand different methods of null hypotheses.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Ecology:** Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Biogeochemical cycles, Ecological Pyramids. System ecology and Ecosystem Modeling **Aquatic and Terrestrial Ecosystems**: Diversity and dominance Indices, Ecosystem Models.	05	01
2	**Lake Ecosystem**: Trophic levels, stratification, **Limiting factors,**	06	02

	nutrient loading, nutrient enrichment, Leibig's Law,**Shelford's law of tolerance,** control of eutrophication. Biodiversity and ecological perspective – human benefits, threats, conservation, preservation and protection.		
3	Cumulative frequency; Surge's rule; Frequency polygon; Ogives; Problems. **Characteristics of Distributions**: Central Tendency – Averages: Arithmetic mean(Ungrouped data & Grouped data); Median (Ungrouped data & Grouped data); Mode (Ungrouped data & Grouped data); Skewness; Geometric mean; Weighted mean;Moving averages – equations to river hydraulics; Problems.	09	03
4	**Probability:** Basic concepts; Types – Classical approach, Relative frequencyapproach, Subjective approach; Probability rules; Problems. **Probability Distributions:** Binomial distribution – derivation; Poisson distribution – derivation; Normal distribution – errors, Gauss function, Area under normal curve, Useof standard normal probability distribution table; Problems.	10	03
5	**Correlation and Regression Analysis:** Scatter Diagrams; Correlation coefficient; Multiple correlation coefficient; Simple linear regression; Multiple regression equation; Estimation using regression line; Method of Least Squares; Standard error of estimate; Problems. **Testing Hypotheses:** Concepts basics; Null hypothesis; Level of Significance; Degreesof Freedom; Hypothesis testing of Means; The Chi-Squared test; F distribution; Studentst test; Analysis of Variance – within samples and between samples; Problems	10	03

Text Books:

- Odum E.P. & Barret G.W., (2005), "Fundamentals of Ecology", 5th Edition , Cengage Learning
- Adam M. Neville and John B. Kennedy, "Basic Statistical Methods for Engineers and Scientists", International Text Book Company.
- Richard I. Levin and David S. Rubin, "Statistics for Management", Prentice Hall of India Pvt. Ltd., New Delhi.

Reference Books:

- George E. P. Box, William G. Hunter, and J. Stuart Hunter, "Statistics for Experimentsan Introduction to Design, Data Analysis, and Model Building", John Wiley & Sons.
- APHA, (2002), "Standard Methods for Examination of Water and Wastewater"; 21stEdition.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **https://unstats.un.org/unsd/environment/envpdf/UNSD_Yaounde_Workshop/Session%2002-1%20Basic%20concepts%20(UNSD).pdf**

SWAYAM/NPTEL: NIL

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**
3. **Any others**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	3	-	3
CO2	1	-	3	3	-	3
CO3	-	-	-	3	3	3
CO4	-	-	3	-	3	3
CO5	-	2	-	3	3	3

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV161	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Risk Assessment And Hazardous Waste Management						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Ecology, Environmental Studies

COURSE OBJECTIVE: The course deals with sufficient knowledge on need and principles of risk assessment methodologies and tools. Hazardous waste management techniques are also covered. Provides detailed design aspects of the treatment, disposal and analytical methods of hazardous wastes.

COURSE OUTCOMES (Cos)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain risk assessment models and tools. Perform the process ofrisk assessment and illustrate exposure assessment models and Apply various testing methods for exposure assessment in different environmental systems and human exposure models.	L3
CO2	List hazard identification methods and Describe release assessment models and monitoring methodologies including statistical models and Review of case studies with respect to risk identification, assessment and emergency preparedness.	L4
CO3	Identify the sources and describe characteristics of hazardous wastes. Enumerate on waste minimization and resource recovery techniques	L3
CO4	Prepare the protocol for safe transport, treatment and disposal of hazardous wastes.	L5
CO5	Propose and design the treatment methods including Engineered land fill and containment and Describe in-situ and ex-situ bioremediation processes for contaminated soil.	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Risk Assessment** **Risk** – Importance, Identification, characterization, communication – Internal & External,Risk – Management Structure, management Cycle, Participation and Consultation **Ecological Health impact assessment**. Exposure assessment. Risk factors. Sorption/partitioning of organics, volatilization and structural / property activity relation. **Risk factor calculation, impact identification** – Risk Area, impact, Likelihood, consequences, Controls, Severity, risk score calculation; Toxicology and Risk Assessment:Toxic effects, Dose response assessment, Risk exposure assessment,	10

	Carcinogenesis, ecotoxicology, risk characterization.	
2	**Hazard identification and Risk Assessment** – HAZOP, HAZID, Risk Ranking Matrix, Process and Instrumentation Diagram, and importance of Standard operating procedures,Material safety and Data Sheets, Guidelines, case study **Emergency Preparedness**, Incident Investigation, Non Conformity, action and Preventive and Corrective Actions, Auditing.	**10**
3	**Hazardous Waste Management** Sources, Classification, Impacts of Mismanagement, Problems in Developing Countries,and Regulations for Hazardous Waste Management **Hazardous Waste Characterization**, Designated Hazardous Wastes, Waste Minimization and Resource Recovery – Approaches, Development of a Waste Tracking System, Selection of waste Minimization Process, Case Studies.	**10**
4	**Transportation of Hazardous Waste** – requirements, regulations, containers and Labeling, bulk and non-bulk transport, Emergency Response, personal protective equipment. **Treatment & Disposal:** Physico-chemical, Chemical and Biological Treatment ofhazardous waste, Thermal treatment – Incineration and pyrolysis	**10**
5	**Landfill** – Site selection, design approach, liner and leachate and gaseous collection systems. Cover system, Contaminant transport through landfill barriers, landfill stability, closure and post closure care, other types of disposal facilities, Design Criteria and Examples. Facility Siting and Process Selection for treatment, storage, disposal facility (TSDF). In situ and Ex situ bioremediation of contaminated soils. Software mini tab	**12**

Text Books:

- Lagrega M.D., Buckingham P.L., and Evans J.C., (1994), "Hazardous wasteManagement", McGraw Hill International Edition
- Wentz C.A., (1995), "Hazardous Waste Management", McGraw Hill International Edition

Reference Books:

- Sincero A.P., and Sincero G.A., (1996)," Environmental Engineering- A Design Approach", Eastern Economy Edition, Prentice Hall of India Pvt., Ltd.
- Lehman, (1983), "Hazardous Waste Disposal", Plenum Press.
- Fawcett, (1984), "Hazardous and Toxic Materials: Safe Handling and Disposal", JohnWiley.
- CPCB guidelines for Hazardous Wastes

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

https://inis.iaea.org/collection/NCLCollectionStore/_Public/30/001/30001804.pdf

SWAYAM/NPTEL:

https://nptel.ac.in/courses/105106056

Self-Learning Exercises:

- **Case Study projects**
- **Mini Projects**
- **Any others**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	3	-	3				
CO2	3	-	-	3	3	3				
CO3	3	-	-	-	-	-				
CO4	3	-	-	3	-	3				
CO5	3	3	-	3	3	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV162	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Natural Resources Conservation And Management						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Ecology, Environmental Studies

COURSE OBJECTIVE: The course describes natural resources and their significance for life existence with an emphasis on Sustainable Development. It deliberates in depth on the various conservation techniques to be adopted. The course also enriches the student with possible legislative measures and managementoptions for effective and efficient management of available natural resources for human consumption and societal development.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Classify natural resources, identifies the threats and comprehends the flow of resources in nature capability on issues such as resource allocation, use and pollution problems of forests.	L2
CO2	Enhances thinking capability on issues such as resource allocation, use and pollution problems of water, and abiotic components of natural resources.	L2
CO3	Outlines the importance of food security, modern agricultural practices, use and impact of chemical fertilizers and pesticides. Able to estimate and identify food production and its problems related to storage, transport and allocation.	L3
CO4	Capable of determining energy demand. Able to understand the energy footprint, crisis in energy production, impacts of fossil fuel burning. Develops knowledge on alternate energy sources for sustainable development.	L3
CO5	Comprehend the symbiotic and synergic relationships of different ecosystems. Appreciates the need for conserving biodiversity and identifies possible threats. Able to list and appreciate the ecological importance of major biodiversity hot-spots. Capable of applying the knowledge of environmental legislation for resource management.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Introduction to Sustainable Development** Need, importance and role of Environmental Engineers **Renewable and Non-renewable Resources** Resources - Appraisal, problem, classes, renewable resources flow, destruction versusconservation **Forest Resources**	10

	Ecological and economic significance, types and management, forest resources of theworld and India, deforestation and its impact and solution	
2	**Water Resources** Worldwide supply, renewal and distribution, water resources of India, Managing water resources, Environmental Impact of large dams, River water disputes, water pollutionproblems **Mineral Resources** Sources, exhaustibility, Exploration and uses, Environmental impacts and solutions	**10**
3	**Food Resources** World food production and problems, agri production, live stock production, modern agripractices, use of pesticides and fertilizers – environmental impact, environmental limits of increasing food production, sustainable agriculture **Land Resources** Land as a resource, soil – types and degradation, soil conservation	**10**
4	**Energy Resources** Energy resources, world energy demand, Indian resources, renewable, alternate / non- conventional energy resources – solar, tidal, wind, geothermal, hydel, hydrogen, biomass, nuclear, wave (ocean)	**10**
5	**Biodiversity Resources** Genetic and species diversity, Ecosystem diversity & major ecosystems, importance ofbiodiversity, value of biodiversity, hot-spots of biodiversity, threats to biodiversity, conservation of biodiversity **Environmental Legislation for resource management** Legal frame work, organizations and institutions, acts promulgated by India – Wild LifeAct, Biodiversity Conservation Act, Environmental (Protection) Act, Forest Act	**12**

Text Books:

- Anjaneyulu Y., (2004), "Introduction to Environmental Science", B.S. Publications, Hyderabad
- Misra S.P. and Pandey S.N., (2008), "Essential Environmental Studies", Ane Book Publishers, New Delhi
- Ram krishna mandal., (2015), "Natural resources management under sustainable development"

Reference Books:

- Trivedi P R and Sudharshan K N., "Environment and natural resources conservation"
- Vajiram and Ravi., (2018), "NATURAL RESOURCES"

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **http://npshistory.com/publications/natres-mgt-handbook-1968.pdf**

SWAYAM/NPTEL:

- **12 Weeks NPTEL Course on "Soil and Water Conservation Engineering" by** Prof. Rajendra Singh, IIT, Kharagpur
- **12 Weeks NPTEL Course on "Non-Conventinal Energy Resources" by** Prof. Prathap Haridoss, IIT, Madras

Self-Learning Exercises:

- **Case Study projects**
- **Mini Projects**
- **Any others**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES						PROGRAM SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-				
CO2	3	-	-	3	-	3				
CO3	3	-	-	3	-	3				
CO4	3	-	-	3	-	3				
CO5	3	-	-	3	-	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV163	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Environmental Health And Occupational Safety						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	4		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	4	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Environmental Studies

COURSE OBJECTIVE: This course enables student to learn the basic principles of safety, OSH act and the national policy. It instills knowledge on cause - effect relationships of accidents at work places, need for economics & ergonomics, hazard identification and control aspects, fire prevention and control. Work place health related issues are also covered.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain Occupational Health safety administration, theories of accident, Investigation & stages of document preparation.	L2
CO2	Interpret ergonomics and problem associated with strategies and measures and risk assessment.	L2
CO3	Identify and analyze hazards in selected industries using techniques and suggest remedial measures.	L3
CO4	Explain the aspects of fire – types, prevention and protection & understanding the need of product safety and electrical safety.	L2
CO5	Discuss Health and Safety Considerations at work places with understanding of PPEs & recommend health emergency mechanism and address best management practices.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours
		Lecture
1	**Introduction to Occupational Health,** Occupational Hazard and control, Principles of Safety, National Safety Policy. Occupational safety and Health Act (OSHA), Occupational Health and Safety administration - Laws governing OSHA and right to know. **Accident** – causation, investigation, investigation plan, Methods of acquiring accidentfacts, Supervisory role in accident investigation, industrial safety – Man	10

	vs. Machine, Facts and fact finding – safety psychology and education. Monitoring, Report writing & mind map, Review and Audit.	
2	**Ergonomics at work place,** Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, and Ergonomic Programs. Risk assessment – Objectives, Needs and forms.	**10**
3	**Hazard cognition and Analysis,** Human Error Analysis – Fault Tree Analysis – Emergency Response, Decision for action – purpose and considerations. Engineering versus management control, Hazard control measures.	**10**
4	**Fire prevention and protection -** Fire Triangle, Stages of Fire development, mode of heat transfer, Classification of fire and Fire Extinguishers. Electrical Safety – Hazards associated and protective methods. Product safety – Technical Requirements of Product safety. Chemical Safety – Routes of entry, sources of information used to convey a chemical's hazard, safety procedures at nuclear installations.	**12**
5	**Health considerations at work place –** types of diseases and their spread, Emergency, prevention. Personal Protective Equipment (PPE) – types, importance and advantages. Occupational Health and Safety considerations during handling of municipal solid wastes, in water and wastewater treatment plants.	**10**

Text Books:

- D.L. Goetsch, "Occupational Safety and Health for Technologists,Engineers and Managers", Prentice Hall, 1999.
- H.W. Heinrich, "Industrial Accident Prevention - A Scientific Approach",McGraw Book Co, 2007.

Reference Books:

- D.A. Colling, "Industrial Safety Management and Technology", Prentice Hall,New Delhi, 1990.
- D.E. Della and Giustina, "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc, 1996.
- Biomedical Waste (Handling and Management) Rules
- "IndustrialSafety and Pollution Control Handbook", National Safety Council and Associate (Data) Publishers Pvt. Ltd., 1991.
- R. A. Trevethick, "Environmental and Industrial Health Hazards"- WilliamHeinemann Medical Books Ltd., London, 1973.

Journals/Magazines:

- Safety: Safety+Health Magazine (safetyandhealthmagazine.com)
- Occupational Health & Safety Magazine Digital Edition -- Occupational Health & Safety (ohsonline.com)
- INDUSTRIAL HEALTH & SAFETY REVIEW | Fire Industry Magazine | Safety Magazine India | Security Magazine India | Life Safety Magazine | Occupational Health Safety Magazine (isrmag.com)

Web/Digital resources:

- Microsoft Word - lecnote_fm_template.doc (cartercenter.org)
- I (pria-academy.org)
- 7278484 (osti.gov)

SWAYAM/NPTEL:

- Safety and Risk Analytics by Prof. Jhareswar Maiti, IIT Kharagpur.
- Safety in Construction by Prof. J. Uma Maheswari, IIT Delhi
- Introduction to Human Factors and Ergonomics by Vivek Kant, Ph.D., IIT Bombay

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Emerging issue related with different industries and acts.	Regular field and Industrial visit	Communication and Basic Knowledge

Self-Learning Exercises:

- **Case Study projects: Presentation on the specific case studies on recent issue.**
- **Mini Projects: Internships**
- **Any others**

Course Articulation:

	Program Outcomes						PROGRAM SPECIFIC OUTCOMES		
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	3	3	-
CO2	3	3	-	3	2	-	3	3	-
CO3	3	3	2	3	-	2	3	3	3
CO4	3	-	-	3	-	-	-	3	-
CO5	3	-	-	3	2	2	-	-	3

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV170L	Total Credits	1.5	Course Type	Professional Core Laboratory		
Course Title	Physico-Chemical Treatment Processes Lab						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	-	-		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	39	1.5	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	39	1.5	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PRE-REQUISITE: Chemistry

COURSE OBJECTIVE: The lab course provides an opportunity to collect and preserve water samples from different sources, conduct various tests on water quality parameters, perform experiments on selected lab scale treatment processes. It also enriches the student knowledge of determining coagulant dose, efficiency of settling basin, rate of adsorption and life of adsorbent. The lab course also exposes the student to various advanced instruments used in analyzing toxic chemicals and trace organicsin water and wastewater.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Acquaint with precision and accuracy of analytical data and to appreciate rounding off to asignificant value in the context of water quality parameters. Apply various methods of sample preservation and conduct titrimetric and instrumental analyses on water samples	L3
CO2	Carryout and determine treatment efficiency of various water treatment processes – aeration, jar test for optimum dose of coagulant and settling experiments, adsorptionexperiments with isotherms and break through curve	L4
CO3	Plan and perform filtration experiments, understand the significance of break point chlorination and plot particle size distribution curve, determine Uniformity coefficient. Develop the skill of analyzing, interpreting and inferring the laboratory data	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

Week	List of Experiments/ Programs	No. of Hours
1	Titrimetric and Instrumental Analyses of Water Quality Parameters – Ground and TapWater Samples	3
2	Titrimetric and Instrumental Analyses of Water Quality Parameters – Ground and TapWater Samples	3
3	Determination of Chlorine Demand for a given water sample and to plot the Break PointChlorination Curve	3
4	Determination of Optimum Coagulant Dose using Jar Test Apparatus for givenwater samples	3

5	Conducting Settling Experiments and identify Type 1 and Type 2 settling and thedetermination of settling efficiency	3
6	Performing Sieve Analysis for Filter Sand samples	3
7	Performing Sieve Analysis for Filter Sand samples	3
8	Carrying out experiments on Single and Multimedia Filters and Head Loss calculation	3
9	Carrying out experiments on Single and Multimedia Filters and Head Loss calculation	3
10	Conducting Adsorption Experiments using Activated Carbon and plotting of Isotherms and Breakthrough Curve	3
11	Conducting Adsorption Experiments using Activated Carbon and plotting of Isotherms and Breakthrough Curve	3
12	Demonstration of Advanced Instruments such as ICP, UV-VIS Spectrophotometer,HPLC	3
13	Laboratory Test	3

Text Books:

- Sawyer G.N., McCarty P.L. and Parkin G.F. "Chemistry for Environmental Engineering and Science", 5th Edition, Tata McGraw Hill publications. 2003.

Reference Books:

- APHA - AWWA - WEF. "Standard Methods for Examination of Water and Wastewater", Washington DC. 21st Centennial edition. 2014.
- Manual on water and wastewater analysis, NEERI, Nagpur.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Course Articulation:

COURSE OUTCOMES ↓	**PROGRAM OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	3	-	3	-	3
CO2	3	3	-	3	-	3
CO3	-	3	-	3	-	3

High – 3, Medium – 2, Low – 1