2nd Semester Syllabus

Department	Environmental Engineering						
Course Code	22PEV210	Total Credits	4	Course Type	Professional Core Course		
Course Title	Air Quality Modeling and Design of Air Pollution Control Techniques						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	38	4		CIE	SEE	Total
	Tutorial	14	-	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 covers the air pollution sources, classification, effects, and measurement of air pollutants, standards. The course emphasizes on global burden of disease, importance of meteorology in dilution and dispersion, pollutants, models for estimating dilution and dispersion of pollutants and control technologies.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Able to distinguish pristine and polluted atmosphere based on composition and explain the interlinks of air emissions, global burden of disease, climate change and urban planning.	L4
CO2	Describe the basic concepts atmospheric stability and influence of meteorological parameters which influence the dispersion of air pollutants and to create wind rose diagram	L2
CO3	Explain the underlying principle of sampling, general guidelines, sampling types, procedure and importance of gaseous and particulate matter monitoring for assessing ambient air quality	L2
CO4	Explain different types of models , assess the suitability of model for given scenario and estimate plume rise	L2
CO5	Describe the working principle and design aspects of various air pollution control equipment and importance of source apportionment in framing policy matters	L2

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

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Introduction :** Composition and structure of the atmosphere; Interlinks of air emissions, Radiative forcing, UHI, climate change and urban planning. Air pollution: sources, classification and Impacts on public health and Environment. Global burden of disease. Numerical problems on Units and conversions.	07	02
2	**Meteorology:** Wind circulation, solar radiation, lapse rates, atmospheric stability conditions and Pasquill and Gifford atmospheric stability classification, wind velocity profile, Maximum Mixing Depth, Ventilation coefficient, Temperature Inversions, plume behavior, Wind rose diagram, general characteristics of stack emissions	08	02
3	**Ambient air quality monitoring:** Sampling concepts (active, passive, stationary, mobile monitoring). General guidelines for monitoring and Sampling devices for gaseous and non-gaseous pollutants. Stack sampling (Isokinetic sampling), gas exhaust analyzer.	08	04

	Importance of Indoor air quality & monitoring parameters		
4	**Pollutants' dispersion models:** Need for air quality models, types of models. Box model, Gaussian plume dispersion model – for point source (with and without reflection, for ground level and elevated source). Plume rise and effective stack height calculations and Numerical Problems.	**06**	**04**
5	**Air Pollution Control Equipment:** Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP) - Design principles and design criteria, Numerical problems Need for Emission inventory and source apportionment	**07** **02**	**02**

Text Books:

- Wark, K., Warner, C.F., and Davis, W.T., (1998), "Air Pollution- Its Origin and Control" 3rd edition, Harper & Row Publishers, New York.
- Stern A.C, Boubel R.W, Turner D.B., Fox D.L (1984) "Fundamentals of Air Pollution" Second edition Academic Press Inc

Reference Books:

- Sincero, A.P. andSincero, G.A. (1999), "Environmental Engineering - A Design Approach",Prentice Hall of India, New Delhi.

Journals/Magazines:

- Refer good research articles from Atmospheric environment, Air Pollution Research, Science of total environment

Web/Digital resources:

- WHO Global Air Quality Guidelines https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines
- CPCB Website
- Guidelines for the Measurement of Ambient Air Pollutants https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMjdfMTQ1ODExMDQyNl9OZXdJdGVtXzE5Nl9OQUFRTVNfVm9sdW1lLUkucGRm

SWAYAM/NPTEL:

Air pollution and control offered by IIT Roorkee

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Preparing Windrose diagram for given meteorological data set	WRPLOT Lakes software/ Origin Lab	Software exposure Interpreting Windrose plot for given data/study region
2	Preparation of concentration contour for given emission scenario	Any US-EPA free softwares/ CFD simulations	Estimating dilution, dispersion

Self-Learning Exercises:

1. **Case Study projects –** Review on scientific literature to understand the recent trends research
2. **Mini Projects –** Air quality Data visualization and analysis based on data available in public domain using visualization and data analysis softwares (SPSS, Tablaue, R, Python, Matlab)
3. **Any others –** On campus monitoring/Demonstration of monitoring equipment's available in lab

Course Articulation:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	-	2
CO2	3	2	3	2	-	-
CO3	3	-	3	-	-	-
CO4	3	-	3	-	2	-
CO5	3	-	3	2	2	2

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV220	Total Credits	4	Course Type	Professional Core Course		
Course Title	Environmental Legislation and Impact Assessment						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	40	4		CIE	SEE	Total
	Tutorial	12	-	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 provides a detailed insight into the Indian environmental legislation aspects includingNational Environmental Policy, legal framework, Green Tribunal and various Acts related to environmental pollution, Prevention and control.

The course also deliberates on carrying capacity concepts, objectives, scope and types of impact assessment. Explains the process of impact assessment; and deals with various methodologies. Distinguishes between EMP and DMP. It reviews few case studies on EIA.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the Constitution of India, National Environmental policy and Legal frameworkrelated to environmental aspects.	L2
CO2	List and identify various Indian Environmental Acts in vogue, Amendments, modificationsand notifications. Describe the Role of Green Tribunal.	L2
CO3	Discuss the concept of Carrying Capacity, steps to carryout Environmental Impact Assessment studies, defines objectives and types of EIA. Lists and describes.	L2
CO4	Describe various EIA methodologies, the need for public participation in EIA. Explain importance of assessment of various attributes and carryout Environmental audit.	L4
CO5	Distinguish between EMP and DMP and review important case studies.	L4

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

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Environmental Legislation:** Introduction & need, Constitution of India- Fundamental rights, duties, articles sections related to environmental protection, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (National Green Tribunal) Legal Framework, Legislative act, rules, regulations, notification andamendments.	08	02
2	**Indian Environmental Acts**: Environment (Protection) Act, 1986, Air & Water Acts. Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, Forest Act, 1927, Environmental Tribunal Authority, 1995. Wild Life Protection Act, 1972,Biodiversity Rules, 2004- Authorities, delegation, functions and penal procedures. ISO certification.	10	02
3	**Environmental Impact Assessment:** Carrying capacity concept,	10	02

	Evolution, Objectives, Types - Rapid and Comprehensive EIA, EIS, FONSI, Accreditation to EIA Consultants. Scope of EIA, Step-by-step process, EIA process limitations, TOR.		
4	Methodologies and techniques of EIA, Public participation in EIA. Attributes – Air, water, land, noise, biotic, socio-economic - Standards and Value functions, Impact prediction models. Environmental Audit.	08	02
5	Environmental Management Plan (EMP) and Disaster Management Plan (DMP). EIA Case Studies – Pharmaceutical, Thermal Power Plant, Mining, Airports and Water and Wastewater Treatment Plants.	04	04

Text Books:

- CPR Environmental Education Centre, (2006), Environmental Laws of India – An Introduction.
- Canter L., (1995), "Environmental Impact Assessment", McGraw Hill.
- Jain R.K., Urban L.V., Stacey G.S., (1977), "Environmental Impact Analysis – A New Dimension in Decision Making", Van Nostrand Reinhold Co. 12
- Clark B.C. Bisett and Tomlinsan P, (1985), "Perspective on Environmental Impact Assessment", Allied Publishers.

Reference Books:

- Indian Acts related to Environmental Pollution Prevention and Control.
- Anjaneyulu and Valli Manickam, (2010), "Environmental Impact Assessment Methodologies", BS Publications.

Journals/Magazines:

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

Web/Digital resources:

- Executive summary of the Project reports in Karnataka - https://kspcb.karnataka.gov.in/node/406
- Accreditation of EIA Consultant: Organizations https://nabet.qci.org.in/eiafile/Accreditation_EIA_Consultant_organizations.pdf
- Reference DMP report: http://environmentclearance.nic.in/writereaddata/online/RiskAssessment/17032016K2ZJUBO1Annexure_RiskAssessment.pdf

SWAYAM/NPTEL:

- Environmental Impact Assessment by Prof. Harshit Sosan Lakra, IIT Roorkee.

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	EIA methodologies	Using old reports, preparing checklists, matrices, networks with examples	Use of techniques for assessment
2	Important Case studies		

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	-	3
CO2	3	-	3	3	-	3
CO3	3	3	3	3	-	3
CO4	-	3	3	3	2	-
CO5	-	3	-	3	2	-

High – 3, Medium – 2, Low – 1

Department	**Environmental Engineering**						
Course Code	**22PEV230**	**Total Credits**	**4**	**Course Type**	Professional Core Course		
Course Title	**Transport Processes And Modelling**						
Teaching Learning Process		**Contact Hours**	**Credits**	**Assessment in Weightage and marks**			
	Lecture	**41**	**4**		**CIE**	**SEE**	**Total**
	Tutorial	**11**	**-**	**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: Water Resources and Hydrology

COURSE OBJECTIVE:

The course emphasizes on various transport processes and illustration of mathematical models insimulation and prediction of pollutant concentration, and dispersion in surface and subsurface water bodies.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Illustrate the fate and transport of pollutants with case studies. Derive related equations with analytical solutions.	**L3**
CO2	Correlation of the mathematical models and prediction of pollutant (conservative and non-conservative) concentrations in lakes and rivers under steady-state conditions with suitable numerical exercises.	**L3**
CO3	Explain the concept of mixing zone in natural aquatic bodies and its influence on pollutant dispersion and also to prepare field monitoring protocol for measuring hydraulic as well water quality parameters.	**L2**
CO4	Design and compare stratified and completely-mixed lake systems with mathematical equations to compute pollutant distribution in lake, Ocean and estuarine systems.	**L2**
CO5	Derive 1-D groundwater model considering the influencing processes and apply the various prediction models for prediction of groundwater quality.	**L3**

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

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	Modelling – Introduction, applications in environmental management. Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion,convective - diffusion equations for turbulent & shear flow regimes.	08	02
2	Steady-state water quality modeling - models for conservative and non-conservativesubstances. 1-D Oxygen balance models - Streeter-Phelps equation, critical point method. Calibration and verification of DO simulation model. Dissolved oxygen models for lakes under completely mixed and stratified conditions.	09	03

3	Mixing zones in rivers – types of outfalls and mixing regimes. Stream tube concept, Steady-state 2-D analysis. Parameter estimation - lateral mixing coefficient - critical point method, Case studies.	08	02
4	Data collection and analysis - specialized water quality surveys, estimation of decay and re-aeration rates. Estuaries – Salinity distribution, mathematical analysis of pollutant dispersion in estuaries. Ocean - disposal of wastewater - siting and design of outfalls.	08	02
5	Ground water quality modeling concepts - formulation of 1-D model with decay and retardation for instantaneous sources, plume delineation studies. Migration of pollutants through soil. Salient features of environmental simulation models / software. Lab Component River Water Quality Prediction Models – STREAM, QUAL2KW, MIXING ZONE Models Data Analysis Models IA 2D PIT Prediction Models for estuary, lake and ocean using excel spreadsheet	08	02

Text Books:

1. Thomann R.V., and Mueller J.A., (1987), "Principles of Water Quality Management and Control", Harper & Row Publications.
2. Schnoor J.L., (1996) "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.

Reference Books:

1. Rich L.G., "Environmental Systems Engineering ", McGraw Hill.
2. Thomann R.V., (1980), "Systems Approach to Water Quality Management", McGraw Hill.
3. Lee C.C., and Lin S.D., (1999), "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.
4. Metcalf and Eddy Inc., (1995), "Wastewater Engineering - Treatment and Reuse", 3RD Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Journals/Magazines:

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

Web/Digital resources:

https://assets.cambridge.org/97805211/19245/frontmatter/9780521119245_frontmatter.pdf

SWAYAM/NPTEL:

https://www.digimat.in/nptel/courses/video/103108098/L01.html

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	3	3	3
CO2	3	-	3	3	3	3
CO3	3	3	3	3	-	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV241	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Operation, Maintenance and Management of Environmental Facilities						
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: Water Treatment Engineering, Design of Wastewater Treatment Processes

COURSE OBJECTIVE: The course encompasses the aspects of operation, maintenance and management of Environmental facilities. It highlights the operational problems and suggests the control, preventive and corrective measures.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	State the significance, types, basic principles, organizational structure, work planning and scheduling and cost estimates of O&M	L2
CO2	Identify and list the operational problems in water treatment and supply facilities and apply preventive and corrective maintenance measures	L4
CO3	Describe the operational problems in Domestic wastewater collection and treatment facilities and enumerate the remedial measures.	L4
CO4	Describe the operational problems in industrial wastewater collection and treatment facilities and enumerate the remedial measures.	L4
CO5	Identify and discuss the troubles in air pollution control systems and suggest the preventive and control measures	L3

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

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Introduction** Significance, Basic Principles, Objectives, Requirements, limitations, Organizational Structure, Work Planning, Preparation and Scheduling of operation, maintenance and Management. **Data Base Facilities** Plan, Drawing, Map, Operation Manual, Record keeping, Task Description Sheet (TDS), Standard Operating Procedure (SOP) Computer Applications in O&M and SCADA.	08
2	**Water Treatment and Supply Facilities** – Operation, maintenance and management problems and their respective remedial and control measures of Different Units of water Treatment**: Screening, Aeration, Sedimentation, coagulation and Flocculation, Filtration, Disinfection, Water Softening and Defluoridation** and Water Supply Facilities: Intakes, Rising Mains, Pumping Station, Distribution System	10

3	**Wastewater Collection and Treatment Facilities:** Operation, maintenance and management problems and their respective remedial and control measures of wastewater collection & conveyance – Sewer Inspection, Sewer Cleaning Equipments, Sewer Appurtenances Operation, maintenance and management problems and their respective remedial and control measures of wastewater treatment facilities – Screening, Grit Chamber, Primary Settling tank, Secondary Treatment Processes – Activated Sludge Process (ASP) and Trickling Filters	**14**
4	**Industrial wastewater collection and treatment facilities**: Mixing of Industrial Wastewater with Municipal Wastewater – Partially or Fully, Operation, maintenance and management problems and their respective remedial and control measures of Industrial Wastewater treatment facility – Volume Reduction Methods, Strength Reduction Methods, Neutralization tank, Equalization Tank, Proportioning Operation, maintenance and management problems and their respective remedial and control measures for treatment facilities in Manufacturing Industries: Pulp and Pape, Cement, Sugar, Fertilizer, Steel Operation, maintenance and management problems and their respective remedial and control measures for treatment facilities in Processing Industries: Dairy, Tannery, Distillery, Pharmaceutical, Food Processing.	**14**
5	**Air Pollution Control Facilities:** Operation, maintenance and management problems and their respective remedial and control measures of air pollution control facilities - Gravity settling chambers, Centrifugal collectors, Wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP).	**06**

Text Books:

- Hammer M.J., and Hammer Jr. M.J., (2008)," Water and Wastewater Technology", Prentice Hall of India Pvt. Ltd., New Delhi.
- Metcalf and Eddy Inc., (2003), "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering" McGraw Hill.
- Santhosh Kumar Garg, "Water Supply Engineerng", Khanna Publishers (Recent Edition).
- B. S. N. Raju, "Water Supply and Wastewater Engineering"

Reference Books:

- Training Manual on O&M for Municipal Staff, Asian Development Bank Project, Government of Karnataka.
- CPHEEO Manual, (1999) "Water Supply & Treatment", GOI Publication.
- CPHEEO Manual., (1999) on Sewerage & Sewerage Treatment, GOI Publication.
- National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991), "Industrial Safety and Pollution Control Handbook"

Journals/Magazines:

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

Web/Digital resources:

https://www.researchgate.net/publication/305309435_Operation_And_Maintenance_In_Facilities_Management_Practices_A_Gap_Analysis_In_Malaysia

Self-Learning Exercises:

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

Course Articulation:

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

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV242	Total Credits	04	Course Type	Professional Elective Course		
Course Title	Design of Advanced Wastewater Treatment Processes						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	40	4		CIE	SEE	Total
	Tutorial	12	-	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, Ecology and Wastewater Treatment technology.

COURSE OBJECTIVE: The course covers in-depth the advanced and hybrid wastewater treatment systems for the removal of nutrients, toxic organics, inorganic and trace contaminants, as well as sludge handling and disposal practices. It allows the student to understand design criteria and design the various advanced wastewater treatment processes.

COURSEOUTCOMES(COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the residual pollutants in the effluent of conventionally treated wastewater and their removal by various advanced processes	L3
CO2	Describe different combinations of hybrid reactor systems and to design them for a given situation.	L3
CO3	Explain the nutrients removal using advanced wastewater treatment processes design.	L3
CO4	Explain the fecal sludge management, handling and disposal methods of both biological a chemical sludge from effluent treatment facilities and design principles of sludge treatment.	L4
CO5	Use Genetically modified microorganisms for treatment of wastewater and concepts of power generation from wastewater.	L4

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

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Advanced Wastewater Treatment Systems:** Residuals in treated wastewater and their Removal, Gas Stripping, DAF, Advanced Oxidation, Electro dialysis, Ion Exchange & Adsorption, Micro and Ultra Filtration	06	02
2	**Hybrid Wastewater Treatment Systems:** Need for upgrading treatment plants and advanced Wastewater Treatment Systems, Possible Combinations of Physico chemical and Biological Processes and anaerobic filters, multistage anaerobic filters. Electrochemical coagulation, Membrane filtration, Membrane bio reactors, Microbial fuel cells, Decentralized Wastewater Treatment System. Moving bed biofilm reactor.	12	04

3	**Nutrients' Removal from Wastewaters:** Nitrification and denitrification, physico chemical and biological phosphorus removal, SBR and its modifications. **Biological sludge** – Sources and generation, characterization, utilization possibilities–compost.	08	02
4	**Fecal Sludge Management (FSM)** Fecal Sludge- Characteristics, Quantification, FS Value Chain, Containment, Transportation, Collection and Conveyance. Design of a Fecal Sludge Treatment plant; Case studies. **Industrial Sludge Management** Chemical and biological sludge – sources and generation, Quantification and characterization, sludge volume index (SVI), centrifugal settleability index (CSI), alternate uses of sludge and disposal options. Calorific value estimation from proximate and ultimate analysis data.	08	02
5	**Recent Trends** Genetically modified microorganisms for wastewater treatment – externalities and wastewater reclamation facilities. Environmental Biotechnology genetically engineered microorganisms for wastewater treatment, bioremediation, power generation from wastewater.	06	02

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., "Wastewater treatment plants: planning, design, and operation" - 2nd edition, CRC Press LLC,2009.
2. Peavy, H. S., Rowe, D. R., and Tchobanoglous, G., "Environmental Engineering", McGraw Hill Book Co.,2015.
3. Benefield R. D., and Randal C. W., "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey,1980.
4. Ronand L., and Droste, "Theory and Practice of Water and Wastewater Treatment", John Wiley and Sons Inc.,1997.
5. Moo-YoungM., AndersonW.A., ChakrabartyA.M., "Environmental Biotechnology– Principles and Applications," Kluwer Academic Publishers, 2007.

Journals/Magazines:

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

Web/Digital resources:

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

SWAYAM/NPTEL:

- **https://nptel.ac.in/courses/105105048**
- **https://www.nptelvideos.com/video.php?id=1115**

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Design of Treatment Plant	Excel spread sheet	software
2			

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	**22PEV243**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**Global Warming and Climate Change**						
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, Chemistry and Biology

COURSE OBJECTIVE: The course emphasizes on the history of earth's climate, climate change, climate change impacts and vulnerability. It also covers the significant influence of anthropogenic and developmental activities on global warming and climate change. Several climate change models are also introduced. The student gains the knowledge of climate change mitigative measures, emission trading and its monitoring.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Review earth's climate change, identifies the causes for climate change and describes theclimate change models and their application.	L3
CO2	Describe impacts of climate change on various environmental compartments and Stresses the need for vulnerability assessment and its approach.	L2
CO3	Explain the Indian scenario of climate change and its impact and reviews various impact predictive models.	L2
CO4	Define & describes emission trading, distinguishes different types of emission trading,understands the consequences of emission trading., Highlight the need for emission trading, Describe emission trading mechanisms	L3
CO5	State the importance of suitable monitoring and enforcing agencies, their role and responsibilities in emission trading.	L4

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

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Introduction**: Global warming aggravations, Earth's climate, climate change, drivers of climate change, Kyoto,Montreal and New Delhi Protocols **Climate models**: Models for climate change, GCMs, RCMs, climate change scenarios; Sector models – water resources, Agricultural, forestry, energy, GHG prediction models	**10**
2	**Climate change impacts**: Impacts of climate change on water sector, agriculture sector,infrastructure and energy systems with case studies **Vulnerability/adaptation**: Need for vulnerability assessment; generic steps, approachesand tools of assessment; adaptation to climate change by various sectors **Mitigation**: Mitigation measures for climate change, CDM and case studies	**12**
3	Climate change and India, impacts, sectoral and regional vulnerability in India, Evaluation of model simulation over India;	**10**

4	**Emission trading** Evolution of emission trading and design features, trading mechanisms Cost-effective permit markets, the role of transaction costs, the role of technical change,Consequences of emission trading	**10**
5	**Monitoring and enforcement**: domestic enforcement process, nature of international enforcement process, economic enforcement, current enforcement practice, program Effectiveness, global responsibilities for controlling climatic change	**10**

Text Books:

- Shukla, P.R., et al. (2004), "Climate Change and India: VulnerabilityAssessment and Adaptation" - Universities Press
- Konrad Soyez, and Hartmut Grabl, (2008), "Basic Facts, Evaluation and Technological Options" - Springer Publications

Reference Books:

- Thomas H. Tietenberg ,(2006), "Emissions trading: principles and practice" an REFPress book
- Noel D Nevers, (2000), "Air Pollution Control Engineering", McGraw Hill InternationalEditions, Civil Engineering Series, McGraw Hill
- Wark K., Warner C.F., and Davis W.T., (1997), "Air Pollution – Its Origin and Control",Third Edition, Prentice Hall of India Publishers

Journals/Magazines:

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

Web/Digital resources:
https://files.eric.ed.gov/fulltext/ED503680.pdf

SWAYAM/NPTEL:
https://onlinecourses.swayam2.ac.in/nou21_ge37/preview

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	1	2	3				
CO2	3	3	3	0	0	3				
CO3	3	3	3	0	2	3				
CO4	3	3	3	0	0	3				
CO5	3	3	3	0	0	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV251	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Vulnerability Assessment and Disaster 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 imparts a thorough understanding of natural and manmade disasters, impact and vulnerability assessment, emergency response, preparedness, mitigative measures. Stresses the role of modern engineering and information technology in disaster management. The course also supplements details on the legal framework along with few case studies.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain disasters and list the types of disasters and identify the cause- effect relationships.	L3
CO2	Apply the concept of vulnerability assessment for pre-planning, early warning systems and response plan and Prepare on-site and off-site ERPs.	L3
CO3	Recognize the role of IT in creating vulnerability scenarios through simulation exercises using GIS and other related software and prepare Disaster and Environmental Management Plans	L4
CO4	Schedule the Pre Disaster Planning, Disaster Response Planning, Preparedness	L4
CO5	Consolidate the information on National policy on disaster management along with required legal framework for effective mitigation and Extrapolate some recent case studies of disaster and plan the preparedness and mitigation measures	L6

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

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Introduction:** Disasters, causes and impacts, scope of disaster management, disaster Managers- professionals and specialists active in various phases of disasters, Risk management, preparedness, operational functions of disaster management, Resource management, impact reduction. **Disasters:** Natural disasters - Drought, Floods, Earth Quake, Volcanoes, Land Slides, Cyclones, Tsunami; Manmade - Air accidents, Rail and Road accidents, Industrial, Chemical, Biological (Bio-Terrorism) nuclear Disasters, accidental oil spills and other types of Disasters.	12
2	**Vulnerability Assessment and Disaster Preparedness:** Vulnerability assessment(VA). Importance and advantages, Process of VA, Steps in VA, Report, Prioritization,Emergency Response Plan (ERP).	10
3	**Information Technology in Disaster Management**: Application of GIS and Remote sensing for Disaster Management, Simulation studies. Use of Unmanned aerial vehicles (UAVs) in disastermanagement and monitoring.	10

4	**Pre disaster Planning:** Earthquakes, cyclones, epidemics outbreak, drought and famine. Disaster resistant constructions, rehabilitation and reconstruction. Coping mechanism and relief assistance, disaster management continuum, Early warning and management, Global Disaster alerting and coordination system (GDACS), Flood forecasting, flood control systems.	**10**
5	**Disaster Response Planning, Preparedness and Mitigation**: Earthquake, Cyclone, Landslide, Flood preparedness and response. NDMA act 2005, National Disaster Management Policy, Disaster Management Plans (DMP) , Guidelines. **Case studies:** Natural, Industrial, Nuclear, Biological, Accidental Oil Spills, Recent case studies	**10**

Text Books:

- National Research Council 2007. Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery. Washington, DC: The National Academies Press. https://doi.org/10.17226/11824
- National Research Council 2007. Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management. Washington, DC: The National Academies Press. https://doi.org/10.17226/11793

Reference Books:

- Trim, P.R.J. (2004), "An integrative approach to disaster management and planning", Disaster Prevention and Management, Vol. 13 No. 3, pp. 218-225. https://doi.org/10.1108/09653560410541812
- National Research Council 2006. Facing Hazards and Disasters: Understanding Human Dimensions. Washington, DC: The National Academies Press. https://doi.org/10.17226/11671
- National Research Council 2007. Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises. Washington, DC: The National Academies Press. https://doi.org/10.17226/11895.
- National Research Council 2006. The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness: Summary of the June 21, 2005 Workshop of the Disasters Roundtable. Washington, DC: The National Academies Press. https://doi.org/10.17226/11619.
- WCDR Session Report UNEP, (2005), "Environmental Management and Disaster Preparedness" Building a multi-stakeholder partnership.

Journals/Magazines:

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

Web/Digital resources:

- **https://nidm.gov.in/research.asp**
- http://www.adrc.or.jp/top_gen.asp
- http://www.cdc.gov

SWAYAM/NPTEL:

- **NPTEL 8 weeks course on "Natural Hazards" by** Prof. Javed N. Malik, IIT Kanpur
- **Short Term Training Programs by NIDM, GOI**

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	-	1	-	-	3				
CO2	3	3	-	3	-	3				
CO3	3	3	-	3	-	3				
CO4	3	3	-	3	-	3				
CO5	3	3	-	3	-	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22EVE252	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Non-Point Sources Pollution 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 OBJECTIVE: The course deals with importance, significance and types of non-point sources of pollution. It alsocovers mathematical simulation models for qualitative and quantitative assessment of non-point source pollution and exposes to best management practices

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Illustrate the problem and magnitude of non-point source pollution and quantify the total load giving due consideration to components of hydrologic and atmospheric conditions.	L2
CO2	Identify and explain the transport and fate of ground water pollution and influence of urbanization on pollution quantification and its movement.	L2
CO3	Illustrate the area and line source models for quantifying emissions from different air pollution sources.	L2
CO4	Enlist the qualitative and quantitative aspects of non-point source pollution from agricultural and mining areas.	L2
CO5	Design the simulation models for pollution quantification and to evaluate the impacts of 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: Problem and magnitude, Surface Water Problems, Waste Assimilative Capacity and In-stream and Effluent Discharge standards.	10
2	Hydrologic Considerations: Introduction, Precipitation – Runoff Relationship. Overland Routing of the Precipitation excess, Interflow, Groundwater flow. Pollution from the Atmosphere – Atmospheric Input.	10
3	Groundwater Pollution: Sources of Groundwater Contamination, and Groundwater Movement. Comparative Assessment of Pollution Impact from land uses, Land-use and non-point sources of pollution.	10
4	Pollution from impervious urban areas: Urban storm water quantification, Deposition and accumulation of pollutants on impervious surfaces. Removal of Solids from street surfaces and porous pavement.	10
5	Pollution from agricultural and mining areas: Quantification and qualitative analysis. Non-point Pollution Simulation Models: Basic Concepts, Brief Description of Non-point Pollution Simulation Models. Best Management Practices of Non-point sources of pollution control.	12

Text Books:

1. Pavoni, J.L., "Water Quality Management Planning" Edited by Pavoni. J.L, (1997), Van Nostrand Reinhold Environmental Engg., Series
2. Novotny, V., and Chester's, G., (1981), "Hand Book of Non-point Pollution sources and Management" - Van Nostrand Reinhold Company.

Journals/Magazines:

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

Web/Digital resources:

- **https://seagrant.psu.edu/sites/default/files/Nonpoint%20Source%20Pollution%20FS.pdf**

SWAYAM/NPTEL:

- **https://www.google.com/url?q=https://onlinecourses.nptel.ac.in/noc23_ge17&sa=D&source=editors&ust=1672120834859656&usg=AOvVaw1k8riblQXI7jCnJxiDE_xp**

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	3	3				
CO3	3	3	3	3	3	3				
CO4	3	3	3	3	3	3				
CO5	3	-	-	-	3	-				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV253	Total Credits		Course Type	Professional Elective Course		
Course Title	Remote Sensing and GIS						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	04		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	04	Minimum Marks	20 marks	25 marks	45 Marks

COURSE OBJECTIVE: The course lays the foundation for basics of remote sensing, remote sensing systems, image processing, and related aspects. It also covers the various facets of GIS and data management as well as the applications of RS & GIS in Environmental Management

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Describe the principle of remote sensing system.	L2
CO2	Explain the significance of platforms, orbits and sensor resolutions.	L2
CO3	Interpret satellite images by applying the concepts of elements of visual image interpretation and image processing techniques.	L2
CO4	Recognize the need of GIS in environmental management; explain representation of geographic features digitally, considering the concepts of co-ordinates/projection system and data models; Determine data input method and create simple digital spatial data using GIS software.	L3
CO5	Perform raster and vector spatial analysis and design applications of remote sensing andGIS for various environmental issues.	L3

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

Course Content / Syllabus:

UNIT No.	Content	Lecture Hours
1	**Remote Sensing (RS)** **Basics of remote sensing:** EMR spectrum; Energy sources and radiation laws, Energy interactions with atmosphere and Earth's surface features; Spectral reflectance curves, passive and activeremote sensing	06
2	**Remote Sensing Systems:** Platforms and orbits; spectral, radiometric, spatial, and temporal resolutions of satellites; multi-spectral, thermal and hyper-spectral sensing; remotesensing satellites and their features	07
3	**Image interpretation and processing:** Visual image interpretation; concept of color composites, Preprocessing, image registration, image enhancement, spatial filtering, image transformation, image classification	08
4	**Geographical Information System (GIS)** **Introduction:** Origin and importance of GIS; scale; coordinate and projection systems,Linkage of Remote Sensing to GIS **Data Models and Structures:** Spatial data models – Raster, vector; spatial and	09

	attributedata. **Spatial Data Input and Editing: M**ethods of data input: keyboard, scanning, manual and automatic digitizing, GPS, concept of topology.	
5	**Spatial Analysis;** Raster and Vector overlay analysis; Terrain modeling; Spatial interpolation; Buffering and Neighbourhood function, Network analysis **Applications of RS and GIS:** Pattern detection and characterization, pattern comparison,space-time emphasizing application, predictive modeling applications (Watershed management; Rainfall-runoff modeling; Flood mapping; Environmental monitoring; Groundwater vulnerability modeling; Optional routing of solid wastes collection system of an urban area; Environmental siting and zoning atlas development)	**09**

Text Books:

- Lillesand, T. M., Kiefer, R. W., Chipman, J. W. (2004) "Remote sensing and Image Interpretation", 5th Edition, John Wiley & Sons
- Burrough, P. A., McDonnell, R. A., Lloyd, C. D., "Principles of Geographical Information Systems", 3rd Edition, Oxford University Press, (2015)
- Michael N. DeMers, "Fundamentals of Geographical Information Systems", 4thEdition, John Wiley and Sons. Inc., (2008)

Reference Books

- Anji Reddy "Text Book of Remote sensing and Geographical Information systems", 3rd Edition, B. S. Publications, Hyderabad, 2008
- Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographical Information Systems: Principles, Techniques, Management and Applications, 2nd Edition, John Wiley & Sons, 2005.

Journals/Magazines:

- Journal articles in reputed journals describing applications of Remote Sensing and GIS in Environmental Management

Web/Digital resources:

- Videos on YouTube
- Coursera

SWAYAM/NPTEL:

- Geographic Information Systems, By Prof. Arun K. Saraf, IIT Roorkee
  https://onlinecourses.nptel.ac.in/noc22_ce26/preview
- Remote Sensing and GIS, By Prof. Rishikesh Bharti, IIT Guwahati
  https://onlinecourses.nptel.ac.in/noc22_ce84/preview

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Data capture and editing	GPS, GIS software	Hands-on software
2	Overlay/neighbourhood analysis	GIS software	Hands-on software

Self-Learning Exercises:

1. **Case Study bibliography**

Course Articulation:

	PROGRAM OUTCOMES					
COURSE OUTCOMES ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	-	-	-
CO2	1	-	-	2	1	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	22PEV260	Total Credits	4	Course Type	Open Elective Course		
Course Title	Vulnerability Assessment and Disaster 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 imparts a thorough understanding of natural and manmade disasters, impact and vulnerability assessment, emergency response, preparedness, mitigative measures. Stresses the role of modern engineering and information technology in disaster management. The course also supplements details on the legal framework along with few case studies.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain disasters and list the types of disasters and identify the cause- effect relationships.	L3
CO2	Apply the concept of vulnerability assessment for pre-planning, early warning systems and response plan and Prepare on-site and off-site ERPs.	L3
CO3	Recognize the role of IT in creating vulnerability scenarios through simulation exercises using GIS and other related software and prepare Disaster and Environmental Management Plans	L4
CO4	Schedule the Pre Disaster Planning, Disaster Response Planning, Preparedness	L4
CO5	Consolidate the information on National policy on disaster management along with required legal framework for effective mitigation and Extrapolate some recent case studies of disaster and plan the preparedness and mitigation measures	L6

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

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Introduction:** Disasters, causes and impacts, scope of disaster management, disaster Managers- professionals and specialists active in various phases of disasters, Risk management, preparedness, operational functions of disaster management, Resource management, impact reduction. **Disasters:** Natural disasters - Drought, Floods, Earth Quake, Volcanoes, Land Slides, Cyclones, Tsunami; Manmade - Air accidents, Rail and Road accidents, Industrial, Chemical, Biological (Bio-Terrorism) nuclear Disasters, accidental oil spills and other types of Disasters.	12
2	**Vulnerability Assessment and Disaster Preparedness:** Vulnerability assessment(VA). Importance and advantages, Process of VA, Steps in VA, Report, Prioritization,Emergency Response Plan (ERP).	10
3	**Information Technology in Disaster Management**: Application of GIS and Remote sensing for Disaster Management, Simulation studies.	10

	Use of Unmanned aerial vehicles (UAVs) in disastermanagement and monitoring.	
4	**Pre disaster Planning:** Earthquakes, cyclones, epidemics outbreak, drought and famine. Disaster resistant constructions, rehabilitation and reconstruction. Coping mechanism and relief assistance, disaster management continuum, Early warning and management, Global Disaster alerting and coordination system (GDACS), Flood forecasting, flood control systems.	**10**
5	**Disaster Response Planning, Preparedness and Mitigation**: Earthquake, Cyclone, Landslide, Flood preparedness and response. NDMA act 2005, National Disaster Management Policy, Disaster Management Plans (DMP) , Guidelines. **Case studies:** Natural, Industrial, Nuclear, Biological, Accidental Oil Spills, Recent case studies	**10**

Text Books:

- National Research Council 2007. Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery. Washington, DC: The National Academies Press. https://doi.org/10.17226/11824
- National Research Council 2007. Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management. Washington, DC: The National Academies Press. https://doi.org/10.17226/11793

Reference Books:

- Trim, P.R.J. (2004), "An integrative approach to disaster management and planning", Disaster Prevention and Management, Vol. 13 No. 3, pp. 218-225. https://doi.org/10.1108/09653560410541812
- National Research Council 2006. Facing Hazards and Disasters: Understanding Human Dimensions. Washington, DC: The National Academies Press. https://doi.org/10.17226/11671
- National Research Council 2007. Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises. Washington, DC: The National Academies Press. https://doi.org/10.17226/11895.
- National Research Council 2006. The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness: Summary of the June 21, 2005 Workshop of the Disasters Roundtable. Washington, DC: The National Academies Press. https://doi.org/10.17226/11619.
- WCDR Session Report UNEP, (2005), "Environmental Management and Disaster Preparedness" Building a multi-stakeholder partnership.

Journals/Magazines:

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

Web/Digital resources:

- **https://nidm.gov.in/research.asp**
- http://www.adrc.or.jp/top_gen.asp
- http://www.cdc.gov

SWAYAM/NPTEL:

- **NPTEL 8 weeks course on "Natural Hazards" by** Prof. Javed N. Malik, IIT Kanpur
- **Short Term Training Programs by NIDM, GOI**

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	-	1	-	-	3				
CO2	3	3	-	3	-	3				
CO3	3	3	-	3	-	3				
CO4	3	3	-	3	-	3				
CO5	3	3	-	3	-	3				

High – 3, Medium – 2, Low – 1

Department	Environmental Engineering						
Course Code	22PEV270	Total Credits	1.5	Course Type	Mandatory Course		
Course Title	Research Methodology and IPR						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	20	1.5		CIE	SEE	Total
	Tutorial	-	-	Weightage	40 %	60 %	100 %
	Practical	-	-	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	20	1.5	Minimum Marks	20 marks	25 marks	45 Marks

COURSE OBJECTIVE: The course imparts a thorough understanding of natural and manmade disasters, impact and vulnerability assessment, emergency response, preparedness, mitigative measures. Stresses the role of modern engineering and information technology in disaster management. The course also supplements details on the legal framework along with few case studies.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain And Illustrate the Basic Principles of Research and Defining the Research Problem.	L3
CO2	Design of Various Sample Surveys and Measurement and Scaling	L4
CO3	Develop Various Data Collection Method	L4
CO4	Explain the concepts of IPR and Plagiarism	L2
CO5	Develop Interpretation and Prepare a Research Report/Thesis	L4

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

Course Content / Syllabus:

UNIT No.	Content	Hours Lecture
1	**Unit-1: Introduction** Research Methodology: Meaning, Objectives, Characteristics, Approaches of Research - Significance of Research - Research Methods Vs. Methodology - Types of Research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research Process - Criteria of Good Research - Developing a Research Plan. Defining the Research Problem: Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem.	04
2	**Unit-2: Reviewing Of The Literature** Introduction, Importance of Literature Review in Defining a Problem - Survey of Literature - Primary and Secondary Sources - Reviews, Treatise, Monographs Patents - Web as a Source - Searching the Web - Identifying Gap Areas from Literature Review - Development of Working Hypothesis	04
3	**Unit-3: Design Of Sample Surveys** Introduction, Sample Design, Sampling and Non - Sampling Errors, Steps in Sampling Design - Characteristics of a Good Sample Design - Types of Sample D Data Collection: Methods of Data Collection - Collection of Primary Data and Secondary Data – Selection of Appropriate Method for Data Collection	04
4	**Unit-4: Ipr And Plagiarism** Invention and Creativity - Intellectual Property - Importance and Protection of Intellectual Property Rights (IPRs) - A Brief Summary of: Patents, Copyrights, Trademarks, Industrial Designs - Integrated Circuits - Geographical Indications -	04

	Establishment of WIPO - Application and Procedures. Plagiarism – Sensitive Issues of Plagiarism and Different Tools for Plagiarism Check	
5	**Unit-5: Interpretation And Report Writing** Interpretation and Report Writing - Techniques of Interpretation - Structure and Components of Scientific Reports - Different Steps in The Preparation - Layout, Structure and Language of the Report - Illustrations and Tables - Types of Report - Technical Reports and Thesis	**04**

Text Books:

- Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
- Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publisher

Reference Books:

- Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
- Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
- Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 20

Journals/Magazines:

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

Web/Digital resources:

- **https://iare.ac.in/sites/default/files/MTECH-CAD.CAM-R18-RM-IP-NOTES.pdf**
- **https://ccsuniversity.ac.in/bridge-library/pdf/Research-Methodology-CR-Kothari.pdf**

SWAYAM/NPTEL:

- **Swayam Course on "Research Methodology in Natural Sciences" by Prof. Soumitro Banerje, IISER, Kolkota**
- **https://in.coursera.org/learn/research-methodologies**

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	-	-	3	-	3				
CO3	3	-	-	3	-	3				
CO4	3	-	-	3	-	3				
CO5	3	3	-	3	-	3				

High – 3, Medium – 2, Low – 1

Department	**Environmental Engineering**						
Course Code	**22PEV280L**	***Total Credits***	***1.5***	***Course Type***	Professional Core Laboratory		
Course Title	**Biological Treatment Processes Lab**						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	**-**	**-**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**-**	***Weightage***	***40 %***	***60 %***	***100 %***
	Practical	**3**	**1.5**	***Maximum Marks***	***40 Marks***	***60 Marks***	***100 Marks***
	Total	**3**	**1.5**	***Minimum Marks***	***20 marks***	***25 marks***	***45 Marks***

COURSE PRE-REQUISITE: - WASTEWATER TREATMENT PROCESS ENGINEERING

COURSE OBJECTIVE: The lab course provides an opportunity to collect and preserve domestic wastewater samples as well as industrial effluents, conduct various tests on wastewater characteristics, perform experiments on selected lab scale treatment processes. It also enriches the student knowledge of determining bio kinetic constants for aerobic treatment process. The lab course also exposes the student to carryout analysis on biological sludge developed during the biological treatment of wastewater

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Acquaint with the planning of domestic wastewater and industrial wastewater collection,transportation and preservation of samples. Perform standard tests for qualitative analysis and quantification of organic load. Conduct continuous CBOD and NBOD test.	L4
CO2	Design and use the experimental set up to determine bio kinetic constants of biological waste treatment process. Characterize bio sludge through standard procedure to identify significantparameters.	L4
CO3	Plan and perform aerobic and anaerobic bench scale treatment processes on both domestic wastewater and industrial effluent. Use constructed wetland (bench scale) system as polishing unit. 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	Domestic and Industrial Wastewater analysis for different parameters	3
2	Domestic and Industrial Wastewater analysis for different parameters	3
3	Determination of CBOD and NBOD of both domestic and industrial wastewater usingBOD apparatus	3
4	Determination of CBOD and NBOD of both domestic and industrial wastewater usingBOD apparatus	3
5	Determination of Bio kinetic Constants - F/M, Θ, Θ_c ,K_d, Y, q, μ	3
6	Analysis of Biological Sludge – MLSS, MLVSS, SVI	3
7	Aerobic process of treating domestic wastewater	3
8	Aerobic process of treating domestic wastewater	3
9	Anaerobic process of treating domestic wastewater	3
10	Anaerobic process of treating domestic wastewater	3
11	Polishing unit – constructed wetland	3

12	Polishing unit – constructed wetland	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.
- Metcalf and Eddy, (2003), "Wastewater Engineering, Treatment and Reuse", 4th Edition,Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

- American Public Health Association, American Water Works Association, (1998), Standard Methods for Examination of Water and Wastewater, 20th edition, APHA.
- Adams and Eckenfelder Jr. W.W. (1974), "Environmental, Process Design Techniques for Industrial Waste Treatment", Nashville (USA), 1974.
- Benefield, L.D., and Randall, C.W., (1980), "Biological Process Design for WastewaterTreatment", Prentice Hall, Englewood, Chiffs, N.J.
- CPHEEO Manual (2014), "Wastewater Collection, Treatment and Disposal", Ministry of Urban Development, Government of India, New Delhi.

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	-	3
CO2	3	3	-	3	-	3
CO3	3	3	-	3	3	3

High – 3, Medium – 2, Low – 1