COEP Technological University

(Unitary Public University of Government of Maharashtra)

Wellesely Road, Shivajinagar, Pune - 411005

Department of Civil Engineering

Curriculum

(Structure, Evaluation Scheme and Course Content)

For

Post Graduate Program

Master of Technology

In

Environmental and Water Resources Engineering

With Effect From

Academic Year 2025-2026

Master of Technology

Environmental and Water Resources Engineering
NEP Curriculum Structure: 2025-26

Programme Educational Objectives (PEOs)

I. Graduates of the programme will have in-depth knowledge to identify and formulate challenging environmental and water resources problems, apply appropriate research methodologies, use modern engineering tools and provide technically sound, economical and sustainable solutions.

II. Graduates will have ability for higher studies and undertake high value research on environmental, water resources and other related issues.

III. Graduates of programme will have sound analytical and lateral thinking ability to engage in lifelong learning for professional advancement to cope up with multidisciplinary and changing technologies in environmental and water resources engineering.

IV. Graduates of the programme will have sense of social responsibility, will demonstrate ability to communicate and work effectively as a team member in an ethical way, and will play leadership roles in their profession, public services and community.

Programme Outcomes (POs)

On completion of the Programme, students will be able to

PO1: Apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude, independently carrying out research /investigation and development works.

PO2: Write and present a substantial technical report / document.

PO3: Demonstrate a degree of mastery in environmental and water resources engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor Programme.

PO4: Gain knowledge/skill in integrating environmental and water resources concepts for collaborative multidisciplinary solutions and carry out planning and management of projects as a member and a leader in a team considering economic and financial factors.

PO5: Recognize the need for and have ability in lifelong learning independently for professional advancement, demonstrate professional ethics, work culture and understanding of responsibility to contribute to community for sustainable development of society.

Correlation between the PEOs and the POs

	PO 1	PO 2	PO 3	PO 4	PO 5
PEO 1	3	2	3	3	2
PEO 2	3	2	3	2	3
PEO 3	2	1	3	2	3
PEO 4	2	3	2	3	3

Master of Technology
Environmental and Water Resources Engineering Curriculum Structure

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.00
PSBC	Programme Specific Bridge Course	1	3	3.75
PCC + LC	Programme Core Course + Laboratory Course	6	24	30
PEC	Programme Elective Course	3	9	11.25
OJT	On Job Training	1	3	3.75
OE	Open Elective	1	3	3.75
LLC	Liberal Learning Course	1	1	1.25
SLC	Self Learning Course	2	6	7.50
RM	Research Methodology	1	3	3.75
AEC	Ability Enhancement Course	1	2	2.50
Project	Project	2	22	27.5
	Total	**20**	**80**	**100**

M.Tech. Civil- Environmental and Water Resources Engineering
NEP Curriculum Structure: 2025-26

Semester I

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1.	PSMC	EW-25001	Statistical Methods in Hydrology and Environmental Engineering	3	1	-	1	4	30	20	50	-	-
2.	PSBC	EW-25002	Applications of Geoinformatics in Environmental and Water Resources Engineering	2	-	2	1	3	30	20	50	50	50
3.	PCC	EW-25003	Channel and River Hydraulics	3	1		1	4	30	20	50		
4.	PCC	EW-25004	Advanced Water and Wastewater Treatment	3	-	-	1	3	30	20	50		
5.	PCC	EW-25005	Ground Water Hydrology	3	-	-	1	3	30	20	50		
6.	PCC	EW-25006	Environmental Engineering Laboratory	-	-	4	-	2				50	50
7.	PEC-1	EW(PE)-2500	Programme Elective -I 1) Principles of Water and Air Quality Legislation 2) Decentralized Liquid Waste Management 3) Hydrological Hazard Mitigation and Management 4) Climate Change and Water Resources	3	-	-	1	3	30	20	50	-	-
8	RM	<tbd>	Research Methodology	2	1	-	1	3	30	20	50	-	-
			Total Credits	**25**									

Legends:

L-Lecture, **T**-Tutorial, **P**-Practical, **S**-Self Study, **Cr**-Credits, **ISE**: In-Semester-Evaluation, **ESE**: End-Semester-Evaluation, **MSE**: Mid-Semester Evaluation, **TA**: Teacher's Assessment, **CIE**: Continuous-Internal-Evaluation

Semester II

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1.	OE	<tbd>	Open Elective	3	-	-	1	3	30	20	50	-	-
2.	PCC	<tbd>	Solid and Hazardous Waste Management	3	-	2	1	4	30	20	50	50	50
3.	PCC	<tbd>	Urban Hydrology and Watershed Management	3	-	-	1	3	30	20	50	50	50
4.	PCC	<tbd>	Environmental Impact Assessment	3	-	-	1	3	30	20	50	50	50
5.	PEC-2	<tbd>	Programme Elective -II 1) Computational Fluid Dynamics 2) Land and Water Management 3) Air Pollution Control and Industrial Wastewater Treatment 4) Water and Air Quality Models	3	-	-	1	3	30	20	50	-	-
6.	PEC-3	<tbd>	Programme Elective -III 1) Water Resources Planning, Management and Economics 2) Irrigation and Drainage 3) Transport of Water and Wastewater 4) Advance Environmental Engineering Practices	3	-	-	1	3	30	20	50	-	-
7.	PCC	<tbd>	Water resources Engineering Laboratory	-	-	4	-	2				50	50
8.	AEC	<tbd>	Technical Communication Skills	1	-	2	1	2	50	50	-	100	-
9.	LLC	<tbd>	Liberal Learning Course	-	-	2	2	1	-	-	-	100	-
			Total Credits	**24**									

Semester III

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	SLC	<tbd>	Massive Open Online Course –I	3	-	-	1	3	-	-	100	-	-
2	SLC	<tbd>	Massive Open Online Course –II	3	-	-	1	3	-	-	100	-	-
3	OJT	<tbd>	Internship	-	-	-	-	3	-	-	100	-	-
4	Project	<tbd>	Dissertation Phase – I	-	-	22	12	11	-	-	-	70	30
Total Credits				**20**									

Semester IV

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	Project	<tbd>	Dissertation Phase – II	-	-	22	12	11	-	-	-	70	30
Total Credits				**11**									

Statistical Methods in Hydrology and Environmental Engineering

Course Code: EW-25002	**Credit:** 4
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
Tutorial: 1 Hrs	ESE: 50

Course Outcomes: Students will be able to:

1. Acquire foundational knowledge of sampling and its various types geometry.
2. Develop a basic understanding of probability concepts and their practical applications
3. Apply appropriate regression models for environmental and water resource analysis
4. Comprehend and utilize statistical models effectively. and
5. Apply time series analysis appropriately for predicting environmental and climate change trends.
6. Interpret human behaviour patterns in terms of mathematics

Unit 1: Introduction & Probability Basics **[8 Hrs]**

Stochastic hydrology – definition and scope, Need for statistical methods in hydrology, Probability axioms, Total probability theorem and Bayes theorem, Independence and independent events.

Unit 2: Probability Tools & Frequency Analysis **[8 Hrs]**

Construction of probability paper, Probability plotting, Flood frequency analysis, Parameter estimation, Moments and expectations of distributions, Frequency analysis of hydrologic variable.

Unit 3: Hydrologic Data & Probability Distributions **[10 Hrs]**

Hydrologic data – nature and sampling errors, Graphical presentation, Random numbers, Probability distributions used in hydrology – Binomial, Poisson, Normal, Exponential, and Extreme value distributions.

Unit 4: Sampling Theory & Hypothesis Testing **[8 Hrs]**

Sampling distributions, Confidence intervals, Hypothesis testing, Large sample tests for mean and proportion, Goodness-of-fit tests - Chi-square and K–S tests.

Unit 5: Regression & Correlation Analysis **[6 Hrs]**

Curve fitting using least squares, Simple and multiple linear regression, Evaluation of regression, Correlation coefficient and its significance.

Unit 6: Self Study **[8 Hrs]**

Hydrologic time series – nature and basic components (trend and periodicity), Stationarity, Autocorrelation and its importance, Basic modeling of hydrologic time series, Thomas–Fiering model.

Textbooks:

[1] Statistical Methods in Hydrology – Haan, C.T. (1995)
[2] Statistical Models in Hydrology – Clarke, R.T. (1994)
[3] Probability and Statistics in Hydrology – Yevjevich, V. (1972)
[4] Probabilistic Concepts in Engineering Planning and Design, Vol. 1 – Ang, A.H.S. and Tang, W.H. (1975)

Reference Books:

[1] Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5 th edn. MacMillan, N.Y.
[2] Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRC Press.
[3] Vic Environmental Statistics Methods and Applications, Wiley Series in Probability and Statistics.
[4] P Jaya Rami Reddy, Stochastic Hydrology, Laxmi Publication (P) Limited, New Delhi.

Web Resources:

[1] nptel.ac.in/courses/105108079

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	1	3	2	2
CO3	3	2	3	2	2
CO4	3	3	3	2	3
CO5	3	2	3	2	3
CO6	2	1	2	2	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Applications of Geoinformatics in Environmental and Water Resources Engineering

Course Code: EW-25002		**Credit:**	3		
Teaching Scheme		**Examination Scheme**			
Lectures:	2 Hrs	MSE:	30	Lab ISE:	50
Self-Study:	1 Hrs	TA:	20	Lab ESE:	50
Lab:	2 Hrs	ESE:	50		

Course Outcomes: Students will be able to:

1. Apply remote sensing and geoinformatics principles to interpret multispectral satellite data for spatial and environmental analysis.
2. Analyze digital image processing techniques to enhance the accuracy and interpretation of geospatial datasets.
3. Evaluate GIS functionalities for data management, spatial modeling, and visualization in environmental and water resource applications.
4. Apply GPS-based data collection and positioning methods for precise mapping and navigation.
5. Evaluate integrated geoinformatics approaches for environmental monitoring and water resource management using advanced GIS tools.

Unit 1: Basics of Geoinformatics and Remote Sensing [4 Hrs]
Introduction to Geoinformatics (RS- GIS-GPS), Fundamental of Remote Sensing History, Type of Remote Sensing, Remote Sensing platforms and sensors, Data acquisition through various platforms, Cameras and sensor parameters.

Unit 2: Satellite Data and Image Analysis [8 Hrs]
Elements of satellite images, Concept of bands, pixel, digital number, metadata, Multispectral Remote Sensing, False color composite, Interpretation of multispectral image, Combination of sensors, Image interpretation parameters, Ground truths.

Unit 3: Digital Image Processing [6 Hrs]
Atmospheric, radiometric, geometric corrections, Histograms, Density slicing, Contrast stretching, Principle component analysis, Basics of digital image processing techniques

Unit 4: Geographic Information Systems (GIS) [8 Hrs]
Introduction to GIS, Components of GIS, Hardware and software, GIS functionality, Data capture, management, analysis and visualization, Projections and georeferencing, Concepts of projections, Types of projections and their applications, Topological data model, TIN, spaghetti, polygon structure data models, Digitization processes

Unit 5: Global Positioning System (GPS) and Applications of Geoinformatics [10 Hrs]
Introduction to GPS, Fundamental concepts, Coordinates and reference systems, Components of GPS system, GPS for land navigation and survey reconnaissance, Static / Differential Positioning, Dynamic / Kinematic Positioning, GPS equipment, National GPS applications. Applications of geoinformatics in environmental and water resources field.

Unit 6: Self-study Component [6 Hrs]
Case studies on Geoinformatics applications in water resources and environment, Exploration of open-source software (QGIS, Google Earth Engine), Review of recent developments (drones, LiDAR, cloud-based platforms), Study of national initiatives (NRSC, ISRO Bhuvan portals)

Lab Assignments

1. Installation and Interface Familiarization of QGIS
2. Importing and Georeferencing Raster Data
3. Visualization of Indian Administrative Boundaries

4. Creation and Editing of Vector Layers
5. Working with QGIS Plugins
6. Adding and Comparing Basemaps
7. Vector Data Conversion and Spatial Analysis
8. Map Layout Design and Exporting Maps

Textbooks:

[1] Remote Sensing and Image Interpretation by Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman

[2] Geographic Information Systems and Environmental Modeling by Clarke, Keith C., Bradley O. Parks, and Michael P. Crane. Upper Saddle River, NJ: Prentice Hall, 2002.

[3] Principles of Remote Sensing- Edition: ITC Educational Textbook Series 2, Publisher: ITC, nschede Editors: N. Kerle, L.L.F. Janssen, G.C. Huurneman.

Reference Books:

[1] Bhatta, B. (3 Nov 2011). Remote Sensing and GIS (ISBN 019569239X, 9780195692396 ed.). University of Minnesota: Oxford University Press, 2008

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	3	3	3	3
CO4	3	2	3	2	2
CO5	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Channels and River Hydraulics

Course Code: EW-25003	**Credit:** 4
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
Tutorial: 1 Hrs	ESE: 50

Course Outcomes: Students will be able to:

1. Analyze & Calculate parameters governing the flow through open-channels and types of water surface profiles.
2. Compute flow profiles in channel transitions and due to hydraulic structures
3. Analyze gradually-varied flow, rapidly-varied flow, unsteady flow and sediment transport in open channel
4. Design stable channels, erodible and lined channels for clear and sediment flows.

Unit1: Hydraulics of Uniform & Critical Flow **[6Hrs]**

Basic concepts of free surface flow, Flow regimes, Velocity and Pressure distribution, Energy principles and its applications, Specific energy, Critical flow computations, Momentum equations and its applications, Specific force diagram, Theoretical concepts of surface roughness, Velocity equation, Uniform flow computation.

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Unit 2: Gradually Varied Flow **[6 Hrs]**

Steady gradually varied flow, Dynamic equation, Characteristics of flow profile and methods of computation, Practical problems, Gradually varied flow classification, analysis and computations, Compound channels, Canal delivery problem, Channel networks

Unit3: Rapidly Varied Flow – RVF & Unsteady Flow **[8Hrs]**

Steady rapid varied flow, Hydraulic jump analysis and location, Jump in sloping channels and Oblique jump, Surge analysis, Design of spillways, Energy dissipaters, Channel transitions

Unsteady rapidly varied flow, Monoclinal rising wave, Dam break problem, Moving hydraulic jump, Positive and Negative surges, Hydrualic flood routing

Unit4: Fluvial Hydraulics & Sediment Transport **[8Hrs]**

Fluvial hydraulics, Basic characteristics of river beds and sediments, Initiation of motion, Bed load, suspended load, total load and sediment measurements, Regimes of flow, Plan form and stream bed variations of rivers, Sediment control

Unit 5: Channel Design & Reservoir Sedimentation **[6Hrs]**

Design of stable channels, Design of erodible and lined channels for clear and sediment – laden flows – CBI & P method, Regime method, Tractive force methods, Reservoir sedimentation, Erosion and deposition, Sediment transport in pipes

Unit 6: Self Study Component **[6Hrs]**

Similitude and models, Dimensional analysis and similitude, Scale ratios, Fixed – bed and movable bed Models

Textbooks:

[1] Modi, P. N. and S. N. Seth " Hydraulics and Fluid Mechanics", Standard book house, New Delhi, ISBN: 978-81-89401-26-9.

Reference Books:

- Chow V.T. “Open Channel Hydraulics”, McGraw Hill, Inc. New York.
- Henderson “Open channel flow”, McMillan Pub. London
- Subramanya K. “Flow in Open Channels”, Tata McGraw Hill Pub.
- Garde and Ranga Raju K.G. “Mechanics of sediment transportation and Alluvial Stream Problems”,
- Wiley Eastern, New Delhi
- Chaudhry M.H. “Open – Channel Flow”, Prentice Hall of India, New Delhi
- French R.H. “Open Channel Hydraulics”, McGraw Hill Pub Co., New York.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	3	2
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Advanced Water and Wastewater Treatment

Course Code: EW-25004		**Credit:**	3		
Teaching Scheme		**Examination Scheme**			
Lectures:	3 Hrs	MSE:	30	Lab ISE:	50
Self-Study:	1 Hrs	TA:	20	Lab ESE:	50
		ESE:	50		

Course Outcomes: Students will be able to:

1. Analyze quality of water and waste water
2. Select appropriate technology for treatment of water and wastewater
3. Design a treatment facility for treatment of water and wastewater
4. Investigate advanced water and wastewater treatment methods

Unit 1: Introduction to Water Quality **[8 Hrs]**

Water Quality Parameters: Physical, chemical, and biological parameters of water. Water Quality Requirements**:** Definition of potable water, significance of water quality for various uses. Water Quality Standards: Potable water standards (IS 10500), wastewater effluent standards. Water Quality Indices: Concept and computation of water quality index (WQI).

Unit 2: Natural Water Purification Systems **[8 Hrs]**

Water Purification in Natural Systems: Overview of physical, chemical, and biological processes in nature. Self-Purification in Rivers and Streams: Oxygen sag curve, natural aeration and sedimentation. Introduction to Treatment Systems: Overview of primary, secondary, and tertiary treatment methods

Unit 3: Primary Treatment Processes **[8 Hrs]**

Mixing and Clarification: Concept of mixing, types of sedimentation and clarifiers. Sedimentation Units: Design considerations, detention time, and removal efficiency. Aeration and Gas Transfer: Objectives, types of aerators, and factors affecting aeration efficiency. Coagulation and Flocculation: Principles, coagulants used, mechanisms of destabilization and aggregation.

Unit 4: Secondary and Advanced Treatment Processes **[8 Hrs]**

Clariflocculation: Combined process of coagulation, flocculation, and sedimentation. Filtration: Theory of granular media filtration, Types: slow sand filter, rapid sand filter Mechanism and operational modes Problems: negative head, air binding Dual and Multimedia Filtration: Principles and advantages.

Unit 5: Advanced Purification and Disinfection Techniques **[8 Hrs]**

Adsorption Processes: Adsorption equilibrium and isotherms (Freundlich, Langmuir) Applications in water and wastewater treatment Disinfection Methods: Chlorine, chlorine dioxide, chloramines, ozonation, and UV radiation. Ion Exchange and Membrane Processes: Ion exchange principles and applications Membrane processes: Reverse osmosis, ultrafiltration, electrodialysis

Unit 6: Self-Study

Emerging Treatment Technologies: Nano-filtration, advanced oxidation processes (AOPs). Case Studies: Recent developments in water and wastewater treatment plants. Water Reuse and Recycling: Concepts and sustainability considerations.

Reference Books:

1. Weber W.J. “Physicochemical processes for water quality control”, John Wiley and Sons, New York
2. Peavy H.S., Rowe D.R. and Tchobanglous G. “Environmental Engineering”, McGraw Hills, New York
3. Metcalf and Eddy “Waste water Engineering, Treatment and Reuse”, Tata Mc- GrawHill.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	2	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Groundwater Hydrology

Course Code: EW-25005	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Demonstrate the different terminologies related with groundwater hydrology
2. Evaluate methods for determining aquifer parameters
3. Analyze groundwater exploration techniques and appraise groundwater potential
4. Compare and contrast suitable ground water quality management methods and ground water model.

Unit 1: Introduction [8 Hrs]

Ground Water: porosity, specific yield and specific retention of water in rocks/aquifers, compressibility of rock, zone of aeration and saturation, fluctuation of water table and piezometric surfaces, storage coefficients of aquifers, specific yield, specific retention, unconfined and confined aquifer, ground water potential in India, geophysical methods for groundwater explorations.

Unit 2: Ground water flow: [8 Hrs]

Laminar and turbulent flow, Darcy's law, Reynolds number, permeability and transmissibility, Groundwater flow potential, Ground water theory for one, two and three dimensional problem, Differential equations governing groundwater flow for steady and unsteady state problems, Theim and Dupuit's theory for unconfined and confined aquifers, use of finite difference method to solve simple ground water flow problem.

Unit 3: Evaluation of Aquifer Properties: [8 Hrs]

aquifer tests, control well, observation well, Solution of aquifer parameters for confined aquifer by Theis method, Jacob and Chow's method, Theis' recovery method, bounded aquifer, interference among wells, aquifer properties for bounded aquifers by theory of images.

Unit 4: Well drilling [8 Hrs]

Construction of Wells: Types of wells and method of construction, tube well design and well drilling: well screen, development and completion of wells, well performance test, well loss, Rotary drilling and Rotary percussion drilling, maintenance of wells. Ground Water Modeling: Groundwater Modeling: Groundwater flow, sand models, membrane model, thermal model, electric analog model and mathematical models.

Unit 5: Groundwater Recharge, Development and Management [8 Hrs]

Components of ground water balance, estimation of recharge component, ground water storage changes, conjunctive use, artificial recharge of groundwater- different methods, subsurface dam, recharge by urban storm runoff, percolation from tanks, recharge from irrigated fields, groundwater quality, estimation of ground water discharge, ground water resource evaluation in India.

Unit 6: Self-Study

Laminar and turbulent flow, Darcy's law, Reynolds number.

Reference Books:

1. Todd, D.K. "Ground Water Hydrology", John Wiley & Sons, Singapore.
2. Raghunath, H.M. "Ground Water" New Age International (P) Limited, New Delhi.
3. Karanth, K. R. "Ground Water Assessment Development and Management", Tata McGraw Hill Publishing Company Limited, New Delhi
4. Domenico "Concepts and Models in Groundwater Hydrology", McGraw Hill Inc., NewYork
5. L. Harvil and F. G. Bell, Ground Water Resources and Development, Butterworth's, London.
6. Herbert F Wang and Mary P. Anderson "Introduction to Ground Water Modeling", W.H. Freeman and Company, NewYork
7. Garg S.P. "Groundwater and Tube wells", Oxford and IBH Publishing Co. New Delhi.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Environmental Engineering Lab

Course Code: EW-25006	**Credit:** 2
Teaching Scheme	**Examination Scheme**
Lab Practices: 4 Hrs	ISE: 50
	ESE: 50

Course Outcomes: Students will be able to:
1: Analyse the characteristics of the water and wastewater
2. Demonstrate the techniques and procedures for accurately measuring contaminant concentrations in water and wastewater samples
3. Acquire practical skills in analyzing contaminant levels in water and wastewater samples and interpreting the results. Implement appropriate method to control the characteristics of water and wastewater.

Syllabus Contents: (perform any 14)

1. To determine pH of the sample
2. To determine alkalinity in water
3. To determine hardness in water
4. To determine turbidity in water
5. Determination of Optimum coagulant dose.
6. To residual chlorine in water
7. To determine sodium dodecyl sulphate in water
8. To determine nitrate contents in water
9. To determine Phosphate in water
10. To determine fluoride content in water
11. Determination of electrical conductivity
12. To determine dissolved oxygen
13. To determine BOD
14. To determine COD
15. To determine sludge volume index
16. To determine the solids
17. Site visit to near water or wastewater treatment plant

References:

1. APHA (2017) Standard methods for the examination of water and wastewater. Rodger B. Baird, Andrew D. Eaton, Eugene W. Rice American Public Health Association 1-1545

Principles of Water & Air Quality Legislation

Course Code: EW(PE)-25001		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:

1. Analyze water law principles and uncertainty concepts in water resources planning
2. Apply water quality monitoring and modeling techniques for pollution control
3. Develop strategies for water quality management in various water bodies
4. Integrate legal aspects and environmental protection laws into water management plans

Unit 1: Introduction **[8 Hrs]**

Introduction to Water Law and Rights – Riparian rights, Groundwater ownership, Prior appropriation, Permit systems, acquisition and use of rights. Uncertainty concepts in Water Resources Planning – methods for uncertainty analysis and applications. Overview of water resource governance and its implications in integrated water management.

Unit 2: Water Quality and Monitoring **[8 Hrs]**

Water Quality and Monitoring – Water quality monitoring, Water pollution, Sources of pollution, Nature of pollutants, and existing approaches for control and abatement of water quality degradation. Water quality monitoring in river basins and the role of national frameworks in maintaining water quality standards.

Unit 3: Water Quality Modelling **[8 Hrs]**

Modelling and Monitoring, evolution of water quality models, types of water quality models, DO and BOD in streams, transformation and transport processes, oxygen transfer, and turbulent mixing. Introduction to Non-Point Source Pollution and modelling approaches for non-point source pollution prediction.

Unit 4: Water Quality Management and Control **[8 Hrs]**

Water quality objectives and standards, water quality control models, flow augmentation, wastewater transport systems, river and lake water quality models, and groundwater quality models. Practical applications in wastewater transport and integrated water quality management in rivers, streams, and other natural water bodies.

Unit 5: Legal and Institutional Framework **[8 Hrs]**

Legal aspects of environmental systems, principles of law applied to water rights and water allocation, Environmental Protection Law, Water Pollution Control Acts and Legislation, Air Pollution Act, and other related environmental control acts. Emphasis on legislative mechanisms and compliance in India.

Unit 6: Self-Study

Case studies on national and international water laws, judicial perspectives on groundwater ownership, transboundary water disputes, policy analysis on river basin management, and review of contemporary challenges in water legislation and pollution control.

Reference Books:

1. Tebutt T.H.Y. "Principles of Water Quality Control", Pergamon Press, Oxford
2. Gerard Kiely "Environmental Engineering", McGraw Hill Publications.
3. Viessman W. Jr. and Hammer M.J. "Water supply and Pollution control", Harper & Row Publications Inc., Singapore.
4. Jerald L. Schnoor "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley & Sons Inc. New York.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Decentralized Liquid Waste Management

Course Code: EW(PE)-25002	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Analyse the benefits, objective and options for liquid waste management
2. Comprehand the concept of fecal waste management
3. Identify, locate and quantify contamination contributed by onsite system
4. Get insight into the treatment options for toilet system and domestic liquid waste
5. Design and analyzes the rector
6. Promote appropriate treatment for safe urban/or rural sanitation

Unit 1: Introduction to wastewater and sanitation systems [8 Hrs]

Sources of wastewater and its characteristics, brief overview of conventional, centralized, and decentralized wastewater treatment options. Discussion on the consequences, benefits, and challenges associated with each approach, with particular emphasis on the operational challenges of decentralized systems. Introduction to rural and urban sanitation needs and overview of issues related to fecal waste management.

Unit 2: Fecal waste management systems and sanitation [8 Hrs]

Problems associated with fecal waste management, various options for its safe collection, transport, and disposal. Overview of toilet technologies, sewer systems for wastewater conveyance, and basics of sanitation and liquid waste management. Importance of integrating sustainable sanitation in both rural and urban contexts.

Unit 3: Decentralized and natural treatment options [8 Hrs]

Introduction to grey water and black water treatment systems. Overview of decentralized treatment options such as fluidized aerobic bed reactor, packed bed reactor, phytoremediation, constructed wetlands, phytoremediation in constructed wetlands, duckweed ponds, hybrid reactor systems, upflow anaerobic sludge blanket (UASB) reactors, biogas-linked toilets, sullage stabilization ponds, and grey water treatment and reuse at household level.

Unit 4: Reaction kinetics and reactor fundamentals [8 Hrs]

Fundamentals of reaction kinetics, rate of reaction, order of reaction, and the effect of temperature on reaction rates. Detailed study of types of reactors such as batch reactors, plug flow reactors, continuous stirred tank reactors (CSTR), packed bed reactors, and fluidized bed reactors. Introduction to the concept of molar and mass balance principles and their application to different reactor types.

Unit 5: Advanced reactor analysis and flow modeling [8 Hrs]

Molar balance and mass balance equations for batch, plug flow, and continuous stirred tank reactors. Use of Levenspiel plots for reactor sizing. Analysis of non-ideal flow reactors using tracer studies, need for tracers, and interpretation of tracer response curves. Study of ideal plug flow reactors and continuous stirred tank reactors connected in series, and comparison with plug flow reactors in series.

Unit 6: Self-Study

Rural sanitation practices

Reference Books:

1. Handbook on Scaling up Solid and Liquid Waste Management in Rural Areas,
2. Water and Sanitation Program, World Bank New Delhi and Ministry of Drinking Water & Sanitation, GoI, New Delhi.
3. Handbook for Managing Onsite and Clustered (Decentralized) Wastewater
4. Treatment Systems, An Introduction to Management Tools and Information for Implementing EPA's Management Guidlines.
5. Technology Options for Household Sanitation, Rajiv Gandhi National Drinking
6. Water Mission, Department of Drinking Water Supply, Ministry of Rural development, Government of

India, New Delhi and UNICEF (United NationsChildren's Fund).
7. Kara L. Nelson, Small and Decentralized System for Wastewater Treatment and Reuse, Proceeding

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2
CO5	3	3	3	3	3
CO6	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Hydrological Hazard Mitigation and Management

Course Code: EW(PE)-25003	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Identify causes, characteristics, and impacts of hydrological hazards such as floods and droughts.
2. Analyze flood and drought mitigation strategies and evaluate structural and non-structural control measures.
3. Apply GIS, Remote Sensing early warning, and disaster response.
4. Assess risk and develop management frameworks for emergency response, community participation, and resilience planning.
5. Develop integrated approaches for hydrological hazard mitigation through case studies and policy analysis.

Unit 1: Introduction to Hydrological Hazards **[8 Hrs]**
Basics of hydrological hazards and their classification. Causes and characteristics of floods and droughts. Overview of natural and man-made floods and droughts. Historical perspectives and global occurrences of hydrological disasters. Introduction to mitigation and management principles for extreme hydrological events

Unit 2: Flood Hazard Mitigation and Management **[8 Hrs]**

Concepts of flood hazard and floodplain management. Structural and non-structural flood control measures, including embankments, levees, floodways, and reservoirs. Design principles of flood control structures. Flood forecasting and early warning systems. Applications of Geographical Information Systems (GIS) and Remote Sensing in flood management. Review of flood case studies in India and abroad.

Unit 3: Drought Hazard Mitigation and Management **[8 Hrs]**

Nature and classification of droughts – meteorological, hydrological, agricultural, and socioeconomic droughts. Natural and human-induced droughts. Principles of watershed management and its role in drought mitigation. Drought monitoring and management techniques. Application of GIS and Remote Sensing in drought assessment. Drought problems specific to arid and semi-arid regions. Case studies on successful drought mitigation programs.

Unit 4: Crisis and Emergency Management **[8 Hrs]**

Nature of extreme hydrometeorological events – cyclones, flash floods, and associated flooding. Global and regional challenges of catastrophe response and emergency management. Frameworks for crisis management, community mobilization, and public participation in disaster response. Case studies demonstrating successful emergency management systems and institutional responses.

Unit 5: Risk Assessment and Advanced Warning Systems

Risk identification, assessment, and quantification methods in hydrological hazards. Risk reduction and management approaches, including the role of insurance companies in disaster recovery. Advanced early warning systems – Global Positioning Systems (GPS), Remote Sensing, and GIS-based monitoring networks. Application of Information Technology (IT) and Decision Support Systems (DSS) in natural hazard mitigation and management.

Unit 6: Self-Study

Study of national and international best practices in hydrological hazard management.

Reference Books:
1. Centre for Science & Environment, Wrath of Nature: Impact of Environmental Destruction on Floods and Droughts, Centre for Science & Environment, New Delhi.
2. Beven, K. and Carling, P., (eds.), Floods: Hydrological, Sedimentological and Geomorphological Implications, British Geomorphological Research Group Symposia Series, Wiley, Chichester, 1989.
3. B.H.R.A., Hydraulic Aspects of Floods & Flood Control, B.H.R.A., England, 1983.
4. Brown, J.P., Economic Effects of Floods, Springer-Verlag, Berlin, 1972.

5. Prasad, P., Famines and Droughts: Survival Strategies, Rawat, Jaipur, 1998.
6. A.K. Schwab, K. Eschelbach, David J. Brower, Hazard Mitigation and Preparedness, John Wiley, 2007.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Climate Change and Water Resources

Course Code: EW(PE)-25004	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Analyze the drivers and components of the climate system.
2 Evaluate climate change impacts on water and related sectors.
3 Assess tools and models for climate vulnerability analysis.
4 Evaluate adaptation and mitigation measures for climate resilience.
5 Analyze case studies to identify sustainable water management practices.

Unit 1: Climate System and Its Components [8 Hrs]

The Climate System — Definitions: Climate, Climate system, climate change – Drivers of Climate change – Characteristics of climate system components – Greenhouse effect – Carbon cycle – Wind systems – Trade Winds and the Hadley Cell – Ozone hole in the stratosphere – El Nino, La Nina – ENSO, Teleconnections.

Unit 2: Impacts of Climate Change [8 Hrs]

Impacts of Climate Change – Observed and Projected Global Scenario – Indian Scenario – Observed changes and projected changes of IPCC – Impacts on water resources – NATCOM Report – Impacts on sectoral vulnerabilities – SRES – Different scenarios.

Unit 3: Tools for Vulnerability Assessment [8 Hrs]

Tools for Vulnerability Assessment – Need for vulnerability assessment – Steps for assessment – Approaches for assessment – Models – Quantitative models, Economic model, Impact matrix approach – Box models – Zero-dimensional models – Radioactive-convective models – Higher-dimension models – EMICs (Earth-system models of intermediate complexity) – GCMs (global climate models or general circulation models) – Sectoral models.

Unit 4: Adaptation and Mitigation Strategies [10 Hrs]

Adaptation and Mitigation – Water-related adaptation to climate change in the fields of ecosystems and biodiversity, agriculture and food security, land use and forestry, human health, water supply and sanitation, infrastructure and economy (insurance, tourism, industry and transportation) – Adaptation, vulnerability and sustainable development – Sector-specific mitigation – Carbon dioxide capture and storage (CCS), Bio-energy crops, Biomass electricity, Hydropower, Geothermal energy, Energy use in buildings, Land-use change and management, Cropland management, Afforestation and Reforestation – Potential water resource conflicts between adaptation and mitigation – Implications for policy and sustainable development.

Unit 5: Case Studies and Practical Applications [8 Hrs]

Case Studies – Water resources assessment case studies – Ganga Damodar Project, Himalayan glacier studies, Ganga valley project – Adaptation strategies in assessment of water resources – Hydrological design practices and dam safety – Operation policies for water resources projects – Flood management strategies – Drought management strategies – Temporal & spatial assessment of water for irrigation – Land use & cropping pattern – Coastal zone management strategies.

Unit 6: Self-Study

Study of India's National Action Plan on Climate Change (NAPCC) and related missions; exploration of open-access tools for climate data and hydrological impact assessment.

Reference Books:

1. IPCC Report Technical Paper VI – Climate change and water , 2008.
2. UNFCC Technologies for Adaptation to climate change, 2006.
3. P R Shukla, Subobh K Sarma, NH Ravindranath, Amit Garg and Sumana Bhattacharya, Climate Change and India: Vulnerability assessment and adaptation, University Press (India) Pvt Ltd, Hyderabad.
4. Preliminary consolidated Report on Effect of climate change on Water Resources, GOI, CWC, MOWR, 2008.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Solid and Hazardous Waste Management

Course Code:		**Credit:**	4
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:
1. Analyze key sources, quantities, composition, and properties of solid and hazardous wastes.
2. Apply waste disposal or transformation techniques, such as landfills and incinerators.
3. Comprehend relevant regulations governing waste disposal and destruction facilities.
4. Design Solid and Hazardous Waste Landfills (RCRA Subtitle D and C), considering closure, post-closure, and rehabilitation issues.

Unit 1: Introduction to Solid Waste Management [6Hrs]
Definition, sources, and types of solid waste. Study of physical and chemical characteristics of solid waste. Classification of hazardous waste and its presence within municipal solid waste (MSW). Sources, types, and quantities of hazardous waste in MSW. Significance of hazardous waste in urban waste streams and its overall environmental implications. Impacts of solid and hazardous wastes on human health, air, water, and soil environments. Overview of national legislation and regulatory frameworks for waste management.

Unit 2: Collection and Transportation of Solid Waste [8Hrs]
Collection systems for municipal solid waste, methods of collection, and factors affecting efficiency. Design and operation of transfer stations for waste collection and transport. Waste allocation strategies and optimization of collection routes. Study of equipment and logistics used in solid waste collection. Role of community participation and institutional arrangements in efficient waste management.

Unit 3: Treatment and Disposal of Solid Waste [6Hrs]
Overview of solid waste treatment technologies including landfill method, incineration, and composting. Site selection criteria for landfills, landfill design principles, and operational methods such as area filling, trench filling, and depression filling. Detailed discussion on the elements of landfill closure plans, environmental monitoring systems, and post-closure management. Occurrence of gases and leachate in landfills, control of landfill gases, and leachate collection and treatment techniques.

Unit 4: Landfill Management and Environmental Considerations [8Hrs]
Design and management aspects of landfills including site condition analysis and design parameters. Study of leachate characteristics, analysis, and treatment options. Environmental monitoring around landfill sites for air, water, and soil quality. Revegetation of landfill areas, factors influencing plant growth on landfill covers, and sustainable closure methods. Application of control technologies for mitigating environmental risks.

Unit 5: Hazardous Waste Management and Toxicological Aspects [6Hrs]
Introduction to physical, chemical, and biological processes involved in hazardous waste treatment. Onsite technologies for hazardous waste site cleanup. Study of groundwater contamination due to hazardous wastes, management of storage tanks, oily wastes, and oil spills. Hazardous waste management guidelines and waste minimization approaches. Understanding of metal pollution, ecotoxicology, and toxicokinetics. Discussion of health-based safety limits including NOAEL, LOAEL, ADI, RFD, Hazard Index, and Daily Intake. Methods for controlling the release of heavy metals into the environment.

Unit 6 (Self-Study Component): [4 Hrs]
Study of advanced technologies for solid and hazardous waste management such as plasma gasification, pyrolysis, and waste-to-energy systems. Review of international best practices and case studies of successful solid waste management systems.

Reference Books:
1. Nag, K. Vizayakumar, "Environmental Education and Solid Waste Management" New Age International Publishers.
2. Donald R. Rowe, George Techobanoglous, Howard S. Peavy, "Environmental Engineering", McGraw-Hill Book Company.

3. George Techobanoglous, Hilary Thesien, Samual Vigil, “Integrated Solid Waste Management Engineering Principles and Management Issues” McGraw-Hill Inc.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Urban Hydrology and Watershed Management

Course Code:		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:
1. Demonstrate different terminologies related to urban hydrology.
2. Apply the various concepts of planning and modelling
3. Plan, design or suggest suitable stormwater control and disposal system.
4. Demonstrate different terminologies related to watershed management and assess land erosion, sedimentation.
5. Select suitable method of water harvesting.

Unit 1: Introduction to Urban Hydrology and Urban Systems [6Hrs]
Introduction to urban system, functional elements of urban system, urbanisation effects on water cycle, trends in urbanization, hydrological problems, challenges and issues of urban area. Urban water resources management model.

Unit 2: Urban Runoff Modeling and Rainfall Analysis [8Hrs]
Type of models- Physically based-conceptual based –Urban surface runoff model. Rainfall analysis in urban environment, importance of short duration rainfall and runoff data, urban runoff computations- empirical, Time-area and Unit Hydrograph approaches, rational method, SCS peak flow method runoff modeling.

Unit 3: Urban Drainage, Sewerage Systems, and Stormwater Design [6Hrs]
Introduction to urban drainage and sewerage network, Storm water management, Storm Systems- information needs, design criteria, rational method of design, hydraulic analysis and designs, Storm water drainage channels- rigid-lined channels, flexible lined channels.

Unit 4: Stormwater Control, Drainage System Design & Flood Routing [8Hrs]
Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation Storm water control: street and highway drainage- design considerations, Storm Water Detention- types of surface detention.

Unit 5: Watershed Concepts, Soil Erosion & Sediment Management [6Hrs]
Watershed, need of watershed concept, Introduction to watershed management, Characteristics: size, shape, physiography, slope, climate and drainage, Different stakeholders and their relative importance, Soil Erosion, estimation of soil erosion, sources of sediments, sedimentation in streams and reservoirs.

Unit 6 (Self-Study Component): [6 Hrs]
Water harvesting, techniques for preparing water harvesting catchments, storage of harvested water, traditional methods of water harvesting, objectives and functions of water storage structures, different structures and their suitability, losses of stored water, control of losses of stored water, conjunctive use of water.

References:
1. Hall , M. J., Urban Hydrology, Elsevier Applied Science Publishers, 1984
2. Chow, V.T., Handbook of Applied Hydrology: A compendium of water technology, Mc,Hill, NY1964
3. Larry W. Mays "Water Resources Engineering", John Wiley & Sons, inc NY, ISBN0-471-29783-6
4. Philip B. Bedient and Wayne C. Huber. "Hydrology and flood plain analysis", Addison- Wesley Publication Company, Inc ISBN 0-201-12056-9
5. P. R. Bhave. Optimal Design of Water Distribution Networks Narosa Publishing house. ISBN 81-7319-505-6
6. Warren Viessmann, Jr. Gary L. Lewis. "Introduction to Hydrology" Eastern Economy Edition, PHI learning Pvt. Ltd. New Delhi. ISBN978-81-203-3368-0
7. Allen P. Davis and Richard H. Mc Cuen" Storm water Management for Smart Growth", Springer, ISBN 10: 0-387-26048-X, ISBN-13: 9780387275932

8. Rajvir Singh, "Watershed Planning and Management", Yash Pulishing House, Jaipur, India 3rd Edition 2016
9. J V S Murty, “Watershed Management”, New Age International Publisher, Daryaganj New Delhi, Second Edition 2013
10. Madan Mohan Das and Mimi Das Saikia, “Watershed Management”, PHI Learning Private Limited New Delhi, Edition 2013
11. E.M. Tideman," Watershed Management: Guidelines for Indian Conditions", Omega Scientific Publishers.
12. Ghanshyam Das, "Hydrology and Soil Conservation Engineering", Prentice Hall India. V. P. Singh and Donald K. Frevert, “Watershed Models", Taylor & Francis

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	3	2
CO5	3	2	3	3	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Environmental Impact Assessment

Course Code:		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:

1. Analyze environmental imbalances and impacts of human activities using indicators and measurements.
2. Evaluate Environmental Impact Assessment (EIA) concepts, objectives, advantages, and limitations.
3. Apply environmental indicators and methodologies for EIA
4. Assess environmental issues in water resources and industrial development, utilizing case studies for understanding

Unit 1: Environment and Human Interaction **[6Hrs]**
Introduction to the environment and its interaction with human activities. Study of environmental imbalances and their causes. Attributes, impacts, indicators, and measurements of environmental change. Overview of anthropogenic pressures on the environment. Role of environmental indicators in assessing sustainability and ecological balance.

Unit 2: Environmental Impact Assessment (EIA): Concepts and Processes **[8Hrs]**
Concepts, objectives, and scope of Environmental Impact Assessment (EIA). Advantages and limitations of EIA in environmental planning and policy. Overview of the EIA process including screening, scoping, baseline data collection, and impact prediction. Distinction between rapid and comprehensive EIA. Significance of EIA in sustainable development and project appraisal.

Unit 3: Environmental Indicators and Socio-Economic Parameters **[6Hrs]**
Environmental indicators for climate, terrestrial, and aquatic subsystems. Criteria for the selection and classification of indicators. Discussion on socio-economic indicators, including economic, health, nutrition, and cultural indicators. Importance of social and economic data in environmental assessments. Integration of ecological and socio-economic indicators in EIA frameworks.

Unit 4: EIA Methodologies and Risk Analysis **[8Hrs]**
Overview of EIA methodologies and tools for impact prediction. Discussion of approaches such as Ad-hoc, Checklist, Matrix, Network, Overlay, Fault Tree Analysis, and Benefit-Cost Analysis. Application of environmental risk analysis and assessment criteria. Guidelines for choosing appropriate methodologies and establishing review criteria. Study of case studies demonstrating effective application of EIA methods in real-world projects.

Unit 5: Environmental Issues in Water and Industrial Development **[6Hrs]**
Environmental issues in water resources development including land use changes, soil erosion, and their short-term and long-term effects. Disturbances caused by hydrological interventions and their impact on flow quantity and quality. Water Quality Impact Assessment – attributes, data requirements for assessing dams and reservoirs, and impacts of dams on the environment. Environmental issues in industrial development – on-site and off-site impacts, long-term climatic effects, greenhouse gases, and industrial effluents. Study of environmental impacts associated with highways, mining, and energy development projects.

Unit 6 (Self-Study Component): **[6Hrs]**
Study of national and international case studies on Environmental Impact Assessment of major infrastructure and industrial projects.

References:

1. Jain R.K., Urban L.V. and Stracy G.S. "Environmental Impact Analysis", Van Nostrand Reinhold Co. New York
2. Rau J.G. and Wooten D.C. "Environmental Impact Assessment", McGraw Hill Publications Co. New York
3. UNESCO "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", WNESCO/UNEP, Paris
4. Canter L.W. "Environmental Impact Assessment", McGraw Hill Pub. Co. New York

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	3	2
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Computational Fluid Dynamics

Course Code:		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:

1. Acquire knowledge of Computational Fluid Dynamics (CFD) as an engineering analysis tool.

2. Apply the derivation of flow governing equations; implement turbulence modeling; utilize modeling approaches for multiphase flow; establish initial and boundary conditions.

3. Discretize the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for unsteady transport equation.

4. Apply techniques to solve discretized equations; employ direct methods, classical iterative methods, advanced methods for structured matrices, conjugate gradient techniques, and multigrid methods

5. Employ methods to solve coupled equations, including techniques for compressible flows, evaluation of pressure in incompressible flows, and pressure velocity coupling algorithms.

Unit 1: Introduction to Computational Fluid Dynamics [8Hrs]

Introduction to Computational Fluid Dynamics (CFD) and its significance in fluid flow analysis and design. Principles of conservation and derivation of governing equations. Continuity Equation, Navier–Stokes Equations, and Energy Equation. General structure and form of conservation equations for mass, momentum, and energy. Classification of partial differential equations and their physical behaviour. Overview of approximate and numerical solution methods in fluid flow simulations.

Unit 2: Error Minimization and Numerical Approximation Techniques in CFD [8Hrs]

Error minimization principles and the role of approximation in CFD. Variational principles and the Weighted Residual Approach. Introduction to the fundamental concepts of discretization including the Finite Element Method (FEM), Finite Difference Method (FDM), and Finite Volume Method (FVM). Comparative analysis of these methods for various types of fluid flow and transport equations.

Unit 3: Fundamentals of Finite Volume Method and Time [6Hrs]

Finite Volume Method – conceptual basics, control volume formulation, and step-by-step discretization through one-dimensional steady-state diffusion problems. Boundary condition implementation and discretization of unsteady-state problems. Important consequences of time-dependent discretization including the concepts of consistency, stability, and convergence. Introduction to the Lax Equivalence Theorem and grid independence studies. Discussion of time-step independence and the criteria for convergence.

Unit 4: Stability Analysis of Parabolic and Hyperbolic Equations in CFD [8Hrs]

Stability analysis of parabolic equations such as one-dimensional unsteady-state diffusion problems using FTCS (Forward Time Central Space), CTCS (Leapfrog), and Dufort–Frankel schemes. Stability analysis of hyperbolic equations using FTCS, FTFS (Forward Time Forward Space), FTBS (Forward Time Backward Space), and CTCS schemes. Finite volume discretization of two-dimensional unsteady diffusion-type problems. Introduction to numerical solution methods for systems of linear algebraic equations – elimination methods, iterative methods, and gradient search methods.

Unit 5: Flow Field Discretization, Coupling Algorithms, and Turbulence Models [8Hrs]

Discretization of convection–diffusion equations using the finite volume approach. Discretization of the Navier–Stokes equations using both the stream function–vorticity formulation and the primitive variable approach. Discussion of pressure–velocity coupling algorithms including the SIMPLE and SIMPLER algorithms. Introduction to unstructured grid formulations and their advantages in complex geometries. Overview of turbulence modelling and its role in practical CFD analysis.

Unit 6 (Self-Study Component):

Application of CFD tools for real-world fluid flow and heat transfer problems. Review of case studies on CFD-based design optimization in hydraulics, aerodynamics, and environmental flows.

References:

1. Computational Fluid Dynamics by John D. Anderson.
2. Computational Fluid Flow and Heat Transfer by K. Murlidhar and T. Sundararajan. (The first few chapters are good for introductory approach of Finite volume method. 12th chapter which is about semi-explicit method is written by Prof. Atul Sharma, IITB)
3. Introduction to CFD by SuhasPatankar. (Good for Finite difference method).
4. An Introduction to Computational Fluid Dynamics by HK Versteeg and W Malalasekera. (I did not refer to this book because it would create confusion as different authors have different styles of explaining. The book is on Finite Volume method).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Land and Water Management

Course Code:		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:
1. Implement appropriate methods for effective land and water management.
2. Design suitable soil and water conservation structures.
3. Estimate crop water requirements and select suitable irrigation methods.
4. Perform land suitability classification and recommend appropriate dry land farming practices.

Unit 1: Soil Erosion and its Control **[8Hrs]**
Concepts and types of soil erosion; mechanics of wind and water erosion; factors influencing erosion; control measures for wind and water erosion; design, construction, and maintenance of vegetated waterways; planning and construction of terraces, contour bunds, and other soil conservation structures.

Unit 2: Runoff, Evapotranspiration, and Drainage Systems **[6Hrs]**
Concept and estimation methods of runoff; factors affecting runoff; concept and estimation of evapotranspiration; design and planning of irrigation and drainage systems for soil and water conservation; cost analysis of conservation works.

Unit 3: Irrigation Methods and Design Principles **[8Hrs]**
Physics of surface irrigation; design and evaluation of border, check basin, and furrow systems; operation and maintenance guidelines; sprinkler irrigation – types (quick coupling, dragline, movable, center pivot), design, installation, and efficiency evaluation; spray losses and drop size; drip irrigation - types, emitters, design, clogging, maintenance, automation, and field performance.

Unit 4: Irrigated Crops and Agricultural Practices **[8Hrs]**
Irrigated agriculture and its influence on crop production; soil and climatic requirements of major irrigated crops; selection of irrigation methods for vegetable and fruit crops; agronomical practices for major irrigated crops in India; drainage requirements; economic analysis and field evaluation of irrigated crops.

Unit 5: Watershed Development and Land Management **[6Hrs]**
Concept, objectives, and characteristics of watershed development and management; hydrologic cycle and data analysis; land degradation problems and management; land use capability classification; soil and water conservation for agricultural and non-agricultural lands; watershed planning, monitoring, evaluation, and economic analysis.

Unit 6 (Self-Study Component):
Dry land farming and water harvesting in hilly/arid regions; grassland development and management; legal and social aspects of water sharing (case studies); land suitability classification (USBR & FAO frameworks); mapping and causes of soil degradation; reclamation and management of waterlogged and salt-affected soils; economic evaluation of wasteland development projects.

References:

1. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008
2. Murthy, V.V.N., Land and Water Management, Khalyani Publishers, 2004
3. Muthy, J. V. S., Watershed Management, New Age International Publishers, 1998
4. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 1998
5. Majumdar, D.K., Irrigation Water Management, Prentice Hall of India, New Delhi, 2000
6. Michael, B.A.M., Irrigation, Vikas Publishing House Pvt. Ltd. New Delhi, 1990
7. Scwabe, G.O., Fangmeir, D.D., and Elliot W.J., Soil and Water Management Systems, John Wiley and Sons, N York, 1996
8. Asawa, G.L. (1996) —Irrigation Engineering", New Age International Pub. Co. N Delhi.
9. Suresh, R.L. (1999) —Soil and Water Conservation Engineering", Standard Publishing Co. Delhi.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4.	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Air Pollution Control and Industrial Wastewater Treatment

Course Code:		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:
1. Analyze sources and reactions of air pollutants and their environmental impacts..
2. Evaluate the reactions of pollutants in the atmosphere and their effects on the environment.
3. Assess industrial wastewater characteristics and treatment requirements.
4. Design suitable physical, chemical, and biological treatment systems for industrial effluents.
5. Formulate sustainable and economical wastewater management and disposal solutions.

Unit 1: Fundamentals of Air Pollution – Sources, Classification, and Atmospheric Reactions [8Hrs]
Air pollutants-Sources, classification, Combustion processes and pollutant emission, Effect on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects- Smoke, smog and ozone layer disturbance.

Unit 2: Air Pollutant Dispersion, Measurement, and Control Technologies [6Hrs]
Atmospheric diffusion of pollutants and their analysis, Transport, transformation and deposition of air contaminants on a global scale, Air sampling and pollutant measurement methods, principles and instruments, ambient air quality and emission standards, control, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods, Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal method.

Unit 3: Characteristics and Impacts of Industrial Wastewater [8Hrs]
Industrial wastewater treatment: Sources of Pollution, Physical, Chemical, Organic & Biological properties of Industrial Wastes, Difference between industrial & municipal waste waters, Effects of industrial effluents on sewers and Natural water Bodies.

Unit 4: Treatment Methods for Industrial Wastewater [8Hrs]
Pre & Primary Treatment, Equalization, Proportioning, Neutralization, Oil separation by Floating-Waste Reduction-Volume Reduction-Strength Reduction. Waste Treatment Methods - Nitrification and De-Phosphorous removal Heavy metal removal - Membrane Separation Process - Air Stripping and Absorption Processes

Unit 5: Special Treatment Methods and Common Effluent Treatment Plants [8Hrs]
Special Treatment Methods - Disposal of Treated Wastewater. Characteristics and Composition of waste water and Manufacturing Processes of Industries like Sugar, Food processing Industries, Petroleum Refineries, Textiles, Tanneries. Joint Treatment of Raw Industries wastewater and Domestic Sewage – Common Effluent Treatment Plants (CETP) – Location, Design, Operation and Maintenance Problems – Economical aspects.

Unit 6 (Self-Study Component):
Basic and emerging concepts related to air and water pollution control form the focus of this unit. Topics include the fundamentals of air pollution meteorology, the role of greenhouse gases and their influence on climate change, and the basic principles of air pollution and its environmental implications.

References:
1. Rao, M. N., & Rao, H. V. N. (1989). *Air Pollution.* New Delhi: Tata McGraw-Hill Publishing Company Limited.
2. Metcalf & Eddy, "Wastewater Engineering Treatment disposal reuse", Tata McGraw Hill.
3. Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hill
4. Rao, M. N., & Dutta, A. K. (1987). *Wastewater Treatment.* New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
5. Mark J. Hammer, Mark J. Hammer, Jr., "Water & Wastewater Technology", Prentice Hall of India.
6. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.
7. C.G. Gurnham –Principles of Industrial Waste Engineering

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 – Substantially

Water and Air Quality Models

Course Code:	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Design models for analysing stream water quality and quantity.
2. Develop air quality models under different atmospheric stability conditions
3. Design and analysis of Models for micro-organisms studies
4. Evaluate reaction kinetics, carbonate equilibriums, and biological processes

Unit 1: Physical, Chemical, and Biological Phenomena in Environmental Systems [8Hrs]
Physical Phenomena, Transport, Gas transfer, Thermal phenomena, Sedimentation, Chemical phenomena, Solution equilibriums, Reaction kinetics, Carbonate equilibriums, Colloidal behaviour. Biological phenomena, Organic materials, Growth kinetics, Biochemical oxygen demand, Aerobic and Anaerobic decomposition, Photosynthesis, Enzymic reactions Natural transport systems

Unit 2: Dissolved Oxygen Dynamics and Stream Modelling [8Hrs]
Dissolved Oxygen system, D.O. Models for Streams - Dissolved oxygen model for streams - sources and sinks of dissolved oxygen, Estimation of system parameters, Streeter - Phelps model, Oxygen 'sag' curve, Determination of deoxygenating and re-aeration coefficients.

Unit 3: Mass Transport and Water Quality Modelling for Estuaries and Lakes [8Hrs]
Bethnal oxygen demand - mass transport mechanisms, Advective and diffusive mass transport - Models by O'Connor, Dobbins and Thomann. Streams, Estuaries, Transport in the Air nvironment. Models for Estuary and Lakes - Physical chemical and biological processes in estuaries, Water quality distribution in estuaries - dispersion coefficient, Modelling estuaries and lakes for water quality, Temperature models for lakes and rivers.

Unit 4: Ecological and Microbiological Modelling [8Hrs]
Microbiology and Ecology, Types of microorganisms, Models for microorganisms decay, nitrogen and phytoplankton, Metabolism, Ecological Principles, Food chains, Food webs, Ecological pyramids, Pesticide concentration, Eutrophication, Population Growth models

Unit 5: Air Quality Modelling and Atmospheric Dispersion [6Hrs]
Air quality models - Micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, Stack height computation, Regional air quality models,

Unit 6 (Self-Study Component):
Case studies on integrated environmental modelling systems

References:

1. Rich L.G. "Environmental Systems Engineering", McGraw Hill Inc.
2. Sincero A.P., Sincero G.A. "Environmental Engineering – A Design Approach", Prentice Hall of India, New Delhi
3. Gerard Kiely "Environmental Engineering", McGraw Hill Publications
4. Peavy H.S., Rowe D.R., Tchobanglous G., "Environmental Engineering", McGraw Hills, New York 5. Jerald L. Schnoor "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley & Sons Inc. New York
6. Gillbert M. Masters "Introduction to Environmental Engineering and Science", Prentice Hall.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	3
CO3	3	2	3	3	2
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Water Resources Planning, Management and Economics

Course Code:	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Explain principles of water resources systems analysis and planning.
2. Design and estimate reservoir capacity, yield, and flood routing parameters.
3. Apply reservoir regulation strategies for hydropower, flood control, and water supply.
4. Apply basic concepts of water resources economics in planning and management.
5. Evaluate projects using benefit–cost analysis and financial appraisal methods.
6. Integrate technical, socio-economic, and environmental aspects for sustainable water resources development.

Unit 1: Introduction to Water Resources Systems and Planning
General principles of systems analysis in water resources and environment, objectives of water resources planning and development, socio-economic characteristics, data requirements and surveys, and environmental constraints on water resources development.

Unit 2: Reservoir Planning and Design
Determination of reservoir capacity and yield, flood routing methods, reservoir sediment distribution and its necessity, evapotranspiration methods, and determination of gross irrigation requirement.

Unit 3: Reservoir Regulation and Hydropower Development
Reservoir regulation principles, reservoir planning for hydropower, load duration curve, planning of run-of-river and storage hydropower plants, base load and peak load plants, reservoir regulation and operation policies - standard operation, hedging rules, and rule curves.

Unit 4: Fundamentals of Water Resources Economics
Planning period and time horizon, economic and demographic projections, integrated and disaggregated model analysis, demand resilience and consumer behavior, basic economic concepts – present worth, future worth, annuities, depreciation, cost curves, tangible and intangible values, and indifference curves.

Unit 5: Economic Analysis and Project Evaluation
Planning period and time horizon, economic and demographic projections, integrated and disaggregated model analysis, demand resilience and consumer behavior, basic economic concepts – present worth, future worth, annuities, depreciation, cost curves, tangible and intangible values, and indifference curves.

Unit 6 (Self-Study Component):
Socio-economic and environmental aspects in water resources planning, importance of data collection and surveys, concepts of reservoir sedimentation and control, basics of evapotranspiration and irrigation requirement, load duration curve interpretation, simple understanding of benefit–cost ratio, and overview of water pricing and project financing.

References:

1. Loucks D.P., Stedinger J.R. and Haith D.A. "Water Resources Systems Planning and Analysis", Prentice Hall Inc. New York.
2. Chaturvedi M.C. "Water Resources Systems Planning and Management", Tata McGraw Hill Publication Co., New Delhi.
3. Hall W.A. and Dracup J.A. "Water Resources Systems", Tata McGraw Hill Publication Co., New Delhi.
4. James L.D. and Lee R.R. "Economics of Water Resources Planning", McGraw Hill Publication Co., New York. 5. Kuiper E. "Water Resources Development, Planning, Engineering and Economics", Buttersworth, London.

6. S. K. Jain and V. P. Singh, “Water Resources Systems Planning and Management,” Elsevier Science B.V, Amsterdam, 2003.
7. S. Vedula and P. P. Mujumdar, “Water Resources Systems Modelling Techniques and Analysis,” Tata-McGraw Hill, New Delhi, 2005

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CO6	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Irrigation and Drainage

Course Code:	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:
1. Evaluate water conveyance systems and canal linings for design, economy, and efficiency.
2. Analyze and design cross-drainage works and regulating structures in canal networks.
3. Design and assess lift irrigation systems for effective water delivery.
4. Develop efficient drip and sprinkler irrigation designs suited to field conditions.
5. Analyze and design suitable surface and subsurface drainage systems.
6. Summarize key concepts of canal lining, cross-drainage, irrigation, and drainage through self-directed learning.

Unit 1: Introduction to Water Conveyance Systems [8 Hrs]

Canals and open channels, types and functions; lined and unlined channels, canal losses and their estimation; advantages and economics of lined channels; materials and methods of channel lining.

Unit 2: Cross Drainage Works [8 Hrs]

Types and necessity of cross drainage works, aqueducts, super passages, siphons, and culverts; design and layout considerations; regulating structures and their functions in canal networks.

Unit 3: Lift Irrigation Systems [8 Hrs]

General concepts and components of lift irrigation systems; elements such as intake well, jack well, rising main, and distribution system; design considerations and overall economics of lift irrigation.

Unit 4: Drip and Sprinkler Irrigation Systems [8 Hrs]

Drip irrigation – general concept, advantages, limitations, elements, and design principles; sprinkler irrigation – concept, advantages, limitations, components, types of sprinklers, and design considerations.

Unit 5: Drainage and Salinity Control [8 Hrs]

Land drainage principles, combined irrigation and drainage systems, water balance equation, drainage survey, field drainage effects on agriculture; salinity and salt balance, salinization due to capillary rise, leaching, reclamation, bio-drainage, and design and management of surface and subsurface drainage systems.

Unit 6: Self-Study

Concepts of canal losses and control measures, types and importance of canal lining, functions of cross drainage works, advantages and limitations of drip and sprinkler irrigation, basic idea of salinity and leaching, and simple understanding of surface and subsurface drainage systems.

Reference Books:

1. Michael, BAIl. "Irrigation", Vikas Publishing House Pvt. Ltd. N Delhi.
2. Asawa, G.L. "Irrigation Engineering", New Age International Pub. Co. N Delhi.
3. Michael A M "Irrigation -Theory and Practice" Vikas Publishing House Pvt. Ltd. New Delhi.2009
4. Murthy, V.V.N. (1999) "Land and Water Management Engineering", Kalyani Publishers, Ludhiana.
5. Bhattacharya A.K. and Michael A.M. "Land Drainage Principles, Methods and Applications" Konark Publishers Pvt. Ltd, New Delhi, 2003.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
CO6	2	3	2	2	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Transport of Water and Wastewater

Course Code:		**Credit:**	3
Teaching Scheme		**Examination Scheme**	
Lectures:	3 Hrs	MSE:	30
Self-Study:	1 Hrs	TA:	20
		ESE:	50

Course Outcomes: Students will be able to:
1. Design water storage and transmission system including pumping of water
2. Computer applications in distribution network analysis
3. Design of storm drains-storm water inlets
4. Assess the maintenance needs of sanitary sewage and storm drainage systems

Unit 1: Water Storage, Transmission & Pumping System Design [8Hrs]
Water Storage and Transmission - Storage requirements, impounding reservoirs, intakes, pressure conduits, Hydraulics, pumps and pumping units, Capacity and selection of water pumps, Economic design of pumps and economic design of gravity and pumping mains.

Unit 2: Pipe Materials, Network Analysis & Pressure Transients in Water Distribution [8Hrs]
Materials for pipes - Specification for pipes, pipe appurtenances, Types of loads and stresses, Water hammer - causes and prevention, control devices. Distribution Systems - Principles of design, Analysis of distribution networks, Hardy Cross, equivalent pipe and Newton Raphson methods, Computer applications in distributions network analysis.

Unit 3: Optimal Network Design, Sewer Hydraulics & Model-Based Design of Collection Systems [8Hrs]
Optimal design of networks, Maintenance of distribution systems, Methods of control and prevention of corrosion, Storage, distribution and balancing reservoirs. Sanitary Sewerage - Sanitation technology selection, sanitary sewage flow estimation, Sanitary sewer materials, Hydraulics of flow in sanitary sewers - partial flows, sewer design, sewer layouts, Concept of model based design - hydraulic fundamentals of design models, Basic properties and model formulations for the design of wastewater of collection system, Transitions in flow of sewage.

Unit 4: Storm Drainage Systems: Design, Hydraulics & Runoff Estimation [6Hrs]
Storm Drainage - Basic philosophy in storm drainage, drainage layouts, Storm runoff estimation, Rainfall data analysis, Hydraulics of flow in storm water drains, Storm water drain materials and sections, Design of storm drains - storm water inlets.

Unit 5: Preventive Maintenance, Corrosion Control & Wastewater Pumping Systems [8Hrs]
Preventive maintenance - monitoring safety requirements, Corrosion in sewers - prevention and control, Specific problems related to waste water pumping - pumping - pump selection - wastewater pumping networks.

Unit 6 (Self-Study Component):
Maintenance requirements of sanitary sewerage and storm drainage systems, Manpower requirement, Equipment requirement

References:
1. Mohanty A.K. “Fluid Mechanics”, Prentice Hall of India, New Delhi
2. Tebutt T.H. Y. " Principles of Water Quality Control", Pergamon Press, Oxford.

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Advanced Environmental Engineering Practices

Course Code:	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs	MSE: 30
Self-Study: 1 Hrs	TA: 20
	ESE: 50

Course Outcomes: Students will be able to:

1. Establish a strong theoretical knowledge base to equip students for roles in industries, academia and research
2. Evaluate the environmental impacts of industrial waste disposal, both untreated and treated
3. Explore fundamental concepts integral to industrial wastewater treatment
4. Apply experimental design to conduct research, analyze data, interpret results, and draw conclusions.

Unit 1: Advanced Water Treatment Technologies and Specialized Filtration Processes [8Hrs]
Advanced water treatment Modification of Rapid Sand Filter- Up flow Filters. Dual Media, Multimedia and mixed bed filters. Diatomaceous filters. Application Membrane Processes, Reverse Osmosis, Ultra filtration, Electrodyalisis, Defluridation (Causes of fluorides in water, significance of high and low fluorides in water, methods of de fluoridation), arsenic removal (Introduction, sources, effects and treatment process).

Unit 2: Advanced Wastewater Treatment, Rural Sanitation & Sustainable Solid Waste Management [6Hrs]
Advanced Waste management Modification in conventional wastewater treatment (MBBR and SBR), sources, treatment of grey and black water, treatment of mixed grey and black water, used of treated wastewater, minimum and maximum velocity in sewer, USBR, FAB reactor, Constructed wetland, Duckweed pond process, Rural Sanitation, Feacal Sludge Treatment Plant, Ecosan Toilet, Twin Pit system, Solid and Hazardous waste management: Definition, Types, effects and Treatment, waste minimization, transfer station, break even analysis, bio-mining of old dumped solid waste, sustainable solid waste management, Dose response relationship, measurement of toxic substances, E-waste management.

Unit 3: Air Pollution Meteorology, Dispersion Modeling & Pollution Control Concepts [8Hrs]
Air Pollution: Meteorological Aspects: Parameters influencing air pollution, measurement of parameters plume behavior, transport, and diffusion. Formulae for stack heights, Gaussian diffusion models for finding ground level concentration. Design problems of height of chimney and ground level concentration. Photochemistry of air pollution, Photochemical smog reactions involved in its formation, Factors influencing its reactions. Effects on man, animals, vegetation and property, Economics of loss due to pollution, Episodes, Air Pollution index. Cost / benefit ratio, optimization, Control of Pollution: By process modification, Change of raw materials, Fuels, process equipment and process operation by use of air pollution control equipments, For particulate pollutants.

Unit 4: Air Pollution Control Equipment, Sampling Techniques & Environmental Standards [8Hrs]
Air Pollution control by using Equipments, Design of control equipments as ESP, Scrubber, Bag filter, Cyclones etc Control of gaseous pollutants Absorption devices, Adsorption Devices, Combustion devices, Condensation devices Land use planning: As a method of air pollution control, Sampling and Analysis: Air Pollution survey, Basic and statistical considerations of sampling sites, Devices and methods used for sampling gases and particulars, Stack sampling, Iso kinetic sampling Analysis of air samples, Chemical and instrumental methods, Ambient air quality standards and emission standards.

Unit 5: Noise & Odor Pollution Control and Environmental Impact Assessment (EIA) [8Hrs]
Noise and Odor pollution and Environmental Impact Assessment Odors: Sources, measurement and control, Environmental Impact Assessment: Definition, Broad Goals, Objectives, Phases in EIA, Contents of Application form, Advantages & Disadvantages of EIA, Environmental management plan, Environmental Impact of Industries, Urbanization and Agricultural activities.

Unit 6 (Self-Study Component):
Noise characteristics, measurement of noise, Effects of noise, Control of noise.

References:

1. Metcalf & Eddy, "Wastewater Engineering Treatment disposal reuse", Tata McGraw Hill.
2. Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hill

3. M.N. Rao and Dutta – Industrial Waste.
4. Mark J. Hammer, Mark J. Hammer, Jr., “Water & Wastewater Technology”, Prentice Hall of India.
5. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.
6. C.G. Gurnham –Principles of Industrial Waste Engineering. Mohanty A.K. “Fluid Mechanics”, Prentice Hall of India, New Delhi

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	3
CO2	3	2	3	3	3
CO3	3	2	3	2	2
CO4	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Water Resources Engineering Lab

Course Code:	**Credit:** 2
Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs	ISE: 50
	ESE: 50

Course Outcomes: Students will be able to:
1: Measure the flow through pipe and the calibration of hydraulic structures.
2. Perform the basic as well as advance tests on water.
3. Utilize software's related to environment and water resources
4. Apply software for solution of problems
5. Prepare models based on software

Syllabus Contents:
1. To determine Reynolds number
2. To verify Bernoulli's equation
3. To measure the flow by venturimeter
4. To measure the flow by orifice meter
5. To study the uniform flow in open channel
6. To study the standing wave flume
7. To study the hydraulic jump
8. Watershed Simulation Flood Control
9. Optimization Design of water distribution system
10. Storm drainage design
11. Detention basin design
12. Water quality modeling in rivers
13. Groundwater flow simulations
14. Rainfall runoff modeling
15. Crop water management

Softwares:
1. Introduction and basics of Water and Sewer Gems

Reference
1. P. N. Modi and S. M. Seth, *Hydraulics and Fluid Mechanics including Hydraulic Machines*, 15th ed. New Delhi, India: Rajsons Publications, 2018.

SEMESTER III

Massive Open Online Course – I

Course Code:	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Lecture: 3 Hrs/week	CIE: 50
Self study : 1 Hrs/week	ESE: 50

Course Outcomes: Students will be able to:

1. Acquire new skills or knowledge to enhance their personal and professional development.
2. Receive a flexible learning environment, allowing one to study at own pace and convenience.
3. Opportunity for lifelong learning.
4. Foster collaboration and networking among participants.

The students in consultation with the faculty advisor, opt for a single course of 12 weeks offered by the NPTEL in the current semester. The students need to register for the examination conducted by the NPTEL. For the students who secured a passing score in the NPTEL examination, the marks obtained for assignments (in 25 marks) will be upscaled to out of 50 marks of CIE and the marks obtained from the certificate examination (in 75 marks) will be downscaled 50 marks of ESE assessments.

Massive Open Online Course – II

Course Code:	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Lecture: 3 Hrs/week	CIE: 50
Self study : 1 Hrs/week	ESE: 50

Course Outcomes: Students will be able to:

1. Acquire new skills or knowledge to enhance their personal and professional development.
2. Receive a flexible learning environment, allowing one to study at own pace and convenience.
3. Opportunity for lifelong learning.
4. Foster collaboration and networking among participants.

The students in consultation with the faculty advisor, opt for a single course of 12 weeks offered by the NPTEL in the current semester. The students need to register for the examination conducted by the NPTEL. For the students who secured a passing score in the NPTEL examination, the marks obtained for assignments (in 25 marks) will be upscaled to out of 50 marks of CIE and the marks obtained from the certificate examination (in 75 marks) will be downscaled 50 marks of ESE assessments.

Dissertation Phase – I

Course Code:	**Credit: 11**
Teaching Scheme	**Examination Scheme**
Lab: 22 Hrs	CIE: 70
Self-Study: 12 Hrs	ESE: 30

Course Outcomes: Students will be able to:

1. Demonstrate how to search the existing literature to gather information about a specific problem or domain.
2. Identify the state-of-the-art technologies and research in the chosen domain and highlight open problems that are relevant to societal or industrial needs.
3. Evaluate various solution techniques to determine the most feasible solution within the given constraints for the chosen dissertation problem.
4. Apply software engineering principles related to requirements gathering and design to produce relevant documentation.
5. Write a dissertation report that details the research problem, objectives, literature review, and solution architecture.
6. Deliver effective oral presentations to communicate the findings and outcomes of the research work.

Guidelines:

The dissertation is a year-long project, conducted and evaluated in two phases. It can be carried out either in-house or within an industry as assigned by the department. The project topic and internal advisor (a faculty member from the department) are determined at the beginning of Phase I.

Students are expected to complete the following activities in Phase-I:

1. Literature survey
2. Problem Definition
3. Motivation for study and Objectives
4. Preliminary design /feasibility / modular approaches

Deliverables:

1. A report having the following details: Abstract, Problem statement, Requirements specification, Literature survey, Proposed solution, High-level design description, Plan for implementation and testing in Phase-II
2. A presentation that covers the major points covered in the report.

Evaluation:

Two independent assessments (Mid-Semester and End-Semester evaluations) will be made. In both the Examinations, the internal guide, along with a Senior Faculty member of the department, will evaluate the work. The marks obtained in these two assessments will be combined to get the final evaluation out of 100 marks. The course grading, like other courses, will be relative in nature.

The evaluation will take place based on criteria such as literature survey and well-defined project problem statement, proposed high level system design, concrete plan for implementation and result generation, presentation etc.

The panel (external examiner(s) and senior faculty) will provide a report about suggestions/changes to be incorporated during phase-II.

SEMESTER IV

Dissertation Phase – II

Course Code:		**Credit:**	**11**
Teaching Scheme		**Examination Scheme**	
Lab:	22 Hrs	CIE:	70
Self-Study:	12 Hrs	ESE:	30

Course Outcomes: Students will be able to:

1. Achieve proficiency in the languages, tools, libraries, and technologies used in the dissertation work.
2. Apply project planning principles and techniques to ensure effective and efficient project execution.
3. Demonstrate an understanding of the entire lifecycle of a software product or solution.
4. Produce artifacts such as source code, test plans, and test results based on the dissertation work.
5. Write research paper(s) and a thesis in accordance with publication ethics.
6. Exhibit the presentation skills needed to effectively present the work at various platforms.

Guidelines:
Students are expected to complete the following activities in Phase-II:

1. Implementation of the proposed approach in the first stage
2. Testing and verification of the implemented solution
3. Writing of a report and presentation
4. Publish the work done at a suitable Scopus indexed conference/in a journal

Deliverables:
1. Source code (if the project is in-house)
2. Dissertation report that gives overview of the problem statement, literature survey, design, implementation details, testing strategy and results of testing
3. All the artifacts created throughout the duration of dissertation such as requirements specification, design, project plan, test cases etc
4. Presentation based on the dissertation report
5. Research Paper(s) based on the dissertation work

Evaluation:
Mid-Semester evaluation: In the MSE, the internal guide, along with a Senior Faculty of the department, will evaluate the work. In the End Semester Examination evaluation, the internal guide, along with an external expert (usually from an Industry) will evaluate the work. The marks obtained in these two assessments will be combined to get the final evaluation out of 100 marks. The course grading, like other courses, will be relative in nature. The assessment is done on the criteria such as concrete system design, implementation status and concrete plan for completion of remaining tasks, presentation etc. The purpose of Mid-Semester evaluation is also to check preparedness of students for the End-Semester evaluation. Examiners may give suggestions for changes/corrections to be incorporated before the final evaluation. If the work done till then may not lead to successful completion of the dissertation in the remaining time, the student may be asked to take an extension in time to complete the course.
End-Semester evaluation: The assessment of End-Semester evaluation will be done based on the criteria such as quality of implementation, result analysis, project outcomes (publications, patent, copyright, contribution to opensource community, participation in project competition etc.), quality of report, presentation etc. The total assessment of phase-II work is for 100 marks and the grading, like other courses, will be relative.