



**ROYAL SCHOOL OF ENGINEERING &
TECHNOLOGY
(RSET)**

DEPARTMENT OF CIVIL ENGINEERING

**COURSE STRUCTURE & SYLLABUS
(BASED ON NATIONAL EDUCATION POLICY 2020)**

FOR

**Master of Technology
in**

Water Resource Development and Management

W.E.F

AY - 2025 – 26

Course Structure

(AY 2025-26 onwards)

Semester I

Sl. No	Course Code	Course Name	Hours per week			Credit
			L	T	P	C
1	CEE024C10W1	Advanced Hydrology	3	1	0	4
2	CEE024C10W2	Advanced Open Channel Flow	3	1	0	4
3	CEE024C10W3	Watershed Conservation and Management	3	1	0	4
4	CEE024C10W4	Numerical Methods	3	1	0	4
5	CEE024C10W5	Disaster Management	1	0	0	1
6	CEE024C11W6	Hydrology Lab	0	0	2	1
7	CEE024C10W1	Elective-I	3	0	0	3
8	CEE024C10W2	Elective-II	3	0	0	3
TOTAL			19	4	2	24

Semester II

Sl. No	Course Code	Course Name	Hours per week			Credit
			L	T	P	C
1	CEE024C20W1	Computational Fluid Dynamics	4	0	0	4
2	CEE024C20W2	Ground Water Engineering	4	0	0	4
3	CEE024C20W3	Systems Analysis in Water Resources	4	0	0	4
4	CEE024C20SW1	Research Methodology & IPR	3	0	0	3
5	CEE024D20Wx	Elective-III	3	0	0	3
6	CEE024D20Wx	Elective-IV	3	0	0	3
TOTAL			21	0	0	21

Semester III

Sl. No	Course Code	Course Name	Hours per week			Credit
			L	T	P	C
1	CEE024C30W1	Urban Water Resources Management	3	0	0	3
2	CEE024C32SW1	Dissertation (Phase-I) & Presentation	0	0	0	14
3	CEE024D30Wx	Elective-V	3	0	0	3
4	CEE024C33SW2	Summer Internship	0	0	0	1
TOTAL			6	0	0	21

Semester IV

Sl. No	Course Code	Course Name	Hours per week			Credit
			L	T	P	C
1	CEE024C42SW1	Dissertation (Phase-II) & Presentation	0	0	0	14

SEMESTER	CREDITS
I	24
II	21
III	21
IV	18
Total	84

Elective – I

Sl.No.	Code	Course
1	CEE024D10W1	Fluvial Hydraulics
2	CEE024D10W3	Water Resources Planning and Management

Elective – II

Sl.No.	Code	Course
1	CEE024D10W2	Climate Change Vulnerability assessment
2	CEE024D10W4	Water Power Engineering

Elective – III

Sl.No.	Code	Course
1	CEE024D20SW1	Design of Hydraulic Structures
2	CEE024D20W2	Soft Computing in Water Resources Engineering

Elective – IV

Sl.No.	Code	Course
1	CEE024D20W3	Coastal Engineering and Coastal Zone Management
2	CEE024C20SW2	Theory and Applications of GIS

Elective – V

Sl.No.	Code	Course
1	CEE024D30W1	Principles of Water Quality and EIA
2	CEE024D30W2	Flood Control and Drainage Engineering

Semester I

Advanced Hydrology (CEE024C10W1)

Scheme of Evaluation: T

L-T-P-C: 3-1-0-4, Credit Units: 04

Pre-requisite:

- Good command of Higher Secondary level physics
- Basic knowledge of hydrologic cycle and fluid mechanics
- Familiarity with engineering mathematics and probability concepts

Course Objectives:

The course aims to provide an advanced understanding of hydrologic processes governing the occurrence, movement, and distribution of water in natural systems. It focuses on developing analytical and quantitative skills required for precipitation analysis, evaporation and infiltration modelling, and rainfall–runoff estimation. The course also introduces advanced watershed response analysis and groundwater hydrology concepts essential for water resources planning and management. Emphasis is placed on the application of statistical techniques, hydrologic modelling approaches, and GIS-based tools for solving real-world hydrologic problems.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of advanced hydrologic cycle analysis, precipitation processes, evaporation, infiltration, runoff mechanisms, and groundwater occurrence.	BT1
CO2	Explain the principles of rainfall frequency analysis, evapotranspiration estimation, infiltration modelling, hydrograph analysis, and groundwater flow behaviour.	BT2
CO3	Apply hydrological methods to analyze rainfall data, estimate infiltration and runoff, develop unit hydrographs, and simulate watershed responses.	BT3
CO4	Analyze watershed and groundwater systems using hydrologic modelling approaches, statistical techniques, and GIS-based hydrologic applications.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Advanced Hydrologic Concepts and Precipitation Analysis: Hydrologic cycle as a global and watershed-scale phenomenon; hydrologic continuity equation; water balance and hydrologic modelling concepts; history and scope of advanced hydrology. Atmospheric circulation and precipitation processes; forms and distribution of precipitation; rainfall measurement and data acquisition. Presentation and processing of rainfall data including consistency analysis and missing data estimation. Depth–area–duration relationships; mean rainfall estimation methods such as isohyetal and trend surface methods. Statistical analysis of rainfall including normal and log-normal distributions, frequency analysis, goodness-of-fit tests, climate classification, rainfall intensity-duration-frequency (IDF) relationships, and rain gauge network design.	15	25
II	Evaporation and Infiltration Modelling: Methods of evaporation estimation including energy balance and aerodynamic methods. Evapotranspiration concepts including potential evapotranspiration, consumptive use, and crop water requirements. Soil-water balance and climatic influences on evaporation. Subsurface water movement including unsaturated flow processes, soil moisture flux, infiltration rates and capacity. Measurement of infiltration using field methods. Infiltration models including Horton's equation, Philip's equation, and Green-Ampt method. Ponding time estimation and determination of infiltration indices.	10	25
III	Runoff Hydrology and Watershed Response: Watershed processes and	10	25

	hydrologic response mechanisms. Surface runoff processes including Horton's overland flow concept and variable source area theory. Subsurface flow mechanisms through soil matrix and pipes. Streamflow components and hydrograph analysis including baseflow separation and flow recession analysis. Unit hydrograph theory including derivation methods, S-curve applications, synthetic unit hydrographs, and travel time estimation. Catchment response analysis and factors affecting runoff generation.		
IV	Groundwater Hydrology and Hydrologic Applications: Occurrence and vertical distribution of groundwater including zones of aeration and saturation. Types of aquifers and aquifer properties such as storage coefficient, permeability, and hydraulic conductivity. Groundwater movement based on Darcy's law. Flow through anisotropic aquifers and determination of groundwater flow direction. Introduction to groundwater recharge estimation methods. Applications of GIS in hydrological studies including watershed delineation, runoff analysis, and groundwater mapping.	10	25

Text Books

1. Raghunath H. M., *Hydrology: Principles, Analysis & Design*, New Age International Publishers.
2. K. C. Patra, *Hydrology & Water Resources Engineering*, Narosa Publishing House.

Reference Books

1. V. T. Chow (Ed.), *Handbook of Hydrology*, McGraw Hill.
2. K. N. Mutreja, *Applied Hydrology*, Tata McGraw Hill.
3. Dingman, S. L., *Physical Hydrology*, Waveland Press.
4. Maidment, D. R., *Handbook of Hydrology*, McGraw Hill.

Advanced Hydraulic Engineering (CEE024C10W2)

Scheme of Evaluation: T

L-T-P-C: 3-1-0-4, Credit Units: 04

Pre-requisite:

- Basic knowledge of Fluid Mechanics
- Basic knowledge of Open Channel Flow and Hydraulics
- Familiarity with continuity, energy, and momentum principles

Course Objectives:

The course aims to provide advanced knowledge of hydraulic engineering principles governing flow in open channels and river systems. It focuses on developing analytical and design capabilities for uniform, gradually varied, and rapidly varied flow conditions. The course introduces advanced concepts of sediment transport, movable boundary hydraulics, and regime theories for channel stability. It further emphasizes river behavior, hydraulic structure interaction, and application of physical and numerical hydraulic models for solving real-world river and canal engineering problems. The course also aims to equip students with the ability to analyze complex hydraulic systems and design efficient river training and channel stabilization measures.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of advanced open channel hydraulics including flow classification, uniform flow resistance, and hydraulic parameters.	BT1
CO2	Explain the hydraulic principles governing gradually varied flow, rapidly varied flow, and sediment transport mechanisms in natural channels.	BT2
CO3	Apply hydraulic and sediment transport theories to design stable channels, evaluate flow transitions, and estimate sediment transport rates.	BT3
CO4	Analyze river behavior and hydraulic system performance using river training concepts and physical and numerical hydraulic modelling techniques.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Fundamentals of Advanced Open Channel Flow: Review of open channel hydraulics; classification of flow (steady/unsteady, uniform/non-uniform, subcritical/supercritical); channel geometry and hydraulic elements; velocity distribution and boundary resistance; uniform flow equations including Chezy's and Manning's formulas; computation of normal depth; resistance to flow in natural channels; compound channel hydraulics; conveyance computation in irregular channels; energy concepts and introduction to specific energy relationships.	10	25
II	Rapidly Varied Flow and Channel Design: Critical flow concepts; specific energy and critical depth determination; flow transitions in open channels including contractions and expansions; choking phenomenon; gradually varied flow analysis including classification of water surface profiles; backwater and drawdown curves; direct step and standard step methods; rapidly varied flow including hydraulic jumps, energy loss estimation, flow under gates and over spillways; design of non-erodible channels and introduction to prismatic and non-prismatic channel design considerations.	10	25
III	Sediment Transport and Silt Theories: Mechanics of sediment transport; modes of sediment transport including bed load and suspended load; sediment continuity and sediment rating curves; initiation of motion of sediment particles; regime theory and stable channel design; Kennedy's silt theory; Lacey's regime theory; design of erodible and non-erodible channels; channel stability concepts; sediment transport equations and movable bed hydraulics.	10	25
IV	River Engineering and Hydraulic Models: River morphology and river behavior; causes and mechanisms of bank erosion; sediment deposition and channel shifting; river training works including spurs, embankments, revetments, and guide bunds; flood control measures; environmental considerations in hydraulic engineering; introduction to physical hydraulic models and similitude principles; numerical hydraulic modelling concepts; applications of hydraulic models in river engineering and dam projects.	15	25

Text Books

1. Ranga Raju, K. G., *Flow Through Open Channels*, Tata McGraw Hill.
2. Chow, V. T., *Open Channel Hydraulics*, McGraw Hill.
3. Henderson, F. M., *Open Channel Flow*, McGraw Hill.

Reference Books

1. Chaudhry, M. H., *Open Channel Flow*, Prentice Hall of India.
 2. River Behavior Management and Training, Vol. I & II, CBIP, New Delhi.
 3. Andre Robert, *River Processes: An Introduction to Alluvial Dynamics*, Arnold, London.
 4. French, R. H., *Open Channel Hydraulics*, McGraw Hill.
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Watershed Conservation and Management (CEE024C10W3)

Scheme of Evaluation: T

L-T-P-C: 3-1-0-4, Credit Units: 04

Pre-requisite:

- Understanding of soil properties and water resources systems
- Familiarity with basic surveying and hydrologic processes

Course Objectives:

The course aims to provide a comprehensive understanding of watershed systems and the need for integrated watershed management approaches. It focuses on developing knowledge of watershed characteristics, soil erosion processes, and conservation practices for sustainable land and water management. The course introduces various water harvesting techniques and design of small-scale hydraulic structures used in watershed development. Emphasis is also placed on watershed planning, project formulation, participatory management approaches, and the application of remote sensing and GIS tools in watershed conservation and management. The course prepares students to design and evaluate watershed development plans for sustainable environmental and water resource management.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of watershed characteristics, soil erosion processes, and watershed delineation methods.	BT1
CO2	Explain the principles of soil conservation measures, water harvesting techniques, and watershed development planning.	BT2
CO3	Apply watershed management techniques to estimate soil loss, design water harvesting structures, and prepare watershed development plans.	BT3
CO4	Analyze watershed systems using integrated management approaches, GIS tools, and participatory planning strategies for sustainable watershed development.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Watershed Concepts: Watershed definition and classification; need for integrated watershed management; watershed characteristics and influencing factors including geology, soil, land use, climate, and topography. Morphological characteristics of watersheds; use of topographic sheets for watershed delineation; watershed codification and prioritization methods; watershed development in the Indian context and national watershed management programs.	10	25
II	Soil Conservation Measures: Types of soil erosion including water and wind erosion; causes, factors affecting erosion, and environmental impacts. Estimation of soil loss using empirical methods such as Universal Soil Loss Equation (USLE). Soil conservation practices including agronomical measures such as contour farming, strip cropping, and mulching; mechanical measures such as terraces, bunds, and check dams; sedimentation processes and control techniques.	10	25
III	Water Harvesting and Conservation: Principles of water harvesting; micro-catchment techniques; design of small water harvesting structures including farm ponds, percolation tanks, check dams, and recharge structures. Estimation of runoff yield from catchments; groundwater recharge techniques; water conservation practices for sustainable watershed development.	10	25
IV	Watershed Management and GIS Applications: Watershed project formulation and planning; preparation of watershed development plans; entry point activities and cost estimation. Watershed economics and evaluation techniques; agroforestry, grassland, and wasteland management. Participatory watershed management approaches and community involvement. Application of Remote Sensing and GIS in watershed planning including land use mapping, watershed modelling, and decision support systems; case studies of watershed development projects.	15	25

Text Books

1. Murthy, J. V. S., *Watershed Management*, New Age International Publishers.
2. Tideman, E. M., *Watershed Management: Guidelines for Indian Conditions*, Omega Scientific Publishers.

Reference Books

1. Schwab, G. O., Frevert, R. K., Edminster, T. W., and Barnes, K. K., *Soil and Water Conservation Engineering*, John Wiley & Sons.
 2. Brooks, K. N., Ffolliott, P. F., and Magner, J. A., *Hydrology and the Management of Watersheds*, Wiley-Blackwell.
 3. Suresh, R., *Soil and Water Conservation Engineering*, Standard Publishers.
 4. Lal, R., *Soil Erosion Research Methods*, Soil and Water Conservation Society.
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Numerical Methods (CEE024C10W4)

Scheme of Evaluation: T

L-T-P-C: 3-1-0-4, Credit Units: 04

Pre-requisite: Engineering Mathematics

Course Objectives:

To equip postgraduate civil engineering students with advanced numerical and statistical techniques for solving complex engineering problems through differential equations, matrix-based computations, and multivariate data interpretation.

Course Outcomes:

On successful completion of the course the students will be able to:

SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember and study errors and curve fitting principle.	BT 1
CO 2	Understand solutions of linear and non-linear equations.	BT 2
CO 3	Apply numerical differentiation and integration techniques to solve differential equations relevant to engineering.	BT 3
CO 4	Analyze engineering data using statistical tools such as regression, correlation, and predictive modeling.	BT 4

Detailed Syllabus:

Module	Content	Periods
I	Fundamentals of Numerical Methods: Error Analysis, Polynomial Approximations and Interpolations, Curve Fitting; Interpolation and extrapolation.	15
II	Solution of Non-linear Algebraic and Transcendental Equations: Elements of Matrix Algebra: Solution of Systems of Linear Equations, Eigen Value Problems.	15
III	Numerical Differentiation & Integration: Solution of Ordinary and Partial Differential Equations.	15
IV	Statistical Tools: Bivariate and multivariate data, Simple and multiple correlation. Predictive Analysis: Simple Regression, Multicollinearity, Multiple Regression.	15
	Total	60

Text/Reference Books:

1. An Introduction to Numerical Analysis, Atkinson K.E., J. Wiley and Sons, 1989.
2. Applied Linear Regression, Sanford Weisberg, John Wiley & Sons, Inc, 2005.
3. Theory and Problems of Numerical Analysis, Scheid F, McGraw Hill Book Company, (Shaum Series),1988.
4. Introductory Methods of Numerical Analysis, Sastry S. S, Prentice Hall of India, 1998.

Disaster Management (CEE024C10W5)

Scheme of Evaluation: T

L-T-P-C: 1-0-0-1, Credit Units: 01

Pre-requisite: Nil

Course Objectives:

This course introduces the fundamental principles and interdisciplinary nature of disaster management, focusing on both natural and man-made disasters. It discusses the classification, causes, consequences, preparedness, and mitigation strategies, with special reference to disaster-prone areas in India. The course aims to enhance risk evaluation capabilities and to foster community-based disaster response and mitigation planning.

Course Outcomes:

On successful completion of the course the students will be able to:

SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Define key concepts and distinguish between various types of disasters.	BT 1
CO 2	Classify vulnerable areas and evaluate associated risks.	BT 2
CO 3	Apply preparedness and mitigation strategies at individual and community levels.	BT 3
CO 4	Discover national and international efforts in disaster risk reduction.	BT 4

Detailed Syllabus:

Module	Content	Periods
I	Fundamentals of Disaster Management: Introduction to Disaster Management, Definition, Factors, Significance of Disasters, Difference between Hazard and Disaster, Natural Disasters: Earthquakes, Volcanism, Cyclones, Tsunamis, Floods, Droughts, Landslides, Avalanches. Man-made Disasters: Industrial Accidents, Oil Spills, Wars, Epidemics.	4
II	Impact and Vulnerability Assessment: Repercussions of Disasters: Economic, Human & Animal Life, Ecosystem, Disaster-Prone Areas in India: Seismic Zones, Floods, Droughts, Coastal Hazards and Tsunamis; Post-Disaster Diseases.	4
III	Risk Reduction and Mitigation: Disaster Preparedness: Monitoring, Evaluation, Remote Sensing, Risk Evaluation: Media, Meteorological Data, Community Preparedness, Concepts of Disaster Risk and Reduction (Global/National Perspectives), Risk Assessment Techniques; Community Participation Global Cooperation & Strategies for Survival, Disaster Mitigation: Concepts & Strategies Structural vs Non-Structural Mitigation Measures, Mitigation Programs in India.	4
IV	Case Study and Simulation: Case Study and Problem-Solving Session, Disaster Response Simulation Exercise.	3
	Total	15

Text/Reference Books:

1. R. Nishith, Singh A.K., Disaster Management in India: Perspectives, Issues and Strategies, New Royal Book Company.
2. Sahni, Pardeep et al. (Eds.), Disaster Mitigation: Experiences and Reflections, Prentice Hall of India.
3. Goel, S. L., Disaster Administration and Management: Text and Case Studies, Deep & Deep Publications Pvt. Ltd., New Delhi.

Hydrology Lab (CEE024C11W6)

Scheme of Evaluation: P

L-T-P-C: 0-0-2-1, Credit Units: 01

Pre-requisite:

- Basic knowledge of Hydrology and Water Resources Engineering
- Familiarity with watershed concepts and hydrologic processes
- Basic understanding of statistical analysis and GIS fundamentals

Course Objectives:

The course aims to provide practical exposure to fundamental hydrologic measurements, data analysis techniques, and watershed-based applications used in water resources engineering. It focuses on developing skills in watershed delineation, rainfall measurement planning, and analysis of hydrologic parameters such as precipitation, evaporation, and streamflow. The course also introduces laboratory and computational techniques for sediment yield estimation, statistical analysis of hydrologic data, and GIS-based watershed planning. Emphasis is placed on developing analytical competence and hands-on skills necessary for hydrologic data interpretation and real-world water resources applications.

Course Outcome:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental laboratory procedures related to watershed delineation, hydrologic measurements, and rainfall data collection methods.	BT1
CO2	Explain the procedures for hydrologic data measurement, flow determination, and statistical analysis of hydrologic variables.	BT2
CO3	Apply hydrologic techniques to measure streamflow, analyze rainfall data, estimate sediment yield, and perform GIS-based watershed analysis.	BT3
CO4	Analyze hydrologic datasets and watershed characteristics using statistical and simulation techniques for water resources planning.	BT4

Total Lab Hours = 30 (2 hours per week)

Sl. No.	Laboratory Topics / Course Content
I	Watershed delineation and characterization using topographic maps and digital elevation models (DEM).
II	Design of rain gauge network based on catchment characteristics and rainfall variability analysis.
III	Measurement and analysis of hydrologic data including precipitation, streamflow, evaporation, and evapotranspiration.
IV	Determination of water characteristics and basic water quality parameters.
V	Measurement of flow in pressure conduits using suitable hydraulic devices.
VI	Estimation of sediment yield and simulation of streamflow using simplified hydrologic models.
VII	Application of statistical techniques for analysis of hydrologic random variables including probability distribution fitting.
VIII	Application of GIS tools in watershed planning including watershed delineation and drainage network analysis.

Text Books

1. Raghunath, H. M., *Hydrology: Principles, Analysis & Design*, Revised 2nd Edition, New Age International Publishers, New Delhi.
2. Patra, K. C., *Hydrology & Water Resources Engineering*, 2nd Edition, Narosa Publishing House, New Delhi.

Reference Books

1. Chow, V. T. (Ed.), *Handbook of Hydrology*, McGraw Hill, New Delhi.
2. Mutreja, K. N., *Applied Hydrology*, Tata McGraw Hill, New Delhi.

Elective – I: Fluvial Hydraulics (CEE024D10W1)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite:

- Basic knowledge of Fluid Mechanics
- Fundamental understanding of Hydrology
- Prior knowledge of Open Channel Flow

Course Objectives:

The course aims to develop a comprehensive understanding of fluvial processes governing sediment transport and river hydraulics. It focuses on analyzing sediment properties, initiation of sediment motion, and sediment transport mechanisms in alluvial channels. The course introduces the principles of stable channel design and sediment control techniques essential for river engineering applications. Emphasis is also placed on understanding scouring and sedimentation processes and applying physical and mathematical modelling techniques for the analysis and design of river training works. The course prepares students to evaluate sediment-related hydraulic problems and develop engineering solutions for sustainable river management.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of sediment properties, sediment-fluid interactions, and initiation of sediment motion in river channels.	BT1
CO2	Explain the mechanisms of sediment transport including bed-load, suspended-load transport, and formation of bed forms in alluvial channels.	BT2
CO3	Apply sediment transport theories and regime concepts to design stable channels and implement sediment control measures.	BT3
CO4	Analyze scouring, sedimentation processes, and river hydraulic behaviour using physical and mathematical modelling techniques.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Sediment Mechanics and Initiation of Motion: Sediment-related problems in rivers; significant sediment properties including size, shape, density, and gradation; properties of sediment mixtures; properties of fluid and sediment-fluid mixtures. Terminal fall velocity of sediment particles in fluid. Initiation of sediment motion including Shields' analysis; incipient motion of uniform and non-uniform sediments; determination of critical tractive stress for sediment movement; critical conditions for sediment entrainment in natural channels.	10	—
II	Sediment Transport and Bed Forms: Formation and classification of bed forms in alluvial channels; bed-load and suspended-load transport mechanisms for uniform and non-uniform bed materials. Approaches for estimation of bed-load transport; suspended-load profile equations and sediment concentration distribution. Total-load equations and sediment discharge concepts; sediment pickup functions; sediment sorting and streambed armouring. Sediment sampling techniques and field measurement methods.	10	—
III	Stable Channel Design and Sediment Control: Principles of stable channel design; regime theory concepts; sediment control measures in channels; effective bed roughness determination; design of non-scouring erodible boundary channels; flow regime classification; design considerations for sediment transport stability in river engineering projects.	10	—
IV	Scouring, Sedimentation, and Physical/Mathematical Modelling: Bed level variations including degradation and aggradation processes; local scour at	15	—

	contractions, bridge piers, abutments, pipelines, and hydraulic structures; scour countermeasures and protective works. Reservoir sedimentation and monitoring techniques. Introduction to physical and mathematical modelling; dimensional analysis; dynamic similitude concepts; immobile bed and mobile bed model studies; application of model studies in design of guide bunds and river training structures.		
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Text Books

1. Garde, R. J., and Ranga Raju, K. G., *Mechanics of Sediment Transportation and Alluvial Stream Problems*, Wiley Eastern Ltd.
2. Chang, H. H., *Fluvial Processes in River Engineering*, John Wiley & Sons.

Reference Books

1. Yang, C. T., *Sediment Transport: Theory and Practice*, McGraw Hill.
2. Julien, P. Y., *River Mechanics*, Cambridge University Press.
3. Raudkivi, A. J., *Loose Boundary Hydraulics*, Pergamon Press.
4. Simons, D. B., and Senturk, F., *Sediment Transport Technology*, Water Resources Publications.



Elective – I: Water Resources Planning and Management (CEE024D10W3)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite:

- Basic knowledge of Hydrology and Water Resources Engineering
- Familiarity with watershed processes and surface water systems
- Understanding of basic engineering economics and statistics

Course Objectives:

The course aims to develop a comprehensive understanding of planning and management principles applied to water resources systems. It focuses on evaluating water resources availability, demand analysis, and allocation strategies under varying hydrologic and socio-economic conditions. The course introduces methods of system analysis, reservoir planning, irrigation planning, and integrated water resources management (IWRM). Emphasis is placed on the use of optimization techniques, economic evaluation methods, and decision-support tools for efficient planning and sustainable management of water resources. The course prepares students to analyse complex water resources problems and formulate scientifically sound management strategies considering environmental and societal aspects.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of water resources systems, planning principles, and water demand estimation methods.	BT1
CO2	Explain the methodologies for water resources planning, reservoir operation, irrigation planning, and water allocation strategies.	BT2
CO3	Apply system analysis and optimization techniques to evaluate water resource development alternatives and allocation policies.	BT3
CO4	Analyze integrated water resources management strategies considering economic, environmental, and socio-economic factors.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.
I	Water Resources Systems and Planning Concepts: Introduction to water resources systems; objectives of water resources planning; systems approach in water resources development; components of water resources systems. Water resources assessment including surface water and groundwater availability; water demand analysis for domestic, agricultural, industrial, and environmental uses. Water balance concepts and basin-level planning; data requirements and uncertainties in planning.	10
II	Reservoir and Irrigation System Planning: Multipurpose reservoir planning and operation; storage-yield relationships; reservoir capacity determination methods; rule curves and operation policies. Irrigation planning concepts including cropping patterns, irrigation scheduling, water duty and delta relationships. Canal command area planning; conjunctive use of surface and groundwater resources; drought and flood management planning.	10
III	System Analysis and Optimization in Water Resources: Introduction to system analysis techniques; linear programming and dynamic programming applications in water resources systems. Network flow analysis for water distribution systems; simulation modelling of reservoir and basin systems. Multi-objective optimization techniques; decision-making under uncertainty; economic evaluation of water resources projects including benefit-cost analysis and cost effectiveness.	10
IV	Integrated Water Resources Management (IWRM): Principles of integrated water resources management; watershed-based planning approaches. Environmental considerations in water resources development; water quality management; sustainability concepts in water resources planning. Institutional and policy frameworks for water	15

	management; stakeholder participation and participatory irrigation management (PIM). Climate change impacts on water resources planning; decision-support systems and case studies in integrated water resources management.	
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Text Books

1. Loucks, D. P., Stedinger, J. R., and Haith, D. A., *Water Resource Systems Planning and Analysis*, Prentice Hall.
2. Wurbs, R. A., and James, W. P., *Water Resources Engineering*, Prentice Hall.
3. Vedula, S., and Mujumdar, P. P., *Water Resources Systems: Modelling Techniques and Analysis*, Tata McGraw Hill.

Reference Books

1. Maass, A., Hufschmidt, M. M., Dorfman, R., Thomas, H. A., Marglin, S. A., and Fair, G. M., *Design of Water Resource Systems*, Harvard University Press.
 2. Mays, L. W., *Water Resources Engineering*, Wiley.
 3. Yeh, W. W. G., *Systems Analysis in Water Resources*, McGraw Hill.
 4. Biswas, A. K., *Integrated Water Resources Management: Global Theory and Practice*, Springer.
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Elective – II: Climate Change Vulnerability assessment (CEE024D10W2)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite:

- Basic knowledge of Hydrology and Environmental Science.
- Familiarity with climatology and watershed processes.
- Understanding of statistics and data interpretation techniques.

Course Objectives:

The course aims to provide advanced knowledge of climate change science and its impacts on natural and human systems, particularly water resources. It focuses on developing an understanding of climate variability, greenhouse gas emissions, and global climate processes influencing regional hydrology and ecosystems. The course introduces methods for assessing climate change vulnerability, exposure, and adaptive capacity of water resources systems. Emphasis is placed on climate risk assessment tools, hydrological modelling under changing climate scenarios, and the development of adaptation and mitigation strategies. The course prepares students to analyze climate-related risks and design sustainable management solutions for climate-resilient water resources planning.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of climate change, greenhouse gas emissions, climate variability, and global climate systems.	BT1
CO2	Explain the mechanisms of climate change impacts on hydrological processes, ecosystems, and socio-economic systems.	BT2
CO3	Apply vulnerability assessment techniques to evaluate climate risks using climate data and hydrological indicators.	BT3
CO4	Analyze climate change adaptation and mitigation strategies for sustainable water resources and environmental management.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.
I	Climate Change Fundamentals: Climate system components including atmosphere, hydrosphere, cryosphere, biosphere, and lithosphere. Concepts of weather and climate; climate variability and climate change. Greenhouse gases and global warming; carbon cycle and radiative forcing mechanisms. Causes of climate change including natural and anthropogenic factors. Historical trends in global and regional climate change; introduction to climate models and emission scenarios.	10
II	Climate Change Impacts on Water Resources: Impacts of climate change on hydrologic cycle including precipitation, evapotranspiration, runoff, groundwater recharge, and water availability. Effects on river flows, floods, droughts, and extreme weather events. Impacts on agriculture, ecosystems, and water quality. Climate variability and extreme hydrologic events; regional climate change scenarios and hydrological responses.	10
III	Climate Change Vulnerability and Risk Assessment: Concepts of vulnerability, exposure, sensitivity, and adaptive capacity. Methods of vulnerability assessment including indicator-based approaches and risk assessment frameworks. Climate risk mapping and hazard assessment. Use of statistical and GIS-based techniques for vulnerability assessment. Climate modelling outputs and uncertainty analysis; development of vulnerability indices and assessment of climate-sensitive sectors.	10
IV	Adaptation and Mitigation Strategies: Climate change adaptation strategies in water resources management; integrated water resources management under climate change. Flood and drought mitigation strategies; water conservation and sustainable practices. Policy frameworks and international agreements related to climate change. Role of remote sensing and GIS in climate monitoring. Climate-resilient infrastructure planning and case studies related to climate adaptation and mitigation in water resources systems.	15

Text Books

1. IPCC, *Climate Change Assessment Reports*, Cambridge University Press.
2. Subramanya, K., *Climate Change and Water Resources*, Tata McGraw Hill.
3. Bates, B. C., Kundzewicz, Z. W., Wu, S., and Palutikof, J. P., *Climate Change and Water*, IPCC Technical Paper.

Reference Books

1. Wilby, R. L., and Dawson, C. W., *Climate Change Impacts on Water Resources*, Wiley.
 2. Solomon, S., et al., *Climate Change: The Physical Science Basis*, Cambridge University Press.
 3. Kundzewicz, Z. W., *Climate Change Impacts on Freshwater Resources*, Springer.
 4. Dessai, S., and Hulme, M., *Climate Change Vulnerability Assessment Methods*, Routledge.
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Elective – II: Water Power Engineering (CEE024D10W4)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite:

- Basic knowledge of Fluid Mechanics
- Fundamental understanding of Hydrology and Open Channel Flow
- Familiarity with hydraulic machines and energy concepts

Course Objectives:

The course aims to provide advanced knowledge of the principles and applications of hydropower engineering. It focuses on understanding the development and utilization of water power resources, including estimation of hydropower potential and planning of hydroelectric projects. The course introduces hydraulic turbines, their design and performance characteristics, and the layout and components of hydroelectric power plants. Emphasis is placed on reservoir planning, power regulation, and economic evaluation of hydropower projects. The course also addresses environmental and social impacts of hydropower development and modern approaches to sustainable and efficient water power generation.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of hydropower development, classification of hydroelectric plants, and components of water power systems.	BT1
CO2	Explain the principles of turbine operation, power estimation, reservoir regulation, and plant layout in hydropower engineering.	BT2
CO3	Apply hydraulic and hydrological principles to estimate hydropower potential and design basic components of hydroelectric power plants.	BT3
CO4	Analyze hydropower system performance, economic feasibility, and environmental impacts for sustainable water power development.	BT4

Detailed Syllabus

Module	Topics / Course Content	Hrs.
I	Introduction to Hydropower Engineering: Role of hydropower in energy generation; classification of hydroelectric plants based on head, storage, and load conditions. Hydrologic considerations in hydropower development; estimation of water availability and dependable flow; flow duration curves and power duration curves. Assessment of hydropower potential including theoretical, technical, and economic potential; planning and development of hydroelectric projects.	10
II	Hydraulic Turbines: Classification of hydraulic turbines including impulse and reaction turbines. Working principles of Pelton, Francis, and Kaplan turbines. Specific speed of turbines; turbine selection criteria based on head and discharge. Performance characteristics of turbines including efficiency, characteristic curves, cavitation, and draft tube theory. Governing of turbines and speed regulation methods.	10
III	Hydroelectric Power Plant Components and Layout: Components of hydroelectric plants including dams, reservoirs, spillways, intake structures, penstocks, surge tanks, turbines, generators, and tailraces. Layout of hydroelectric power plants; surface and underground power stations. Design considerations for penstocks and surge tanks. Load curves and power plant operation; pumped storage plants and multipurpose reservoir planning.	10
IV	Power Regulation, Economics, and Environmental Aspects: Reservoir operation and power regulation methods including load balancing and firm power estimation. Economic evaluation of hydropower projects including capital and operational costs, cost-benefit analysis, and tariff considerations. Environmental and social impacts of hydropower development including displacement, sedimentation, and ecological effects. Modern trends in hydropower including small hydropower plants, renewable energy integration, and sustainable hydropower practices.	15

Text Books

1. Dandekar, M. M., and Sharma, K. N., *Water Power Engineering*, Vikas Publishing House.
2. Modi, P. N., *Hydraulic Turbines*, Standard Book House.
3. Nag, P. K., *Power Plant Engineering*, Tata McGraw Hill.

Reference Books

1. Mosonyi, E., *Water Power Development*, Akademiai Kiado.
 2. Varshney, R. S., *Hydropower Engineering*, Nem Chand & Bros.
 3. Finnemore, E. J., and Franzini, J. B., *Fluid Mechanics with Engineering Applications*, McGraw Hill.
 4. USBR, *Hydraulic Design of Hydroelectric Power Plants*, U.S. Bureau of Reclamation.
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Semester II

Computational Fluid Dynamics (CEE024C20W1)

Scheme of Evaluation: T

L-T-P-C: 3-1-0-4, Credit Units: 04

Pre-requisite:

- Basic knowledge of Fluid Mechanics
- Fundamental understanding of Engineering Mathematics
- Exposure to Numerical Methods and differential equations

Course Objectives:

The course aims to provide an advanced understanding of computational techniques used to solve fluid flow and heat transfer problems governed by conservation laws. It focuses on the formulation of governing equations, their mathematical representation, and discretization using numerical methods such as finite difference, finite volume, and finite element methods. The course introduces numerical solution techniques, stability and convergence criteria, and modern computational algorithms for solving complex fluid flow problems. Emphasis is placed on pressure–velocity coupling strategies, grid generation techniques, and turbulence modelling approaches. The course prepares students to develop computational models and analyze engineering flow problems relevant to hydraulic, environmental, and water resources engineering applications.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental governing equations of fluid flow and heat transfer, boundary conditions, discretization methods, and numerical solution techniques used in computational fluid dynamics.	BT1
CO2	Explain the principles of finite difference, finite volume, and finite element methods, along with stability, convergence, and grid generation concepts in numerical modelling of fluid flow.	BT2
CO3	Apply numerical methods and solution algorithms to discretize governing equations and solve fluid flow and heat transfer problems using appropriate computational schemes.	BT3
CO4	Analyze computational fluid flow solutions by evaluating grid quality, pressure–velocity coupling strategies, and turbulence models for different engineering flow applications.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Governing Equations and Mathematical Modelling: Conservation laws of mass, momentum, and energy; differential and integral forms of governing equations; Navier–Stokes equations for incompressible and compressible flows; physical interpretation of governing equations; simplification of governing equations for engineering flows; boundary and initial conditions; dimensional analysis and non-dimensionalization of governing equations; introduction to computational modelling approaches for fluid flow and heat transfer problems.	15	25
II	Discretization Techniques: Finite Difference Method (FDM) including Taylor series expansion, discretization of diffusion and convection–diffusion equations, treatment of boundary conditions, and truncation error analysis. Finite Volume Method (FVM) including control volume approach, discretization of conservation equations, flux evaluation techniques, upwind, central difference, and hybrid schemes. Finite Element Method (FEM) including weak formulation, interpolation functions, Galerkin method, least-squares method, and comparison of discretization techniques.	10	25
III	Numerical Solution Methods and Stability: Solution of algebraic equation systems including direct and iterative methods such as Gauss–Seidel, Successive Over-Relaxation (SOR), and Tri-Diagonal Matrix Algorithm	10	25

	(TDMA). Alternating Direction Implicit (ADI) method. Time integration schemes including explicit, implicit, and Crank–Nicolson methods. Stability and convergence analysis including von Neumann stability analysis; truncation errors and consistency; error propagation; applications to transient heat conduction and advection–diffusion equations.		
IV	Navier–Stokes Solutions, Grid Generation and Turbulence Modelling: Pressure–velocity coupling algorithms including SIMPLE, SIMPLER, PISO, and fractional step methods. Structured and unstructured grid generation; mesh quality criteria; coordinate transformation and mapping techniques. Introduction to turbulence modelling including Reynolds Averaged Navier–Stokes (RANS), k – ϵ model, k – ω model, Large Eddy Simulation (LES), and Direct Numerical Simulation (DNS). Applications of CFD in hydraulic engineering including river flow simulation, flow around hydraulic structures, sediment transport modelling, and environmental flow analysis.	10	25

Text Books

1. Versteeg, H. K., and Malalasekara, W., *Introduction to Computational Fluid Dynamics: The Finite Volume Method*, Pearson.
2. Ferziger, J. H., and Perić, M., *Computational Methods for Fluid Dynamics*, Springer.
3. Anderson, D. A., Tannehill, J. C., and Pletcher, R. H., *Computational Fluid Mechanics and Heat Transfer*, Taylor & Francis.

Reference Books

1. Patankar, S. V., *Numerical Heat Transfer and Fluid Flow*, CRC Press.
2. Hirsch, C., *Numerical Computation of Internal and External Flows*, Elsevier.
3. Moukalled, F., Mangani, L., and Darwish, M., *The Finite Volume Method in Computational Fluid Dynamics*, Springer.
4. Chung, T. J., *Computational Fluid Dynamics*, Cambridge University Press.

Ground Water Engineering (CEE024C20W2)

Scheme of Evaluation: T and P

L-T-P-C: 1-0-3-4, Credit Units: 04

Pre-requisite:

- Basic knowledge of Fluid Mechanics and Hydraulics
- Fundamental understanding of flow through porous media

Course Objectives:

The course aims to develop advanced understanding of groundwater occurrence, movement, and development techniques used in groundwater engineering. It focuses on the analysis of aquifer properties, groundwater flow behavior, and well hydraulics under steady and unsteady conditions. The course introduces methods of groundwater exploration using geological and geophysical techniques and provides practical knowledge of well design, construction, and performance evaluation. Emphasis is placed on tube-well construction methods, aquifer testing, and determination of groundwater yield. The course also addresses environmental impacts on groundwater systems, including pollution, groundwater fluctuations, and land subsidence, enabling students to evaluate sustainable groundwater development and management strategies.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of groundwater occurrence, aquifer characteristics, permeability, and principles of well hydraulics.	BT1
CO2	Explain groundwater movement mechanisms, aquifer testing methods, and techniques used in groundwater exploration and well design.	BT2
CO3	Apply groundwater flow equations and well design principles to determine aquifer parameters, safe yield, and well performance characteristics.	BT3
CO4	Analyze groundwater systems by evaluating well interference, pumping test data, and environmental impacts affecting groundwater sustainability.	BT4

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Detailed Syllabus:

Module	Content	Periods
I	<p>Introduction: Importance of CAD in civil engineering, Basics of structural modeling, Overview of structural engineering software, Types of structures and loadings.</p> <p>Structural Modeling and Analysis: History and Applications. Spring and Bar Elements, Minimum Potential Energy Principle, Direct Stiffness Method, Nodal Equilibrium equations, Assembly of Global Stiffness Matrix, Element Strain and Stress.</p>	15
II	<p>Analysis Techniques: Linear static analysis, Linear dynamic analysis (Response spectrum and time history methods), Buckling and stability analysis, Modal analysis.</p>	15
III	<p>Design of Structural Elements: Design of RCC and steel members using software: Beams, Columns, Slabs, Footings Code compliance: IS:456, IS:800, IS:875, IS:1893, IS:13920 Drawing and Detailing of the structure.</p>	15
IV	<p>Case Studies and Applications: Modeling and analysis of: Simply supported beams; Portal frames; multi-story buildings Project-based learning: Complete modeling, analysis and design of a civil engineering structure, Report preparation and interpretation of software output.</p>	15
	Total	60

Text/Reference Books:

1. Krishna Raju, Advanced Reinforced Concrete Design, CBS Publishers
2. Ramamrutham S., Design of Reinforced Concrete Structures
3. Structural Engineering Software Manuals and User Guides
4. IS Codes: IS 456:2000, IS 800:2007, IS 875 (Part I-V), IS 1893:2016, IS 13920:2016.

Systems Analysis in Water Resources (CEE024C20W3)

Scheme of Evaluation: T

L-T-P-C: 3-1-0-4, Credit Units: 04

Pre-requisite:

- Good knowledge of Engineering Mathematics
- Basic understanding of optimization techniques
- Familiarity with probability and statistics is desirable

Course Objectives:

The course aims to provide advanced knowledge of systems analysis techniques used in water resources planning and management. It introduces the fundamental concepts of systems engineering and emphasizes the application of mathematical optimization and simulation techniques to complex water resources systems. The course focuses on linear programming, dynamic programming, simulation methods, and advanced optimization approaches used in reservoir operation, irrigation planning, and multipurpose water resources development. Emphasis is placed on formulation of decision models, sensitivity analysis, and the integration of deterministic and stochastic techniques to support efficient water resources decision-making. The course prepares students to develop analytical models for planning, operation, and management of water resources systems under varying physical and operational constraints.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental concepts of systems analysis, optimization methods, and mathematical models used in water resources systems.	BT1
CO2	Explain the formulation and solution techniques of linear programming, dynamic programming, and simulation models in water resources engineering.	BT2
CO3	Apply optimization and simulation techniques to develop mathematical models for reservoir operation and water allocation problems.	BT3
CO4	Analyze complex water resources systems using advanced optimization techniques and evaluate alternative management strategies under varying constraints.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	System Concepts and Linear Programming: Definition, classification, and characteristics of systems; scope and steps in systems engineering; need for systems approach in water resources and irrigation engineering. Introduction to operations research; linear programming problem formulation; graphical solution techniques; simplex method for solving linear programming problems; sensitivity analysis; applications of linear programming to design and operation of reservoirs; single and multipurpose reservoir development planning; case studies related to irrigation and water allocation systems.	15	25
II	Dynamic Programming: Principles of dynamic programming; Bellman's optimality criterion; stages, states, and decision variables; recursive relationships; formulation of dynamic programming problems; deterministic dynamic programming models; applications to reservoir design and operation; optimization of multipurpose reservoir systems; case studies illustrating real-world applications in water resources management.	10	25
III	Simulation Techniques: Basic principles and concepts of simulation; random variables and random processes; probability distributions used in hydrologic simulations; Monte Carlo simulation techniques; development of simulation models; identification of system inputs and outputs; deterministic and stochastic simulation approaches; simulation of single and multipurpose reservoir systems; evaluation of system performance using simulation models; case studies in reservoir and watershed simulation.	10	25
IV	Advanced Optimization Techniques: Integer programming and parametric linear programming; goal programming models and their applications in water resources planning; discrete differential dynamic programming; incremental dynamic programming; linear decision rule models and their applications;	10	25

	stochastic dynamic programming models; optimization under uncertainty; applications of advanced optimization techniques to water allocation, irrigation scheduling, and reservoir operation planning.		
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Text Books

1. Loucks, D. P., and van Beek, E., *Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications*, UNESCO Publishing, Paris, 2005.
2. Gupta, P. K., and Man Mohan, *Problems in Operations Research (Methods and Solutions)*, Sultan Chand and Sons, New Delhi.

Reference Books

1. Hillier, F. S., and Lieberman, G. J., *Introduction to Operations Research*, CBS Publications, New Delhi.
2. Taha, H. A., *Operations Research: An Introduction*, Prentice Hall.
3. Simonovic, S. P., *Tools for Water Management: A Systems Approach*, UNESCO Publishing.
4. Labadie, J. W., *Optimal Operation of Multireservoir Systems*, Journal of Water Resources Planning and Management.

Research Methodology & IPR (CEE024C20SW1)

Scheme of Evaluation: T

L-T-P-C: 2-0-0-2, Credit Units: 02

Pre-requisite: Nil

Course Objectives:

The main objective is to explain different aspects of research.

Course Outcomes:

On successful completion of the course the students will be able to:

SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember key concepts of research methodology and ethics	BT 1
CO 2	Understand technical writing, proposals, and plagiarism issues.	BT 2
CO 3	Apply IPR knowledge to innovation and patenting	BT 3
CO 4	Analyze recent trends and case studies in IPR.	BT 4

Detailed Syllabus:

Module	Content	Periods
I	Introduction to Research: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	15
II	Research Ethics & Proposals: Effective literature studies approach, analysis of Plagiarism, Research ethics Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	15
III	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	15
IV	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	15
	Total	60

Text/Reference Books:

1. "Research Methodology: A Step by Step Guide for beginners" Ranjit Kumar, 2nd Edition.
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".

Elective – III: Design of Hydraulic Structures (CEE024D20SW1)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-0, Credit Units: 03

Pre-requisite: Mechanics of Solids

Course Objectives:

The primary objectives of this course are to provide postgraduate students with an in-depth understanding of the hydraulic, structural, and geotechnical principles governing the planning and design of hydraulic structures. The course aims to develop strong analytical skills required for the design, stability assessment, and performance evaluation of both major and minor hydraulic structures. It further seeks to familiarize learners with modern design philosophies, and the application of relevant BIS and international codes. Emphasis is placed on integrating safety, sustainability, and climate-resilient strategies into hydraulic infrastructure development. Additionally, the course is intended to equip students with practical insights through real-world case studies, design assignments, and exposure to contemporary engineering challenges.

Course Outcomes:

On successful completion of the course the students will be able to:

SI. No	Course Outcome	Bloom's Taxonomy Mapping
CO1	Understand and explain the flow behaviour, types of loads, and hydraulic forces acting on various hydraulic structures.	BT1, BT2
CO2	Apply IS codes, numerical modeling tools, and modern analytical techniques to solve hydraulic engineering problems.	BT2, BT3
CO3	Design major hydraulic structures such as dams, spillways, canal regulators, headworks, and weirs using engineering principles.	BT3, BT4
CO4	Analyze and evaluate the safety, stability, and performance of hydraulic structures under various loading conditions.	BT4, BT5

Detailed Syllabus:

Module	Content	Periods
I	Introduction to Dams Definition, classification of dams, factors governing selection of type of dam, selection of site for dam, preliminary and final investigations of dam sites	7
II	Design and Construction of Gravity Dams Forces acting on gravity dams, load combinations design, reaction of foundation and principal and shear stresses, modes of failure of dam- stability requirements, quality and strength of concrete and masonry, elementary profile of gravity dam, practical profile of gravity dams, joints, fey and water stops, openings in dams, galleries, temperature control in concrete dams, foundation treatment, design problems.	15
III	Buttress And Arch Dams Introduction, buttress dams, types of buttress dams, forces on buttress dams, design of flat slab type buttress dams, advantages and disadvantages of buttress dams, arch dams, types of arch dams, forces on an arch dams, design of arch dams, problems	8
IV	Embankment Dams Introduction, type of earth dams, foundation of earth dams, design of earth dams, causes and failure of earth dams, safety against overtopping, determination of seepage line, characteristics of seepage line, stability analysis, stability of earth dams against horizontal shear, design problems and Theory and design principles of Canals And Canal Structures.	15
	Total	45

Text/Reference books

1. Irrigation Engineering and Hydraulic Structures S.K. Garg, Khanna Publications
2. Irrigation and Water Power Engineering Dr. B.C. Punmia, Dr. Pande B. Lal, Ashok K. Jain and Arun K. Jain Lakshmi Publications Pvt. Ltd.
3. Hydraulic Structures P. Novak, A.I.V Moffet, C. Nalluri and R. Narayan, Taylor & Francis

Elective – III: Soft Computing in Water Resources Engineering (CEE024D20W2)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisites: Knowledge of Hydrology, Statistics, Numerical Methods, and basic programming (MATLAB/Python preferred).

Course Objectives:

This course aims to introduce postgraduate students to advanced soft computing techniques and their applications in water resources engineering. The course develops understanding of artificial intelligence-based modelling tools such as Artificial Neural Networks (ANN), Fuzzy Logic Systems (FIS), Genetic Algorithms (GA), and hybrid optimization techniques. Emphasis is placed on data-driven modelling, uncertainty handling, and optimization of complex water resources systems. The course also focuses on real-world applications such as rainfall–runoff modelling, groundwater prediction, flood forecasting, reservoir operation, and water quality modelling. Students will gain the ability to design intelligent models for solving nonlinear and uncertain water resources problems.

Course Outcomes:

On successful completion of the course the students will be able to:

CO No.	Course Outcomes
CO1	Recall the fundamental concepts of soft computing, artificial intelligence, and their relevance to water resources engineering problems.
CO2	Explain the principles of artificial neural networks, fuzzy logic, and evolutionary algorithms used in modelling and optimization.
CO3	Apply soft computing techniques to develop predictive and optimization models for hydrologic, hydraulic, and water resources systems.
CO4	Analyze the performance of soft computing models and integrate hybrid techniques for solving complex water resources engineering problems.

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Introduction to Soft Computing and Artificial Intelligence: Overview of soft computing techniques; comparison between conventional numerical methods and soft computing methods; characteristics of soft computing systems—adaptability, learning, and uncertainty handling. Introduction to Artificial Intelligence (AI) in water resources engineering; data-driven modelling concepts; problem formulation in hydrology and hydraulics; preprocessing of hydrologic data including normalization, noise filtering, and missing data handling.	10	25
II	Artificial Neural Networks (ANN): Biological neuron model and artificial neuron structure; architecture of neural networks—single-layer and multi-layer feedforward networks; learning algorithms—supervised and unsupervised learning; backpropagation algorithm; selection of network parameters; training, testing, and validation of ANN models; performance evaluation indices (RMSE, MAE, R ²). Applications of ANN in rainfall–runoff modelling, streamflow forecasting, groundwater level prediction, and water quality assessment.	12	25
III	Fuzzy Logic Systems and Genetic Algorithms: Fundamentals of fuzzy sets and fuzzy logic; membership functions; fuzzification and defuzzification techniques; rule-based fuzzy inference systems (Mamdani and Sugeno models); development of fuzzy models for hydrologic forecasting and reservoir operation. Introduction to Genetic Algorithms (GA); encoding schemes; selection, crossover, mutation; optimization strategies; multi-objective optimization. Applications of fuzzy logic and genetic algorithms in reservoir operation, irrigation scheduling, and water distribution network optimization.	12	25
IV	Hybrid Soft Computing Techniques and Applications: Integration of ANN, fuzzy logic, and genetic algorithms (neuro-fuzzy and GA-based hybrid systems); swarm intelligence methods—Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO); machine learning approaches in water resources engineering. Application of soft computing techniques in flood forecasting, drought prediction, sediment transport modelling, groundwater contamination modelling, and climate change impact analysis. Model uncertainty analysis, sensitivity analysis, and performance evaluation. Case studies involving real-world water resources systems.	11	25
	Total	45	100

Text Books

1. Rajasekaran, S. and Vijayalakshmi Pai, G. A., *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications*, Prentice Hall of India.
2. Jang, J. S. R., Sun, C. T., and Mizutani, E., *Neuro-Fuzzy and Soft Computing*, Prentice Hall.
3. Nayak, P. C. and Sudheer, K. P., *Soft Computing in Water Resources Engineering*, Springer.

Reference Books

1. Goldberg, D. E., *Genetic Algorithms in Search, Optimization and Machine Learning*, Addison-Wesley.
 2. Haykin, S., *Neural Networks and Learning Machines*, Pearson Education.
 3. Maier, H. R., Jain, A., Dandy, G. C., and Sudheer, K. P., "Methods used for the development of neural networks for hydrologic modelling," *Journal of Hydrology*.
 4. ASCE Task Committee Reports on Artificial Intelligence Applications in Hydrology and Water Resources.
 5. Jain, A. and Srinivasulu, S., *Artificial Intelligence Techniques in Hydrology*, Springer.
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Elective – IV: Coastal Engineering and Coastal Zone Management (CEE024D20W2)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite:

- Basic knowledge of Fluid Mechanics and Hydraulics
- Fundamental understanding of Hydrology and Open Channel Flow
- Introductory knowledge of sediment transport and coastal processes

Course Objectives:

The course aims to provide advanced knowledge of coastal processes and engineering principles essential for planning, design, and management of coastal infrastructure. It focuses on understanding wave mechanics, tides, sediment transport processes, and shoreline dynamics that govern coastal morphology. The course introduces the design principles of coastal protection structures and modern approaches to coastal hazard mitigation. Emphasis is placed on integrated coastal zone management (ICZM), environmental sustainability, coastal policies, and decision-support tools such as GIS and numerical modelling. The course prepares students to analyze coastal systems, design coastal engineering solutions, and evaluate coastal vulnerability and risk for sustainable coastal development.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental coastal processes including waves, tides, currents, and sediment dynamics influencing coastal systems.	BT1
CO2	Explain coastal sediment transport mechanisms, shoreline dynamics, and principles governing coastal erosion and accretion processes.	BT2
CO3	Apply coastal engineering principles to design coastal protection structures and evaluate shoreline stabilization measures.	BT3
CO4	Analyze coastal hazards and vulnerabilities using Integrated Coastal Zone Management (ICZM) tools and propose sustainable coastal management strategies.	BT4

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Fundamentals of Coastal Processes: Introduction to coastal engineering including scope, importance, and applications. Ocean wave mechanics including generation of waves, classification of waves, linear and non-linear wave theories. Wave parameters including wave height, wavelength, wave period, group velocity, and wave energy. Wave transformation processes including shoaling, refraction, diffraction, and breaking mechanisms. Tides and tidal currents including causes, harmonic analysis, and tidal prediction. Sediment characteristics and coastal geomorphology including coastal landforms and sediment properties.	10	25
II	Coastal Sediment Transport and Shoreline Dynamics: Sediment transport mechanisms including bed load and suspended load transport in coastal environments. Longshore and cross-shore sediment transport equations. Coastal erosion and accretion processes and their influencing factors. Beach profile analysis including equilibrium beach concepts and analytical models. Morphodynamics of nearshore zones. Shoreline change modelling using empirical and numerical approaches. Case studies of erosion-prone coastal regions in India.	10	25
III	Coastal Engineering Structures and Protection Measures: Design principles of coastal engineering structures including seawalls, revetments, groynes, breakwaters, and jetties including their types, functions, and failure modes. Fundamentals of offshore and port structures and stability analysis. Soft engineering techniques including beach nourishment, dune restoration, and vegetation-based coastal protection. Coastal flooding and storm surge modelling. Impacts of climate change on coastal systems. Guidelines and standards relevant to coastal engineering including IS codes, PIANC, and USACE manuals.	10	25

IV	<p>Coastal Zone Management and Policy Framework: Concepts of Integrated Coastal Zone Management (ICZM). Coastal environmental impacts including pollution, habitat degradation, and salinity intrusion. Coastal regulation frameworks including Coastal Regulation Zone (CRZ) notifications and National Disaster Management Authority (NDMA) guidelines. Tools for coastal zone management including GIS, remote sensing, numerical modelling, and decision support systems. Coastal vulnerability and risk assessment methods. Sustainable coastal development strategies and stakeholder participation. Case studies from Indian coastal states and global best practices in coastal management.</p>	15	25
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Text Books

1. Dean, R. G., and Dalrymple, R. A., *Coastal Processes with Engineering Applications*, Cambridge University Press.
2. Kamphuis, J. W., *Introduction to Coastal Engineering and Management*, World Scientific.
3. Sorensen, R. M., *Basic Coastal Engineering*, Springer.

Reference Books

1. Komar, P. D., *Beach Processes and Sedimentation*, Prentice Hall.
2. U.S. Army Corps of Engineers (USACE), *Coastal Engineering Manual (CEM)*.
3. Narayan, R., *Coastal Zone Management in India: Problems, Practices and Future*.
4. Bird, E., *Coastal Geomorphology: An Introduction*.
5. IS 4651 (Parts I–VII), *Planning and Design of Ports and Harbours*, Bureau of Indian Standards (BIS).
6. Coastal Regulation Zone (CRZ) Notification (latest), Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India.

Elective – IV: Theory and Applications of GIS (CEE02D20SW2)

L–T–P–C: 3–0–0–3

Credit Units: 03

Semester: II

Prerequisites

- Basic knowledge of electromagnetic radiation and remote sensing
- Fundamental understanding of mapping, photography, and imaging
- Introductory knowledge of hydrology and water resources systems

Course Objectives

The course aims to provide comprehensive knowledge of geographic information systems (GIS) and remote sensing principles relevant to water resources engineering. It focuses on the physics of remote sensing, characteristics of spatial data, and preprocessing techniques required for hydrologic analysis. The course introduces GIS database structures, spatial modelling methods, and geospatial analysis techniques for hydrologic applications such as watershed delineation, groundwater mapping, and flood modelling. Emphasis is placed on the integration of remote sensing and GIS tools with hydrologic models to support decision-making in water resources planning and management. The course prepares students to apply modern geospatial technologies for solving complex water resources engineering problems.

Course Outcomes:

On successful completion of the course the students will be able to:

Sl. No.	Course Outcomes	Bloom's Taxonomy Level
CO1	Recall the fundamental principles of remote sensing, electromagnetic radiation, GIS components, spatial data formats, and hydrologic data sources used in water resources applications.	BT1
CO2	Explain the characteristics of remote sensing data products, preprocessing techniques, GIS database structures, and spatial analysis methods used for hydrologic feature identification and watershed analysis.	BT2
CO3	Apply remote sensing and GIS techniques to perform spatial data interpretation, watershed delineation, groundwater mapping, and hydrologic modelling using standard geospatial tools.	BT3
CO4	Analyze spatial and hydrologic datasets using integrated RS–GIS models to support water resources planning, flood-risk assessment, groundwater management, and decision-support systems.	BT4

Detailed Syllabus

Module	Topics / Course Content	Hrs.	Marks
I	Fundamentals of Remote Sensing for Water Resources: Principles of electromagnetic radiation relevant to hydrologic applications; active and passive remote sensing systems; electromagnetic spectrum including reflectance, transmission, and absorption characteristics of water, soil, and vegetation; thermal emissions and heat signatures of water bodies and land surfaces; interaction of electromagnetic radiation with the atmosphere; atmospheric windows and their importance in data acquisition; spectral reflectance properties of earth surface features including wetlands and vegetation; multispectral, hyperspectral, and multitemporal remote sensing concepts; fundamentals of microwave remote sensing for flood mapping, soil moisture estimation, and water-level monitoring.	10	25
II	Remote Sensing Data Analysis for Hydrologic Applications: Characteristics of remote sensing data products including Landsat, Sentinel, MODIS, Bhuvan, and Synthetic Aperture Radar (SAR). Data preprocessing techniques including atmospheric correction, radiometric correction, and geometric correction for hydrological accuracy. Data standardization for rainfall–runoff modelling, groundwater mapping, and watershed delineation. Image interpretation techniques including visual interpretation elements such as tone, texture, pattern, and association. Identification of hydrologic features such as water bodies, rivers, reservoirs, and floodplains. Change detection techniques for hydrologic and environmental monitoring.	10	25
III	Fundamentals of GIS and Spatial Analysis: Introduction to geographic information	10	25

	systems and spatial modelling of water resources systems. Spatial and non-spatial data formats used in hydrology including vector, raster, DEM, and TIN formats. GIS components including hardware, software, data, and users. Data collection, input, and conversion techniques from surveys, remote sensing, and field measurements. Database management including file structures and data compression techniques. Spatial analysis methods including proximity and buffer analysis, overlay analysis for watershed prioritization, network analysis for water distribution systems, spatial interpolation techniques, and digital terrain model (DTM) and digital elevation model (DEM) generation for watershed and flood modelling.		
IV	Integrated Applications of GIS in Water Resources Engineering: Integration of GIS with surface water hydrology models including watershed delineation and parameter extraction using models such as SWAT and HEC-HMS. Groundwater data integration with GIS and application of groundwater flow models such as MODFLOW and Visual MODFLOW. Spatial techniques for groundwater recharge mapping and aquifer delineation. Development of hydrologic databases using Arc Hydro data models. GIS-based planning and design of water supply, irrigation, and wastewater systems. Application of GIS in drought monitoring, flood forecasting, reservoir operation, and floodplain mapping. Spatial Decision Support Systems (SDSS) for river basin management and water quality monitoring applications.	15	25

Text Books

1. Bhatta, B., *Remote Sensing and GIS*, 2nd Edition, Oxford University Press, New Delhi.
2. Reddy, M. A., *Textbook of Remote Sensing and Geographical Information Systems*, BS Publications.

Reference Books

1. Lillesand, T. M., Kiefer, R. W., and Chipman, J. W., *Remote Sensing and Image Interpretation*, Wiley.
2. Chandra, A. M., and Ghosh, S. K., *Remote Sensing and GIS*, Narosa Publishing House.
3. Burrough, P. A., and McDonnell, R. A., *Principles of Geographical Information Systems*, Oxford University Press.
4. ESRI, *ArcGIS Desktop Help and Spatial Analyst Manual*.
5. Jensen, J. R., *Introductory Digital Image Processing*, Prentice Hall.

Semester III

Urban Water Resources Management (CEE024C30W1)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite: Knowledge of urban hydrology and basic knowledge of open channel flow

Course Objectives:

This course aims to develop advanced understanding of urban water systems with emphasis on planning, hydrologic and hydraulic analysis, and sustainable drainage design. The course introduces students to urbanization impacts on hydrologic processes and the principles governing drainage system planning and management. It further focuses on computation of urban runoff, design of drainage and sewerage elements, and pollution control strategies. The course also covers operation, maintenance, and modelling of urban drainage systems, including application of kinematic wave theory and modern urban water management tools for sustainable development.

Course Outcomes:

On successful completion of the course the students will be able to:

CO No.	Course Outcomes
CO1	Recall the concepts of urban hydrology, drainage planning principles, and effects of urbanization on the hydrologic cycle.
CO2	Explain hydrologic and hydraulic principles governing urban runoff, drainage system design, and stormwater management practices.
CO3	Apply urban runoff estimation methods and hydraulic design principles to develop efficient drainage and sewerage system components.
CO4	Analyze urban drainage system performance, pollution control measures, and maintenance strategies using modelling approaches and engineering judgement.

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Introduction to Urban Drainage Systems: Introduction to drainage problems in different climates; urbanisation—its effects and consequences for drainage; interaction between urban and peri-urban areas; process of urbanisation and its influence on hydrologic cycle. Planning Concepts and System Planning: Objectives of urban drainage and planning criteria; drainage and system layout; planning tools and data requirements; drainage master planning; examples of urban drainage structures.	15	25
II	Review of Hydrologic and Hydraulic Principles: Urban hydrologic cycle; rainfall analysis in urban environment; design storm concepts; hydraulic and hydrodynamic principles. Urban Runoff Computations: Empirical methods, time–area method, unit hydrograph approach. Design of Drainage System Elements: Hydraulic fundamentals; infiltration and on-site detention of storm water; design of sewerage and drainage channels; design of appurtenances; road drainage systems; pumping station design.	10	25
III	Control of Storm Water Pollution: Pollution build-up and wash-off processes in urban drainage systems; source control techniques in commercial and industrial areas; stormwater storage options—dry and wet detention ponds; biological and chemical treatment methods for stormwater quality improvement.	10	25
IV	Operation and Maintenance of Urban Drainage Systems: Maintenance requirements of drainage structures; maintenance planning; cleaning of sewers and drains; inventory and assessment of damages; repair strategies. Urban Drainage Modelling: Kinematic wave theory approach; introduction to urban watershed modelling software; hydrologic cistern concepts; water conservation and ecological aspects; rainwater harvesting techniques.	10	25
	Total	45	100

Text Books

1. Akan, A. O. and Houghtalen, R. J., *Urban Hydrology, Hydraulics and Storm Water Quality*, John Wiley & Sons.
2. Patra, K. C., *Hydrology & Water Resources Engineering*, Narosa Publishing House, New Delhi.

Reference Books

1. Chow, V. T. (Ed.), *Handbook of Hydrology*, McGraw Hill.
 2. Mutreja, K. N., *Applied Hydrology*, Tata McGraw Hill.
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Elective – V: Principles of Water Quality and EIA (CEE024D30W1)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite: Environmental Engineering

Course Objectives:

This course aims to provide postgraduate students with comprehensive knowledge of water quality principles and environmental impact assessment (EIA) processes relevant to water resources and environmental engineering projects. The course introduces the concepts of environmental sustainability, water quality parameters, and pollutant behavior in aquatic systems. It develops understanding of environmental legislation, impact prediction methods, and assessment techniques related to land, water, air, and ecological systems. The course further emphasizes evaluation of project alternatives, preparation of EIA reports, environmental monitoring, and auditing practices. Students will gain the ability to assess water quality impacts of engineering projects and apply EIA methodologies for sustainable water resources planning and environmental management.

Course Outcomes:

On successful completion of the course the students will be able to:

CO No.	Course Outcomes
CO1	Recall the fundamental concepts of water quality, environmental sustainability, and environmental impact assessment processes and terminology.
CO2	Explain environmental legislation, water quality parameters, baseline studies, and methods used in environmental impact identification and assessment.
CO3	Apply water quality analysis principles and environmental impact prediction techniques to assess the effects of engineering projects on natural resources.
CO4	Analyze environmental alternatives, monitoring strategies, and environmental audit procedures to evaluate sustainable project development and management.

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Concepts of Environment, Water Quality and EIA: Concept of environment and sustainable development; introduction to water quality—physical, chemical, and biological characteristics of water; water quality standards for drinking, irrigation, and industrial uses; sources and classification of water pollutants; environmental impact assessment (EIA)—definitions, terminology, objectives and overview. Evolution of EIA—major features of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) guidelines; role of environmental protection agencies; generalized EIA process flow chart by international organizations; evolution of EIA practices in India—major features of EIA notification and subsequent amendments and implementation framework.	12	25
II	Environmental Legislation and Impact Identification: Environmental legislation in India pertaining to environmental pollution, water quality management, and waste management. Steps in EIA—screening, Initial Environmental Examination (IEE), scoping, public participation. Environmental baseline studies including water quality monitoring programs. Impact identification methods—ad-hoc methods, checklists, matrices, quantitative methods, environmental indices, network analysis, overlay techniques. Considerations in assessing impacts of infrastructure and water resources projects.	13	25
III	Prediction and Assessment of Environmental and Water Quality Impacts: Prediction and assessment of impacts on land, soil, groundwater, surface water quality, air, noise, biological, socio-economic, and visual environments. Transport and fate of pollutants in surface and groundwater systems. Water quality modelling tools and prediction techniques. Guidelines published by the Ministry of Environment, Forest and Climate Change (MoEF&CC) for environmental impact assessment of specific projects including water resources and infrastructure developments.	10	25
IV	Evaluation of Alternatives, Monitoring and Environmental Management:	10	25

	Evaluation of project alternatives based on environmental sustainability principles. Preparation of Environmental Impact Assessment (EIA) reports and Environmental Impact Statements (EIS). Strategic Environmental Assessment (SEA). Environmental monitoring programs and environmental management plans (EMP). Environmental audit procedures and compliance evaluation. Case studies related to water quality management and environmental impact assessment of major engineering projects.		
	Total	45	100

Text Books

1. Canter, L. W., *Environmental Impact Assessment*, McGraw Hill, Inc.
2. Marriot, Betty Bowers, *Environmental Impact Assessment: A Practical Guide*, McGraw Hill, Inc.

Reference Books

1. United Nations Environment Programme (UNEP), *Environmental Impact Assessment Training Resource Manual*.
2. Guidelines for Environmental Impact Assessment, Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India.
3. Peavy, H. S. and Row, D. R., *Environmental Engineering*, McGraw Hill.
4. Metcalf & Eddy, *Wastewater Engineering: Treatment and Reuse*, McGraw Hill.

Elective – V: Flood Control and Drainage Engineering (CEE024D30W2)

Scheme of Evaluation: T

L-T-P-C: 3-0-0-3, Credit Units: 03

Pre-requisite: Knowledge of Hydrology, Open Channel Flow, and Irrigation Engineering.

Course Objectives:

This course aims to provide postgraduate students with advanced knowledge of flood hydrology, flood routing, and flood control strategies applicable to river basins and urban catchments. It introduces the principles of flood estimation, floodplain management, and design of structural and non-structural flood control measures. The course further develops understanding of surface and subsurface drainage systems, including hydraulic design of drainage networks for agricultural and urban areas. Emphasis is placed on modern analytical techniques, modelling approaches, and sustainable flood management practices suitable for real-world engineering applications. The course also addresses climate variability impacts, integrated flood risk management, and design of efficient drainage systems for safe disposal of excess water.

Course Outcomes:

On successful completion of the course the students will be able to:

CO No.	Course Outcomes
CO1	Recall the principles of flood hydrology, flood characteristics, and drainage requirements in river basins and agricultural lands.
CO2	Explain flood estimation methods, flood routing techniques, and drainage system components used in flood control engineering.
CO3	Apply hydraulic and hydrologic principles to design surface and subsurface drainage systems and flood control structures.
CO4	Analyze flood risks, drainage performance, and flood mitigation strategies using modern modelling and integrated flood management approaches.

Detailed Syllabus:

Module	Topics / Course Content	Hrs.	Marks
I	Flood Hydrology and Flood Estimation: Introduction to floods—causes, types, and characteristics of floods; historical flood analysis and flood frequency analysis; rainfall–runoff relationships for flood estimation; design flood estimation methods including empirical formulae, unit hydrograph, synthetic unit hydrograph, and regional flood frequency analysis. Flood hydrographs, peak discharge estimation, flood forecasting concepts, real-time flood warning systems, and impacts of climate variability on flood magnitude and frequency.	12	25
II	Flood Routing and Flood Control Measures: Hydrologic and hydraulic flood routing methods including Muskingum method, reservoir routing, channel routing, and storage routing techniques. Structural flood control measures—levees, embankments, flood walls, detention basins, retarding reservoirs, diversion channels, and spillways. Non-structural flood control measures—floodplain zoning, flood forecasting, flood insurance, and watershed management practices. Floodplain management and river training works.	11	25
III	Surface and Subsurface Drainage Engineering: Objectives and requirements of drainage systems; drainage problems in agricultural and urban areas; surface drainage systems—land grading, field drains, lateral drains, and open drainage networks. Subsurface drainage systems—components, layouts, hydraulic design principles, drainage spacing equations, steady and unsteady drainage theory, design of tile and pipe drainage systems. Design considerations for stormwater drainage and agricultural drainage networks.	11	25
IV	Integrated Flood Management and Advanced Drainage Techniques: Urban flood management and stormwater drainage systems; design of stormwater detention and retention structures; application of GIS and hydrologic modelling tools for flood mapping and drainage design; flood risk analysis and vulnerability assessment; climate change impacts on flood and drainage systems; integrated watershed-based flood control planning; case studies of major flood control and drainage projects in India and worldwide.	11	25
	Total	45	100

Text Books

1. Chow, V. T., Maidment, D. R., and Mays, L. W., *Applied Hydrology*, McGraw Hill.
2. Subramanya, K., *Engineering Hydrology*, Tata McGraw Hill.
3. Ritzema, H. P., *Drainage Principles and Applications*, International Institute for Land Reclamation and Improvement (ILRI).

Reference Books

1. Mutreja, K. N., *Applied Hydrology*, Tata McGraw Hill.
 2. Linsley, R. K., Kohler, M. A., and Paulhus, J. L. H., *Hydrology for Engineers*, McGraw Hill.
 3. Akan, A. O., *Urban Stormwater Hydrology: A Guide to Engineering Calculations*, CRC Press.
 4. ASCE Manuals and Reports on Engineering Practice: *Floodplain Management and Drainage Design*.
 5. World Meteorological Organization (WMO), *Manual on Flood Forecasting and Warning*.
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Dissertation (Phase-I) & Presentation (CEE024C32SW1)

Scheme of Evaluation: T

L-T-P-C: 0-0-0-14, Credit Units: 14

Contents:

Dissertation (Phase-I) will include both Mid-Semester and End-Semester presentations. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. The end semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection, analysis of data, determining solutions and must bring out individual's contribution. Continuous assessment at both stages will be carried out by a departmental committee.

Summer Internship (CEE024C33SW2)

Scheme of Evaluation: T

L-T-P-C: 0-0-0-1, Credit Units: 01

Contents:

Summer Training is a mandatory component to be undertaken during the summer break following Semester II, in an area relevant to the student's academic programme. The topic shall be finalized in consultation with the proposed Dissertation Guide, under whom the student will pursue Dissertation (Phase-I) in Semester III. As this is a credit course, students must prepare a Training Report and submit it to the Head of the Department. The report will be presented in a departmental seminar before the faculty at the beginning of Semester III. After incorporating any necessary corrections, the final report must be submitted to the departmental library.

Evaluation Pattern:

Presentation before faculty members: 50%

Submission of report: 50%



Semester IV

Dissertation (Phase-II) & Presentation (CEE024C42SW1)

Scheme of Evaluation: T

L-T-P-C: 0-0-0-18, Credit Units: 18

Contents:

Dissertation-II is a continuation of the work initiated in Dissertation-I, focusing on the implementation of the proposed methodology through numerical analysis, experimental work, or data collection and interpretation. Continuous assessment will be conducted during the Mid-Semester and End-Semester by a departmental committee. A pre-submission seminar will be held towards the end of the term. Upon approval, the student must submit a detailed report. A viva-voce examination will then be conducted by an external examiner in coordination with the project guide.

