Government College of Engineering, Chhatrapati Sambhajianagar

(An Autonomous Institute of Government of Maharashtra)

Station Road, Osmanpura, Chh. Sambahjinagar – 431005 (M.S.)

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Master of Technology
(Water Resources Engineering)

Curriculum for

M. Tech. Water Resources Engineering

(NEP Compliant)

(With Effect from Academic Year 2026-27)

Dr. S. S. Koranne
Head, Civil Engg.

Dr. Anil Karwankar
Dean , Academics

M.Tech. Water Resources Engineering Curriculum
With effect from Academic Year 2026-2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

Vision of the Institute

- To be globally recognized leader in technical education through industry integration and societal wellbeing.

Mission of the Institute

1. To build career-ready graduates through multidisciplinary learning and industry-sync curricula.
2. To promote ecosystem for cutting-edge research, patents, publications, IPR, innovation, technology transfer and entrepreneurship.
3. To be a premier trusted partner of government allied bodies, industries, and society.

Motto of the Civil Engineering Department

To Build Strong Nation through Dedication

Vision of the Civil Engineering Department

"To developed Civil Engineers with global standards through industry integration, innovation for sustainable infrastructure and societal wellbeing"

Mission of the Civil Engineering Department

1. To impart industry-oriented and multidisciplinary Engineering education.
2. To encourage research, publications, innovation, patents and sustainable Civil Engineering practices.
3. To actively engage with industry, Government and society through consultancy, projects and outreach activities.

Program Outcomes

After the successful completion of the master's programme in water resources engineering, the graduates will be able to:

1. Independently carry out research/investigation and development.
2. Write and present a substantial technical report/document.
3. Demonstrate a degree of mastery over the area as per the specialization of the program in water resources engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Program Specific Outcomes

After the successful completion of the master's programme in geotechnical engineering, the graduates will be able to:

1. Master hydrologic cycles, groundwater extraction, open channel flow, and structural hydraulic design. System Design & Management: Plan, operate, and manage surface-water reservoirs, flood controls, and micro-irrigation schemes.
2. Sustainability & Climate Adaptation: Develop eco-friendly watershed management practices and climate-resilient water infrastructures.

M.Tech Programme components

Components		Total Credits
Programme Core Course (PCC)	Program Courses	20
Programme Elective Course (PEC)	Program Elective	10
Open Elective (OEC) Other than a particular program	Open Elective	02
Vocational and Skill Enhancement Course (VSE)	Skill Courses	02
Ability Enhancement Course (AEC) Technical Presentation	Humanities Social Science and Management (HSSM)	02
Entrepreneurship/Economics/Management Courses (EEM)		02
Indian Knowledge System (IKS)		02
Research Methodology (RMC)	Experiential Learning Courses	02
Dissertation/Project/Internship (DIS/INT)		20
Co-curricular Courses (CCC)	Liberal Learning Courses	Audit
	Total Credits	62

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Teaching and Evaluation Scheme from year 2026-27 (NEP)

M. Tech. Water Resources Engineering

Semester -I											
			Teaching Scheme			Continuous Evaluation in terms of Marks					
	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total
ELC	CEELC5101	Research Methodology	2	0	0	2	10	10		30	50
PCC	CEPCC5101	Computational and Statistical Methods	3	0	0	3	20	20		60	100
PCC	CEPCC5102	Engineering Hydrology and Hydrologic Systems	3	0	0	3	20	20		60	100
PEC	CEPEC5101 TO CEPEC5105	Program Elective Course -I	3	0	0	3	20	20		60	100
PEC	CEPEC5106 TO CEPEC5110	Program Elective Course -II	3	0	0	3	20	20		60	100
VSEC	CEVSE5101	Mini Project	0	0	4	2	-	25		25	50
PCC	CEPCC5103	Water Resources Software Laboratory	0	0	4	2	-	25		25	50
CC	INCCC5101	Audit Course (Stress Management by Yoga/Club Activity)	0	0	2	0	--	-	-	-	-
Total			14	0	10	18	90	140		320	550
Semester -II											
	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total
PCC	CEPCC5204	Advanced Fluid Mechanics	3		-	3	20	20		60	100
PCC	CEPCC5205	Water Resources Systems Planning and Management	3	-	0	3	20	20		60	100
PCC	CEPCC5206	Hydraulic Structures	3	0	0	3	20	20		60	100
OE		Open Elective	2	0	0	2	10	10		30	50
PEC	CEPEC5211 TO CEPEC5215	Program Elective Course -III	4	0	0	4	20	20		60	100
PCC	CEPCC5207	Lab- Water Technology Laboratory	0	0	2	1		25		25	50
PCC	CEPCC5208	Lab- Water Resources Systems Planning and Management	0	0	2	1		25		25	50
AEC	CEAEC5201	Seminar	0	0	4	2	-	25		25	50
DIS	CEDIS5201	Dissertation-I	0	0	4	2		50		50	100
Total			15	0	12	21	90	215		395	700

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Teaching and Evaluation Scheme from year 2026-27 (NEP)

M. Tech. Water Resources Engineering

Semester -III											
			Teaching Scheme			Continuous Evaluation in terms of Marks					
	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total
EEM	CEEEM6101	AI For Earth Observation	2			2	10	10		30	50
IKS	CEIKS6101	Ancient Water Management Practices	2	0	0	2	10	10		30	50
DIS	CEDIS6102	Dissertation-II	0	0	16	8	0	100		150	250
PCC	CEPCC6109	Engineering Hydrology Laboratory	0	0	2	1	0	25		25	50
Total			4	0	18	13	20	145		235	400
Semester -IV											
	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total
OJT	CEOJT6202	Industrial Training	-	-	-	10	-	100	-	-	100
Total			-	-	-	10	-	100	-	-	100
Grand Total			33	0	40	62	200	600	0	950	1750

Note: The internship/Industrial Training of not less than 2 months duration should be completed by the students in vacations.

List of Program Elective Courses			
Sr No	PEC-I	PEC-II	PEC-III
1	CEPEC5101:Groundwater Engineering	CEPEC5106:Micro Irrigation	CEPEC5211:Climate Change and Water Resources
2	CEPEC5102:Channel and River Hydraulic	CEPEC5107:GIS Applications in Water Resources Engineering	CEPEC5212:River Engineering and Flood Control
3	CEPEC5103:Urban Storm Water Management	CEPEC5108:River Basin Management	CEPEC5213:Integrated Watershed Management
4	CEPEC5104:Rural and Urban Water Supply	CEPEC5109:Water Supply Systems	CEPEC5214:Land and Water Management
5	CEPEC5105:Planning and Design of Hydro Power Systems	CEPEC5110:Environmental Impact Assessment	CEPEC5215:Water Quality Monitoring and Modeling

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List of Open Electives I to be offered in PG Semester II (First Year)

Sr. No	Course code	Open Elective Course	Course offering department
1	AMOEC5214	Basics of Finite Element Method	Applied Mechanics
2	CSOEC6002	Data Science	CSE
3	CEOEC5201	Disaster Management	Civil
4	MEOEC6104	Additive Manufacturing	Mechanical
5	EEOEC5101	Data Science for Engineering Applications	Electrical
6	ECOEC5007	Artificial Intelligence of Things	E&TC

List of Humanities I to be offered in PG Semester III (Second Year)

Sr. No.	Course code	Humanities Course	Course offering Department
1	MEEEM6101	Entrepreneurship Skills	Mechanical
2	MEEEM6103	Industrial Management	Mechanical
3	ECEEM6004	AI Governance & Ethics	E&TC
4	CEIKS6101	Ancient Water Management Practices	Civil
5	INIKS6001	Vedic Approach To Mathematics	Applied Mathematics
6	EEEEM5101	Energy Audit & Management	Electrical
7	EEIKS5101	Vedic Approach To Mathematics	Electrical

CEELC5101: Research Methodology

Teaching Scheme		**Evaluation Scheme**	
Theory	2 Hrs/Week	ISE I	10 Marks
Tutorial		ISE II	10 Marks
Total Credits	**2**	End Semester Examination	30 Marks
		Total	50 Marks

Prerequisite: Nil

Course Description:

To guide students from understanding foundational research concepts to critically formulating research problems, culminating in the adept creation of comprehensive research plans and literature reviews. To develop a comprehensive understanding of various research methods, both qualitative and quantitative. To facilitate students in analyzing, evaluating, and creating research proposals. To attain mastery in data collection methods, sampling, data analysis techniques, and result interpretation for robust research outcomes. To equip students with the skills to proficiently create and present diverse research reports, encompassing various formats, oral delivery, technical writing, and ethical awareness regarding plagiarism.

Course Outcomes:

After completing the course students will able to

Course Outcomes	
CO1	explain the fundamental concepts of research methodology, including research approaches, research design, literature review, and problem formulation to identify and define research problems effectively.
CO2	select and apply appropriate qualitative and quantitative research methods, sampling techniques, and data collection tools for conducting research in diverse domains.
CO3	develop a research proposal with clear objectives and hypotheses, analyze qualitative and quantitative data using appropriate statistical techniques, interpret research findings, and prepare comprehensive research reports.

Detailed Syllabus:

Unit 1	**Introduction to Research Methodology:** Meaning of Research, Objectives of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem, Selecting the Problem, Techniques Involved in Defining a Problem, Research Design, Important Concepts Relating to Research Design, Developing a Research Plan, Literature Review.
Unit 2	**Methods of Research and Data Collection:** Qualitative and Quantitative Methods of Research like Historical, Case Study, Ethnography, Ex Post Facto, Documentary and Content Analysis, Survey (Normative, Descriptive, Evaluative, etc.), Field and Laboratory Experimental Studies. Characteristics of Research Methods and their Implications in Research Area. Concept of Sampling and other Concepts related to Sampling. Probability and Non-Probability Samples, their Characteristics and Implications. Tools of Data Collection, their Types, Attributes and Uses. Designing and Redesigning Research Tools like Questionnaire, Opinionnaire, Observation, Interviews, Scales and Tests, etc.
Unit 3	**Development of Research Proposal and Data Analysis:** Research Proposal and its Elements. Formulation of Research Problem—Criteria, Sources and Definition. Development of Objectives and Characteristics of Objectives. Development of Hypotheses and their Applications. Methods of Data Analysis: Analysis of Qualitative Data based on Various Tools. Analysis of Quantitative Data and its Presentation using Tables, Graphs, etc. Statistical Tools and Techniques of Data Analysis—Measures of [illegible] on.

	Decision Making with Hypothesis Testing through Parametric and Non-Parametric Tests. Validity and Delimitations of Research Findings.

Text and Reference Books

1. Garg B. L., Karadia R., Agarwal F. and Agarwal U. K., An introduction to Research Methodology, RBSA Publishers, 2002
2. Kothari C. R., Research Methodology: Methods and Techniques. New Age International, 1990.
3. Merriam S. B., Tisdell E. J., Qualitative Research: A Guide to Design and Implementation, 4th edition, John Wiley & Sons, 2016.
4. Creswell J. W., Research Design: Qualitative, Quantitative and Mixed Methods Approaches, 4th edition, SAGE Publications, Inc, 2014.
5. Olsen C., Devore J., Peck R., Introduction to Statistics and Data Analysis, 5th edition, Brooks/Cole, 2015.
6. Panneerselvam R., Research Methodology, 2nd edition, PHI Learning, 2014.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	1	-	3
CO2	1	-	1	-	-
CO3	1	-	3	1	2

1 – Low 2 – Medium 3 – High

Assessment:

ISE I: Based on unit I and unit II

ISE II : Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following:

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	5	5		5
K2	Understand	5	5		5
K3	Apply				10
K4	Analyze				10
K5	Evaluate				
K6	Create				
Total Marks 50		10	10		30

Table 3: Assessment table

Assessment Tool	K1	K2	K3	K4
	CO1, CO2, CO3	CO1, CO2, CO3	CO1, CO2, CO3	CO1, CO2, CO3
ISE I (10 Marks)	5	5		
ISE II(10 Marks)	5	5		
ISE III				
ESE Assessment (60 Marks)			15	15
Total Marks 50	10	10	15	15

CEPCC5101: Computational and Statistical Methods

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to introduce the students to various methods of numerical solutions of ordinary differential equations such as Taylor's Series, Euler's Method, Runge Kutta Method. Course also develops the knowledge of Correlation and Regression Analysis, Skewness, Moments and Kurtosis. Students will gain an understanding of classification and presentation of data, probability theory and analysis. The course exposes students to the Finite difference methods, FEM, fuzzy and genetic algorithm and its applications to water resources engineering which are widely required to solve engineering problem.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Apply various differential equations methods to the engineering.
CO2	Apply regression and correlation analysis.
CO3	Classify and present data. Apply the knowledge of probability and probability theory.
CO4	Develop FDM and FEM model and apply the knowledge of various soft computing tools such as fuzzy logic, neural network and genetic algorithm.
CO5	Apply various differential equations methods to the engineering.

Detailed Syllabus:

Unit 1	**Introduction Numerical Solution:** Numerical Solution of Ordinary Differential Equations: Solution by Taylor's Series, Euler's Method, Runge Kutta Method, Newton Raphson Method, Bisection Me thod. Gauss-Jordan Method, Method of Leading Coefficient. Relaxation Method.
Unit 2	**Regression Analysis:** Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypothesis – Multiple linear Regression – Correlation and Regression Analysis. Skewness, Moments and Kurtosis
Unit 3	**Probability Techniques:** Classification and Presentation of data, Basic Concepts of Probability, Probability Axioms, Analysis and Treatment of Data, Population and Samples, Measures of Dispersions, Measures of Symmetry Discrete and Continuous Probability Distribution, Functions.
Unit 4	**Finite difference methods:** Finite difference methods and their applications to water resources Engineering. Introduction to FEM and its applications to water resources Engineering.

Unit 5	**Fuzzy logic:** Fuzzy Mathematical Operations, Neural Networks, Mathematical Model of Neuron, Architecture. Introduction to genetic algorithm, Operators, Applications.

References:

1. Gupta. S.P., " Statistical Methods", S. Chand & Sons, New Delhi
2. Kothari C.R., "Research Methodology-Methods and Techniques", New Age International Publishers, New Delhi.
3. Gupta S.L. and Gupta Hitesh, “Research Methodology-Text and cases with SPSS applications” International Book House Pvt. Ltd., New Delhi.
4. Rao V and Rao H., “C++, Neural Networks and Fuzzy Logic”, BPB Publications, New Delhi.
5. Goldberg, D.E., “Genetic Algorithms in Search, Optimization & Machine Learning”, Addison Wesley Longman (Singapore) Pte. Ltd., Indian Branch, Delhi.
6. Klir George J. and Yuan Bo, “Fuzzy Sets and Fuzzy Logic”, PHI Learning Pvt. Ltd, New Delhi

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	3	1	1
CO2	1	2	1	1	2
CO3	-	2	3	1	1
CO4	-	3	3	1	2
CO5	2	2	3	1	2

Teacher’s Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Recommended Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

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Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1, K2	K2, K3	K2, K3	K3, K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPCC5102: Engineering Hydrology and Hydrologic Systems

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the students to system concept and hydrograph analysis. The rainfall-runoff analysis will be taught in the course, for un-gauged catchments. The hydrologic statistics will be studied for the determination of statistical parameters, frequency analysis and design flood. Geographical Information System and its applications to water resources engineering are included in the course. The climate change studies and Soil and Water Assessment Tool (SWAT) are also included in the course.

Course Outcomes

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Develop unit hydrograph for a catchment
CO2	Do the rainfall-runoff analysis
CO3	Analyze the hydrologic statistics
CO4	Work with GIS and climate change effects on hydrology

Detailed Syllabus:

Unit 1	**Introduction Hydrograph:** Introduction: Systems Concept, Linear and Non-Linear Systems, Lumped and Distributed Systems, Deterministic and Stochastic Systems, Time Invariant Systems, Unit Hydrograph Theory, S – Curve Hydrograph, Instantaneous Unit Hydrograph.
Unit 2	**Rainfall – Runoff Analysis:** Rainfall – Runoff Analysis: Review of Rational Methods, Conceptual Model, Clarke and Nash Models, Derivation of Unit Hydrograph for un-gauged Catchments, Synthetic Unit Hydrograph.
Unit 3	**Hydrologic Statistic:** Hydrologic Statistic: Probabilistic Treatment of Hydrologic Data, Frequency and Probability Functions, Statistical Parameters, Frequency Analysis, Annual Maximum and Partial Duration Series Models, Regional Frequency Analysis, Design Flood.
Unit 4	**Hydrologic Flood Routing:** Hydrologic Flood Routing: Reservoir Routing, Channel Routing, Estimation of Flood Routing Models, Flood Forecasting, Analog Models, Real Time Flood Forecasting. Applications of Remote Sensing and GIS in Hydrology: Land Use and Soil Mapping Using Remote Sensing, Watershed Management Using Remote Sensing Techniques, Concepts of Geographical information Systems (GIS) and its Application in Hydrologic Studies.

Unit 5	**Climate Change:** Climate Change: Global Circulation Model (GCM), Regional Circulation Model (RCM), Data collection and analysis, downscaling of climate parameters, uncertainty of regional climate projections, climate change impact, adaptation strategies, Risk and Vulnerability of Agricultu climate forecasting, Soil and Water Assessment Tool (SWAT) Hydrological Model, Socioeconomic scenarios, Policy Initiatives for Climate Change Adaptation in India.

References:

1. Chow, V.T., Maidment, D.R. and Mays, L.W. (1988), "Applied Hydrology", McGraw Hill Inc. N York
2. Singh, V.P. (1986), "Hydrologic Systems", Prentice Hall Inc., N York
3. Singh, V.P. (1992), "Elementary Hydrology", Prentice Hall of India, N Delhi
4. Haan C.T., (1995), "Statistical Methods in Hydrology", East West Press, New Delhi
5. Viessman, W., Lewis, G.L. and Knapp, J.W. (1989), "Introduction to Hydrology", Harper & Row Publications Inc., Singapore
6. Ponce, W.F. (1987), "Engineering Hydrology", Prentice Hall Inc. N York.
7. Lillesand, T.M. and Kiefer, R.H. (1994) "Remote sensing and Image Interpretation", John Wiley & Sons.
8. Subramanya, K. (2011), "Engineering Hydrology", Tata McGraw Hill Education Private Limited, New Delhi.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	1	3
CO2	2	2	3	1	3
CO3	2	2	3	-	3
CO4	2	2	3	-	3

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5101: PEC-I Ground Water Engineering

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course introduces different aspects of ground water engineering, determination of permeability and transmissibility by Theim and Dupuit's theory. It also evaluates aquifer properties for confined aquifer by Theis method, Jacob and Chow's method. Topics ranges from construction of well, water well design, drilling, components of ground water, ground water flow and ground water development and management.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Demonstrate the different terminologies related with groundwater hydrology
CO2	Identify suitable method of determination of aquifer parameters
CO3	Choose suitable ground water exploration techniques and assess ground water potential
CO4	Compare and contrast suitable ground water development and management methods
C05	Estimate ground water recharge

Detailed Syllabus:

Unit 1	**Introduction Ground Water:** Ground Water: porosity, retention of water in rocks, yield of rock, 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:** Ground water flow: 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:** 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	**Ground Water Modeling:** Construction of Wells and Ground Water Modeling: 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. Groundwater Modeling: Groundwater flow, sand models, membrane model, thermal model, electric analog model and

Unit 5	**Groundwater Recharge, Development and Management:** 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.

References:

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

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	1	2
CO2	2	2	3	1	3
CO3	2	2	3	1	3
CO4	2	2	3	2	3
CO5	3	2	3	1	3

Teacher’s Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

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Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II(20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5102: PEC-I Channel and River Hydraulic

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to explore the fundamentals of the specific energy, specific force, energy-depth relations and its computations. Course covers uniform flow calculations by using Chezy's and Manning's equations, computation of gradually varied flow and classification of flow profiles. The course provides detail knowledge of hydraulic jump and the energy dissipation including flow measurement. Course also includes the origin and properties of sediment and its analysis. At the end of this course, the basics of bed load, suspended load and channel design by Lane's theory, Kennedy's theory and Lacey's theory are included.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Calculate specific energy and describe energy-depth relationship.
CO2	Determine Chezy's and Mannings constant and GVF profiles.
CO3	Classify various types of hydraulic jumps and energy dissipation structures.
CO4	Design stable channels considering bed load and suspended loads.

Detailed Syllabus:

Unit 1	**Introduction free surface flows:** Basic concepts of free surface flows: flow regimes, velocity and pressure distribution, kinetic energy and momentum principles, energy-depth relationships, specific energy, critical depth, computation of theoretical depth, section factors, hydraulic exponents, specific force diagram, theoretical concepts of channel bed roughness, transitions in channel sections.
Unit 2	**Computation methods and analysis:** Uniform flow, Chezy's equation, Manning's formula, roughness coefficients, equivalent roughness, uniform flow computations, gradually varied flow, dynamic equation, classification of flow profiles, GVF in different slopes, Computation methods and analysis: Direct integration, Breese's method, Chow's method, numerical methods: direct step method, standard step method
Unit 3	**Rapidly varied flow:** Rapidly varied flow, momentum equation for hydraulic jump, energy loss, classification of jumps, length and location of hydraulic jump in prismatic channel, rolling and ski jumps, energy dissipation works, Flow measurements: thin plate and sharp, broad, round crested weirs, critical depth flumes, Unsteady flows, equation of continuity, equation of motion, uniformly progressive waves, positive and negative surges, flood routing.

Unit 4	**Fluvial hydraulics:** Fluvial hydraulics: Origin, and properties of sediments, size, shape, fall velocity and its effects, orientation, grain size distribution, incipient motion of sediment particles, competency, lift force concept, critical tractive force approach, theoretical and sub theoretical analysis of Shield, White, and Iwagaki, regimes of flow, ripple and dune regime, characteristics.
Unit 5	**Resistance to flow:** Resistance to flow in alluvial streams, basic equations, theories of bed load suspended load, design of stable channels, Lane's theory, Kennedy's theory, Lacey's theory, tractive force methods of design of stable channels, design of stable channels in cohesive soils.

References:

1) Subramanya K. (1998) —Flow in Open Channels", Tata Mc Graw Hill Publishing Co.
2) Chow V.T. (1979) —Open Channel Hydraulics", Mc Graw Hill Inc., New York
3) Garde R, J.and Ranga Raju K.G. (1980) —Mechanics of Sediment Transportation and Alluvial Stream
4) French R.H. (1986) —Open Channel Hydraulics", Mc Graw Hill Publishing Co., New York
5) Chaudhary M. H., "Open Channel Flow. Prentice Hall of India, Eastern Economic Edition , . ISBN:81-203- 08638,New Delhi. 1994.
6) French, R. H., "Open Channel Hydraulics McGraw Hill, New York NY 1985.
7) Srivastava R. Flow through Open Channels Oxford University Press New Delhi 2008.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	2	-	2
CO2	2	2	3	1	3
CO3	2	2	3	1	3
CO4	2	2	3	1	3

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

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Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II(20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5103: PEC-I Urban Storm Water Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: Course focuses on water in an urban eco-system, its resources and problems. It also gives the knowledge of storm water management, its policies and feasibility. Course covers urban surface runoff model and quality model. Course also include structural and nonstructural management practices, hydraulic analysis and design guidelines. At the end, the planning and organizational aspects and general approach to operation and maintenance is covered.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Identify problems on urban eco-system and urban water resources.
CO2	Classify various types of models in urban water management.
CO3	Design flow and storage capacity of urban component.
CO4	Execute operation and management of urban water management system.

Detailed Syllabus:

Unit 1	**Urban eco-system:** Water in the urban eco-system – Urban Water Resources – Major problems – Urban hydrological cycle – Storm water management objectives and limitations – Storm water policies – Feasibility consideration.
Unit 2	**Urban surface runoff models:** Types of models – Physically based – conceptual or unit hydrograph based – Urban surface runoff models – Management models for flow rate and volume control rate – Quality models.
Unit 3	**Storm water management practices:** Storm water management practices (Structural and Non-structural Management measures)– Detention and retention concepts – Modelling concept – Types of storage – Magnitude of storage – Hydraulic analysis and design guidelines – Flow and storage capacity of urban components – Temple tanks.
Unit 4	**Planning and organizational aspects:** Planning and organizational aspects – Inter dependency of planning and implementation of goals and measures – Socio – economic financial aspects – Potential costs and benefit measures – Measures of urban drainage and flood control benefits – Effective urban water user organizations.

Unit 5	**Operations and maintenance:** General approaches to operations and maintenance – Complexity of operations and need for diagnostic analysis – Operation and maintenance in urban water system – Maintenance Management System – Inventories and conditions assessment – Social awareness a involvement.

References:

1. Geiger, W.F., Marsalek, F., and Zuidena, F.C., (Ed), manual ondrainage in urbanized areas – Vol.1 and Vol.II, UNESCO, 1987. L T P C 3 0 0 3 30
2. Hengeveld, H. and C. De Voch.t (Ed)., Role of Water in Urban Ecology, 1982.
3. Martin, P. Wanelista and Yousef, A. Yousef., Storm Water Management, John Wiley and sons, 1993.
4. Neil S. Grigg., Urban Water Infrastructure Planning, Management and Operations, John Wiley and Sons, 1986.
5. Overtens D.E. and Meadows M.E., Storm Water Modelling, Academic Press, New York, 1976.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	1	3
CO2	2	2	3	1	3
CO3	2	2	3	2	3
CO4	2	2	2	2	3

Teacher's Assessment: ISE IIof 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II(20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5104: PEC-I Rural and Urban Water Supply

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: Address issues and various techniques for rural water supply, water quality monitoring, maintenance and operations. It also covers planning, collection, treatment and disposal of waste water. It provides knowledge of compact and simple waste water treatment units and septic tank. The disposal of solid waste, biogas plant, urban water supply, public health, pollution of urban water is also covered. At the end course covers collection, treatment, storage and handling of households' water and emergency water supply.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Identify techniques of rural water supply and rural water quality monitoring.
CO2	Plan waste water collection system, its disposal and treatment.
CO3	Decide suitable method of disposal of solid waste and rural sanitation.
CO4	Describe urban water supply, problems associated with it, monitoring water quality.

Detailed Syllabus:

Unit 1	**Issues of rural water supply:** Issues of rural water supply –Various techniques for rural water supply- merits- National rural drinking water program- rural water quality monitoring and surveillance- operation and maintenance of rural water supplies, Introduction – Epidemiological aspects of water quality, methods for low-cost water treatment – Specific contaminant removal systems.
Unit 2	**Introduction to rural sanitation:** Introduction to rural sanitation- Community and sanitary latrines - Planning of wastewater collection system in rural areas- Treatment and Disposal of wastewater- Compact and simple wastewater treatment units and systems in rural areas stabilization ponds - septic tanks - Inhofe tank- soak pits- low-cost excreta disposal systems Effluent disposal.
Unit 3	**Disposal of Solid Wastes practices:** Disposal of Solid Wastes- Composting- land filling incineration-Biogas plants - Rural health - Other specific issues and problems encountered in rural sanitation.
Unit 4	**Introduction to Urban Water Supply:** Introduction to Urban Water Supply, urban Water and Public Health, problems associated with urban water supply, Water Sources and their Characteristics, urban Water Pollution, Water Treatment Technologies for Large-scale Water Supply, Distribution, Leakage and Illegal Connections, water meter system, MBR, ESR, Valves, Pressure relief valve.

Unit 5	**Operations and maintenance:** Water Safety Plans, Duties and Responsibilities of Water Utilities, Household Water Collection, Treatment, Storage and Handling, Efficient Use of Water, Monitoring Water Quality, Financing Urban Water Services, Water Emergencies and Emergency Water Supply, Public–Private Partnership and Other Commercial Opportunities.

References:

1. Hengeveld, H. and C. De Voch.t (Ed)., Role of Water in Urban Ecology, 1982.
2. Neil S. Grigg., Urban Water Infrastructure Planning, Management and Operations, John Wiley and Sons, 1986.
3. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.
4. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall.
5. Garg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher
6. Handbook on Drinking Water Treatment Technologies, 2011, Ministry of Water and Sanitation, Government ofIndia, India
7. National Rural Drinking Water Program- Movement towards Ensuring i People's Drinking Water Security in Rural India, Framework for Implementation, Department of Drinking Water Supply, Ministry of Rural Development, Government of India, April, 2010 Source: http://swajal.uk.gov.in/files/pdENRDWP_GuidelineApril_10.pdf
8. Training Manual for Trainers of CSS,2007, Gujarat Jal Seva Training Institute, Vol. 1 &2
9. Water and Sanitation Program Report, 2011, Towards drinking water security in India-Lessons from the field, New Delhi, India

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	1	3
CO2	2	2	3	1	3
CO3	2	2	3	1	3
CO4	2	2	3	1	3

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

a. Technical quizzes
b. Application development
c. Question & answer / Numerical solution
d. Group discussion
e. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II(20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5105: PEC-II Planning and Design of Hydro Power Systems

Teaching Scheme		**Evaluation Scheme**	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course provides an overview of hydraulic engineering design of hydroelectric plants as well as it provides a detailed analysis for the optimization of related works and the parameters that influence the performance, safety and operation. The design of a hydroelectric plant begins with a hydrological analysis and hydraulic study, followed by an estimation of available water and eventual rated power to install including the overall quantity of energy to be produced. An understanding of the principles of the hydroelectric plant operation and the associated works is essential to efficiently perform the design and maximize uses of available water.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Analyze and design gravity dams.
CO2	Analyze and design Earth dams.
CO3	Design spillways and energy dissipation structures.
CO4	Design penstocks and surge shafts.

Detailed Syllabus:

Unit 1	**Introduction to Power Plant Design:** Introduction to Power Plant Design, Factors to Consider in Planning Hydrologic Analysis and Calculations Temporary Diversion Spillway & Riparian Flow Structures Composition of the power plant Energy production. Social Economic Research, Technical Survey, Outline of Hydropower Generation, Significance of Small-Scale Hydropower Development.
Unit 2	**Design of hydraulic structures:** Design of hydraulic structures on permeable foundation including weir and barrage; determination of afflux and discharge intensity; waterway and looseness factor; stilling basin level and length; uplift pressures and exit gradient; floor thickness and protection works.
Unit 3	**Earth dams:** Earth dams- homogeneous and zoned sections; filter design and stability analysis. Gravity dams- general features; forces acting on gravity dam; galleries and their functions; stability analysis; roller compacted RCC dams.

Unit 4	**Spillways-layout and design:** Spillways-layout and design of various types of spillways; design of energy dissipaters. Intake Structures-trash racks and their cleaning and handling devices; stop log arrangements; intake entrance; aeration vent; gate control. Tunnels-classification; rock cover; hydraulic design and supporting systems; concrete lining; portals and plugs; underground cavities.
Unit 5	**Gates:** Gates- various types of gates for barrages; spillways; intakes; sluices; structural design considerations for vertical lift and radial gates. Hydro power-function; classification and main components (penstocks, surge tanks, hydro turbines, etc.) of hydro power stations

References:

1. Water Power Engineering by M.M. Dandekar and K.N. Sharma, Vani Educational Books
2. Irrigation and water resources Engg. By G.L. Asawa, New Age international Publishers.
3. B.C. Punmia, Pande B.B. Lal "Irrigation and water power Engineering" Laxmi Publications Private Limited
4. Justinn, Creager and Hinds, "Engineering For Dams.Vol.I, II, III"
5. P.N.Modi. Irrigation and water powerengineering'
6. Paulo C.F. Erbisti "design of hydraulic gates" A.A.Balkema publisher/Lisse/Abingdon/Exton (PA)/ Tokyo
7. E. Mosoni, "Water Power Development – Vol. I & II"
8. G. Brown, "Hydro-electric Engineering Practice Vol. I, II & III"
9. Varshney "Hydro Power Structures"
10. P. K. Bhattacharya, "Water Power Engineering" Khanna Pub., Delhi
11. M. M. Deshmukh, "Water Power Engineering" Dhanpat Rai and Sons

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	1	3
CO2	2	2	3	1	3
CO3	2	2	3	1	3
CO4	2	2	3	1	3

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment	Knowledge	ISE I	ISE II	End Semester
Pattern Level No.	**Level**			**Examination**
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II(20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5106: PEC-II Micro Irrigation

Teaching Scheme		**Evaluation Scheme**	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course emphasizes for understanding the importance of micro irrigation methods. Design and operation of sprinkler and drip irrigation methods is included in the curriculum. The course also emphasize on current developments in irrigation methods and the adoption of micro irrigation in the field.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Design the micro irrigation systems
CO2	Analyze the factors influencing the economics of micro irrigation
CO3	Understand the agricultural practices for enhancement of crop production and productivity
CO4	Understand planning, design and construction of sustainable small- scale micro irrigation schemes

Detailed Syllabus:

Unit 1	**Introduction to irrigation methods:** Importance, classification of irrigation methods – classification of micro-irrigation methods – principles and selection of micro- irrigation systems – low pressure mini spray systems – bubbler system – sprinkler and drip system – irrigation efficiencies.
Unit 2	**Sprinkler irrigation systems:** Development – Use – Types – Portable, Semi portable and Permanent systems – Components – pumping – Main line – Lateral line – Sprinkler heads – Moisture distribution pattern and uniformity of coverage – Testing of water distribution pattern – Design of Sprinkler irrigation systems – Types of system and layout - Selection and spacing – Capacity of sprinkler system – Hydraulic design – Design of laterals – Cost estimation – Operation and Maintenance – trouble shooting – Application of Fertilizers – Fertilizer injection methods and Devices.
Unit 3	**Drip effect on water use:** Drip effect on water use – description of drip irrigation system –types – various methods – manufacturing drip equipments – low- and high-density polythene – main pipe – submains – laterals – emitters – dripper with hole and socket – micro tube emitters – nozzles – self adjusting drippers – double wall pipe – leaky pipe. Principles for design of drip system – hydraulic formulae Darcy Weishbach equation – Hazen Williams formulae – factors to be consider to the design of the system – design procedure –design of emitters, laterals, submains and main lines – head works – drip layout for different crops – field crops – close spaced crops – orchard crops – drip irrigation design and layout – model design

Unit 4	**Effects of discharge rate:** Effects of discharge rate of drip emitter – water movement under drip system – soil moisture distribution – soil water content – drainage flux – irrigation control by soil physical methods - Clogging – water quality and preventive measures – cleaning of clogged system – filtration problems and measures – gravel filters – vortex filters – other methods of filtering and prevention – clogging of outlets. Introduction and list of fertilizers – application of fertilizer – influence on general nutritional problems – fertilizers movement – fertilizing – existing fertilizer practices – continuous fertilizers – methods of applying fertilizers – volume of fertilizer tank – dilution ratio.
Unit 5	**Drip system:** Drip system – engineering design – Agronomic manipulation –commercial production – factors influencing economics of drip system – cost estimates – optimum farm size – economics and financial analysis – present status and application – case studies.

References:

1. Michael, A.M., "Irrigation Theory and Practice", Vikas Publishers, New Delhi, 2000.
2. Dilip Kumar Majumdar., Irrigation Water Management, Prentice Hall Inc., 2004.
3. Dr. R. Suresh, "Principles of Micro-Irrigation Engineering", Standard Publishers Distributors, New Delhi, 2010.
4. R.K. Sivanappan, "Sprinkler Irrigation", Oxford and IBH Publishing Co, New Delhi,1987.
5. J.Keller and D. Karmeli, "Trickle Irrigation Design", Rainbird Sprinkler Irrigation Manufacturing Corporation, Glendora, California, USA.
6. Jack Keller and RondBelisher., "Sprinkler and Trickle Irrigation", Van nastrandReinhold,New York, 1990.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	1	–	3
CO2	1	3	2	1	2
CO3	–	2	2	–	1
CO4	1	1	3	1	2

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

a. Technical quizzes
b. Application development
c. Question & answer / Numerical solution
d. Group discussion
e. Other if any

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Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5107: PEC-II GIS Applications in Water Resources Engineering

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: Course explores physics of remote sensing and various remote sensing platforms. It covers satellite data analysis, visual interpretation and image processing and data mining. The details of GIS, thematic mapping and application of GIS to water resources engineering are also covered at the end of the course.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Classify various remote sensing platforms
CO2	Analysis satellite data and apply image processing and image enhancement.
CO3	Modelling in GIS, thematic mapping obtains digital elevation modelling.
CO4	Apply GIS to various water resources problems.

Detailed Syllabus:

Unit 1	**Introduction to remote sensing:** Physics of remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme.
Unit 2	**Satellite Data analysis:** Satellite Data analysis - Visual interpretation – Digital image processing – Image preprocessing – Image enhancement – Image classification – Data Merging.
Unit 3	**Basic components of GIS:** Definition – Basic components of GIS – Map projections and coordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology – Geodatabase models: hierarchical, network, relational, object-oriented models – Integrated GIS database -common sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards.
Unit 4	**Thematic mapping:** Thematic mapping – Measurement in GIS: length, perimeter and areas – Query analysis – Reclassification – Buffering - Neighborhood functions - Map overlay: vector and raster overlay – Interpolation – Network analysis –Digital elevation modelling. Analytical Hierarchy Process, – Object oriented GIS – AM/FM/GIS – Web Based GIS.

Unit 5	**Spatial data sources:** Spatial data sources GIS approach water resources system –Thematic maps - Rainfall-runoff modelling – Groundwater modeling – Water quality modeling - Flood inundation mapping and Modelling – Drought monitoring – Cropping pattern change analysis – Performance evaluation of irrigation commands. Site selection for artificial recharge - Reservoir sedimentation.

References:

1. Lillesand, T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation" 3 rd Edition. John Wiley and Sons, New York. 1993.
2. Burrough P.A. and McDonnell R.A., "Principles of Geographical Information Systems",.Oxford University Press. New York. 1998.
3. Ian Heywood Sarah, Cornelius and Steve Carver "An Introduction to Geographical Information Systems". Pearson Education. New Delhi, 2002.
4. "Centre for Water Resources", Change in Cropping Pattern in Drought Prone Chittar Sub-basin, Project Report, Anna University, Chennai, 2002.
5. Mesfin Tadesse Bekalo “Landuse Change Detection Using GIS, Remote Sensing and Spatial Metrics”
6. Nigus Tadesse and Mazengia Mengist “Land Suitability Evaluation Using GIS and Remote Sensing Technology”

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	–	–	2
CO2	2	3	2	–	3
CO3	1	2	2	1	3
CO4	–	1	3	1	3

Teacher’s Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

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Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5108: PEC-II River Basin Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course links engineering science with social and economic science under the frame of sustainability with focus on water resource management at river basin level. Communication and conflict management, data and information management, system thinking and hydro social modelling is also included in the curriculum. Best and worst practices of land and water management are discussed.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand concept of sustainability.
CO2	Understand Hydrological and nutrient cycles.
CO3	Know water related diseases, source water protection.
CO4	Understand Climate change management option and tools to analyze hydrological change due to climate change

Detailed Syllabus:

Unit 1	**Introduction:** Sustainability indicators, resources depletion, growth models Planetary System Boundaries, footprints, prosperity Globalization, inter-connected world, Stakeholders in sustainability.
Unit 2	**Climate change:** Anthropocene, Climate change, climate variability, Hydrological cycle, water balance, catchment terminology, River basin management, Water availability, surplus, deficit, Water scarcity, water crisis, Stream morphology and land use, Nutrient cycles.
Unit 3	**Water and society:** Water and society, poverty, demography, Water governance, integrity, accountability, Pollution, water related diseases, source water protection, Water and land use, wetlands, desertification, Dams, diversions, artificial rainfall, Economic and financial instruments in water management, Hydrological change due to climate change
Unit 4	**Protecting water resources:** Protecting water resources / improving water quality, living standards, equity, education and technology transfer, Water conservation and efficiency, improving monitoring and data management, decision support systems, improving management and justice, improving administrative (transnational) structures, Improving prediction and risk assessment

Unit 5	**Sustainability sources:** Sustainability criteria (ecological, economic, institutional, social) multi-criteria decision support.

References:

1. Randhir, T.O., Watershed Management Issues and Approaches, IWA 2007
2. Murty, J.V.S., Watershed management, New Age International 2009
3. Majumdar, D.K., Irrigation Water Management, Prentice Hall 2000
4. Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management, Colorado State University, 1994.American Socy. of Civil Engr., Watershed Management, American Soc. of Civil Engineers, New York, 1975.
5. Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991. Michael A.M., Irrigation Engineering, Vikas Publishing House, 1992. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad, 1995.
6. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	–	1	–
CO2	1	3	2	1	1
CO3	2	2	2	2	–
CO4	–	1	3	1	2

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5109: Water Supply Systems

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: To educate the students in detailed design concepts related to water transmission mains, water distribution system with emphasis on computer application. Explain design concept of different water treatment units. Identify suitable method of treatment to be used for removal of impurity. Design conventional water treatment plant. Analyze water distribution system.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Get a basic knowledge of the design of pipe networks.
CO2	Analyze pipe network problems using different softwares and optimization technique
CO3	Familiar with the terminologies and designs of the water supply system.
CO4	Get a basic knowledge of water quality control techniques.

Detailed Syllabus:

Unit 1	**Water requirement:** Water requirement – sources of water – water demand – reservoir storage – nodal hydraulic gradient level values - water supply consideration, Types of water supply systems- piping system- distribution network- labeling- network components – Network models – design – optimization in practice.
Unit 2	**Conventional Treatment Processes:** Conventional Treatment Processes: Sedimentation, Type of Sedimentation, Zone Setting, Filtration, Gravity Granular — Media Filtration, Head Losses, Back Washing and Media Filtration, Head Losses, Back Washing and Media Fluidization — Pressure Filters —Slow Sand Filters, Coagulation and Flocculation Coagulants, Theory of coagulation and flocculation process, coagulation kinetics, coagulant Aids, Rapid Mixing Devices, Disinfection, Disinfection Methods, Fluoridation, De-fluoridation.
Unit 3	**Energy and hydraulic gradient lines:** Energy and hydraulic gradient lines – head loss in links equivalent pipes – series – parallel pipes – path head loss and loop head loss – analysis of water distribution network- static node, dynamic node – network performance – flow analysis - Layout – in situ lining - pipes material – appurtenances – minimization of water losses – leak detection.
Unit 4	**Water distribution systems:** Water distribution systems, major and minor losses, head discharge relationships, formulation of equations, pipe network analysis, Hardy cross method, Newton Raphson method, linear theory method, and finite element method. Uncertainty and reliability – affecting events- assessment – reliability parameters-configurations. Design methodolog

Unit 5	**Node flow analysis:** Node flow analysis, optimization techniques in pipe networks, hydraulic design of water supply systems, pumping systems, distribution Reservoirs and Service Storage.

References:

1. Viessman Jr., Mark 3. Hammer (1990) Water Supply and Pollution Control. McGraw Hill International Edition.
2. Fair, Geyer, Okun (1990) Water Supply Engineering. John Wiley.
3. Turbuit T H Y (1998) "Principles of Water Quality Control" Pergamon Press.Bhave P. R, Optimal design of water distribution networks, Narosa publishing House, New Delhi,2003
4. Bajwa. G. S, Practical handbook on Public Health Engineering, Deep publishers, Shimla 2003
5. Manual on water supply and treatment, CPHEEO, Ministry of Urban Development, GOI, NewDelhi, 1999
6. B.A. Hauser, practical hydraulics Hand Book, Lewis Publishers, New York, 1991
7. Moser A. P, Buried pipe Design, 3rd Edition, American Water Works Association
8. Robert van Bentum and Lan K. Smout, Buried Pipe lines for surface Irrigation, The Water,Engineering and Development Centre, Intermediate Technology Publications, UK,1994
9. Wurbs R.A., and James W.P. Water Resources Engineering. Prentice Hall of India, Eastern Economic Edition. ISBN: 81-203-2151-0, New Delhi, 2007

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	–	1	2
CO2	2	3	2	1	3
CO3	2	2	2	1	2
CO4	3	1	3	1	1

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

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M.Tech. Water Resources Engineering Curriculum
With effect from Academic Year 2026-2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4	CO5
	K1,K2,K3	K1,K2,K3	K1,K2,K3	K1,K2,K3	K1,K2,K3
ISE I (20 Marks)	10	10			
ISE II (20 Marks)			10	10	
ESE (60 Marks)	12	12	12	12	12

CEPEC5110: Environmental Impact Assessment

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course emphasizes in the curriculum for the practical means by which organizations minimize their impacts on the environment. In this course student will learn how to assess impacts at different scales, and design, implement and monitor mitigation measures. This knowledge will assist you to critically evaluate complex environmental issues and assist in the development of Environmental Impact Statements (EIA's) and the preparation, maintenance and implementation Environmental Management Systems (EMS) in accordance with relevant environmental legislation and international standards.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand the ecological stability and ecological systems concept.
CO2	Real problem due to manmade developmental activities, Select Environmental, Economic and social indicators, collect data and conduct analysis.
CO3	Selecting the appropriate technique and methodology to carry out Environmental Impact Assessment.
CO4	Carry out Environmental Impact Assessment of the water resources components

Detailed Syllabus:

Unit 1	**Water:** Water resources development and environmental issues –Environment in water resources project planning – Environmental regulations and requirements – The EIA (Environmental Impact Assessment) notification.
Unit 2	**EIA:** Environmental Impact Assessment (EIA) – EIA in Project Cycle –Legal and Regulatory aspects in India according to Ministry of Environment and Forests – Types and limitations of EIA – Cross sectorial issues and terms of reference in EIA –Participation of Public and Non-Governmental Organizations in environmental decision making.
Unit 3	**Water quality impacts:** Hydrological and water quality impacts – Ecological and biological impacts – Social and cultural impacts – Soil and landscape changes – Agro economic issues – Human health impacts – Ecosystem changes.

Unit 4	**Environmental Impact Statement:** Team formation – Development of scope, mandate and study design – Base line survey – Check lists – Ad hoc procedures – Network and matrix methods – Semi-quantitative methods – ICID checklist – Economic approaches – Environmental Impact Statement (EIS) preparation.
Unit 5	**Ecological water requirements:** In-stream ecological water requirements - Public participation in environmental decision making –Sustainable water resources development – Eco restoration – Hydrology and global climate change – Human ecology – Ecosystem services – Environmental monitoring programs.

References:

1. Canter, L.W., Environmental Impact Assessment. McGraw Hill International Edition, New York. 1995.
2. Barathwal, R.R., Environmental Impact Assessment. New Age International Publishers, New Delhi. 2002.
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London. 1999.
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Inter Science, New Jersey. 2003.
5. Arnel, N., Hydrology and global environmental change. Prentice Hall, Harlow. 2002.
6. Chari. B., Richa Sharma and S.A. Abbasi, Comprehensive Environmental Impact Assessment of Water Resources Projects: With Special Reference to Sathanur Reservoir Project (Tamil Nadu)/K. Discovery Pub., New Delhi, 2005.
7. UNEP's Environmental Impact Assessment Training Resource Manual -2 nd Edition, 2002.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	–	1	–
CO2	–	3	2	1	1
CO3	–	2	2	1	2
CO4	–	1	3	1	2

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20		

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPCC5204: Advanced Fluid Mechanics

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to introduce to students the concepts of fluid mechanics from both theoretical and applications perspective. There is a well-balanced coverage of physical concepts, mathematical operations along with example and exercise problems of practical importance. The course provides the platform for fundamental understanding of the basic principles of fluid mechanics and help to apply the basic principles to analyze fluid system.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Know and understand the basic concepts kinematics and Dynamics of fluid flow, Ideal flow, Laminar flow and Turbulent flow, Boundary layer theory, dimensional analysis and model analysis.
CO2	Apply the energy equations for practical problem related to fluid flow.
CO3	Analyze the effect of laminar and turbulent flow and boundary layer for fluid in motion.
CO4	Carry out dimensional analysis and model analysis for various practical problems.

Detailed Syllabus:

Unit 1	**Properties of Fluids:** Properties of Fluids: Role of fluid properties in fluid motion, types of fluids based on rheological diagram, Thermodynamic properties: Dimension of R, Isothermal process, Adiabatic Process, Universal Gas Constant kinematics of Fluid flow: Equation of continuity in Cartesian and cylindrical co-ordinate system, Lagrangian and Eulerian approach, stream tube, path lines, streak lines, stream lines and their equations, elements of particle motion, circulation, rotational and irrotational flows, vorticity, angular deformation, stream function, Velocity potential function, Laplace's equation, Flownets.
Unit 2	**Dynamics of fluid flow:** Dynamics of fluid flow: Equations of Motions, Euler's equation of motion in Cartesian and cylindrical coordinate system, energy equation from Euler's equation, practical applications of energy equation Ideal Flow: uniform flow parallel to x and y axis, source flow, sink flow, Free vortex flows, Superimposed flow: Source and Sink Pair, Doublet, A plane surface flow in a Uniform flow, Source and Sink Pair in Uniform flow, A doublet in a Uniform flow.
Unit 3	**Laminar Flow and Boundary layer theory:** Laminar Flow: Navier-Stokes equation of motion, exact and approximate solutions to Navier- Stokes equation, Relationship between shear stress and Pressure Gradient, Flow of viscous fluid in Circular Pipes-Hagen Poiseuille Law, Flow of viscous fluid between two parallel plates: One plate is moving and other at rest-Couette flow and Both plates at rest. Boundary layer theory: boundary layer definitions and characteristics, displacement, momentum, and energy thickness, Momentum Equation for boundary layer by Von Karman, laminar boundary layer, boundary layer separation and its control.

Unit 4	**Turbulent flow:** Turbulent flow: Characteristics of turbulent flow, Shear stress in turbulent flow: Boussinesq's theory, Reynolds theory, Prandtl's mixing length theory, Universal velocity distribution Hydrodynamically smooth and rough boundaries: velocity distribution for turbulent flow in smooth and rough pipes, Common equation for velocity distribution for both smooth and rough pipes, resistance to flow of fluid in smooth and rough pipes.
Unit 5	**Dimensional analysis:** Dimensional analysis: dimensions, dimensional homogeneity, Methods of dimensional analysis: Rayleigh's method and Buckingham's pi methods, limitations of dimensional analysis, Model analysis: Similitude, Forces influencing hydraulic phenomenon, dimensionless numbers and their significance, Model Laws, Types of models, Scale effect in models, Limitations of hydraulic similitude

References:

1. R. K. Rajput, (2006) "Fluid Mechanics", S. Chand and Company Limited, New Delhi, Third Edition, ISBN:81- 219-1667-4.
2. S. Narsimhan (1973) "Engineering Fluid Mechanics", Orient Longman
3. Douglas J.F, Gasiorek S, waffield J.A. (2003) "Fluid Mechanics", Pearson Education (Singapore) Pvt. Ltd. Indian office at 482 F.I.E. Patparganj, Delhi.
4. Mohanthy A.K. (1994) "Fluid Mechanics, Prentice Hall of India, New Delhi

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	–	2	1
CO2	1	3	2	1	1
CO3	2	2	2	1	1
CO4	1	1	3	–	2

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPCC5205: Water Resources Systems Planning and Management

Teaching Scheme		**Evaluation Scheme**	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the students to engineering economy of water resources project for evaluation of benefit cost analysis. Optimization techniques such as linear programming and non-linear programming are included in the curriculum. Simulation and multi-objective optimization is also included in the curriculum. Student will be exposed to the water quantity and water quality management with different models.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand principles of engineering economy
CO2	Optimize the water resources systems
CO3	Analyze the water quantity and quality management
CO4	Understand the legal aspects of water and environment systems.

Detailed Syllabus:

Unit 1	**Introduction:** Introduction: General Principles of Systems Analysis to Problems in Water Resources Engineering, Objectives of Water Resources Systems, Economic Analysis of Water Resources Systems: Principles of Engineering Economy Capital, Interest and Interest rate, Time Value of Money, Depreciation, Benefit Cost Evaluation, Discounting Techniques Socio Economic Analysis.
Unit 2	**Methods of Systems Analysis:** Methods of Systems Analysis: Linear Programming Models, Simplex Method, Sensitivity Analysis, Dual Programming, Dynamic Programming Models.
Unit 3	**Non-linear Programming:** Non-linear Programming, Gradient Techniques, Stochastic Programming, Simulation, Multi Objective Optimization.
Unit 4	**Water Quantity Management:** Water Quantity Management: Surface Water Storage Requirements, Storage Capacity and Yield, Reservoir Design, Water Allocations for Water Supply, Irrigation, Hydropower and Flood Control, Reservoir Operations, Planning of an Irrigation System, Irrigation Scheduling, Groundwater Management, Conjunctive Use of Surface and Subsurface Water Resources

Unit 5	**Water Quality Management:** Water Quality Management: Water Quality Objectives and Standards, Water Quality Control Models, Flow Augmentation, Wastewater Transport Systems, River Water Quality Models. Legal Aspects of Water & Environment Systems: Principles of Law Applied to Water Rights and Water Allocation, Water Laws. Environmental Protection Law.

References:

1. Loucks, D.P., Stedinger, J.R. and Haith, D.A. (1982) —Water Resources Systems Planning and Analysis“, Prentice Hall Inc. N York
2. Chaturvedi, M.C. (1987), —Water Resources Systems Planning and Management“, Tata McGraw
3. Hall. W.A. and Dracup, J.A. (1975), —Water Resources Systems“, Tata McGraw Hill Pub. N Delhi
4. James, L.D. and Lee (1975), —Economics of Water Resources Planning“,McGraw Hill Inc. N York Kuiper, E. (1973) —Water Resources Development, Planning, Engineering and Economics“, Buttersworth, London.
5. Biswas, A.K. (1976) —Systems Approach to Water Management“, McGraw Hill Inc, N York.
6. Taha, H.A. (1996) —Operations Research“, Prentice Hall of India, N Delhi.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	–	1	1
CO2	2	3	2	1	2
CO3	2	2	2	1	2
CO4	2	1	3	2	1

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPCC5206: Hydraulics Structures

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course introduces the different aspects of hydraulic structures. It deals with earthen dam, its types, design criteria and design of earthen dam. It also deals with seepage through dam and foundation and its control. Drainage of embankment and design of filter is also covered. Gravity dam with reference to forces acting, modes of failures, design and foundation treatment is included. Aspects such as strengthening and raising of gravity dam and repairs of concrete dam are also covered. Different aspects of arch dam and buttress dam are also included. Topics ranging from capacity of spillway, types of spillway, energy dissipation below spillway, different types of spillway gates and outlet through dams are also included.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Demonstrate the different terminologies related with hydraulic structures.
CO2	Decide suitability of individual hydraulic structures in different situation.
CO3	Design different hydraulic structures such as dams and spillways
CO4	Compare and contrast suitable hydraulic structure in a particular scenario

Detailed Syllabus:

Unit 1	**Earthen Dams:** Earthen Dams, types of earthen dams, choice of type of dam, causes of failure of earth dams, design criteria for earth dams, selecting a suitable preliminary section for an earth dam, design of earth dams; stability analysis of slopes: shape of slip surface, and method of slices.
Unit 2	**Methods of Seepage Analysis:** Seepage through Dam Section and its Control: fundamentals of seepage flow, Laplacian equation and flow net. Determination of top flow line and discharge through dam, seepage force and its effects, steady seepage. Drainage of Embankment: horizontal drain, chimney drain, design of filter, use of impervious core in seepage control. Control of seepage trough foundation, cut off trench, partial cutoff and upstream impervious blanket.
Unit 3	**Gravity dams:** Gravity dams, forces acting, modes of failure, elementary and practical profile, low and high gravity dam, design of gravity dam, drainage gallery, joints in a gravity dam, foundation treatment in a gravity dam, strengthening and raising of gravity dams, deterioration and repairs of concrete dam, deformation measurement of dam body by plumb lines and off dam reference point.

Unit 4	**Arch dams:** Arch dams: types and its suitability, equations of cylindrical shells, general concepts about trial load method and elastic shell method. Hollow gravity dam, structural features, Buttress dam, types: flat slab type, massive head type, multiple arch type and prestressing of buttress dams.
Unit 5	**Spillways:** Spillways - Determination of capacity, types, ogee, side channel, chute, shaft and 6 Hr siphon. Basic principles of hydraulic design, energy dissipation arrangements below spillway. Spillway Gates: Types such as Tainter, drum, vertical lift, automatic gates. Outlets through dams: types, hydraulics of outlet works, river intakes and trash rack.

References:

1. William P. Creager, Joel Justin and Julian Hinds "Engineering for Dams" Vol. I, II and III, John Wiley and Sons, Inc. London
2. Sharma, H.D. "Concrete Dams" Metropolitan Printers, Delhi 110153
3. Garg, S.K. "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, Delhi.
4. Novak, P., Moffat, A.I.B., Nalluri, C. and Narayanan, R. Hydraulic Structures Unwin Hyman Ltd.London 1989.
5. USBR Design of Small Dams Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1974.
6. Varshney, R.S. Concrete Dams Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1982.
7. Varshney, R.S. Hydro Power Structures – Nem Chand Bros. Roorkee 1973 Guthrie, Brown J.
8. Hydro Electric Engineering Practice Blackie and Son, Glasgow 1970.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	–	1	1
CO2	2	3	2	1	1
CO3	2	2	2	1	2
CO4	1	1	3	2	1

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEOEC5201: Disaster Management

Teaching Scheme		**Evaluation Scheme**	
Theory	2 Hrs/Week	ISE I	10 Marks
Tutorial		ISE II	10 Marks
Total Credits	**2**	End Semester Examination	30 Marks
		Total	50 Marks

Prerequisite: Not applicable

Course Description: This course introduces the principles and practices of disaster management, focusing on understanding the natural and man-made disasters, risk and vulnerability analysis, and frameworks for disaster preparedness, response, mitigation, and recovery. It also covers emerging technologies and tools such as GIS, remote sensing, and early warning systems to enhance disaster resilience. Emphasis is placed on policy, institutional frameworks, and community-based disaster management.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	analyze disaster risk, vulnerability, and the factors contributing to them.
CO2	evaluate post-disaster management and the role of institutional frameworks.
CO3	apply modern tools such as GIS and Remote Sensing in disaster management planning.

Detailed Syllabus:

Unit 1	**Introduction to Disaster Management** Definition: Hazard, Risk, Vulnerability, Disaster, Types and classification of disasters: Natural (Floods, Earthquakes, Cyclones, Landslides, Droughts) and Man-made (Industrial, Chemical, Biological, Nuclear, Accidents), Causes, consequences, and case studies, Disaster management cycle: Prevention, Mitigation, Preparedness, Response, Recovery, Reconstruction.
Unit 2	**Hazard and Vulnerability Analysis** Risk assessment and vulnerability mapping, Factors affecting vulnerability: Physical, Social, Economic, Environmental, Community-based vulnerability assessment, Disaster risk reduction strategies, Role of stakeholders: Government, NGOs, Communities. **Disaster Preparedness and Mitigation** Components of disaster preparedness plans, Early warning systems and forecasting, Structural and non-structural mitigation measures, Land use planning and building codes, Education and awareness generation, Role of technology and media in disaster preparedness.
Unit 3	**Response and Post-Disaster Management** Disaster response planning and implementation, Emergency operations and coordination, Search, rescue, and relief operations, Damage and needs assessment, Rehabilitation and reconstruction, Psychological and social rehabilitation. **Institutional Framework & Technological Interventions** Disaster Management Act 2005 and NDMA guidelines, Role of UN, NIDM, SDMA, and local bodies, Use of GIS, Remote Sensing, AI in disaster management, Mobile applications, drones, and satellite data for real-time monitoring, Integrating disaster risk reduction with climate change adaptation, Case studies on successful disaster manage

References:

1. **Satish Modh** – Introduction to Disaster Management, *Macmillan India*
2. **Coppola D.** – Introduction to International Disaster Management, *Elsevier*
3. **Gupta, Harsh K.** – Disaster Management, *University Press*
4. **Sinha, P.C.** – Disaster Mitigation: Experiences and Reflections, *SBS Publishers*
5. **R. Subramanian** – Disaster Management, *Vikas Publishing House*
6. **NDMA Guidelines and Reports** – *https://ndma.gov.in*
7. **UNISDR** – Disaster Risk Reduction Strategies and Institutional Mechanisms
8. **Government of India** – Disaster Management Act,

Table 1. Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	3	1	2
CO2	3	2	3	2	1
CO3	3	3	2	1	2

Teacher's Assessment: ISE II of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2. Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	5	5	10
K2	Understand	5	5	10
K3	Apply			10
K4	Analyze			
K5	Evaluate			
	Total Marks	10	10	30

Table 3. Assessment Table

Assessment Tool	**K1, K2, K3**	**K1, K2, K3**	**K1, K2, K3**
	CO1	CO2	CO3
ISEI(10 Marks)	5	5	
ISEII (10 Marks)	5	5	
ESE Assessment (30Marks)	10	10	10
Total Marks 50	20	20	10

CEPEC5211: Climate Change and Water Resources

Teaching Scheme		Evaluation Scheme	
Theory	4 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**4**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the students to understand about climate change and to explore possible solutions. There is action that can be taken to prepare for a more variable climate. Improved understanding of our water resource will allow more efficient and flexible allocation system and better investment in infrastructure, both to improve access to water and reduce risks from climate change.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand the climate system, being aware of the impact of climate change on society, adaptation in relation to water and climate change.
CO2	Describe the possible impacts, adaptations and remedies in relation to water resources and climate change.
CO3	To orient towards the global climate change and its impact on water resources.
CO4	To understand the climate change phenomenon and its related issues on water, irrigation and its social implications

Detailed Syllabus:

Unit 1	**Global climate:** Introduction to global climate; Global climatic models; Methods of reconstructing climate; Quaternary climates, sea level changes.
Unit 2	**Glacial / interglacial cycles:** Glacial / interglacial cycles; Geological records of climate change, sediment logy, stable isotopes, geochemistry; Geochronology –relative and numerical methods.
Unit 3	**Geological time:** Vegetation dynamics, migration history, response of vegetation to climatic reversals, Pre-quaternary climates, evolution of climate through geological time.
Unit 4	**Indian Climatology:** Indian Climatology - Different seasons, Distribution of Means Sea level pressure/temperature in different seasons, Wind circulation and temperature distribution over India in lower, middle and upper troposphere in different seasons, Indian rainfall in different seasons, Indian summer monsoon, onset, withdrawal, rainfall distribution, inter annual variability of monsoon. Main synoptic pressure systems causing weather over India in different seasons.

Unit 5	**Climate Change & Variability:** Climate Change & Variability -Overview of the climatic history of the earth. Long term changes (Climate of Past century, past millennium, past glacial period), Methods of determining past climate. Possible causes of climate change- External (Milankovitch variation and Solar activity) and Internal (natural and anthropogenic). General idea of internal dynamical processes of the atmosphere, oceanic processes, Cryospheric processes, land processes. Man's impact on climate, Greenhouse gases and global warming, basic radiation processes, Climate feedback mechanism, Climate predictability, future climate, potential consequences, international efforts to minimize climate change and their effects on Indian scenario

References:

1. R.J. Barry and R.G. Chorley "Atmosphere, Weather and Climate" (Methuen Publication)
2. Y.P. Rao "South West Monsoon" (IMD Publication).
3. S. Pettersen "An Introduction to Meteorology"
4. Miller, Thompson and Paterson "Elements of meteorology"
5. H.R. Byer "General Meteorology"
6. P.K. Das "Monsoon"
7. IPCC Report Technical Paper VI – Climate change and water , 2008.
8. UNFCC Technologies for Adaptation to climate change, 2006.
9. 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.
10. Preliminary consolidated Report on Effect of climate change on Water Resources, GOI, CWC, MOWR, 2008.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	–	1	–
CO2	2	3	2	1	1
CO3	1	2	2	2	1
CO4	1	1	3	1	–

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	Class Test	Teacher's Assessment	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II(20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5212: River Engineering and Flood Control

Teaching Scheme		Evaluation Scheme	
Theory	4 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**4**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course emphasizes in the curriculum to get knowledge of fluvial geomorphology and understand concept of analysis of river flow hydraulics so that they are able to analyze hydraulic geometry and to design stable alluvial channels. So the students will able to do fluvial design for river bank protection and flood control.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand theoretical concepts of water and sediment movements in rivers.
CO2	Inculcate the benefits of fluvial system to the society.
CO3	Appreciate the complex behavior of rivers.
CO4	Gain the skills to take up research activities in river flood management

Detailed Syllabus:

Unit 1	**River:** Primary function of a river – River uses and measures – Water and Sediment loads of river – Rivers in India, Himalaya and Peninsular.
Unit 2	**Flood:** Physical Properties and Equations – Steady flow in rivers –uniform and non uniform – Turbulence and velocity profiles – resistance coefficients – Boundary conditions and back waters – Transitions – Rating Curve – Unsteady flow in rivers : Preoperative of surface waves – Characteristics, flood waves – kinematic and diffusion analogy – velocity of propagation of flood waves – Flood wave –Maximum
Unit 3	**River Equilibrium:** River Equilibrium : Stability of Channel – regime relations – river bend equilibrium – hydraulic geometry of downstream - Bars and meandering - River dynamics – degradation and aggradation of river bed – Confluences and branches – River Data base.
Unit 4	**Mapping:** Mapping – Stage and Discharge Measurements – Sediments – Bed and suspended load Physical hydraulic Similitude – Rigid and mobile bed – Mathematical – Finite one dimensional – multi – dimensional – Water Quality and ecological model.

Unit 5	**River training works:** River training works and river regulation works-Flood forecasting – Flood plain management – waves and tides in Estuaries - Interlinking of rivers – River Stabilization.

References:

1. Janson PL. Ph. Lvan Bendegam Jvanden Berg, Mdevries A. Zanen (Editors), "Principles of River Engineering – The non tidal alluvial rivers" – Pitman, 1979.
2. Pierre Y. Julien ., "River Mechanics" ,Cambridge University Press, 2002.
3. K.L Rao , "INDIA‟s WATER WEALTH" – Orient Longman Ltd., 1979.
4. River Behaviour and Management and Training,-CBIP publication.
5. Anderson, M.C., Burt, T.P. , 'Manual on flood forecasting', New Delhi, 1985.
6. Central Water Commission, 'Hydrological forecasting', John Willy and Sons, 1989.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	–	1	–
CO2	2	3	2	1	1
CO3	2	2	2	1	1
CO4	1	1	3	2	2

Teacher's Assessment: ISE IIof 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

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CEPEC5213: Integrated Watershed Management

Teaching Scheme		Evaluation Scheme	
Theory	4 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**4**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to solve water resources problems which include watershed management and erosion estimation such as USLE equation and modified USLE equation are included in the curriculum. Also the GIS technique and remote sensing is included in the curriculum. Student will be exposed to the watershed development and management with different models.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand Applications of GIS and remote sensing in water resources engineering.
CO2	Understand the aspects of watershed management.
CO3	Analyze the water quality monitoring.
CO4	Understand the watershed management practices and to know the sustainable use of the watershed.

Detailed Syllabus:

Unit 1	**Watershed:** Watershed - Definition and delineation, Watershed approach, Hydrologic cycle, Watershed components, Water budget, Watershed assessment, Watershed planning, Watershed as a management unit, Total maximum daily load. Characteristics of watershed - Size, Shape, Physiography, Slope, Climate, Drainage, Land use, Vegetation, Geology and Soils, Hydrology and hydrogeology, Socio-economic characteristics, Basic data on watersheds.
Unit 2	**Land use:** Land use and water quality issues - Land use impacts on watersheds, Residential activities, Municipal Construction, Mining operations, Agriculture, Forestry practices, Recreation. Water quality monitoring -Temperature, Ph, Dissolved Oxygen and Biological Oxygen Demand, Nutrients, Pathogens, Turbidity, Biological monitoring methods, Species indicators, Biological integrity, Habitat index, Land use index, Water resource assessment, Water yield.
Unit 3	**Erosion:** Erosion - Factors affecting erosion, Effects of erosion on land fertility and land capability, Soil Erosion Modelling, Erosivity and erodibility, Processes, USLE and modified/ revised USLE models for erosion processes. Land Management - Survey, Preparation and development, Soil and soil moisture conservation, Conservation measures, Ploughing, Furrowing, Trenching, Bunding, Terracing, Gully control, Rockfill dams, Brushwood dam, Gabion, Rain water management, Reclamation of saline soils.
Unit 4	**Rainwater harvesting:** Water Harvesting: Rainwater harvesting, Catchment harvesting, Harvesting structures, Soil moisture conservation, Check dams, Artificial recharge, Farm ponds, Percolation tanks. Ecosystem management: Role of ecosystem, Crop husbandry, Soil enrichment, Inter, mixed and

	strip cropping, Cropping pattern, Sustainable agriculture, Bio-mass management, Dry land agriculture, Silvi pasture, Horticulture, Social forestry and afforestation. Model watershed – Government and NGO Projects
Unit 5	**Sustainable Watershed:** Sustainable Watershed Approach & Watershed Management Practices Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation; Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning. Social Aspects of Watershed Management: Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies. Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management. Perspective on recycle and reuse, Waste water reclamation.

References:

1. Murty, J.V.S., Watershed management, New Age International 2009
2. Majumdar, D.K., Irrigation Water Management, Prentice Hall 2000
3. Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management, Colorado State University, 1994.
4. American Society of Civil Engineers, Watershed Management, American Soc. of Civil Engineers, New York, 1975.
5. Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991.
6. Michael A.M., Irrigation Engineering, Vikas Publishing House, 1992.
7. Purandare, A.P., Jaiswal A.K., Watershed Development in India, NIRD, Hyderabad, 1995.
8. Vir Singh, Raj, Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	3	3	1	3
CO2	2	2	3	1	2
CO3	3	3	2	2	2
CO4	3	3	3	–	2

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

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CEPEC5214: Land and Water Management

Teaching Scheme		**Evaluation Scheme**	
Theory	4 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**4**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The aim of this course is to provide an understanding of issues and methods in water resources management, and is set especially within the framework of total, or integrated, catchment management. The course gives an introduction to the unique hydrology of India, major issues of water resource management, the implications of past water management practices, the principles of integrated catchment management and sustainability, and current management tools and strategies.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand the economic development in water resource management in India
CO2	Explain how the changing balance over time in water availability, demand for water and value of water, institutional arrangements, policy and management.
CO3	Demonstrate familiarity with a range of water and land management issues, including origins, impacts and management interventions in both rural and urban areas
CO4	Understand the irrigation methods, types, problems associated with the land degradation

Detailed Syllabus:

Unit 1	**Basic:** Basic concepts of soil erosion; control of soil erosion; Mechanics of wind and water erosion, water and wind erosion control practices; concept of runoff and its estimation, evapotranspiration, methods of evapotranspiration estimation, Design, construction and maintenance of vegetated waterways; Planning, Design, Construction and maintenance of terraces contours and bunds; irrigation and drainage systems for efficient soil and water conservation; cost analysis.
Unit 2	**Surface irrigation:** Physics of surface irrigation; Design and evaluation procedure for border, check basin and furrow irrigation; Guidelines for operation and maintenance of surface irrigation methods. Description of Quick coupling, dragline and movable sprinkler irrigation systems and center Pivot system; Design installation, operation and maintenance of sprinkler irrigation systems; spray losses and drop size distribution in sprinkler irrigation systems and efficiency evaluation. Suitability of drip irrigation system under Indian conditions; Types of drip irrigation systems; Emitter types; Emitter construction; Discharge principles for emitters; Design of drip irrigation systems; water and salt distribution; Emitter clogging; water treatment; Automation; Field performance and evaluation. Irrigated crops- Irrigated agriculture in relation to crop production; irrigated crops around the world; Soil and climatic condition; selection of irrigation methods for irrigated field condition vegetable and fruit crops; Agronomical practices for major irrigated cro[illegible] nent

	for irrigated crops, Economic analysis of major irrigated crops, field visit.
Unit 3	**Management Concept:** Watershed Development and Management Concept of watershed development and management; collection of hydrological data; watershed characteristics and hydrologic cycle; problems of land degradation; Land use capability classification and topographical characteristics of watershed; Appropriate soil and water conservation measures for agricultural and non- agricultural lands; Grassland development and management, Legal aspects in water sharing and management – PC-CP - case studies.
Unit 4	**Techniques :** Techniques for dry land farming based on watershed characteristics; water harvesting techniques for hilly and arid regions; Hydrological and sediment monitoring of watershed; Estimation of peak design runoff rate; Planning, management and economic evaluation ofwatershed development projects; case studies.
Unit 5	**Land suitability:** Land suitability classification according to USBR; Land suitability categories according to FAO framework; Land evaluation; Mapping of degraded soil through soil survey; Land degradation in arid and semi-arid regions, Land degradation due to erosion, Land degradation management by conservation practices; Causes, reclamation and management of water logged and salt affected soils; Rehabilitation and management of ravine lands; Selection, Design and management of irrigation and drainage systems in wastelands; Economic evaluation of wasteland development projects.

References:

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

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	–	3	3	1	1
CO2	3	3	3	1	2
CO3	3	3	2	1	2
CO4	3	3	3	2	2

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPEC5215: Water Quality Monitoring and Modeling

Teaching Scheme		Evaluation Scheme	
Theory	4 Hrs/Week	ISE I	20 Marks
Tutorial		ISE II	20 Marks
Total Credits	**4**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: These courses introduce water quality concepts, its evaluation for irrigation purposes, besides relevant environmental problems and recycle and reuse concepts. Also understand the importance of water quality for irrigation and major uses of water and the role environmental issues.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Understand the water quality and its dependence on sources of water
CO2	Understand and interpret water quality data for its use in water quality models
CO3	Solve the water quality problems.
CO4	Design low cost waste water treatment plant.

Detailed Syllabus:

Unit 1	**Properties of water :** Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – major ions –. Water quality investigation – Sampling design - Samplers and automatic samplers - Data collection platforms – Field kits – Water quality data storage, analysis and inference – Software packages.
Unit 2	**Water quality:** Water quality for irrigation – Salinity and permeability problem – Root zone salinity - Irrigation practices for poor quality water – Saline water irrigation – Future strategies.
Unit 3	**Water treatment technologies:** Sources and Types of pollution – Organic and inorganic pollutants - BOD – DO relationships – impacts on water resources – NPS pollution and its control – Eutrophication control - Water treatment technologies - Constructed wetland.
Unit 4	**Multiple uses of water:** Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation.
Unit 5	**Principles of water quality:** Principles of water quality – Water quality classification – Water quality standards - Water quality indices – TMDL Concepts – Water quality models.

References:

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, "Wastewater Engineering: Treatment and Reuse", McGraw-Hill, 2002.
2. Vladimir Novonty, "Water Quality: Diffuse pollution and watershed Management", 2nd edition, John Wiley & Sons, , 2003
3. Mackenzie L Davis, David A Cornwell, "Introduction to Environmental Engineering", McGrawHill 2006.
4. Stum, M and Morgan, A., "Aquatic Chemistry", Plenum Publishing company, USA, 1985.
5. Lloyd, J.W. and Heathcote, J.A., "Natural inorganic chemistry" in relation to groundwater resources, Oxford University Press, Oxford, 1988

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	1	2
CO2	3	3	3	2	3
CO3	3	3	2	1	2
CO4	–	3	3	2	3

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember	6		18
K2	Understand	7	4	18
K3	Apply	7	10	12
K4	Analyze		6	12
K5	Evaluate			
K6	Create			
	Total Marks	20	20	60

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3	CO4
	K1,K2	K2,K3	K2,K3	K3,K4
ISE I (20 Marks)	10	10		
ISE II (20 Marks)		4	10	6
ESE (60 Marks)	18	18	12	12

CEPCC5207: Lab- Water Technology Laboratory

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	ISE-II	25 Marks
Tutorial	-	ESE	25 Marks
Total Credits	**1**	Total	50 Marks

Prerequisite: Not applicable

Course Description: There are opportunities in the field of analysis, analytical research, fundamental research, quality control departments, governmental and non-governmental organizations etc. for the technical laboratory personnel.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	To acquire skills for Laboratory Management and routine analysis of soil, water and food.
CO2	To improve working ability in analytical laboratory.

Detailed Syllabus:

1. Collection and preservation of samples from open well, tap, bore well, river, water treatment plants, waste water treatment plants.
2. Determination of PH and Electrical Conductivity of water.
3. Determination of Alkalinity and Hardness (Total, Permanent & Temporary)
4. Determination of calcium and Magnesium.
5. Determination of Carbonates & Bi-carbonates.
6. Determination of Chemical Oxygen demand (C.O.D.) and Biochemical Oxygen Demand (B.O.D.)
7. Determination of M.P.N. of water.

Industrial Visit

1. Visit to Sewage Treatment Plant and Water Treatment Plant
2. Visit to CWPRS / MERI / NERI /WALMI

References:

1. Standard Methods for Examination of water & waste wate APHA- AWWA- WPCE
2. Manual of water & waste water analysis, NEERI, Nagpur.
3. Text book of water and waste water engineering by H. K. Hussen.
4. Water supply & sanitary engineering by Birdie.
5. Practical methods in ecology & Environmental science by R. K. Trivedi, P. K. Goel,C. L. Trisal.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	–	2	2
CO2	–	–	2	2	2

Table 2. Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE II
S1	Imitation	9
S2	Manipulation	8
S3	Precision	8
S4	Articulation	
S5	Naturalization	
Total Marks 25		25

Table 3. Assessment Table:

Assessment Tool	CO1	CO2
	S1, S2, S3,	S1, S2, S3,
ISE I: -	-	-
ISE II: -(25 Marks)	15	10
ISE III:		
ESE Assessment		
Total Marks (25)	15	10

CEPCC5208 - Lab- Water Resources Systems Planning and Management

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	ISE-II	25 Marks
Tutorial	-	ESE	25 Marks
Total Credits	**1**	Total	50 Marks

Prerequisite: Not applicable

Course Description: This laboratory course introduces on applications and performance of different methods in economic analysis and operations research. Also the students should learn the water rights and environmental protection laws. Students have to do all the assignments mentioned below.

Course Outcomes:

After successful completion of the course, students will be able to:

Course Outcomes	
CO1	Carry out the economic analysis of hydraulic structures
CO2	Solve the optimization problems in water resources engineering
CO3	Analyze the reservoir operation problems
CO4	Understand the water rights and environmental protection law

Detailed Syllabus:

1. Carry out the cost economic analysis of any existing hydraulic structure using its data (student should work individually)
2. Solve Linear programming problems using Simplex method, dual programming
3. Solve Non Linear programming using gradient technique, Stochastic programming
4. Write the mathematical model for Multi objective reservoir operation and solve it by LINGO
5. Prepare a draft for the water rights and protection laws, Conflicts over water, environmental protection law, legal aspect
6. Redesign any small reservoir by considering requirement, future population growth for upcoming next 35 years
7. Assessment of the water quality of the any area using institutes laboratory and draft report for the implications (Group Task)

Candidates are required to submit the duly completed journals before the end of semester.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	–	3	–	2	3
CO2	3	1	2	2	3
CO3	–	2	2	1	3
CO4	–	–	–	1	2

Table 2. Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE II
S1	Imitation	9
S2	Manipulation	8
S3	Precision	8
S4	Articulation	
S5	Naturalization	
Total Marks 25		25

Table 3. Assessment Table:

Assessment Tool	CO1	CO2	CO3	CO4
	S1, S2, S3,	S1, S2, S3,	S1, S2, S3	S1, S2, S3,
ISE I: -	-	-	-	-
ISE II: -(25 Marks)	5	5	5	10
ISE III:				
ESE Assessment				
Total Marks (25)	5	5	5	10

CEAEC5201: SEMINAR

Teaching Scheme		Evaluation Scheme	
Practical	4 hrs/week	ISE II	25 Marks
Tutorials		ESE	25 Marks
Total Credits	**2**	Total	50 Marks

Course Description:
This course provides postgraduate students with an opportunity to explore recent advances in their specialization through literature survey, technical presentations, and discussions. Students develop skills in technical writing, critical analysis, presentation, and research methodology by preparing and presenting seminars on contemporary topics.

Course Outcomes:
After completion of this course students will be able to;

	Course Outcomes
CO1	conduct a comprehensive literature survey on a selected research topic.
CO2	prepare and deliver a technical seminar using effective presentation and communication skills.
CO3	analyze research findings and prepare a technical report following research ethics and citation standards.

Deatailed Syllabus:
Selection of seminar topic related to the specialization, Identification of research problem, Literature survey using journals, conference proceedings and digital libraries, Review and critical analysis of recent research papers, Research methodology, Technical writing and report preparation, Preparation of presentation slides, Data interpretation and visualization, Referencing and citation techniques, Plagiarism and research ethics, Seminar presentation, Technical discussion, Question and answer session, Peer evaluation, Final seminar report submission.

ISE-I & ISE-II: Practical Examination shall consist of term work assessment and viva-voce.

Assessment: Based on the practical performance, interaction of students till the term end.

Table 1. Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	1	3	3	3	2
CO2	-	1	3		2
CO3	3	3	3	3	2

3-High, 2- Medium, 1 – Low

Table 2. Assessment pattern:

Assessment Pattern Level No.	Knowledge Level	ISE II	End Semester Examination
S1	Imitation	10	10
S2	Manipulation	10	10
S3	Precision	5	5
S4	Articulation	-	-
S5	Naturalization	-	-
Total Marks		25	25

Table 3. Assessment Table:

Assessment Tool	CO1, CO2, CO3
	S1, S2, S3
ISE II:(25 Marks)	25
ESE Assessment (25 Marks)	25
Total Marks (50)	50

CEDIS5201: Dissertation-I

Teaching Scheme		Evaluation Scheme	
Practical	4 hrs/week	ISE II	50 Marks
Tutorials		ESE	50 Marks
Total Credits	**2**	Total	100 Marks

Prerequisite: Not applicable

Course Description: The dissertation work is one of the key areas of post graduate education incorporating the research component in the curriculum. The student is required to study the existing literature from various sources such as referred journals, proceedings of National/International seminar/conferences, post graduate dissertation, PhD thesis, reference book etc. of Civil-Water Resources Engineering. The student would identify the problem and provide solution/s through experimental/comparative study as partial fulfillment of post graduate degree in Civil- Water resources engineering.

The dissertation-I mainly focuses on literature survey, identification of problem and action plan with possible outcomes for the completion of Dissertation-II

Course Outcomes: After successful completion of the course, students will be able:

Course Outcomes	
CO1	To carry out exhaustive literature survey on chosen field of study.
CO2	To formulate/define the problem for dissertation
CO3	To compile and prepare a technical report of the collected literature and present.
CO4	To understand the methodology case study.

Term Work:

The Dissertation-I shall consist of collection of literature from a chosen field of Civil-Water resources engineering from various sources. The candidate shall formulate/define analytical and/or experimental problem for carrying out dissertation work. The candidate shall prepare a technical report in a prescribed format. The evaluation of the term work shall be through submission of report of the student in prescribed format.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 25 Marks: A mid-term evaluation for 25 marks out of 50 marks shall be done as per the schedule given in the institute academic calendar. Students should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and at least one faculty member appointed by the Head of the Department as external examiner. The panel of examiner will assess the contents and presentation and gives the suggestions, if any and assigns the marks out of 25marks.

Part-II: End Semester Evaluation for 25 Marks: Students shall prepare a comprehensive report incorporating the suggestions of part-I, if any and make a power point presentation before the panel of examiners as above and class students and should be able to answer questions asked by the panel of examiners and class students. The panel of examiner will assess the contents and presentation and assigns the marks out of 25 marks.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	1	2
CO2	3	1	2	2	3
CO3	3	2	2	1	2
CO4	–	–	3	1	2

CEEEM6101 : AI For Earth Observation

Teaching Scheme		**Evaluation Scheme**	
Theory	2 Hrs/Week	ISE I	10 Marks
Tutorial		ISE II	10 Marks
Total Credits	**2**	End Semester Examination	30 Marks
		Total	50 Marks

Course Description:

This course introduces the fundamentals of Artificial Intelligence (AI) for Earth Observation (EO) using multispectral, hyperspectral, and Synthetic Aperture Radar (SAR) data. It covers AI and deep learning techniques for image classification, semantic segmentation, target detection, and change detection. The course also introduces advanced AI models, including Vision Transformers, GANs, SAM, and CLIP, with applications in agriculture, urban planning, forestry, disaster management, and environmental monitoring.

Course Outcomes:

After completion of this course students will be able to;

	Course Outcomes
CO1	Understand Earth Observation data, sensors, and AI fundamentals.
CO2	Apply AI and deep learning techniques for Earth Observation tasks.
CO3	Analyze SAR and hyperspectral imagery using AI methods.

Detailed Syllabus:

Unit -1	**Fundamentals of Earth Observation** Overview of Earth Observation (EO) data and sensors, Multispectral imagery: characteristics and challenges, Hyperspectral imagery: characteristics and challenges, Synthetic Aperture Radar (SAR): principles and challenges, Core EO tasks: classification, semantic segmentation, target detection, and change detection, Traditional approaches for semantic segmentation, target detection, and change detection, Multi-sensor and multi-resolution challenges, Motivation for Artificial Intelligence in Earth Observation, Learning paradigms: Supervised, Unsupervised, and Self-supervised learning..
Unit -2	**Deep Learning for Earth Observation** Semantic segmentation using deep learning, U-Net and other semantic segmentation architectures, Generative Adversarial Networks (GAN) and CycleGAN, SAR image processing: despeckling, classification, semantic segmentation, domain adaptation, and PolSAR analysis, Hyperspectral image analysis: classification, dimensionality reduction, spectral unmixing, and image enhancement, Multi-sensor and geographic domain adaptation, Incorporating non-image data in Earth Observation.
Unit -3	**Advanced AI Models and Applications** AI-based change detection: supervised, unsupervised, Early Fusion, and Siamese networks, Vision Transformers for classification and semantic segmentation, Diffusion models for Earth Observation, Vision foundation models: Segment Anything Model (SAM), CLIP, and Earth Observation-specific foundation models, SAM for segmentation, target detection, and change detection, Text-guided change detection and CLIP applications in Earth Observation, Applications of AI in Earth Observation: urban monitoring, forestry, glacier monitoring, agriculture, and land surface forecasting.

NPTEL LINK:
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs98

Text & References:

1. Saha, S., Deep Learning for Multi-sensor Earth Observation, Elsevier, 2025.
2. Del Rosso, M. P., Sebastianelli, A., and Ullo, S. L., Artificial Intelligence Applied to Satellite-Based Remote Sensing Data for Earth Observation, Institution of Engineering and Technology (IET), 2021.
3. Goodfellow, I., Bengio, Y., and Courville, A., Deep Learning, MIT Press, 2016.
4. Richards, J. A., Remote Sensing Digital Image Analysis: An Introduction, 6th Edition, Springer, 2022.
5. Lillesand, T. M., Kiefer, R. W., and Chipman, J. W., Remote Sensing and Image Interpretation, 8th Edition, Wiley, 2015.
6. Jensen, J. R., Introductory Digital Image Processing: A Remote Sensing Perspective, 4th Edition, Pearson, 2015.
7. Schowengerdt, R. A., Remote Sensing: Models and Methods for Image Processing, 3rd Edition, Academic Press, 2007.
8. Zhu, X. X., Tuia, D., Mou, L., Xia, G. S., Zhang, L., Xu, F., and Fraundorfer, F., "Deep Learning in Remote Sensing: A Comprehensive Review and List of Resources," IEEE Geoscience and Remote Sensing Magazine, Vol. 5, No. 4, pp. 8–36, 2017.
9. Camps-Valls, G., Tuia, D., Bruzzone, L., and Benediktsson, J. A., Advances in Machine Learning for Remote Sensing and Geosciences, Wiley, 2024.
10. Zhu, X. X., Tao, C., Mou, L., et al., Deep Learning for Earth Observation: Theory and Practice, Springer, 2024.

Table 1: Mapping of Course Outcome with Program Outcomes

Course outcome	PO1	PO2	PO3	PO4	PSO1	PSO2
CO1	3	2	-	-	1	1
CO2	2	3	2	2	1	-
CO3	2	2	2	1	1	1

3-High, 2- Medium, 1 – Low

Assessment:

ISE I: Based on unit I and unit II

ISE II : Teacher's Assessment: Teachers Assessment of 20 marks is based on one of the / or combination of few of following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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Table 2: Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISEI	ISEII	ISEIII	End Semester Examination
K1	Remember	05	05	-	-
K2	Understand	05	05	-	10
K3	Apply	-	-	-	10
K4	Analyze	-	-	-	10
K5	Evaluate	-	-	-	-
Total Marks 50		10	10	-	30

Table 3. Assessment table:

Assessment Tool	K1, K2, K3,K4	K1, K2, K3,K4	K1, K2, K3,K4
	CO1	CO2	CO3
ISEI(10 Marks)	5	5	-
ISEII (10 Marks)	-	5	5
ESE Assessment (30Marks)	10	10	10
Total Marks 50	15	20	15

CEIKS6101: Ancient Water Management Practices

Teaching Scheme		**Evaluation Scheme**	
Theory	2 Hrs/Week	ISE I	10 Marks
Tutorial		ISE II	10 Marks
Total Credits	**2**	End Semester Examination	30 Marks
		Total	100 Marks

Course Description

This course will explore various dimensions of knowledge on water resources - local, indigenous, traditional, and scientific and its criticality as a resource for development. The course explores how strategies have been evolved by mankind to create knowledge systems and societies for sustainable development of water resources. Particular emphasis of this course is on traditional knowledge for water management.

Course Outcomes:

By the end of the course, students will:

Course Outcomes	
CO1	Explain the dimensions of knowledge, the science–management divide, and the role of integrating traditional and contemporary knowledge for sustainable and adaptive water management.
CO2	Describe the evolution of traditional water management systems in ancient civilizations and evaluate traditional water harvesting, conservation, and management practices in different ecological regions of India.
CO3	Analyze traditional water conservation and management practices of Maharashtra, evaluate their institutional and socio-economic significance, and explore their application for sustainable water resources management using modern technologies.

Course Content:

Unit 1	**Introduction to Knowledge and Water Management:** Knowledge for development; traditional, social and technical knowledge; understanding of knowledge (static, processual and historical); significance of traditional knowledge in water management. Knowledge gap: science–management divide, local and scientific knowledge, need for integration and adaptive management. Knowledge management, knowledge networks, conflict resolution and Hydraulic Societies.
Unit 2	**Traditional Knowledge and Water Management Systems:** Human–water relationship, ancient civilizations (Harappan, Vedic, Mauryan and others), hydrological knowledge in ancient India, rainfall measurement and data storage, hydraulic interlinkages, and the decline of the Harappan civilization. Traditional water management systems across different ecological zones, socio-economic and political aspects, and traditional water harvesting and conservation technologies including Talabs, Baolis, Kunds, Taankas, Kuhls, Zings, Bamboo Drip Irrigation, Jackwells, Ramtek water harvesting structures, wastewater management, and evolution of institutions.
Unit 3	**Traditional Water Conservation Practices in Maharashtra:** Contributions of Rashtrakuts, Satwahans, Yadavas, Chhatrapati Shivaji Maharaj, Rani Ahilyadevi Holkar and Chhatrapati Shahu Maharaj to water resources development. Traditional rainwater harvesting and storage structures including Kunds, Tanks, Open Wells, Baravs, Khajana Wells, Jal Mahals, Earthen Dams and Kolhapur Type Bandharas. Community-based water distribution systems such as Phad Irrigation, Warabandi and Malgujari Talav System, contemporary water use practices, and participatory water management.

References:

1. Hydrology and water resources management in ancient India by Pushpendra Kumar Singh, Pankaj Dey, Sharad Kumar Jain, and Pradeep P. Mujumdar, EGU publication Hydrology and Earth System Sciences Vol 24, Issue 10 year 2020 https://doi.org/10.5194/hess-24-4691-2020
2. Agarwal, A., & Narain, S. (1997). Dying Wisdom: Rise, fall and potential of India's traditional water harvesting systems (Vol. 4): Centre for Science and Environment New Delhi. Chapter 2. Pp 25-268.
3. Koul, D. N., Singh, S., Neelam, G., & Shukla, G. (2012). Traditional water management systems-An overview of Ahar-pyne system in South Bihar plains of India and need for its revival. Indian Journal of Traditional Knowledge, 11(2), 266-272.
4. Mosse, D. (1999). Colonial and Contemporary Ideologies of 'Community Management': The Case of Tank Irrigation Development in South India. Modern Asian Studies, 33(02), 303-338
5. Traditional water management practices of Maharashtra by Dr. D.M. More
6. Evers, H. D. (2008). Knowledge Hubs and Knowledge Clusters: Designing a Knowledge Architecture for Development, ZEF Working Paper Series 27. Bonn: Centre for Development Research.
7. Agarwal, A., & Narain, S. (1997). Dying Wisdom: Rise, fall and potential of India's traditional water harvesting systems (Vol. 4): Centre for Science and Environment New Delhi. Chapter 2. Pp 25-268.
8. Pahl-Wostl, C. (2007). Transitions towards adaptive management of water facing climate and global change. Water Resources Management, 21(1), 49-62.

Websites:

1. Development Gateway http://knowledge.developmentgateway.org
2. United Nations University Traditional Knowledge Initiative http://www.unutki.org
3. World intellectual property organization http://www.wipo.int/tk/en/indigenous/customary_law

Journals

1. Journal of environmental management
2. Ecology and society
3. Water resource management

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	-	1	-
CO2	3	3	2	2	-
CO3	3	3	3	2	-

Teacher's Assessment: ISE II of 20 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

Table 2: Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	End Semester Examination
K1	Remember			10
K2	Understand	5	5	10
K3	Apply	5	5	10
K4	Analyze			
K5	Evaluate			
K6	Create			
	Total Marks	10	10	30

Table 3: Assessment Table

Assessment Tool	CO1	CO2	CO3
	K1, K2, K3	K1, K2, K3	K1, K2, K3
ISE I (10 Marks)	5	5	
ISE II (10 Marks)	5	5	
ESE (30 Marks)	10	10	10

CEDIS6102: Dissertation-II

Teaching Scheme		Evaluation Scheme	
Practical	16 Hrs/Week	ISE II	100 Marks
Total Hours		ESE	150 Marks
Total Credits	**8**	Total	250 Marks

Prerequisite: Not applicable

Course Description:

The dissertation-II is a continuation of Dissertation-I and mainly focuses on solution of the defined problem through experimental/analytical/comparative study as planned.

Course Outcomes: After successful completion of the course, students will be able:

Course Outcomes	
CO1	To appraise the additional literature in the chosen field of water resources engineering.
CO2	To refine the formulated problem in the chosen field of water resources engineering.
CO3	To find solution to the identified problem using appropriate methodology.
CO4	To interpret, discuss, debate the solution and draw conclusions.
C05	To write the dissertation report and present before panel of examiner and peers.

Term Work:

The Dissertation-II shall consist of a complete analytical and/or experimental work in water resources engineering containing literature survey, problem formulation, solution, results, interpretations, discussions and conclusions certified by guide and an internal evaluation committee. The candidate shall prepare a technical report in a prescribed format and submit soft bound 3-hard copies signed by the guide and submit it to the CoE for viva-voce examination. After the viva-voce examination, student shall submit 3-hard bound copies after the corrections, if any, suggested by the panel of examiners along with program exit survey in prescribed format. The evaluation of the term work shall be based on continuous assessment of the student and final submission.

Paper Publications:

A proof of publication or uploading paper to SCI, Web of Science, Scopus, Indian Citation Index journal or filling patent is mandatory requirement for submission of dissertation. However, if the dissertation work is in collaboration with industry/organization/research agency, the uploading of paper/filling a patent shall not be mandatory but desirable.

Pre submission presentation:

There shall be a pre submission presentation before a panel of experts/faculty consisting of guide and faculty/experts and PG students of the concerned class.

Viva Voce Examination:

Students should prepare a power point presentation and present it before the panel of examiners consisting of guide and the external examiner appointed by the Controller of Examination. The candidate should be able to defend his work in front of the panel of examiners and peers. The panel of examiners will assess the dissertation contents and presentation and assigns the marks out of 150.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	2	2
CO2	3	1	2	1	3
CO3	3	2	2	1	3
CO4	1	–	3	1	3
CO5	1	2	1	–	2

CEPCC6109: Engineering Hydrology Laboratory

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	ISE II	25 Marks
Tutorial		ESE	25 Marks
Total Credits	**1**	Total	50 Marks

Course Description: To teach the principles, applications and Performance of unit and synthetic hydrographs. Also the students will learn the flood frequency studies and storage capacity of reservoirs. Students have to do all the assignments mentioned below.

Course Outcome: After successful completion of the course student will be able to:

Course Outcomes	
CO1	Determine flood discharge for different return periods
CO2	Analyse reservoir routing and channel routing
CO3	Determine unit hydrograph and synthetic unit hydrograph
CO4	Decide the storage capacity of reservoir

List of Assignments:

1. Determine the flood discharge for the 100 year return period using real data
2. Route any inflow hydrograph through the river reach
3. Geographical distribution and finding average precipitation over an area
4. Solve Examples based on unit hydrograph method
5. Develop S-curve hydrograph and synthetic unit hydrograph for given data
6. Flood frequency study using Gumbel's distribution.
7. Analysis of Rainfall data (double mass curve technique)
8. Determination of storage capacity of a reservoir
9. Site visit to the nearest metrological station Candidates are required to submit the duly completed journals before the end of semester.

Candidates are required to submit the duly completed journals before the end of semester.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	1	1
CO2	3	3	3	1	1
CO3	–	3	3	2	2
CO4	–	3	3	1	2

CEOJT6202: Industrial Training

Teaching Scheme		**Evaluation Scheme**	
Practical	-	ISE II	100 Marks
Tutorial		ESE	-
Total Credits	**1**	Total	100 Marks

Course Outcomes:

After completion of this course students will be able to:

CO1	evaluate complex civil engineering challenges encountered during internship projects and develop sustainable, economical, safe, and code-compliant technical or managerial solutions using advanced engineering principles.
CO2	apply and integrate advanced civil engineering knowledge, research methods, modern analytical tools, and professional standards to investigate, design, execute, monitor, or optimize real-world engineering activities.
CO3	prepare and present a comprehensive technical internship report documenting the work performed, methodology, project analysis, results, challenges, solutions, professional practices, and advanced learning outcomes in a structured and evidence-based manner.

Scope:

Students are expected to undergo Internship for IV Semester at factory / construction site / design offices or in combination of these. Internship session shall be guided and certified by qualified engineer / architect / contractor in civil engineering.

Term work: At the conclusion of the Internship period, students will be required to submit a comprehensive final report detailing their experiences, accomplishments, and reflections during the Industrial Training. The final report should include a thorough analysis of the projects undertaken, the challenges encountered, and the lessons learned.

Practical/Viva Voce Examination: The students shall prepare presentation/ report based on their Internship and deliver it before the panel of examiners which shall consist of a supervisor and external examiner appointed by COE. The panel will examine the Report contents and presentation and award marks out of 100.

Assessment:

ISE II (100 Marks) is based on the **Internship Report** the internal assessment should focus on the quality of the report, technical learning, analysis, and documentation of the Industry Training.

Table 1: Mapping of Course outcome with Program Outcomes and Program Specific Outcomes

Course outcome	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	3	1	3	-	1
CO2	2	3	2	3	2
CO3	2	2	3	2	2

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Table 2. Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE II
S1	Imitation	40
S2	Manipulation	40
S3	Precision	20
S4	Articulation	-
S5	Naturalization	-
Total Marks		100

Table 3. Assessment Table:

Assessment Tool	CO1	CO2	CO3
	S1, S2, S3	S1, S2, S3	S1, S2, S3
ISE II: (100 Marks)	20	20	60
Total Marks (100)	20	20	60