GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil (Water Resource Engineering)

Subject Code: ME02033061

Subject Name: Hydrosystem Engineering

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Engineering Mathematics, Fluid Mechanics and Hydraulics, Hydrology and Environmental Science and Sustainability Concepts
Rationale:	This course prepares students to tackle the pressing challenges in water resource management by combining core hydro-system engineering principles with modern computational and sustainable approaches. With an emphasis on practical, data-driven solutions, students will gain skills in hydrological analysis, system optimization, and the integration of environmental and social considerations. Aligned with India's NEP 2020, the course promotes interdisciplinary, hands-on learning, empowering students to create effective, sustainable water solutions that address local and global needs.

Course Outcome:

After Completion of the Course, Student will have :

No	Course Outcomes	RBT Level
01	An ability to apply principles of mathematics, science, and engineering to design and assess components of water resource systems, within broader hydro-systems.	A
02	An ability to identify, formulate, and evaluate viable alternatives for water resource systems.	E
03	Proficiency in applying data analytics, soft computing, and simulation techniques to model, analyze, and optimize complex water resource challenges effectively.	N
04	An ability to consider and address economic, environmental, social, and sustainability factors in water resource solutions, fostering an awareness of ethical and sustainable engineering practices.	C

05	An ability to communicate technical information clearly and effectively and collaborate with multi-disciplinary teams and engaging with diverse stakeholders in the water resource sector.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Fundamentals of Hydrosystems Engineering: Introduction to Hydrosystems Engineering: Scope, principles, and role of systems engineering in water resource management. Systems Engineering in Water Resources: Systems approach to resource planning, design of multipurpose projects, optimization for sustainable use. Environmental and Sustainable Practices in Hydro Systems: Strategies for sustainable water resource management, environmental considerations.	12	30%
2.	Optimization Techniques in Hydrosystems: Conventional Optimization Techniques: Functions of single and multiple variables, constrained optimization, Kuhn-Tucker conditions, LP methods (graphical, simplex). Dynamic and Stochastic Optimization: Dynamic programming, stochastic optimization, applications in water resource planning, and reservoir operation models.	11	24%

3.	Soft Computing Techniques: Fuzzy Logic, Genetic Algorithms, Artificial Neural Networks, with applications in water resources. Simulation of Water Resource Systems: If-Then operational rules, reservoir simulation, river basin models, evaluation of performance metrics (reliability, resiliency, vulnerability).	14	30%
4.	Decision-Support Systems: Real-time management tools, scenario analysis, and their role in water resource optimization and policy support. System Sensitivity and Performance Evaluation: Sensitivity and uncertainty analysis, multi-criteria performance evaluation.	6	14%
5.	Interdisciplinary Project-Based Learning: Application of course concepts through group projects on real-world hydro-systems, case studies.	2	4%
	Total	**45**	**100**

Practical Sessions:

Sr. No.	Practical / Tutorial Contents
1	Introduction to Hydrosystems Modeling and Optimization Software
2	Application of Linear Programming (LP) and Dynamic Programming (DP)
3	Multi-objective Optimization and Sensitivity Analysis
4	Soft Computing Techniques (Fuzzy Logic and Genetic Algorithms)
5	Neural Network Applications in Hydrosystems
6	Simulation of Water Resource Systems
7	System Performance Evaluation and Decision
8	Capstone Project in Hydrosystem Engineering

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)

R Level	U Level	A Level	N Level	E Level	C Level
10	15	20	15	20	20

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Optimization of Water Resource Systems - Ronald A. Wurbs (McGraw-Hill Education)
2. Water Resources Systems Planning and Management - Sharad K. Jain, V.P. Singh, and L. Vijay Kumar (Wiley)
3. Engineering Optimization: Theory and Practice - S. S. Rao (Wiley)
4. Soft Computing in Water Resources Engineering - Pushpendra Kumar and Zoran Stojadinovic (Springer)
5. Water Resources Systems Analysis - Mohammad Karamouz, Ali Moridi, and Sara Nazif (Wiley)
6. Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications - Loucks, D. P., Beek, E. V., Stedinger, R. J., Dijkman, J. P.M., and Villars, M. T. (Cambridge University Press)
7. Optimization for Engineering Design - Kalyanmoy Deb (Wiley)
8. Simulation Modeling and Analysis - Averill M. Law (McGraw-Hill Education)
9. Introduction to Operations Research - Frederick S. Hillier and Gerald J. Lieberman (McGraw-Hill Education)
10. Hydrosystems Engineering and Management - Larry W. Mays and Yeou-Koung Tung (Pearson)
11. Principles of Water Resources: History, Development, Management, and Policy - Thomas V. Cech (McGraw-Hill Education)
12. Water Resources Planning and Development - Stedinger, Haith and Loucks (McGraw-Hill Education)
13. Water Resources Systems - Asit K. Biswas (McGraw-Hill Education)
14. Water Resources Systems - Hall and Dracup (McGraw-Hill Education)
15. Water Resources Planning and Development - M.C. Chaturvedi (Wiley)

(b) Open source software and website:

1. NPTEL - Water Resource Systems
   - https://nptel.ac.in/courses/105/105/105105045
2. NPTEL - Optimization Methods for Engineering Design
   - https://nptel.ac.in/courses/112/106/112106134

3. Coursera - Water Resources Management and Policy (University of Geneva)
   - https://www.coursera.org/learn/water-management
4. MIT OpenCourseWare - Water and Wastewater Treatment
   - https://ocw.mit.edu/courses/civil-and-environmental-engineering/
5. edX - Soft Computing for Artificial Intelligence (University of California, Berkeley)
   - https://www.edx.org/course/soft-computing-for-artificial-intelligence
6. GitHub - Open Source Water Resources Optimization and Simulation Tools
   - https://github.com/topics/water-resources
   - HEC-RAS
   - WEAP
   - SWAT
8. FAO - Water Resources and Irrigation
   - http://www.fao.org/land-water/databases-and-software/en/
9. EPANET - Water Distribution Simulation Software (EPA)
   - https://www.epa.gov/water-research/epanet
10. Matlab Resources - Optimization and Simulation Toolboxes
    - https://www.mathworks.com/

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