GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil (Water Resource Engineering)

Subject Code: ME02033071

Subject Name: Hydrological Modeling

w. e. f. Academic Year:	2024-2025
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Basics of hydrology
Rationale:	Hydrologic modeling provides a quantitative framework to study and understand the movement and distribution of water in natural systems, including precipitation, infiltration, runoff, evaporation, and groundwater flow. Hydrologic models are essential tools for effective water resource management, including flood control, drought mitigation, reservoir operation, and irrigation planning. Hydrologic models are widely used for forecasting hydrological events such as floods, droughts, and river flows, providing critical inputs for decision-making. Hydrologic modeling bridges theoretical knowledge with real-world applications, making it indispensable in the study of water resources.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Built basic knowledge of hydrological system and related parameters	R, U
02	Classify forecasting and prediction problems in hydrology	R, U, A
03	Develop a basic knowledge on modelling and simulation of a hydrologic system	R, U
04	Build linkage between hydrological processes	A, N, E
05	Make use of selected hydrological models	A, N, C

**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.	Introduction to Hydrological Modelling: Systems Approach, Linear Models - Deterministic and Probabilistic; Nonlinear Models - Deterministic and Probabilistic. Introduction to Parameters and Variables; Introduction to Calibration of Models (Complexity); Introducing Model Calibration as an Optimization Problem; Introduction to Validation of Models-Different Validation Techniques; Performance Evaluation of Models.	8	20
2.	Watershed Hydrological Models: Introduction to hydrological modelling concepts – Evolution of Rainfall-runoff models; Conceptual and process-based models; Lumped and distributed models; Conceptualizing the interaction between hydrological processes; Data requirement for hydrological models.	8	20
3.	Development of Hydrological Models: Introduction to a conceptual watershed model viz. GR4J, HYMOD, HBV etc.; Introduction to process-based watershed hydrologic models viz. SWAT Model, VIC, etc.	11	20
4.	Sensitivity and Uncertainty Analysis: Simple methods - Linear; Monte Carlo Simulation; Sensitivity Analysis - Sobols' Method; Uncertainty Analysis - Introduction, First Order Uncertainty Analysis, GLUE	8	20
5.	Application of Hydrological Models: Simulation-Optimization Framework - Watershed Management Decisions; Application of Simulation-Optimization Framework - Deficit Irrigation Management; Formulation of Case Examples of Simulation-Optimization Problems	10	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	15	20	20	20	10

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. Applied Hydrology, Chow, V.T., Maidment, D.R., and Mays, L.W., Tata McGraw Hill Edition, 2017 2nd Edition
2. Rainfall-Runoff Modelling: The Primer, Beven, K.J., John Wiley and Sons Ltd., 2006
3. Water Resources Systems Planning and Management – An introduction to methods, models and applications, Loucks, D.P. and Eelco van Beek, UNESCO and Springer, 2017
4. Soil Water Assessment Tool theoretical documentation. Version 2009, Neitsch, S. L., Arnold, J. G., Kiniry, J. R., Williams, J. R., and King, K. W., Texas Water Resource Institute, college station, Texas. TWRI Report, TR-191, 2009
5. Introduction to Hydrology, Viessman, W., and Lewis, G.L., Prentice Hall of India, 2008 5th Edition.

(b) Open source software and website:

1. https://nptel.ac.in/courses/105/101/105101002/

Suggested Course Practical List: If any

List of Laboratory/Learning Resources Required:

1. ArcGIS, QGIS, SWAT (ArcSWAT or QSWAT).
2. MODFLOW, Excel.
3. HEC-HMS, HEC-RAS, SWMM
4. R, Python, MATLAB.

Suggested Project List:

1. Develop a rainfall-runoff model for a given watershed using Excel, HEC-HMS, etc.
2. Simulate streamflow for a river basin using HEC-HMS.
3. Perform a water balance analysis for a catchment area.
4. Model hydrological processes at a watershed scale using SWAT.
5. Simulate flood events and create flood inundation maps.
6. Model urban drainage systems and assess storm water management.
7. Assess the impact of climate change scenarios on hydrological systems.
8. Simulate reservoir inflow and optimize operations for flood control or water supply.
9. Estimate groundwater recharge using hydrological models.
10. Use GIS and remote sensing data for hydrologic modeling.
11. Model sediment transport and deposition in a watershed.

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