NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

Honors in

Water Resource Engineering

SCHEME OF INSTRUCTION AND SYLLABI

(for students of B.Tech., Civil Engineering)

(Effective from 2021-22)

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF INSTRUCTION

Honours Program – Water Resources Engineering

S. No.	Course Code	Name of the Course	L	T	P	Credits	Sem.
1	CE5704	Stochastic Hydrology	3	0	0	3	V
2	CE5751	Water Resources Systems Planning and Management	3	0	0	3	VI
3	CE5752	Groundwater Modelling	3	0	0	3	VI
4	CE5703	Computational Methods in Water Resources Engineering	3	0	0	3	VII
5	CE5714	Land and Water Management	3	0	0	3	VII
6	CE5764	Advanced Hydrologic Modelling	3	0	0	3	VIII
		Total				**18**	

DETAILED SYLLABUS

Honors

Water Resources Engineering

Course Code: CE5704	STOCHASTIC HYDROLOGY	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze hydrologic data
CO2	Perform frequency analysis of hydrologic extremes
CO3	Apply multivariate analysis in hydrologic systems
CO4	Analyze hydrologic time series
CO5	Develop models for synthesis of hydrologic variables

Syllabus:

Deterministic and Stochastic Hydrology, review of concepts of probability, probability axioms, Random variables and their properties, probability distribution and probability density function.

Discrete and continuous probability distributions used in hydrology, moments and expectations of distributions, Parameter estimation, method of moments, maximum likelihood method and method of probability weighted moments.

Hypothesis testing, goodness test of fit tests, Chi Square test and KS test.

Frequency analysis of hydroclimatic extremes, extreme value distributions, analysis of floods, droughts and other natural hazards, Regional flood frequency analysis, Risk and reliability in hydrologic design, Analysis and measures of hydrologic uncertainty.

Correlation analysis and correlation coefficient, Simple linear regression, Multivariate regression analysis, Correlation coefficient and its significance in regional analysis, analysis of variance, applications – rainfall-runoff analysis, rating curves, water quality modelling, Multivariate analysis, principal component analysis, cluster analysis.

Hydrologic Time Series Analysis, Hydrologic time series, stationary and non-stationary time series, Ensemble and realisation, trend analysis, trend removal, analysis of periodicity, Fourier transformation and harmonic analysis, autocorrelation function, spectral density function, Wavelet analysis.

Modelling of Hydrologic Time Series, Time series models, autoregressive and moving average models, periodic models, Calibration and validation of hydrologic time series models, data generation techniques, simulation of hydrologic time series, streamflow forecasting, First order Markov process, Markov chain, Multi-site time series model, cross-correlation, spatial and temporal disaggregation models.

Theory of copula and its use in hydrology, commonly used copula functions, selection of best fit copula, uses of copula.

Learning Resources:

Text Books:

1. Statistical Methods in Hydrology, Haan T. C., East West Publishers, 2002
2. Statistics, Probability and Reliability for Civil and Environmental Engineers, Kotteguda, N.T., and Resso, R., Blackwell Publishing, UK, 2008

Reference Books:

1. Stochastic Water Resources Technology, Kotteguda, N.T., The Macmillan Press, New York, 1982
2. Statistical Methods in Hydrology and Hydroclimatology, Rajib Maity, Springer Nature Singapore Pte Ltd., 2018

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108079/

Course Code: CE5751	WATER RESOURCES SYSTEMS PLANNING AND MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: CE252, CE5704

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply concepts of systems analysis for planning of water resources systems
CO2	Perform basic economic analysis to evaluate the economic feasibility of water resources and environmental engineering projects
CO3	Formulate and solve deterministic optimization models for design and operation of water resources systems
CO4	Formulate and solve stochastic and fuzzy optimization problems for decision making under uncertainty

Syllabus:

Overview of the course, concepts of systems analysis, water resources planning, Modeling techniques, objectives and constraints, overview of optimization techniques.

Linear programming, graphical method, simplex method, sensitivity analysis, duality.

Dynamic programming, concepts, formulation of recursive equation.

Classical optimization techniques, Lagrange methods, Kuhn-Tucker conditions, Search techniques,

Stochastic optimization techniques, chance constrained LP, stochastic dynamic programming, decision making under uncertainty, fuzzy optimization.

Overview of multi objective optimization, multi criteria decision making, Simulation-optimizations.

Overview of Genetic Algorithm and other evolutionary algorithms

Economic analysis, discounting techniques, benefit cost evaluation.

River basin modelling, storage-yield relation, reservoir design and operation.

Overview of applications of optimization and simulation techniques in hydrologic and water resources systems – irrigation management, water quality management, groundwater management, water conveyance and distribution systems.

Learning Resources:

Text Books:

1. Water Resources Systems Planning and Management – An introduction to methods, models and applications, Loucks, D.P. and Eelco van Beek, UNESCO and Springer, 2017
2. Water Resources Systems Modeling Techniques and Analysis, Vedula, S. and Mujumdar, P.P., Tata McGraw Hill Pub. Co., 2005

Reference Books:

1. Water Resources Systems Planning and Analysis, Loucks, D.P., Stedinger, J.R. and Haith, D.A., Prentice Hall Inc., 1982
2. Civil and Environmental Systems Engineering, Charles, S.R., Whitlatch, E.E., and Wright, J.R., Pearson Education Inc., 2004

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108130/

Course Code: CE5752	GROUNDWATER MODELLING	Credits 3-0-0: 3

Pre-requisites: CE252

Course Outcomes: At the end of the course, the student will be able to:

CO1	Assess of groundwater flow and regional groundwater flow modelling
CO2	Identify of groundwater source by groundwater prospecting
CO3	Design water wells
CO4	Manage groundwater resources
CO5	Plan and design artificial recharge systems

Syllabus:

Introduction to Groundwater: Ground water availability, Groundwater in the hydrologic system, Hydrologic budget, Vertical distribution of subsurface strata, Types of aquifers, Aquifer characteristics.

Groundwater Movement: Darcy's law, Hydraulic conductivity and intrinsic permeability, Transmissivity, Homogeneity and isotropy, Stream function, Flownet

Groundwater Flow Hydraulics: Well hydraulics, partial differential equations governing groundwater flow in aquifers estimation of aquifer parameters by different methods, steady groundwater flow analysis for multiwall systems, Well flow near different boundary conditions, Method of images

Groundwater Modelling: Groundwater modelling, formulation of anisotropic and non-homogenous flow of groundwater, finite difference methods for solving groundwater flow problems, regional groundwater flow modelling

Groundwater Prospecting: Geologic method, Remote sensing, Geophysical exploration, Electric resistivity method, Seismic method, Gravity and magnetic methods

Well Logging and Construction: Type of wells, Selection of well site, Well logging, Well construction techniques, Well completion

Groundwater Management: Concept of basin management, Conjunctive use of surface water and groundwater, Groundwater management techniques

Managed Groundwater Recharge: Objective and purpose of MGR, Methods of MGR

Climate Change Impacts on Groundwater: Hydrological components affecting the groundwater, Direct impacts of climate change on groundwater, Indirect impacts of climate change on groundwater, Climate change impacts on water availability in an aquifer

Learning Resources:

Text Books:

1. Groundwater Hydrology: Engineering, Planning and Management, Karamouz, M., Ahmadi, A., and Akhbari, M., CRC Press, Taylor et Francis Group, 2020
2. Groundwater Hydrology, Todd, D. K., and Mays, L. W., John Wiley & Sons, Singapore, 2018
3. Numerical Groundwater Hydrology, Rastogi, A.K., Penram International Publishing Pvt. Ltd., 2012

Reference Books:

1. Hydrogeology, Davis, S. N., and De Weist, R. J. M., John Wiley & Sons, New York, 2013
2. Groundwater Hydrology, Chahar, B. R., McGraw Hill Education (India) Private Limited, New Delhi, 2015

Online Resources:

1. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2002WR001516
2. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/groundwater-management
3. https://www.usgs.gov/mission-areas/water-resources/science/artificial-groundwater-recharge

Course Code: CE5703	COMPUTATIONAL METHODS IN WATER RESOURCES ENGINEERING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply numerical methods for solution of differential equations in Water Resources and Environmental Engineering
CO2	Apply finite difference schemes for solution of hydraulic and hydrologic models
CO3	Apply method of characteristics for hydraulic transients in pipes and channels
CO4	Formulate finite element model for solution of flow through porous media

Syllabus:

Overview of the course, the need for computational and statistical methods, overview of the applications in Civil Engineering in general and Water Resources and Environmental Engineering in particular.

Review of numerical techniques for finding roots of non-linear equations and numerical integration.

Ordinary differential equations, nature of problems, boundary and initial equations, Euler's method, modified Euler's method, Predictor-Corrector methods, Runge-Kutta methods, Boundary value problems, Applications for reservoir routing, gradually varied flow problems, pipe networks

Partial differential equations, classification, nature of problems, Concepts of finite difference method, finite difference schemes, Solution of parabolic equations, pollutant transport, Solution of elliptical equations, solution of Laplace equation and Poisson equation, flow through porous media, Solution of hyperbolic equation, method of characteristics, unsteady flow through open channels, propagation of waves, Concepts of finite volume method.

Basic concepts of Finite Element Method, FEM vs FDM, Element shapes, shape functions, development of shape functions for linear elements, Formulation of FEM for stress analysis problems, flow through porous media, Galerkin's method and Variational method for formulation of stiffness matrix.

Learning Resources:

Text Books:

1. Numerical Methods for Engineers and Scientists, Hoffman, J.D., CRC Press, 2011, Special Indian Edition
2. Statistics, Probability and Reliability for Civil and Environmental Engineers, Kotteguda, N.T. and Renzo Resso, McGraw Hill Companies Inc., New York, 1998
3. Applied Numerical Methods for Engineering, Schilling, R.J., and S.L. Harris, CENGAGE Learning, 2007, India Edition
4. Computational Hydraulics, Abbot, M.A. and Vervey, Elsevier Publications, 1996

Reference Books:

1. The Finite Volume Method in Computational Fluid Dynamics, Moukalled, F., Mangani, L., Darwish, M., Springer International Publishing, 2015.

Online Resources:

1. https://nptel.ac.in/courses/112/105/112105045/

Course Code: CE5714	LAND AND WATER MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Plan irrigation systems and command area development programs
CO2	Evaluate performance of an irrigation system
CO3	Plan measures for reclamation of waterlogged lands
CO4	Develop strategies for conflict management in irrigation projects

Syllabus:

Introduction – Need for proper management of land and water resources.

Planning of irrigation projects – Inadequacies in present approaches in canal irrigation management – command area development programs.

Classification of irrigable soils – soils-plant-water relationships – soil management Irrigation management – Irrigation Management Matrix – Society and irrigation – perceptions of various stake holders on irrigation system performance

Macro and precision irrigation, Diagnostic analysis of irrigation systems – performance indicators for performance evaluation of irrigation projects

Water logging and salinity – water quality for irrigation

Participatory irrigation management – Farmer's management of irrigation system acts - conflict resolution

Legal aspects in water sharing and management – PC-CP - case studies

Learning Resources:

Text Books:

1. Irrigation Water Management, Majumdar, D.K., Prentice Hall of India, New Delhi, 2013, 2nd Ed.
2. Irrigation: Theory and Practice, Michael, A.M., Vikas Publishing House Pvt. Ltd. New Delhi, 2009

Reference Books:

1. Land and Water Management Engineering, Murthy, V.V.N., Kalyani Publishers, Ludhiana, 2011
2. Soil and Water Management Systems, Scwabe, G.O., Fangmeir, D.D., and Elliot W.J., John Wiley and Sons, N York, 1996

Online Resources:

1. https://www.iima.ac.in/c/document_library/4ParticipatoryIrrigation8f9a.pdf?uuid=a5eced82-3f75-4068-9aa1-57aef9de0876&groupId=62390
2. https://www.iwapublishing.com/news/integrated-water-resources-management-basic-concepts
3. https://www.indiawaterportal.org/articles/introduction-integrated-water-resource-management-iwrm-open-courseware-united-nations

Course Code: CE5764	ADVANCED HYDROLOGIC MODELLING	Credits 3-0-0: 3

Pre-requisites: CE252

Course Outcomes: At the end of the course, the student will be able to:

CO1	Classify forecasting and prediction problems in hydrology
CO2	Develop a basic knowledge on modelling and simulation of a hydrologic system
CO3	Build linkage among hydrological process
CO4	Make use of selected hydrological models

Syllabus:

Introduction to Hydrologic 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.

Watershed Hydrological Models: Introduction to hydrological modelling concepts – Evolution of Rainfall-runoff models; Difference between conceptual and process-based models; Difference between lumped and distributed models; Conceptualizing the interaction between hydrological processes; Data requirement for hydrological models.

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.;

Sensitivity and Uncertainty Analysis: Simple methods - Linear; Monte Carlo Simulation; Sensitivity Analysis - Sobols' Method; Uncertainty Analysis - Introduction, First Order Uncertainty Analysis, GLUE

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

Learning Resources:

Text Books:

1. Rainfall-Runoff Modelling: The Primer, Beven, K.J., John Wiley and Sons Ltd., 2006
2. Applied Hydrology, Chow, V.T., Maidment, D.R., and Mays, L.W., Tata McGraw Hill Edition, 2010 2nd Edition
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

Reference Books:

1. 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
2. Introduction to Hydrology, Viessman, W., and Lewis, G.L., Prentice Hall of India, 2008 5th Edition

Online Resources:

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