MAULANA AZAD

NATIONAL INSTITUTE OF TECHNOLOGY, BHOPAL – 462003

M.Tech in Water Resource Engineering and Management

PROPOSED SCHEME M.Tech (w.e.f. July 2024)

First Semester:

Course No.	**Subject**	**Schemes of studies periods per week**			**Total Credits**
		L	T	P	
WR24 511	Applied Hydrology	3	-	-	3
WR24 512	Computational Techniques in Water Resources	3	-	-	3
WR24 513	Advanced Hydraulics	3	-	-	3
	Program Elective - 1	3	-	-	3
	Program Elective - 2	3	-	-	3
WR24 514	Lab-I: Hydraulics Laboratory	-	-	2	1
WR24 515	Lab-II: Computational Laboratory I	-	-	2	1
WR24 516	Seminar-I	-	-	2	1
WR23 517	Minor Project-1 (Self Learning)				2
HUM 511	Communications Skill	-			-
Total Hours: 23 **Total Credits: 20**		**Total Semester Credits**			**20**

Second Semester:

Course No.	**Subject**	**Schemes of studies periods per week**			**Total Credits**
		L	T	P	
WR24 521	Water Resources Systems Planning and Management	3	-	-	3
WR24 522	Integrated Watershed Management	3	-	-	3
	Program Elective – 3	3	-	-	3
	Program Elective - 4	3	-	-	3
	Open Elective	3	-	-	3
WR24 523	Lab-I: Hydrology Laboratory	-	-	2	1
WR24 524	Lab-II: Computational Laboratory II	-	-	2	1
WR24 525	Seminar-II	-	-	2	1
WR24 526	Minor Project-2 (Self Learning)				2
Total Hours: 23+2 (Minor Project) **Total Credits: 40**		**Total Semester Credits**			**20**

*WR24 575 Research Methodology proposed to be included in Elective

Third Semester:

Course No.	Subject	Schemes of studies periods per week			Total Credits
		L	T	P	
WR24 611	Dissertation Phase-I	-	-	40	20
Total Hours: 40 **Total Credits: 60**		**Total Semester Credits**			**20**

Fourth Semester:

Course No.	Subject	Schemes of studies periods per week			Total Credits
		L	T	P	
WR24 621	Dissertation Phase-II	-	-	40	20
Total Hours: 40 **Total Credits: 80**		**Total Semester Credits**			**20**

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M.Tech in Water Resource Engineering and Management

List of Program Electives		List of Open Electives	
WR24 551	Stochastic Hydrology	ARP 581	Introduction to Urban Planning
WR24 552	Disaster Management	BSE 581	Bioprocess Engineering
WR24 553	Urban Water Management	BSE 582	Biophysics Tools and Techniques
WR24 554	Water Conveyance System Development and Operation	CHE 581	Analytical Techniques
WR24 555	Design of Hydraulic Structures	CHE 582	Green Technology & Processes
WR24 556	Irrigation Management for Sustainable Development	CSE 581	Machine Learning
WR24 557	Reservoir Planning and Management	CSE 582	Advanced Data Structures and Algorithms
WR24 558	AI/ML Based Applications in Civil Engineering	PHY 581	Nanotechnology and Nanoscience
WR24 559	Introduction to Flow and Transport in Porous Media	EE 581	Electric Machines & Applications
WR24 560	River Engineering	EE 582	Control and Instrumentation
WR24 561	Hydropower Engineering	ECE 581	Introduction to Fuzzy Logic
WR24 562	Environmental Impact Assessment of Water Resources Projects	ECE 582	Neural Networks and its Applications
WR24 563	Flood Estimation and Control	EC 581	Energy Resource Technologies
WR24 564	Advanced Hydrological Modelling	HUM 581	Intellectual Property Rights for Engineers
WR24 565	Impact of Climate Change on Water Resources	HUM 582	Applied Psychology: Human Centered Design and Engineering
WR24 566	Dam Engineering	MTH 581	Advanced Operations Research
WR24 567	Ecohydroclimatology	MTH 582	Computing Technologies
WR24 568	Groundwater Engineering and Management	ME 581	Value Engineering
WR24 569	Optimization Methods	ME 582	Design Thinking
WR24 570	Hydraulics of Sediment Transport	ME 583	Mechatronics and NDT in

			Engineering
WR24 571	Computational Fluid Dynamics	MME 581	Advanced Instrumentation Methods for Material Analysis
WR24 572	Coastal Engineering	MME 582	Smart Materials and their Application
WR24 573	Environmental Hydraulics	MBA 581	Engineering Startup Management
WR24 575	Research Methodology		

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st	**Year:** 1st

Name of Course	Applied Hydrology
Course Code	WR24 511
Core / Elective / Other	Core
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*	
1.	Understand the relationships between the atmospheric parameters such as temperature, humidity, vapour pressure, precipitation etc.
2.	Predict hydrologic extreme events for hydraulic and hydrologic design
3.	Develop forecasting models for operation of hydrologic systems
4.	Assess surface water resources
Description of Contents in brief:	
1.	Analyse components of hydrologic cycle, types and forms of precipitation and its measurement
2.	Stream flow measurements
3.	Hydrograph Theory
4.	Flood Estimation and Flood Routing
5.	Apply the continuum approach to solve groundwater hydrology and hydraulics related problems
List of Text Books:	
1.	Applied Hydrology, Chow, V.T., Maidment, D.R., and Mays, L.W., Tata McGraw Hill Edition, 2017 2nd Edition
2.	Engineering Hydrology, Subramanya, K., Tata McGraw Hill Publications, 2017 4th Edition
3.	Hydrologic Analysis and Design, McCuen, R.H., Pearson Publications, 2017 4th Edition
List of Reference Books:	
1.	Introduction to Hydrology, Viessman, W., and Lewis, G.L., Prentice Hall of India, 2008 5th Edition
2.	Water Resources Engineering, Mays, L.W., Wiley Publications, 2019 3rd Edition

Lecture Plan:

Lecture No.	Topic
1-4	Introduction: Description of Hydrologic Cycle, Overview of application of hydrology in engineering, Historical aspects of development of hydrology, Eco-hydrology
5-7	Precipitation: Characteristics of precipitation in India, Measurement of precipitation, rain gauge network, collection and presentation of rainfall data, analysis of rainfall data
8-10	Intensity duration-frequency analysis and depth-area-duration analysis, development of design storms for typical regions in data scarce environment
11-14	Abstractions from Precipitations: Evaporation and Evaporation Process, measurement, estimation and control of evaporation, Evapotranspiration,

	measurement and estimation of evapotranspiration, Infiltration
15-20	Stream flow Measurement: Streamflow measurement, stage-discharge relationship and rating curve, Runoff characteristics, catchment characteristics affecting the runoff, yield from a catchment, flow duration curve and flow mass curve
21-23	Hydrograph Theory: Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph
24-26	S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models - synthetic unit hydrograph and its derivation
27-32	Flood Estimation: Peak discharge estimation procedures, deterministic and probabilistic approaches, enveloping curve, rational method, SCS and unit hydrograph methods, Design flood, return period, flood frequency analysis, probabilistic and statistical concepts, and time series analysis, Gumbel's and log Pearson Type III methods
33-36	Flood Routing: Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, Muskingum and Muskingum-Cunge methods of channel routing and flood forecasting
37-40	The continuum approach to transport in subsurface hydrology; Darcy's law and its generalization; flow through saturated and unsaturated porous formations; well hydraulics, analysis of pumping test data, groundwater recharge, water logging, and salinity; modeling contaminant transport through porous media: dispersion, adsorption, and decay, volatilization

Name of Program	M. Tech. Water Resource Engineering and Management	**Semester:** 1st	**Year:** 1st

Name of Course	Computational Techniques in Water Resources
Course Code	WR24 512
Core / Elective / Other	Core
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Apply numerical methods for solution of differential equations in Water Resources and Environmental Engineering
2.	Apply finite difference schemes for solution of hydraulic and hydrologic models
3.	Apply method of characteristics for hydraulic transients in pipes and channels
4.	Formulate finite element model for solution of flow through porous media.

Description of Contents in brief:

1.	Need for computational and statistical methods
2.	Ordinary Differential Equations
3.	Partial Differential Equations
4.	Basic concepts of Finite Element Method

List of Text Books:

1.	Numerical Methods for Engineers and Scientists, Hoffman, J.D., CRC Press, Special Indian Edition, 2011
2.	Statistics, Probability and Reliability for Civil and Environmental Engineers, Kotteguda, N.T. and Renzo Resso, McGraw Hill Companies Inc., New York, 1998

List of Reference Books:

1.	Applied Numerical Methods for Engineering, Schilling, R.J., and S.L. Harris, CENGAGE Learning, India Edition, 2007
2.	Computational Hydraulics, Abbot, M.A. and Vervey, Elsevier Publications, 1996.

Lecture Plan:

Lecture No.	Topic
1-5	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.
6-10	Review of numerical techniques for finding roots of non-linear equations and numerical integration.
11-15	Ordinary differential equations, nature of problems, boundary and initial equations, Euler's method, modified Euler's method, Predictor-Corrector methods.
16-20	Runge-Kutta methods, Boundary value problems, Applications for reservoir routing, gradually varied flow problems, pipe networks.
21-25	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.
26-30	Flow through porous media, Solution of hyperbolic equation, method of

	characteristics, unsteady flow through open channels, propagation of waves, Concepts of finite volume method.
31-35	Basic concepts of Finite Element Method, FEM vs FDM, Element shapes, shape functions.
36-40	Development of shape functions for linear elements. Finite Volume Method, Boundary Element Method

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st	**Year:** 1st

Name of Course	Advanced Hydraulics
Course Code	WR24 513
Core / Elective / Other	Core
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Describe the use and importance of tensor mechanics in fluid flows.
2.	Critique the flows of open channels according to the conditions of the flows
3.	Derive the conservation laws governing the flow of fluid in various conditions
4.	Apply knowledge of integrated mass continuity and energy/ momentum equations to pipe and open channel systems

Description of Contents in brief:

1.	Basics of Tensor Mechanics
2.	Conservation Laws
3.	Fluid Flows and Applications
4.	Open Channel Hydraulics-1
5.	Open Channel Hydraulics-2

List of Text Books:

1.	Ligett, J. A., Fluid Mechanics, McGraw-Hill International Editions, 1994
2.	Batchelor, G. K., An Introduction to Fluid Mechanics, Cambridge University Press, London, 2005.

List of Reference Books:

1.	Chatterjee, R., Mathematical Theory of Continuum Mechanics, Narosa Publishing House, 1999.
2.	Chaudhry, M. H., Open Channel Flow, Prentice Hall of India, 1998.

Lecture Plan:

Lecture No.	Topic
1-4	Basics of Tensor Mechanics: Introduction to cartesian tensors and tensor operations, spatial (Eulerian) and material (Lagrangian).
5-7	Description of motion of deformable bodies, Circulation, rotation and vorticity, strain rate tensor, time rate of change of volume and line integrals.
8-10	Conservation Laws: Reynolds Transport Theorem (RTT), Stress tensor, continuity and equilibrium equations.
11-14	Constitutive equations, derivation of Navier-Stokes equation and its applications, derivation of energy equations
15-20	Fluid Flows and Applications: Introduction to laminar flow, Blasius equation, Karman momentum equation.
21-23	Description of turbulent flow, Kevin-Helmoltz instability, mean flow equations, Prandtl's mixing length, turbulent Poiseuille flow, jets and wakes.
24-26	Open Channel Hydraulics-1: Uniform flow, critical flow and GVF for compound

	channels.
27-32	GVF flow profiles for channel slope transitions, Saint Venant's Equations for open channels, Spatially Varied Flow.
33-36	Open Channel Hydraulics-2: Rapidly varied flow in prismatic and non-prismatic open channels.
37-40	Channel design for erodible and non-erodible open channels, silt theories and river mechanics.

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st or 2nd	**Year:** 1st

Name of Course	Water Resources Systems Planning and Management
Course Code	WR24 521
Core / Elective / Other	Core
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	To understand the aspects of water resources planning, management, linear and dynamic programming
2.	To achieve programming skills related to water resource planning

Description of Contents in brief:

1.	Introduction: Concepts of systems analysis
2.	Linear programming
3.	Dynamic programming
4.	Non-linear optimization techniques
5.	Water–resources economics

List of Text Books:

1.	Operations Research ", S. D. Sharma KedarNath Ram Nath& Co.
2.	"Engineering Optimization – Theory and Practice" S. S. Rao New Age International limited, Publishers

List of Reference Books:

1.	Water Resources System Analysis – Vedula& Mujumdar – Tata McGraw Hill Company Ltd. 2005
2.	Water Resources Economics - James & Lee. Oxford Publishers 2005.

Lecture Plan:

Lecture No.	Topic
1-5	Introduction: Concepts of systems analysis, definition, systems approach to water resources planning and management.
6-10	Role of optimization models, objective function and constraints, types of optimization techniques.
11-15	Linear programming: Formulation linear programming models, graphical method, simplex method.
16-20	Application of Linear programming in water resources, Revised simplex method, duality in linear programming.
21-25	Dynamic programming: Belman's of principles of optimality forward and backward recursive dynamic programming.
26-30	Case of dimensionality, application of dynamic programming for resource allocation.
31-35	Non-linear optimization techniques: Classical method of optimization, Kuch-Tucker, gradient based research techniques for simple unconstrained optimization.
36-40	Water–resources economics: Principles of Economics analysis, benefit cost analysis, socio economic intuitional and pricing of water resources

Name of Program	M.Tech. Water Resource Engineering and Management	Semester: 2nd	Year: 1st

Name of Course	Integrated Watershed Management
Course Code	WR24 522
Core / Elective / Other	Core
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Understand the principles of watershed management.
2.	Apply the modern modelling techniques to watershed management.
3.	Use the basics of remote sensing techniques to identify the water resources and classify the water bodies.
4.	Use of GIS in water resources with some major case studies.

Description of Contents in brief:

1.	Principles of Watershed Management
2.	River basins Watershed Management Practices in Arid and Semi-arid Regions
3.	Conservation of Water
4.	Water Harvesting
5.	Remote sensing

List of Text Books:

1.	Heathcote, I. W. Integrated Watershed Management: Principles and Practice. 2nd Edition, Wiley Inc. 2009.
2.	Murty, J.V.S., Watershed Management, New Age Intl., New Delhi 1998

List of Reference Books:

1.	Tideman, E.M., Watershed Management – Guidelines for Indian Conditions, Omega Scientific Publishers, New Delhi, 1996
2.	American Society of Civil Engineers, Watershed Management, American Soc. of Civil Engineers, New York, 1975

Lecture Plan:

Lecture No.	Topic
1-4	Principles of Watershed Management: Basics concepts, Hydrology and water availability, Surface water
5-7	Groundwater, Conjunctive use, Human influences in the water resources system, Water demand, Integrated water resources system
8-10	River basins Watershed Management Practices in Arid and Semi-arid Regions, Watershed management through wells
11-12	Management of water supply - Case studies, short term and long-term strategic planning.
13-18	Conservation of Water: Perspective on recycle and reuse, Waste water reclamation Social Aspects of Watershed Management: Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations
19-23	Case studies Sustainable Watershed Approach: Sustainable integrated watershed

	management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation.
24-26	Water Harvesting: Rainwater management - conservation, storage and effective utilisation of rainwater, Structures for rainwater harvesting, roof catchment system, check dams, aquifer storage
27-32	Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management.
33-36	Remote sensing: fundamentals – physics of remote sensing – electromagnetic radiation, interaction of ENR with atmosphere, earth surface, soils, water and vegetation.
37-40	Data acquisition, photographic system and imaging systems, single vertical photographs, visible and near infrared imagery, photo interpretation, visual analysis

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st or 2nd	**Year:** 1st

Name of Course	Stochastic Hydrology
Course Code	WR24 551
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*	
1.	Analyse hydrologic data and perform frequency analysis of hydrologic extremes
2.	Apply multivariate analysis in hydrologic systems
3.	Analyse hydrologic time series
4.	Develop models for the synthesis of hydrologic variables.

Description of Contents in brief:	
1.	Deterministic and Stochastic Hydrology
2.	Discrete and continuous probability distributions used in hydrology
3.	Frequency analysis of extreme events
4.	Analysis and Modelling of Hydrologic Time Series
5.	Theory of copula and its use in hydrology

List of 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.

List of 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.

Lecture Plan:

Lecture No.	**Topic**
1-4	Deterministic and Stochastic Hydrology, review of concepts of probability, probability axioms, Random variables and their properties, probability distribution and probability density function.
5-8	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.
9-12	Hypothesis testing, goodness test of fit tests, Chi Square test and KS test. Frequency analysis of hydroclimatic extremes, extreme value distributions
13-16	Analysis of floods, droughts and other natural hazards, regional flood frequency analysis, Risk and reliability in hydrologic design, Analysis and measures of hydrologic uncertainty
17-20	Correlation analysis and correlation coefficient, Simple linear regression, Multivariate regression analysis, Correlation coefficient and its significance in regional analysis.

21-24	Analysis of variance, applications – rainfall-runoff analysis, rating curves, water quality modelling, Multivariate analysis, principal component analysis, cluster analysis.
25-27	Hydrologic Time Series Analysis, Hydrologic time series, stationary and non-stationary time series, Ensemble and realisation, trend analysis, trend removal.
28-31	Analysis of periodicity, Fourier transformation and harmonic analysis, autocorrelation function, spectral density function, Wavelet analysis.
32-34	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
35-38	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
39-40	Theory of copula and its use in hydrology, commonly used copula functions, selection of best fit copula, uses of copula

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st or 2nd	**Year:** 1st

Name of Course	Disaster Management
Course Code	WR24 552
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Assess the hazards and risks involved in various types of disaster.
2.	Apply ICT and geoinformatics in disaster management.
3.	Apply disaster mitigation strategies following the national initiatives and framework.

Description of Contents in brief:

1.	Disaster, Hazard, Vulnerability, Resilience, Risks
2.	Impacts of disaster
3.	Disaster management cycle and its components
4.	Components of disaster relief

List of Text Books:

1.	S. R. Sharma, Disaster Management, A P H Publishers, 2011
2.	S. S. Nair, Training Manual on Geoinformatics Applications in Disaster Management, NIDM, 2012

List of Reference Books:

1.	J. P. Singhal, Disaster Management, Laxmi Publications, 2010
2.	K. V. Rao, Geoinformatics for Disaster Management, Manglam Publishers and Distributors, 2010

Lecture Plan:

Lecture No.	Topic
1-5	Disaster, Hazard, Vulnerability, Resilience, Risks. Natural disasters - hydro-meteorological disasters such as flood, flash flood, cloud burst, drought, cyclone, forest fires etc; geological disasters like earthquake, tsunami, landslides, volcanic eruption.
6-10	Man made disasters - chemical industrial hazards, major power break downs, traffic accidents, fire hazards, biological hazards, nuclear accidents. Environmental hazards - forest hazards (deforestation, degradation and forest fire), land and soil degradation, desertification and pollution (water, air and soil).
10-15	Disasters and national losses. Historical perspective of disasters in India and the Indian sub-continent. Recent major disasters. Disaster management cycle and its components. Earthquake, Landslide, Flood, Drought, Fire etc - classification, causes, impacts including social, economic, political, environmental, health, psychosocial, etc.-
16-20	Differential impacts - in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Global warming and climate change, Adaptation. Dos and don'ts during various types of disasters.

21-24	Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, structural and non-structural measures, roles and responsibilities of the community, Panchayati Raj institutions/ Urban Local Bodies, States, Centre, and other stakeholders including NGOs.
25-28	Institutional processes and framework at State and Central Level – National and State Disaster Management Authorities. Prediction and early warning systems.
29-33	Role of information, education, communication, and training, geoinformatics and IT in disaster preparedness, risk assessment, response, recovery, and management. Role of engineers on disaster management.
34-37	Components of disaster relief - water, food, sanitation, shelter, health, waste management, Institutional arrangements for mitigation, response and preparedness, Legislation in India on Disaster Management. National disaster management policy.
38-40	Other related policies, plans, programmes and legislation relevant to/ pertaining to disaster management. Disaster damage assessment. Disaster mitigation. Existing organizational structure for managing disasters in India. Case studies.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st
Name of Course	Urban Water Management		
Course Code	WR24 553		
Core / Elective / Other	Elective		
Prerequisites	-Nil-		

Course Outcomes: *Students will be able to*	
1.	Identify factors affecting the urban hydrological cycle
2.	Estimate urban water demand and urban stormwater quantity
3.	Plan and design stormwater control and disposal systems
4.	Develop an integrated urban water management system
Description of Contents in brief:	
1.	Urbanization and its effects on hydrology, estimation and design of urban drainage system
2.	The master plan of urban drainage, water resources investigation in urban planning, and use of models in planning
3.	Approaches towards urban drainage and various elements of drainage systems
4.	Stormwater analysis, management practices for urban drainage, and models available for stormwater management.
List of Text Books:	
1.	Storm Water Detention for Drainage, water quality and CSO Management, Stahre, P. and Urbonas, B., Prentice Hall, 1990.
2.	Urban Hydrology, Hall, M.J., Elsevier, 1984.
List of Reference Books:	
1.	Manual on Storm Water Drainage Systems, Central Public Health and Environmental Engineering Organization, MOHUA, 2019
URL	
1.	https://archive.nptel.ac.in/courses/124/105/124105158/

Lecture Plan:

Lecture No.	Topic
1-4	General introduction to urbanization and its effect on the water cycle, urban hydrological cycle trends in urbanization, the effect of urbanization on hydrology, and concept of a smart city.
5-10	Time of concentration, the importance of short duration of rainfall, runoff data, methods of estimation of time of concentration for the design of urban drainage systems.
11-14	Master drainage plans, typical content of an urban drainage master plan.
15-18	Interrelation between water resources investigation and urban planning processes planning objectives, comprehensive planning, use of models in planning
19-22	Basic approaches to urban drainage, runoff quantity and quality, wastewater and stormwater reuse.

23-28	Major and minor drainage systems, elements of drainage systems, open channel, underground drains, appurtenances, pumping, and source control.
29-34	Stormwater analysis, calculation of runoff and peak, design of stormwater network systems, performance evaluation of urban drainage systems, best management practices, detention and retention facilities, and Swales-constructed wetlands.
35-40	Operation and maintenance of urban drainage system, interaction between stormwater management and solid waste management, various models available for stormwater management, and legal aspects.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st

Name of Course	Water Conveyance System Development and Operation
Course Code	WR24 554
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Determine the different conditions of water demand according to the areas ofurbanization
2.	Analyse the basis of water distribution networks and determine the different treatment methods
3.	Evaluate the cases of transients in water distribution systems and remediations to control the transients
4.	Validate the different wastewater collection systems and design the collection systems
5.	Examine the water quality using traditional and modern methods of testing

Description of Contents in brief:

1.	Introduction to water supply systems,
2.	Basics and design of water distribution networks, conservation of mass and momentum in water pipelines.
3.	The solution to hydraulic transients using the method of characteristics, reduction of hydraulic transients using air valves, surge tanks, etc.
4.	Design of combined storm and sewer drainage,

List of Text Books:

1.	Chaudhry, H., Applied hydraulic transients, Van Nostrand Reinhold, New York, 1987.
2.	Streeter, V.L. and Wylie, E.B., Hydraulic Transients, McGraw Hill, New York, 1967

List of Reference Books:

1.	Chaudhry, H., Hydraulic Transients, Tata McGraw Hill, 1998.
2.	McGhee, T. J., Water Supply and Sewerage, McGraw Hill International, 1991.

URL

1.	https://archive.nptel.ac.in/courses/105/105/105105201/

Lecture Plan:

Lecture No.	Topic
1-4	Components of water supply systems, water use and demand estimation, design period, population data, and flow rates for water supply systems.
5-10	Factors affecting water consumption and variation in demand, basic methods of designing water distribution networks, and effects of hydraulic transients in the design of pipelines.
11-14	Equations of unsteady flow in pipes, method of characteristics, solution procedure to solve equation of hydraulic transients using the finite difference method.
15-18	Transient cases of sudden closure of valves, pump failures, and initialization of pumps, methods of analysis for optimal distribution network design.

19-24	Air valves, pressure relief valves, and surge tanks and their optimal locations, types of reservoirs and design parameters and methods, and design of water pumping stations.
25-28	Design principles, separate, combined, and semi-combined sewers, estimation of dry weather flows.
29-33	Sewer pipe hydraulics: sizing of pipes and design, manhole chambers, and stormwater overflows
34-37	Maintenance of water supply and wastewater systems: Cleaning of water towers (Overhead Tanks), Pumping stations, screens and inverted screens,
38-40	Regular maintenance of manholes, Regular checks of leakages from sewer lines, monitoring wells near the potential source locations

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st

Name of Course	Design of Hydraulic Structures
Course Code	WR24 555
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Analyse and design earth and rockfill dams
2.	Analyse and design gravity dams
3.	Design spillways and energy dissipation structures.
4.	Explain the principles of hydraulic modelling.

Description of Contents in brief:

1.	Hydraulic structures for water resources projects and structures on permeable foundations.
2.	Design of embankment dams, gravity dams, outlets, and diversion headworks.
3.	Terminal structures and introduction to hydraulic modelling.

List of Text Books:

1.	Irrigation, Water Power and Hydropower Engineering, Arora K. R., Standard Book Publishing, New Delhi, 5th Edition, 2018.
2.	Irrigation Water Resources and Hydropower Engineering, Modi, P. M., Standard Book Publishing Company, New Delhi, 9th Edition, 2014.

List of Reference Books:

1.	Hydraulic Structures, Novak, P. and Nalluri, C., Taylor & Francis. 2007Edition 4.
2.	Irrigation and Water Resources Engineering, Asawa G.L., New Age International Publishers, New Delhi, 2006.

URL

1.	https://archive.nptel.ac.in/courses/105/105/105105110/
2.	https://archive.nptel.ac.in/courses/112/103/112103249/

Lecture Plan:

Lecture No.	**Topic**
1-6	Introduction: Hydraulic structures for water resources projects. Types of hydraulic structures include storage, diversion, conveyance, distribution structures, reservoir capacity, and reservoir silting.
7-12	Hydraulic structures on permeable foundations, seepage theories, Khosla's theory, design of diversion headworks, and other structures on permeable foundations
13-18	Embankment Dams: Types, design considerations, seepage and control, stability analysis, construction techniques.
19-24	Gravity Dams: Forces acting on the failure of a gravity dam, stress analysis, elementary profile, design of gravity dam, and other functional features.
25-30	Dam Outlet Works: Types of outlet structures, ogee spillway, chute spillway, siphon spillway, side channel spillway, Labyrinth, and Piano-key weir.
31-35	Terminal Structures: Hydraulic jump types, stilling basin, roller bucket, ski jump basin, baffled spillway, drop structure
36-40	Hydraulic Modelling: Basic principles, dimensional analysis, modelling free-surface flows, design of physical models.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st

Name of Course	Irrigation Management for Sustainable Development
Course Code	WR24 556
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Know of basic concepts of irrigation and estimation of crop water requirement.
2.	Design and evaluate water application methods.
3.	Design efficient drainage and management of drainage water and salt affected land.
4.	Manage surface and groundwater for sustainable development.

Description of Contents in brief:

1.	Introduction to irrigation, national water policy, and farm irrigation methods.
2.	Design of pressurized, sprinkler, and drip irrigation methods.
3.	Drainage water, surface drainage, quality of irrigation water, integrated water resources management.

List of Text Books:

1.	Modi P. N. Irrigation Water Resources and Water Power Engineering, StandardBook House.
2.	Michael A. M. Irrigation Theory and Practice, Vikas Publishing House.
3.	Peter Waller, Muluneh Yitayew. Irrigation and Drainage Engineering, Springer.

List of Reference Books:

1.	Drainage Manual, National Institute of Hydrology, Roorkee.
2.	Richard H. Irrigation system design – An Engineering Approach Cuenca, Prentice Hall.

URL

1.	https://archive.nptel.ac.in/content/storage2/courses/105101010/
2.	https://archive.nptel.ac.in/courses/126/105/126105010/

Lecture Plan:

Lecture No.	Topic
1-8	Introduction of Irrigation, inter-basin water transfer, national water policy, water. Requirements of crops, crop evapotranspiration, irrigation scheduling, and irrigation efficiencies
9-18	On-farm irrigation management by surface irrigation methods, basin, border, and furrow methods. On-farm irrigation management by pressurized irrigation systems, hydraulics of pressurized irrigation systems.
19-24	Design and evaluation of sprinkler and drip irrigation systems.
25-34	Drainage water management, surface drainage, and subsurface drainage, water logging, effect, causes and preventive measures, drainage water use, salt-affected soil, and salinity control
35-40	Conjunctive use of surface and groundwater, integrated water resources management (IWRM) for sustainable development

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st/ 2nd	**Year:** 1st

Name of Course	Reservoir Planning and Management
Course Code	WR24 557
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Develop skills in software usage for simulation and water resources management
2.	Understand the application of the latest information technology to water resources engineering
3.	Generate simulation models and use the latest intelligent technology and algorithms

Description of Contents in brief:

1.	Introduction to various methodologies for planning and operation of reservoirs
2.	Reservoir capacity estimation
3.	Basic Probability theory, chance-constrained linear programming, concept of reliability, stochastic dynamic programming
4.	Artificial neural networks, fuzzy inference systems; fuzzy linear programming, genetic algorithms, particle swarm optimization
5.	Model formulation and case studies on planning and operation of reservoirs

List of Text Books:

1.	Loucks, D.P. and Ellco Van Beek (2005) Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications, UNESCO, Netherlands

List of Reference Books:

1.	Vedula, S. and Mujumdar, P.P. (2005) Water Resources Systems: Modeling Techniques and Analysis; Tata McGraw Hill, New Delhi
2.	Simonovic, S.P. (2009) Managing Water Resources: Methods and Tools for a System Approach, UNESCO Publishing, France

URL

1.	https://archive.nptel.ac.in/courses/105/108/105108081/

Lecture Plan:

Lecture No.	**Topic**
1-2	Introduction to reservoir system, various methodologies for reservoir planning
3-7	Single objective reservoir planning, multi-objective reservoir planning, economic considerations in water resources planning
8-14	Deterministic Inflows, reservoir sizing, reservoir capacity using linear programming, reservoir operations, standard operating policies, optimal operating policies, multi-reservoir systems policies
15-22	Random inflow, basic probability theory, chance-constrained linear programming, concept of reliability, stochastic dynamic programming
23-32	Artificial neural networks, fuzzy inference systems; fuzzy linear programming, genetic algorithm, particle swarm optimization
33-40	Model formulation and case studies: Reservoir systems operated for irrigation,

	hydropower, flood control, municipal and industrial supplies, water quality control in river systems, conjunctive use of ground and surface water, and crop yield optimization

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st/ 2nd	**Year:** 1st

Name of Course	AI/ML-Based Applications in Civil Engineering
Course Code	WR24 558
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*	
1.	Comprehend the basic principles of artificial intelligence (AI) and machine learning (ML) algorithms.
2.	Understanding Data collection & management tools & techniques for AI/ML application to Civil Engineering.
3.	Derive the need and benefits of using AI/ML algorithms for developing applications in Civil Engineering using big-data analysis.
4.	Solve the real-life problems in Civil Engineering using real-time data collection and big-data analysis involving AI/ML tools.
5.	Evaluate the performance of different AI/ML algorithms towards a given application in civil engineering.
Description of Contents in brief:	
1.	Introduction to machine learning, big data, taxonomy of machine learning, supervised learning, regression, and clustering algorithms.
2.	Data Collection Apparatuses, cloud storage and computing, and introduction to python.
3.	Applications of machine learning algorithms in civil engineering.
List of Text Books:	
1.	Machine Learning using Python, by Manaranjan Pradhan, U Dinesh Kumar, Wiley.
2.	A Primer on Machine Learning Applications in Civil Engineering, by Deka P C, Taylor & Francis.
3.	Structural Health Monitoring: A Machine Learning Perspective, by Charles R. Farrar, Keith Worden, Wiley.
List of Reference Books:	
1.	Building Blocks for IoT Analytics, By John Soldatos, Athens Information Technology, Greece, River Publishers.
2.	Django - The Easy Way (2nd Edition), By Samuli Natri
URL	
1.	https://onlinecourses.nptel.ac.in/noc19_cs82/preview

Lecture Plan:

Lecture No.	Topic
1-5	Introduction to Machine Learning: Machine Learning Basics: Data Collection, Data Management, Big data, taxonomy of machine learning algorithms.
6-10	Supervised Learning: Classification – Bayesian Classifier, K-nearest Neighbours, Regression- Linear Regression, Multivariate Regression, Logistic regression.
11-15	Support Vector Machine (SVM), Algorithm. Unsupervised Learning: Clustering- K-means clustering algorithm and, Hierarchical clustering algorithm. Reinforcement Learning: Q-Learning algorithm.

16-20	Data Collection Apparatuses: Type of data sources, Types of data, Types of sensors, Edge-devices, Introduction to microcontrollers, data communication protocols.
21-25	Cloud storage and cloud computing, Local server setup, Cloud server setup, Introduction to Python, Introduction to Django server, Database setup.
26-30	Applications in Civil Engineering: Intelligent Transportation systems, smart mobility, shared mobility, Mobility as a Service (MaaS), Real-time data monitoring, Structural health monitoring.
31-35	Fire resistance evaluation of structures, automation in water resource management, Water quality monitoring, water distribution system monitoring, air and noise pollution monitoring.
36-40	Rainfall-runoff modelling, Climate change monitoring, Soil liquefaction, Forecasting foundation related parameters, Building occupancy modelling, Building information modelling, Energy demand prediction, Predictive maintenance of equipment, roads and buildings.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st

Name of Course	Introduction to Flow and Transport in Porous Media
Course Code	WR24 559
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Understand the basic operations of tensors and their applications in water resources.
2.	Derive the fundamental continuity and momentum equations through the Reynolds transport theorem.
3.	Characterize the pore networks and upscale the parameters to a continuum scale.
4.	Understand the basics of modelling of groundwater flow and transport in porous media.

Description of Contents in brief:

1.	Introduction to cartesian tensors, operations, RTT, stress tensor, and derivation of equilibrium, and constitutive equations.
2.	Representative elementary volume, pore networks, introduction to transport in porous media, and derivation of contaminant transport equations.
3.	Pollution sources, simulation-optimization modelling for identification and management.

List of Text Books/ Reference Books:

1.	Bear, J., Dynamics of Fluids in Porous Media, Dover Publications, 1972.
2.	D. Stauffer, and A. Aharony, Introduction to Percolation Theory, Taylor and Francis, London, 1992.
3.	M. Sahimi, Applications of Percolation Theory, Taylor and Francis, London, 1994.

URL

1.	https://nptel.ac.in/courses/103105160
2.	https://archive.nptel.ac.in/courses/105/105/105105042/

Lecture Plan:

Lecture No.	Topic
1-8	An elementary introduction to Cartesian tensors and tensor operations, spatial (Eulerian), and material (Lagrangian) description of the motion of deformable bodies. Rotation and vorticity, strain rate tensor, time rate of change of volume, and line integrals
9-14	Reynold's transport theorem, stress tensor, continuity, equilibrium equations, and constitutive equations
15-22	Representative elementary volume characterization using porosity, hydraulic conductivity, and other fluid properties. Pore level characterization, Pore networks. Upscaling of pore-scaled networks to representative elementary volume.
23-32	Transport in Porous Media: Advection, diffusion, dispersion, adsorption, and reactive transport. Ficks first and second law. Dispersivity tensor and its components in isotropic form. Derivation of contaminant transport equation.
33-40	Simulation-Optimization modeling for identification of pollution sources.

	Management of groundwater resources, Development of management model; Applications: pollution control, mining and construction dewatering, saltwater intrusion, wetland protection from dewatering.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st
Name of Course	River Engineering		
Course Code	WR24 560		
Core / Elective / Other	Elective		

Course Outcomes: *Students will be able to*	
1.	Understand the basics of river engineering
2.	Understand the behavior of river
3.	Understand the morphology of river.
4.	Demonstrate proficiency in understanding and applying the governing equations unsteady flow.
5.	Understand the diversity of river training works and their respective functionalities
Description of Contents in brief:	
1.	Introduction: Classification of Rivers, channel and flood plain features, sediment budgets, river morphology.
2.	Behaviour of Rivers: River channel patterns, causes, characteristics and prevention of meanders, cutoff characteristics, bed forms, delta form and control
3.	River Morphology: Bed level variation in alluvial streams, continuity equation for sediment, equilibrium depth of scour in long channel contractions, silting of reservoirs, local scour, Scour around bridge piers, secondary currents, flow in rigid boundary open channel bends, scour and deposition at alluvial bends.
4.	Unsteady Flow: Governing equations for one dimensional flow, hydrograph routing, kinematic routing, diffusion routing, Muskingum–Cunge routing.
5.	River Training Works: Introduction to river training, types of river training works, working of different river training structures, protection bridge, guide bund, embankment and spurs.
List of Text Books:	
1.	H. H. Chang, "Fluvial Processes in River Engineering", Krieger Publishing Company, 1st Edition, 2008.
List of Reference Books:	
1.	W. Wu, "Computational River Dynamics", Taylor & Francis, 1stEdition, 2007.
2.	P Y Julien River Mechanics, Cambridge university press, 2nd edition, 2018
3.	M. B. N. Al-BaghdadiK, "Progress in River Engineering & Hydraulic Structures", CreateSpace Independent Publishing Platform, 1st Edition, 2018.
URLs:	
1.	https://archive.nptel.ac.in/courses/105/103/105103204/

Lecture Plan (about 30-40 Lectures):

Lecture No.	Topic
1-3	Introduction: Classification of Rivers, channel and flood plain features, sediment budgets, river morphology.
4-6	Behaviour of Rivers: River channel patterns, causes, characteristics and prevention of meanders,
7-9	Cutoff characteristics, bed forms, delta form and control
10-11	River Morphology: Bed level variation in alluvial streams, continuity equation for sediment

12-16	Equilibrium depth of scour in long channel contractions, silting of reservoirs, local scour, Scour around bridge piers,
17-20	Secondary currents, flow in rigid boundary open channel bends, scour and deposition at alluvial bends
21-22	Unsteady Flow: Governing equations for one dimensional flow
23-27	Hydrograph routing, kinematic routing, diffusion routing, Muskingum–Cunge routing
28-30	River Training Works: Introduction to river training, types of river training works
31-34	Working of different river training structures, protection bridge, guide bund, embankment and spurs.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st
Name of Course	Hydropower Engineering		
Course Code	WR24 561		
Core / Elective / Other	Elective		

Course Outcomes: *Students will be able to*	
1.	Knowledgeful about the fundamentals of hydropower, transient analysis and various components of a hydropower plant.
2.	Able to understand the components of hydropower system and its design aspects
3.	Better understanding on the importance of hydropower as a renewable source of energy.
4.	Knowledgeful about the environmental impact assessment on hydropower development
Description of Contents in brief:	
1.	Estimation of Water Power Potential. Demand and Supply, Firm and Secondary Power, Prediction of Load, Environmental Impact Assessment of Hydropower Project
2.	Types of Hydro-Power Plants: Run of River Plants, Valley Dam Plants, Diversion Canal Plants, High Head Diversion Plants, Pumped Storage Power Plants, Small Scale Hydropower
3.	Hydropower Plant Components: Dams, Types of Dams, Penstocks: Design and Analysis, Gated and Non-gated Spillways
4.	Intakes, Critical Submergence and Swirling Flow, Power Channels, Desiltation Cambers, Trash Rack Designs, Turbines, Cavitation, Turbine Model Testing
5.	Water Hammer and Surges, Resonance in Penstocks, Transient Analysis, Governing Equations
List of Text Books:	
1.	Barrows, H.K., "Water Power Engineering", Tata McGraw Hill Publishing Company Ltd
2.	Dandekar, M.M., and Sharma, K.H., "Water Power Engineering", Vikas Publishing House Pvt. Ltd.
List of Reference Books:	
1.	Norwegian Institute of Technology: Hydropower Development: Vols. 3, 4, 5 & 6, Division of Hydraulic Engineering.
2.	Streeter, V.L., and Wylie, B., "Fluid Transients", McGraw-Hill Book Company

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1	Introduction to Hydropower Engineering, Types of Renewable Energy sources, Basics of Hydropower Projects, Hydropower Potential and Development in India
2-4	Types of Hydropower Plants and Various Classifications, Introduction to Various Components of Hydropower Project, Examples of various Hydropower Projects
5-8	Hydropower Assessments, Stream flow data for hydropower studies, Flow duration curve, Extrapolation of Flow Duration Data to Ungaged Sites, Development of Flow Duration Curve for Un-gauged Site using Physiographic Catchment Parameters, Estimation of available water power
9-11	Classes of Water Power- Firm and Secondary, Efficiency, Economic analysis of hydropower, Discounting Factors, methodology for analysis, Present-worth comparison, Rate-of-return comparison, Benefit-cost ratio comparison, Annual-worth comparison
12-14	Electrical Loads, Storage and Pondage, Load curve, Load Factor, Capacity and

	Utilization Factors, Prediction of load, Pondage capacity analysis.
15-18	Hydraulics of Hydropower Intakes, Types of intakes, Design of intake structures, Hydraulic design of bellmouths, Intake transitions, Centerline locating, Air-entrainment, Critical submergence and swirling flow, Sump design
19-21	Penstocks and quality of approach flow towards turbines, Classification of penstocks, Layout of penstocks, Economical diameter of penstocks, Design Criteria for Penstocks, Hydraulic losses in penstock,
22	Power Channel, Design of lined power channel, Most economical section,
23	Trash Racks, Hydraulic Design of trash racks, Head loss through racks, Vibration of racks, Resonance
24-25	Settling Basins, Flushing discharge, Velocity at Basin, Sediment Removal Efficiency,
26-28	Spiral Case of Turbines, Hydraulic Design, Stay Vanes, Rectangular scroll case, Meridonial and Tangential velocity, Design procedure for circular scroll case,
29-31	Hydraulic turbines, Classifications, Theory of turbomachinery, Performance of turbines, Turbine characteristics, Hydraulic design of draft tube,
32-37	Hydraulic transients, Causes of Water Hammer, Wave velocity, Basic equations for transient flow, solution by characteristics method, Method of specified time intervals, Equivalent pipe
38-40	Methods for control of transients, Surge tanks, Types of Surge Tanks, Design consideration, Simple surge tank -governing equation, Jaeger's Equation, Stability criteria

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st / 2nd	**Year:** 1st

Name of Course	Environmental Impact Assessment of Water Resources Projects
Course Code	WR24 562
Core / Elective / Other	Elective
Prerequisite:	-Nil-

Course Outcomes: *Students will be able to*	
1.	Explain the importance of EIA as an integral part of planning process
2.	Examine different environmental attributes and selecting the environmental parameters affecting project
3.	Apply various methods to Predict the Environmental impacts of project after deciding various environmental attributes
4.	Create the EIA report for getting Environmental clearance

Description of Contents in brief:	
1.	Concepts of Environmental Impact Assessment; Detailed Contents of EIA
2.	Environmental Monitoring Program; Collection and interpretation of baseline data for various environmental attributes.
3.	Prediction and Methods of Assessment of Impacts on Various aspects of Environment

List of Text Books:	
1.	Environmental Impact Analysis Handbook – by Rau Whooten; McGraw Hill publications.
2.	Environmental Impact Assessment – by Larry Canter; McGraw Hill publications.

List of Reference Books:	
1.	Environmental Impact Analysis – A Decision Making Tool by R. K. Jain.
2.	Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications.

URLs:	
1.	https://archive.nptel.ac.in/courses/124/107/124107160/
2.	https://www.youtube.com/watch?v=_iLdyhgFv1U

Lecture Plan:

Lecture No.	Topic
1 to 5	Concepts of Environmental Impact Assessment: Environment; Environmental Impacts; Environmental Impact Analysis; Environmental Impact Assessment And Environmental Impact Statement; EIA- As An Integral Part of The Planning Process
6 to 10	Detailed Contents of EIA: Introduction; Project Description; Description of The Environment; Anticipated Environmental Impacts and Mitigation Measures
11 to 15	Analysis of Alternatives; Environmental Monitoring Program; Additional studies; Project Benefits; Environmental Cost Benefit Analysis
16 to 20	Environment attributes: air; water; noise; land and soil. Description of the Baseline Environment: Purposes for defining the Environmental Setting;
21 to 28	Selection of parameters, Monitoring of physical environmental parameters, Collection and interpretation of baseline data for various environmental attributes
29 to 33	Prediction and Methods of Assessment of Impacts on Various aspects of Environment; Application of various models for the Prediction of impact on Air Environment, Water Environment, Noise Environment and Land

34 to 40	EIA notification September 2006 and amendments: Categorization of projects, Procedure for getting environmental clearance. Public participation in environmental decision-making process. Case studies on EIA for Industries and Water resources projects

Name of Program	M.Tech Water Resources Engineering and Management	**Semester–** I/II	**Year - 2024**

Name of Course	Flood Estimation and Control
Course Code	WR24 563
Core / Elective / Other	Elective

Course Outcomes:	
1.	To understand Flood and its impact on the stream morphology.
2.	To study the relevance of flood estimation and routing for the infrastructure development.
3.	To understand the development criteria for flood control measures.
4.	To give basic knowledge on flood forecasting.

Description of Contents in brief:	
1.	Flood Estimation: Project hydrology Design flood PMF storm transportation, PMP and PMF for project by using conceptual models, Introduction to glacier lake outburst flood (GLOF).
2.	Flood routing: Lumped flow routing, distributed flow routing models including kinematic, diffusion and dynamic wave routing models. Numerical solutions of distributed flow routing models.
3.	Hydrologic statistics: Hydrologic statistics, Flood forecasting and flood frequency analysis. Hydrologic design of storm water drainage system, preparation
4.	Flood control and its assessment: Types of Floods, Different methods of Flood control, Floods in major Indian river basins, Types and design of flood forecasting and protection systems, Comparison of levees with bypass channels and off stream storage, reservoir operation for flood control and management, flood damage estimation models.

List of Text Books:	
1.	Chow, V. T., Maidment, D. R., and Mays, L. W., "Applied Hydrology", McGraw Hill International editions, New Delhi, 2017.
2.	Subramanya, K., "Engineering Hydrology", Fourth Edition, Tata McGraw-Hill Publishing company Ltd., New Delhi, 2017.

List of Reference Books:	
1.	Singh, V. P., "Elementary Hydrology", Prentice Hall, New Delhi,1991.
2.	Ojha, C. S. P., Bhunya, P., and Berndtsson, P., "Engineering Hydrology", Oxford University Press, Noida, 2008.
3.	Raghunath, H. M., "Hydrology Principles, Analysis and Design", New Age International Pvt. Ltd., New Delhi, 2015

URLs:	
1.	https://archive.nptel.ac.in/courses/105/105/105105214/
2.	https://archive.nptel.ac.in/courses/105/101/105101002/

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1-5	Flood history of Indian subcontinent, Flood Estimation: Project hydrology Design flood PMF storm transportation
6-9	PMP and PMF for project by using conceptual models, Introduction to glacier lake outburst flood (GLOF).
10-14	Flood routing: Lumped flow routing, distributed flow routing models including kinematic

15-18	diffusion and dynamic wave routing models. Numerical solutions of distributed flow routing models.
19-23	Hydraulic and Hydrologic routing, Hydrologic statistics,
24-28	Flood forecasting and flood frequency analysis. Hydrologic design of storm water drainage system, preparation
29-33	Flood control and its assessment: Types of Floods, Different methods of Flood control,
34-36	Floods in major Indian river basins, Types and design of flood forecasting and protection systems
37-38	Comparison of levees with bypass channels and off stream storage
39-40	Reservoir operation for flood control and management, flood damage estimation models.

Name of Program	**M.Tech. Water Resource Engineering and Management**	**Semester:** 1st or 2nd	**Year:** 1st
Name of Course	Advanced Hydrological Modelling		
Course Code	WR24 564		
Core / Elective / Other	Elective		
Prerequisites	-Nil-		

Course Outcomes: *Students will be able to*	
1.	Understand the fundamental principles of hydrology and their application in water resources management.
2.	Develop a basic knowledge on modelling and simulation of a hydrologic system.
3.	Analyse the interactions between land use, climate change, and hydrological processes and evaluate the uncertainty and reliability of hydrological models and predictions.
4.	Explore emerging trends and technologies in hydrological modelling, including remote sensing and GIS.

Description of Contents in brief:	
1.	Introduction to Hydrological Modelling
2.	Statistical Methods in Hydrology
3.	Rainfall-Runoff Modelling and Watershed Modelling
4.	Flood Risk Assessment
5.	Uncertainty, Sensitivity Analysis and Remote Sensing GIS Application

List of Text Books:	
1.	Applied Hydrology by Ven Te Chow et al.
2.	Hydrologic Modelling: Concepts and Applications by Daniel P. Loucks and Eelco van Beek

List of Reference Books:	
1.	Introduction to Environmental Modelling by John Wainwright and Mark Mulligan

Lecture Plan:

Lecture No.	**Topic**
1-5	Introduction to Hydrological Modelling: Concepts and components of the hydrological cycle, Importance of hydrological modelling in water resources management, and Overview of modelling approaches and techniques.
6-10	Statistical Methods in Hydrology: Probability distributions and frequency analysis, Time series analysis and stochastic modelling, and Regression analysis and empirical relationships
10-15	Rainfall-Runoff Modelling: Unit hydrograph theory and applications, Conceptual and physically-based rainfall-runoff models, and Calibration and validation of hydrological models
16-20	Watershed Modelling: Representation of land use, soil properties, and topography, Distributed hydrological models (e.g., SWAT, VIC), and Model coupling and integration with GIS and remote sensing data
21-25	Flood Risk Assessment: Flood frequency analysis and flood mapping, Flood routing methods and hydraulic modelling, and Risk assessment and management

	strategies.
26-30	Climate Change Impacts on Hydrology: Climate models and scenarios for hydrological impact assessment, Modelling the effects of climate change on water availability and extremes, and Adaptation strategies for water resources management.
31-35	Uncertainty and Sensitivity Analysis: Sources of uncertainty in hydrological modelling, Methods for uncertainty quantification and sensitivity analysis, and Decision-making under uncertainty in water resources management
36-40	Remote Sensing and GIS Applications: Remote sensing techniques for hydrological parameter estimation, GIS-based spatial analysis in watershed modelling, AND Integration of remote sensing and GIS with hydrological models.

Name of Program	M.Tech. Water Resource Engineering and Management	Semester: 1st or 2nd	Year: 1st

Name of Course	Impact of Climate Change on Water Resources
Course Code	WR24 565
Core / Elective / Other	Core
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*	
1.	Explain the basic concepts of climate and climate systems
2.	Explain the climate models
3.	Assess the impacts of climate change on Hydrology and Water Resources
4.	To understand the climate change phenomenon and its related issues on water, irrigation and its social implications.

Description of Contents in brief:	
1.	Introduction of Climate change
2.	Climate Change and Extreme Events
3.	Adaptation and Mitigation Strategies
4.	Case Studies in Climate Change and Water Resource
5.	Socio-economic Implications

List of Text Books:	
1.	Climate Change: The Science of Global Warming and Our Energy Future by Edmond A. Mathez
2.	Climate Modeling for Engineers and Scientists by John B. Drake

List of Reference Books:	
1.	Climate Change Modeling, Mitigation, and Adaptation edited by Sven E. Jørgensen et al.

Lecture Plan:

Lecture No.	Topic
1-5	Climate change: introduction; causes of climate change; modeling of climate change, global climate models, general circulation models, downscaling.
6-10	IPCC scenarios; commonly used statistical methods in hydro-climatology: trend analysis; empirical orthogonal functions, principal component analysis; canonical correlation; statistical downscaling with regression.
10-14	Impact of Climate Change on Water Availability: Changes in precipitation patterns, Snowpack and glacier melt, and Effects on surface water and groundwater resources.
15-18	Climate Change and Extreme Events: Intensity and frequency of floods and droughts
19-23	Impacts on water infrastructure and management systems, and Resilience-building strategies
24-28	Adaptation and Mitigation Strategies: Integrated water resource management approaches, Water conservation and demand management, and Policy frameworks

	for climate change adaptation
29-33	Case Studies in Climate Change and Water Resource: Regional case studies demonstrating the impacts of climate change on water resources, and Successful adaptation and mitigation strategies.
34-37	Socio-economic Implications: Impacts on livelihoods and communities, Equity and justice considerations in water allocation
38-40	Economic valuation of water resources under climate change

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 1st/2nd	**Year:** 1st

Name of Course	Dam Engineering
Course Code	WR24 566
Core / Elective / Other	Elective
Prerequisites	-Nil-

Course Outcomes: *Students will be able to*

1.	Understand the principles of dam engineering, including hydraulics, geotechnical aspects, and structural design
2.	Analyze the design considerations and construction techniques for different types of dams and irrigation infrastructure
3.	Evaluate the environmental and socio-economic impacts of dam projects and irrigation systems
4.	Explore modern techniques and technologies for dam safety assessment, maintenance, and rehabilitation

Description of Contents in brief:

1.	Introduction to dam and irrigation infrastructure
2.	Hydraulic engineering principles: Open channel hydraulics
3.	Geotechnical considerations for dams
4.	Structural design: Gravity, arch, and buttress dams
5.	Environmental and socio-economic aspects
6.	Design of irrigation infrastructure
7.	Dam safety monitoring systems

List of Text Books:

1.	Hydraulics of Dams and River Structures by Farhad Yazdandoost and Jalal Attari

List of Reference Books:

1.	Design of Small Dams by United States Department of Agriculture
2.	Irrigation Engineering by N.N. Basak

Lecture Plan:

Lecture No.	**Topic**
1-5	Introduction to dam and irrigation infrastructure, overview of dam types and functions, and role of irrigation infrastructure in agriculture and water supply
6-10	Open channel hydraulics, sediment transport, and erosion control
11-16	Geotechnical considerations for dams: Site investigation and soil properties, foundation design, and stability analysis
17-24	Structural design of gravity, arch, and buttress dams, dam materials and construction methods, and seismic design and safety considerations
25-30	Environmental impact assessment (EIA), resettlement and rehabilitation of affected communities, and sustainable dam development and ecosystem preservation
31-36	Canal design and layout, irrigation scheduling and water distribution, and modernization of irrigation systems (drip irrigation, sprinkler systems)
37-40	Dam safety monitoring systems, risk assessment and emergency preparedness, and maintenance, inspection, and rehabilitation practices

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st or 2nd	**Year:** 1st
Name of Course	Ecohydroclimatology		
Course Code	WR24 567		
Core / Elective / Other	Elective		
Prerequisites	-Nil-		

Course Outcomes: *Students will be able to*	
1.	Understand the principles and concepts of ecohydroclimatology and its relevance to water resources management.
2.	Analyze climate data and identifying hydrological trends and patterns.
3.	Elaborate the extreme climate events and modelling of climate change
4.	Explore emerging trends and challenges in ecohydroclimatology research and applications
Description of Contents in brief:	
1.	Introduction of Climate and climate change
2.	Global climate models and downscaling
3.	Extreme Climate Events
4.	Statistical Methods in Hydro-Climatology
List of Text Books:	
1.	Ecohydrology: Processes, Models and Case Studies by Paul G. Whitehead et al.
2.	Ecohydrology: Vegetation Function, Water and Resource Management edited by Derek Eamus et al
List of Reference Books:	
1.	Climate Change and Water Resources Planning Criteria by Donald R. Fournier

Lecture Plan:

Lecture No.	Topic
1-5	Introduction: Climate system; climate, weather and climate change; overview of earth's atmosphere; vertical structure of atmosphere.
6-10	Radiation and temperature; laws of radiation; head-balance of earth atmosphere system; Random temperature variation.
11-15	Modeling vertical variation in air temperature; temporal variation of air temperature; temperature change in soil; thermal time and temperature extremes
16-20	Hydrologic Cycle: Introduction; Global water balance; cycling of water on land, a simple water balance model; climate variables affecting precipitation.
21-25	Precipitation and weather, humidity, vapor pressure, forms of precipitation, types of precipitation; cloud; atmospheric stability; monsoon; wind pattern
26-30	Climate Change: Introduction; causes of climate change; modeling of climate change, global climate models, general circulation models, downscaling; IPCC scenarios.
31-35	Statistical Methods in Hydro-Climatology: Trend analysis; Empirical orthogonal functions, principal component analysis; canonical correlation; statistical downscaling with regression.
36-40	Extreme Climate Events: Floods, Cloud burst, Droughts and Drought indicators, Heat waves, Sea level Rise, Compound Extremes.

Name of Program	M.Tech Water Resources Engineering and Management	Semester– I/II	Year - 2024

Name of Course	Groundwater Engineering and Management
Course Code	WR24 568
Core / Elective / Other	Elective

Course Outcomes:	
1.	Understand the importance of Groundwater for the domestic as well as industrial purposes
2.	Classify different kinds of aquifers and identify the aquifer parameters such as permeability and storativity by interpreting the experimental datasets.
3.	Determine the role of unsaturated water with soil water characteristics for the root development of plants
4.	Modelling the fate and transport of contaminants in groundwater using Groundwater Modelling Systems (GMS) software.
Description of Contents in brief:	
1.	Introduction to Groundwater Engineering, History of groundwater development in India and World, Classification of aquifers, Continuum approach to flow through porous media
2.	Aquifer storativity, Dupuit-Forchimer Equation, hydraulic conductivity, Laplace equation
3.	Differential equations governing ground water flow in polar coordinates, confined and unconfined aquifers
4.	Concept of interfacial tension, principles of flow in the unsaturated zone, groundwater depletion, Groundwater Modelling Systems
List of Text Books:	
1.	Todd, D.K., Groundwater Hydrology, Wiley.
2.	Bear J., Hydraulics of Groundwater, McGraw-Hill.
List of Reference Books:	
1.	Bouwer, H., "Groundwater Hydrology", McGraw-Hill.
2.	Kruseman, G.P. and Ridder, N.A., "Analysis and Evaluation of Pumping Test Data", IILRI.
URLs:	
1.	https://archive.nptel.ac.in/courses/105/101/105101214/
2.	https://archive.nptel.ac.in/courses/105/105/105105042/

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1-2	Introduction to Groundwater Engineering, History of groundwater development in India and World,
3-5	Moisture distribution in a vertical profile, Classification of aquifers, Continuum approach to flow through porous media, Darcy's law,
6-9	Hydraulic Conductivity, Eigen values of the hydraulic conductivity tensor, Flow in anisotropic aquifers, Dupuit assumptions for a phreatic aquifer.
10-14	Aquifer storativity, Dupuit-Forchimer Equation, Basic equation of continuity in Cartesian coordinates, initial and boundary conditions
15-19	Simplified case of the continuity equation with isotropic hydraulic conductivity and steady state, Laplace equation
20-24	Differential equations governing ground water flow in polar coordinates, well hydraulics, analytical solutions for confined,

25-28	leaky confined and unconfined aquifers, image well theory, time-variant pumping rates, well interference, Analysis of pumping test data
29-34	Concept of interfacial tension, principles of flow in the unsaturated zone, Capillary pressure and retention curves, soil water characteristic curves (SWCC), Continuity equation in unsaturated zone, One dimensional Richard's equation.
35-36	Reasons for the depletion of groundwater, Artificial recharge
37-40	Contamination of Groundwater, different sources of contamination, solution procedure of the source identification problem, management of the aquifer using aquifer remediation techniques. Groundwater Modelling Systems (GMS): A software to model flow and transport in groundwater

Name of Program	M.Tech Water Resources Engineering and Management	Semester– I/II	Year - 2024

Name of Course	Optimization Methods
Course Code	WR24 569
Core / Elective / Other	Elective

Course Outcomes:	
1.	Determine the need for optimal design in engineering, necessary and sufficient conditions of optimality.
2.	Determine the optimality of constrained and unconstrained problems using classical search techniques
3.	Determine the optimality of non-linear problems and linear problems using classical optimization methods
4.	Apply evolutionary algorithms for basic problems as wells as advanced engineering design problems.

Description of Contents in brief:	
1.	Introduction to Optimization, Basics of engineering analysis and design, global and local optima
2.	constrained and unconstrained problems, Exhaustive search method, Region elimination method, Newton-Raphson Method and Bisection method
3.	descent direction, Quadratic approximation, convex and concave functions, Evolutionary algorithms
4.	Genetic Algorithm (GA), Differential Evolution (DE), Genetic Algorithm (GA), Differential Evolution (DE), Non-Classical and Metaheuristic Optimization Algorithms

List of Text Books:	
1.	Deb. K., Optimization for engineering design: Algorithms and examples, PHI Pvt Ltd., 1998.
2.	Arora., J.S., Introduction to optimum design, McGraw Hill International edition, 1989.

List of Reference Books:	
1.	Hafta, R.T. and Gurdal. Z., Elements of structural optimization, Kluwer academic publishers, Third revised and expanded edition, 1996.
2.	Bennis, F. and Bhattacharjya, R.K., Nature-Inspired Methods for Metaheuristics Optimization, Springer, 2020.

URLs:	
1.	https://archive.nptel.ac.in/courses/105/103/105103210/
2.	https://archive.nptel.ac.in/courses/111/105/111105039/

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1-3	Introduction to Optimization: Basics of engineering analysis and design, Need for optimal design
4-9	Difficulties associated with optimization problems, Problems of global and local optima, Single and multivariable problems, Necessary and sufficient condition for optimality.
9-14	Classical Optimization 1: Basics of constrained and unconstrained problems, Stationary points, points of maxima, points of minima and inflection points,
15-21	Exhaustive search method, Bounding phase method, Region elimination method,

	Interval halving method, Golden section search method, Newton-Raphson Method and Bisection method
22-27	Classical Optimization 2: Definition of descent direction, Steepest descent direction method, Newton method, Quadratic approximation of a function
28-32	Convex and concave functions, Convex optimization problem, Kuhn-Tucker conditions, Linear Programming, Simplex method and Dynamic programming.
33-36	Non-Classical and Metaheuristic Optimization Algorithms 1: Introduction to Evolutionary algorithms, Introduction to Genetic Algorithm (GA), Differential Evolution (DE), Simulated Annealing (SA).
37-38	Non-Classical and Metaheuristic Optimization Algorithms 2: Particle Swarm Optimization (PSO),
39-40	Firefly Algorithms (FA), Shuffled Frog Leaping Algorithm (SFLA), Invasive Weed Growth Optimization (IWO) and other metaheuristic principles of biomimicry

Name of Program	M.Tech Water Resources Engineering and Management	**Semester– I/II**	**Year - 2024**

Name of Course	Hydraulics of Sediment Transport
Course Code	WR24 570
Core / Elective / Other	Elective

Course Outcomes:	
1.	To understand basic laws governing sediment-particle fall velocity, particle-size analysis, incipient motion, bed forms, bed load, suspended load, and natural river processes.
2.	To understand the concepts of classic and modern sediment-transport theories, sediment transport predictors, sediment yield
3.	To make familiar with the peculiar characteristics of flow in alluvial streams, prediction of bed-form regimes in alluvial streams,
4.	To understand the relevance of depth-discharge relations for rivers, sediment transport rates in rivers, and channel stability
Description of Contents in brief:	
1.	Physical Properties of Fluid and Sediment, Terminal Fall Velocity of Sediment in Fluid, Sediment Threshold, Lift Force Concept, Threshold of Nonuniform Sediment Motion
2.	Bed-Load Transport, Bed Shear Stress Concept for Bed-Load Transport, Discharge and Velocity Concept for Bed-Load Transport, Sediment Sorting and Streambed Armoring
3.	Suspended-Load Transport, Vertical Distribution of Sediment Concentration, Sediment Suspension, Types of Bedforms
4.	Fluvial Processes, Meandering, Braided rivers, Scour around hydraulic structures, types of scour, Scour Countermeasures
List of Text Books:	
1.	Dey, S. Fluvial Hydrodynamics, Springer Heidelberg, 2014.
2.	Chen N, Wan Z. Mechanics of Sediment Transport. ASCE Press.
List of Reference Books:	
1.	Garde, R J and Rangaraju, K G. Mechanics of Sediment Transport and Alluvial Stream Problem, New Age International Publishers.
URLs:	
1.	https://archive.nptel.ac.in/courses/105/103/105103204/

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1-3	Introduction to Sediment Threshold, Definition of Sediment
4-7	Threshold Velocity Concept, Yang's Threshold Velocity Model, Lift Force Concept
8-12	Threshold Bed Shear Stress Concept. Probabilistic Concept of Entrainment, Threshold of Nonuniform Sediment Motion
13-15	Bed-Load Transport: Bed Shear Stress Concept for Bed-Load Transport
16-19	Governing equation of saltation, Velocity Concept for Bed-Load Transport
20-22	Probabilistic Concept for Bed-Load Transport, Sediment Pickup Function
23-25	Particle Trajectory and Characteristic Parameters (van Rijn's Approach), Sediment Sorting and Streambed Armoring
26-29	Suspended-Load Transport: Generalized Advection–Diffusion Equation of Suspended Sediment Motion

30-32	Vertical Distribution of Sediment Concentration due to Nonuniform Streamwise Variation,
33-34	Effects of Suspended Load on von Kármán Constant k, Effects of Sediment Suspension on Turbulence characteristics. Total-Load Transport
35-36	Types of Bedforms, Prediction of Bedforms, Bed Features in Gravel-Bed Streams, Resistance to Flow Due to Bedforms.
37-38	Meandering and Braiding. Mathematical Modeling of Meandering Rivers
39-40	Scour due to channel contraction, local scour around hydraulic structures, Dimensional Analysis and Similitude

Name of Program	M.Tech Water Resources Engineering and Management	**Semester– I/II**	**Year - 2024**
Name of Course	Computational Fluid Dynamics		
Course Code	WR24 571		
Core / Elective / Other	Elective		

Course Outcomes:	
1.	The course deals with the numerical solution of equations governing fluid flow. Students will be able to simulate and simplify a real fluid-flow system into a simplified model problem.
2.	Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.
3.	Improve the student's understanding of the advanced principles of fluid dynamics.
4.	Able to understand the advanced numerical modelling of fluid flow interactions.
Description of Contents in brief:	
1.	Introduction to advanced fluid dynamics: Conservation Laws, the primitive variables (non-conservative) and conservative forms of the governing equations.
2.	Navier-Stokes equations and vorticity stream function formulation, Fluid Flow Partial Differential Equations and their Classifications, The Finite Volume Method, Convection-Diffusion (Advection) Problems
3.	Discretization techniques, grid convergence study, The Boundary Conditions, Numerical schemes: finding face values, Solution Algorithms, tri-diagonal matrix algorithm,
4.	Finite Volume Method for Unsteady Flows Implicit method to 2-D and 3-D problems, Multiphase simulation models, Software exposure: Fluent, Openfoam
List of Text Books:	
1.	Anderson J.D. (1995) Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill, Inc.).
2.	Versteeg, H.K. and Malalasekera, W. (1995), An introduction to computational fluid dynamics: The finite-volume method, Longman Scientific & Technical (in USA, by John Wiley and Sons Inc.
List of Reference Books:	
1.	Ferziger J.H. & Peric M. (1999) Computational Methods for Fluid Dynamics, Springer, Berlin, Germany
URLs:	
1.	https://onlinecourses.nptel.ac.in/noc21_me126/preview
2.	https://nptel.ac.in/courses/112105045

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1-3	Introduction to advanced fluid dynamics: Conservation Laws (Mass, Momentum, and Energy) of Fluid Flow & Heat Transfer
4-7	Conservation laws in integral form, Conservation laws in differential form. The primitive variables (non-conservative) and conservative forms of the governing equations.
8-12	Navier-Stokes equations and vorticity stream function formulation, Fluid Flow Partial Differential Equations and their Classifications
13-16	The Finite Volume Method for flow Problems and Convection-Diffusion (Advection) Problems. The First Order and Second Order Upwind Difference Discretization Schemes

16-19	The Boundary Conditions & Discretization, Solution Algorithms (SIMPLE, SIMPLER, SIMPLEC, and PISO) for Pressure-Velocity Coupling in Steady Flows
20-24	Solution of Discretized Equations, The tri-diagonal matrix algorithm (TDMA)/Thomas algorithm
25-26	Application of TDMA to two-dimensional and three-dimensional problems.
27-30	The Finite Volume Method for Unsteady Flows, One-dimensional unsteady heat conduction with explicit and implicit formulations,
31-33	Discretization of multiphase modelling of free surface interaction and bubble formation.
34-36	Extension of implicit method to 2-D and 3-D problems, The unsteady SIMPLE and pressure implicit with splitting of operators (PISO) algorithms
37-40	Major commercial software packages like Fluent, Openfoam. Problem solving demonstrations using student version (normally, free)

Name of Program	M.Tech Water Resources Engineering and Management	Semester– I/II	Year - 2024

Name of Course	Coastal Engineering
Course Code	WR24 572
Core / Elective / Other	Elective

Course Outcomes:	
1.	Understanding the basics of ocean engineering
2.	Learn the physics of ocean currents and circulation, seabed features and wave hydrodynamics
3.	Understanding infrastructure development for the protection of coastal regions
4.	Understand the importance of risk assessment and management aspects for sea level rise, wave slamming and coastal storms.
Description of Contents in brief:	
1.	Physical oceanography; Ocean currents and circulation; seabed features; Coastal regions and special economic zones;
2.	Sea level rise and climate change effects; Sediments and minerals; Variation along the depth. Introduction to ocean structures
3.	Fixed and floating structures for oil and gas exploration; Coastal structures such as breakwater, groin, and jetties for port and harbour development; Steel and RC structures; Floating structures for passenger and RoRo/RoPax facilities Basics of offshore wind, wave, current
4.	Wave slamming and slapping effects Design life; encounter probability; Relationship between return period and encounter probability; Selection of design parameters for fixed and floating structures.
List of Text Books:	
1.	Turget Sarpkaya, Wave forces on offshore structures, Cambridge university press, UK, ISBN: 978-113-91-9589-8, 2014
2.	Robert G Dean and Robert A Dalrymple, Water wave mechanics for engineers and scientists, Advanced series on Ocean Engineering: Vol. 2, World Scientific, Singapore, ISBN: 978-981-02-0420-4, 1991
List of Reference Books:	
1.	Chakrabarti, SK, Hydrodynamics of Offshore Structures, WIT Press, Southampton, UK. ISBN: 978-0-90545-166-4, 1994
2.	Barltrop, NDP and Adams, AJ., Dynamics of fixed marine structures, Butterworth-Heinemann, ISBN: 978-0-7506-1046-9, 1991
3.	Srinivasan Chandrasekaran, and A.K. Jain, 2016, Ocean structures: Construction, Materials and Operations, CRC Press, Florida, ISBN: 978-149-87-9742-9, 2001
URLs:	
1.	https://archive.nptel.ac.in/courses/114/105/114105002/
2.	https://archive.nptel.ac.in/courses/114/106/114106025/

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1-4	Physical oceanography; Ocean currents and circulation; seabed features
5-9	Coastal regions and special economic zones; Sea level rise and climate change effects
10-13	Sediments and minerals; Variation along the depth. Introduction to ocean structures
14-17	Fixed and floating structures for oil and gas exploration;
18-24	Coastal structures such as breakwater, groin, and jetties for port and harbour

	development; Steel and RC structures; Floating structures for passenger and RoRo/RoPax facilities
25-28	Basics of offshore wind, wave, current; tidal variations; regular and random waves; Tidal and wind-driven currents;
29-32	Design water levels; Tide and storm surge; Deck and crest elevation for coastal and offshore structures
33-35	Joint Probability distribution between wave and current; Load combinations and risk assessment.
36-37	Wave slamming and slapping effects Design life; encounter probability;
38-40	Relationship between return period and encounter probability; Selection of design parameters for fixed and floating structures

Name of Program	M.Tech Water Resources Engineering and Management	Semester– I/II	Year - 2024

Name of Course	Environmental Hydraulics
Course Code	WR24 573
Core / Elective / Other	Elective

Course Outcomes:	
1.	This course deals with the fluid mechanics to problems of pollutant transport and mixing and in the water environments
2.	To understand the roles of hydro-engineering for environmental management in river basins
3.	To obtain scientific knowledge on fundamental theories for water and material transport in river basins
4.	To analyse material transport phenomena in rivers, lakes, reservoirs, and coastal seas.
Description of Contents in brief:	
1.	Flow in Rivers, Continuity and momentum equations, Uniform and non-uniform flow, gradually varied flow, Unsteady flow computations
2.	Pollutant Transport: Definitions, Fick's law, Advective-Diffusion equation, Turbulence and diffusion, Solutions of advective-diffusion equation
3.	Heat and salinity transport, Problems with the heat and salinity transport in river basins, Basic knowledge of the heat and salinity in the hydrosphere, Characteristics of the heat and salinity dynamics in the hydrosphere.
4.	Current problems and future perspectives in environmental hydraulics, Eutrophication in lakes and inland seas, Sediment management in dams and reservoirs,
List of Text Books:	
1.	1. Fischer, H.B. et al., 1979, Mixing in Inland and Coastal Waters, Academic Press, New York, N.Y.
2.	2. Metcalf and Eddy; Wastewater Engineering Treatment and Reuse, Mc Graw Hill. ISBN: 0-07-1122250-8.
List of Reference Books:	
1.	Barnes, D., Liss, P.J., Gould, B.W., and Vallentine, H.R. (1981) Water and Wastewater Engineering Systems. (Pitman: London, UK).
2.	Sing, V. P. AND Hager, W. H. Environmental Hydraulics, Springer; Softcover reprint of hardcover 1st ed. 1996 edition (6 December 2010).
3.	Dunnivant, F. M. and Anders, E. A Basic Introduction to Pollutant Fate and Transport: An Integrated Approach with Chemistry, Modeling, Risk Assessment, and Environmental Legislation, John Wiley & Sons, Inc., 2 December 2005, Print ISBN:9780471651284 |Online ISBN:9780471758136
URLs:	
1.	https://archive.nptel.ac.in/courses/105/105/105105110/
2.	

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1-4	Flow in Rivers, Continuity and momentum equations, Uniform and non-uniform flow, gradually varied flow
5-9	Unsteady flow computations, Application of numerical models for predicting flow, water quality and sediment transport in practical environmental engineering

	problems
10-14	Pollutant Transport: Definitions, Fick's law, Advective-Diffusion equation,
15-18	Turbulence and diffusion, Solutions of advective-diffusion equation (point source, line source and plane source),
19-24	Longitudinal dispersion, Chemical reaction kinetics, Flow measurement - dilution gauging, Water quality indicators.
25-29	Heat and salinity transport, Problems with the heat and salinity transport in river basins
30-32	Basic knowledge of the heat and salinity in the hydrosphere,
33-34	Characteristics of the heat and salinity dynamics in the hydrosphere
35-37	Current problems and future perspectives in environmental hydraulics, Eutrophication in lakes and inland seas
38-39	Sediment management in dams and reservoirs,
39-40	Vegetation overgrowth in river channels, River ecosystem and disturbance.

Name of Program	M.Tech Water Resources Engineering and Management	**Semester– I/II**	**Year - 2024**

Name of Course	Research Methodology
Course Code	WR24 575
Core / Elective / Other	Elective

Course Outcomes:	
1.	Understanding the basic concepts and types of research
2.	Develop research design and techniques
3.	Present research to the scientific community like the mode of publications
4.	Develop an understanding of the ethical dimensions of conducting research

Description of Contents in brief:	
1.	Exploring Research Inquisitiveness: Various aspects of research and role of each components involved in scientific research.
2.	Data Analysis: Literature review: Tools and Techniques, Collection and presentation of data, processing and analysis of data
3.	Research writing and Ethics: Reporting and presenting research
4.	The codes of ethics, copyright, patents, intellectual property rights, plagiarism, citation, acknowledgement, avoiding the problems of biased survey

List of Text Books:	
1.	Krishnaswamy, K.N., Sivakumar, A.I., and Mathirajan, M. (2006). Management Research Methodology, Pearson Education.
2.	Leedy, P, D. (2018). Practical Research: Planning and Design (12 e) Pearson.

List of Reference Books:	
1.	Kothari, C.R. (2004). Research Methodology – Methods and Techniques, New Age International Publishers.
2.	Mike Martin, Roland Schinzinger, (2004) Ethics in Engineering, Mc Graw Hill Education

URLs:	
1.	https://onlinecourses.nptel.ac.in/noc23_ge36/preview
2.	https://archive.nptel.ac.in/courses/127/106/127106227/

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1-5	Philosophy of Scientific Research, Role of Research Guide, Planning the Research Project, Research Process, Research Problem Identification and Formulation, Variables,
6-11	Framework development, Research Design, Types of Research, Sampling, Measurement, Validity and Reliability, Survey
12-18	Designing Experiments, Research Proposal, Research Communication, Research Publication, Structuring a research paper, structuring thesis/ dissertation.
19-22	Data Analysis: Literature review :Tools and Techniques, Collection and presentation of data, processing and analysis of data, Descriptive statistics and inferential statistics
23-26	Measures of central tendency, dispersion, skewness, asymmetry, Probability distributions, Single population and two population hypothesis testing, Parametric and non-parametric tests,

27-31	Design and analysis of experiments: Analysis of Variance (ANOVA), completely randomized design
32-35	Measures of relationship: Correlation and regression, simple regression analysis, multiple regression, interpretation of results, Heuristics and simulation.
36-37	Research writing and Ethics: Reporting and presenting research, Paper title and keywords, writing an abstract, writing the different sections of a paper, revising a paper, responding to peer reviews.
38-40	The codes of ethics, copyright, patents, intellectual property rights, plagiarism, citation, acknowledgement, avoiding the problems of biased survey.

Name of Program	M.Tech Water Resources Engineering and Management	**Semester– I/II**	**Year - 2024**

Name of Course	Hydraulics Laboratory
Course Code	WR24 514
Core / Elective / Other	Core

Course Outcomes:	
1.	The course will help the students to explore the fundamental principles of fluid mechanics through experimentation
2.	Demonstrate and analyse key hydraulic phenomena using hands-on physical devices and computer modelling.
3.	Investigate engineering design principles for pipe networks, open channel systems, and ground water regimes.
4.	Develop skills for analysing experimental data and working in teams and also learn to design a custom hydraulics experiment.
List of Experiments	
1.	Experimental study on flow around hydraulics structures
2.	Flow hydrodynamics study around circular cylinders
3.	Streamline and Potential line formation around bluff bodies with assessment on flow net
4.	Experimentation on flow measurement devices like venturimeter and orifice meter
5.	Cavitation studies in pipe flow
6.	Demonstration of hydraulic jump in open channel
7.	Bedload transport in open channels. Investigate influencing variables of bed load transport (flow velocity and inclination)
8.	Ripple formation on the riverbed
9.	Observing the formation of meanders using formation of river courses apparatus
10.	Scour around spur dikes
List of Text Books:	
1.	Finnemore and Franzini, Fluid Mechanics with Engineering Applications, 10th Edition, McGraw-Hill.
2.	Dey, S. Fluvial Hydrodynamics, Springer Heidelberg, 2014.
List of Reference Books:	
1.	Subramanya, K. Flow in open channels, Tata McGraw Hill Publishing. Company, 2001
2.	
URLs:	
1.	
2.	

Name of Program	M.Tech. Water Resource Engineering and Management	**Semester:** 1st	**Year:** 1st
Name of Course	Computational Laboratory-I		
Course Code	WR24 515		
Core / Elective / Other	Lab		

Course Outcomes: *Students will be able to*	
1.	Perform statistical analysis of hydrologic data
2.	Analyse hydrologic time series and develop hydrologic time series models
3.	Analyse and design water distribution networks, apply numerical methods for computation of backwater profile, hydraulic flood Routing
4.	Use software tools like R and MATLAB for hydraulic and hydrologic design
Description of Contents in brief:	
1.	Introduction to Programming and Algorithms, Basic concepts and syntaxes of R, Python, and MATLAB, Using R/MATLAB for statistical analysis, frequency analysis of hydrologic extremes, time series analysis, and modelling, and reservoir flood routing modules using R/MATLAB. Apply finite difference methods for hydraulic flood routing.
List of Online Resources:	
1.	https://rstudio-education.github.io/hopr/
2.	https://in.mathworks.com/help/matlab/

S. No.	**List of Experiments**
1-3	Introduction to Programming and Algorithms, Basic concepts and syntaxes of R, Python, and MATLAB
4-6	Introduction to GIS software, Practical exercises using ArcGIS or QGIS for spatial analysis and mapping.
7-10	Using R/MATLAB for statistical analysis, frequency analysis of hydrologic extremes, time series analysis, and modelling
11-13	Reservoir flood routing modules using R/MATLAB
14-16	Apply finite difference methods for hydraulic flood routing.

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 2nd	**Year:** 1st

Name of Course	Hydrology Laboratory
Course Code	WR24 523
Core / Elective / Other	Lab
Prerequisite:	-Nil-

Course Outcomes: *Students will be able to*

1.	Perform experiments and determine hydrological and flow parameters in surface water.
2.	Determine the cone of depression and hydraulic gradient in groundwater flow.
3.	Demonstrate the effect of dewatering, and natural or manmade lakes on piezometric head around the experimental site.
4.	Perform experiments and determine the effect of pipe/ retaining wall on groundwater flow.

Description of Contents in brief:

1.	Groundwater flow, hydraulic gradient, water table, effect of wells in confined aquifers, percolation through polders or lakes using groundwater flow model experimental setup.
2.	Land drainage, base level change in alluvial channel, stream power on the channel using a rainfall simulator.
3.	Effect of a pile or cutoff wall on groundwater flow, and uplift using seepage flow apparatus.

List of Text / Reference Books:

1.	Todd, D.K., Ground Water Hydrology, Wiley, New York, 1998.
2.	Bear, J., Dynamics of Fluids in porous Media, Dover Publications, 1972.

Experiments:

Experiment No.	Topic
1	Determine the cone of depression on single/ multiple wells in an unconfined aquifer
2	Demonstrate groundwater flow and resulting hydraulic gradient between two different potentials.
3	Demonstrate the dewatering of an excavation site by locally lowering the water table using wells
4	Determine the effect of a single well in a confined aquifer with radial symmetry
5	Simulate the draining of a manmade polder or natural lake and investigate the factors involved using a groundwater flow model experimental setup
6	Determine the effect of land drainage on runoff hydrograph, generation of overland flow
7	Determination of effect to base level change in alluvial channel morphology
8	Determine the effect of changing stream power on channel morphology using rainfall simulator
9	Determination of the effect of a pile or cut-off wall on groundwater flow using flow lines in a seepage flow apparatus

Name of Program	M.Tech. Water Resources Engineering and Management	**Semester:** 2nd	**Year:** 1st

Name of Course	Computational Laboratory II
Course Code	WR24 524
Core / Elective / Other	Lab
Prerequisite:	Computational Laboratory I

Course Outcomes: *Students will be able to*

1.	Design a decision support system for hydrology and hydraulics-related problems.
2.	Apply fuzzy logic, ANN, and data mining in hydro meteorology and hydrology.

Description of Contents in brief:

1.	Introduction to hydroinformatics, basics of programming, decision support systems, web-based information system, artificial neural networks, fuzzy logic applications, optimization applications for water resources using MATLAB, R or Python.

List of Text / Reference Books:

1.	Ross, T.J., "Fuzzy Logic with Engineering Application", 2nd Edition, John Wiley & Sons.
2.	Mallach, E.G., "Decision Support System and Data Warehouses Systems", Tata McGraw Hill.
3.	Witten, I.H., and Frank E, "Data Mining", Morgan Kaufmann Publishers.
4.	Babovic, V and Larsem, L.C., "Hydroinformatics '98", AA Balkema

Experiments:

Experiment No.	Topic
1-2	Introduction to hydroinformatics and overview of emerging techniques. Introduction to basics of Programming.
3-4	Databases design and connectivity. Introduction to information systems, decision support system, spatial decision support systems, web-based information system, expert systems
5-6	Data mining, artificial neural networks, and their application in hydrology. Introduction to fuzzy logic and applications
7-8	Application of ANN and fuzzy logic using software like MATLAB, R, Python
9-10	Optimization applications for water resources using simulation-optimization approaches and metaheuristic optimization algorithms using MATLAB, R, or Python.