ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

Abbreviation used:

AC	Audit course	LC	Lab Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC	Mandatory/ Common Course	EA	End-Semester Assessment		

Subject Code Format:

A1	A2	B3	C4	C5	C6
School/ Dept. (Offering) **BH:** Basic Sciences and Humanities **CS:** Computer Sciences **EE:** Electrical Sciences **EI:** Electronic Sciences **IP:** Infrastructure and Planning **MS:** Mechanical Sciences **BT:** Biotechnology **TE:** Textile Engineering		**Level** **1:** UG/ Int. Msc. (1st Year) **2:** UG/ Int. Msc. (2nd Year) **3:** UG/ Int. Msc. (3rd Year) **4:** UG/ Int. Msc. (4th Year) **5:** UG/ Int. Msc. (5th Year) **6:** PG (1st Year) **7:** PG (2nd Year) **8:** Ph.D.	**0:** AC **1:** PC **2:** PE **3:** OE **4:** MC **5:** LC **6:** PR **7:** SE **8:** **9:**	**Serial Number (01 to 99)** 01/ 03/…/ 19: Odd Sem. (GTE) 21/ 23/…/ 39: Odd Sem. (STE) 41/ 43/…/ 59: Odd Sem. (WRE) 61/ 63/…/ 79: Odd Sem. (URP) 81/ 83/…/ 99: Odd Sem. (Prog-5) 02/ 04/…/ 20: Even Sem. (GTE) 22/ 24/…/ 40: Even Sem. (STE) 42/ 44/…/ 60: Even Sem. (WRE) 62/ 64/…/ 80: Even Sem. (URP) 82/ 84/…/ 98: Even Sem. (Prog-5)	

1st Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 1	IP6141	Advanced Fluid Mechanics (CE)	3	0	0	3	40	60	-	100
2	MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3	40	60	-	100
3	MC 2	MS6403	Research Methodology and IPR	2	0	0	2	40	60	-	100
4	LC 1	IP6541	Hydraulic Engineering Lab	0	0	4	2	-	-	100	100
5	AC 1	Any One from the List of AC 1 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**10**	**0**	**4**	**10**	**160**	**240**	**100**	**500**

2nd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 2	IP6143	Advanced Hydrology	3	0	0	3	40	60	-	100
2	PE 1 (Any One)	IP6241	Water Resources System Planning and Management	3	0	0	3	40	60	-	100
		IP6243	Design of Hydraulic Structure and Hydropower Engineering								
		IP6245	Modelling, Simulation and Optimization								
3	PE 2 (Any One)	IP6242	Advanced Numerical Methods	3	0	0	3	40	60	-	100
		IP6244	Application of Soft Computing Techniques								
		IP6246	Advanced Irrigation Engg. and Drainage								
4	LC 2	IP6543	Hydrology Engineering Lab	0	0	4	2	-	-	100	100
5	AC 2	Any One from the List of AC 2 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**11**	**0**	**4**	**11**	**160**	**240**	**100**	**500**

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3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 3	IP6142	Applied Hydraulics	3	0	0	3	40	60	-	100
2	PE 3 (Any One)	IP6248	Water Quality Modeling and Management	3	0	0	3	40	60	-	100
		IP6250	Remote sensing and GIS Application in Water Resources Engineering								
		IP6252	Hydrometry, Water acts and Water services								
3	OE 1	Any One from the List of OE 1 (Appendix-I)		3	0	0	3	40	60	-	100
4	PR 1	IP6642	Project (Specialization Related)	0	0	4	2	-	-	100	100
			Total	**9**	**0**	**4**	**11**	**120**	**180**	**100**	**400**

4th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 4	IP6144	Ground Water Hydrology	3	0	0	3	40	60	-	100
2	PE 4* (Any One)	IP7241	Fluvial Hydraulics	3	0	0	3	40	60	-	100
		IP7243	Hydrologic system Modeling								
		IP7245	Ground water Assessment and Development								
3	LC 3	IP6542	Software Lab	0	0	4	2	-	-	100	100
			Total	**6**	**0**	**0**	**08**	**80**	**120**	**100**	**300**

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

5th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 2	IP7641	Dissertation (Phase-I)	0	0	24	12	-	-	100	100
			Total	**0**	**0**	**20**	**12**	**-**	**-**	**100**	**100**

6th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 3	IP7642	Dissertation (Phase-II)	0	0	32	16	-	-	100	100
			Total	**0**	**0**	**32**	**16**	**-**	**-**	**100**	**100**

Credits and Maximum Marks

Sl. No.	Semester	Credits	Maximum Marks
1	1st	10	500
2	2nd	11	500
3	3rd	11	400
4	4th	08	300
5	5th	12	100
6	6th	16	100
	Total	**68**	**1900**

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

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School/ Department: School of Infrastructure and Planning
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1st Semester

PC 1	IP6141	Advanced Fluid Mechanics (CE)	3	0	0	3

Course Objective:

1. To derive the partial differential equations governing the conservation of mass, momentum, and energy of an incompressible Newtonian fluid.
2. To obtain dimensionless forms of the governing equations, and from these extract the dimensionless parameters that determine the flow field and present some exact solutions to the Navier-Stokes equations.
3. To obtain knowledge about turbulence, diffusion and their applications on fluid mechanics
4. To derive the boundary layer equations and show how to obtain exact and approximate integral solutions.

MODULE- I

Introduction to Fluid Mechanics: Structure of Fluid Mechanics; Fluid Type, Motion Characteristic and spatial Dimensionality Consideration; Quantitative Definition of Fluid and Flow, Reynolds Transport Theorem, Mass, Momentum and Energy Conservation Principles for Fluid Flow.

Kinematics of Flow: Equation of continuity in Cartesian, polar and cylindrical coordinates, rate of deformation, dilation, vorticity.

Potential Flow: Frictionless I rotational Motions, 2 - D Stream Function and Velocity Potential Function in Cartesian and Cylindrical Polar Coordinate Systems, Standard Patterns of Flow, Source, Sink, Uniform Flow and irrotational vortex, Combinations of Flow Patterns

MODULE-II

Viscous Flow: Study of Local Behavior, Differential Approaches in Analysis of Viscous Flows Equations of motion for laminar flow of a Newtonian fluid - Viscous flow – Navier-Stoke's equations, Approximate solutions to N-S Equations

Turbulence: Origin of turbulence, universal velocity distribution, laws of turbulence. Turbulent Flow obtained from N – S Equations, Models for Turbulence, Theories of Turbulent Shear Stresses, Velocity Distribution in Smooth and Rough Pipes, Resistance Coefficients for Pipes

MODULE –III

Diffusion: Equations of Fluid Dynamics for a Mixture of Fluids, Dispersion of Pollutants in a Fluid Medium, Coefficient of Mass Transfer.

Boundary Layer Theory: Boundary Layer Concept, Prandtl's Boundary Layer Equations, Laminar Boundary Layer along a Flat Plate, Integral Momentum Equation, Blassius Solution. Turbulent Boundary Layer and Boundary Layer Separation, Applications of Boundary layer concept to real life problems, Drag and lift, Applications of Boundary layer concept to real life problems.

Text/Reference Books:

1. Som S. K and Biswas G "Introduction to Fluid Mechanics and Fluid Machines", TMH
2. Schlichting: "Boundary Layer theory", International Text – Butterworth
3. White, F.M. "Viscous Fluid Flow", McGraw Hill Pub. Co, NYork
4. Yalin, M.S. "Theory of Hydraulic Models", McMillan Co.
5. Fox R.W., Pitchard P.J, and Mcdonald A "Fluid Mechanics" Wiley India.
6. Rouse, H. "Advanced Fluid Mechanics", John Wiley & Sons, NYork
7. Mohanty A.K. "Fluid Mechanics", Prentice Hall of India, Delhi.
8. K. Subramanya, Theory and application of Fluid Mechanics, Tata Mc Grawhill, New Delhi.
9. Jain, A.K. Fluid Mechanics and Hydraulic machines
10. Patra K.C. "Engineering F.M.to Hydraulic Machines, Narosa Publishing House, Delhi

COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. Review and understand the continuity, momentum and energy equations for viscous, incompressible fluids and understand vorticity and circulation concepts and theorems.
2. Understand and utilize approximate solutions of the Navier-Stokes equation and Have a fundamental understanding of analytic and numerical methods used to solve fluid dynamics problems.
3. Understand the usage of tables and charts to determine properties for problem solutions and use the skill to develop models of real processes and systems and draw conclusions

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Syllabus (Effective from 2023-24)

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MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Refer Appendix-I for detailed Syllabus.

MC 2	MS6403	Research Methodology and IPR	2	0	0	2

Refer Appendix-I for detailed Syllabus.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

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LC 1	IP6541	Hydraulic Engineering Lab	0	0	4	2

Course Objectives:

1. To design experiments on various aspects of open channel and hydraulic jump.
2. To demonstrate hydraulic principles used in engineering design and apply them for solving problems.
3. To develop skills for analyzing experimental data, designing and conducting experiments, and working in teams.

List of experiments

1. Measurement of velocity profile in straight and meandering open channel;
2. Experiments on velocity distribution and Boundary shear in rough and smooth channels,
3. Discharge measurement by weir to find critical depth and Surface profile;
4. Characteristics of Hydraulic Jump in horizontal and Sloping Channels
5. Determination of Manning's N for Composite Sections
6. Velocity Distribution in Open Channels and momentum correction Factors
7. Drag coefficients of flow past cylinders
8. Boundary layer velocity profile.
9. Energy loss in Bends
10. Analysis of Distribution Networks

COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. Understand open channel cross sections, hydrostatic pressure distribution and Manning's law.
2. Determine water surface profiles, boundary layer and Velocity distribution profile for different types of flow in open channels.
3. Analyze distribution networks, energy loss in bends and drag coefficient of flow past cylinder.

AC 1	Any One from the List of AC 1 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

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2nd Semester

PC 2	IP6143	Advanced Hydrology	3	0	0	3

Course Objective:

1. To analyze hydrological modeling over varying spatial (catchment to global) and temporal scales.
2. To understand fundamental mechanisms of hydrologic cycle with the probabilistic approaches will be discussed in a logical progression. land-atmosphere interactions in relation to large-scale hydrological modeling, surface water-groundwater interactions in the context of increasing water exploitation, climate change, and sea level rise, use of remote sensing in hydrology, and human-water interactions.

Module-I

Statistics and Probability in Hydrology:

Probability and probability distributions – basic concepts, Properties of random variables 'Some discrete distribution and applications in earth sciences, Normal distribution and other continuous distributions, Parameter estimation theory and methods, Time series analysis.

Module-II

Hydrograph Theory: Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph, S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models - Time Area Diagram, Clark model, Nash model, Dooge models, synthetic unit hydrograph and its derivation

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.

Module-III

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.

Modelling Approaches in Hydrology:

Hydrological Model: Mathematical models and types, watershed models and types.

PRMS (Precipitation Runoff Modeling System) model, Hydrologic Modeling System (HEC-HMS), MODFLOW, ARIMA.

Text Books

1. Chow, V.T, Maidment, D.R., and Mays, L.W., Applied Hydrology, Tata McGraw Hill
2. McCuen, R.H., Hydrologic Analysis and Design, Prentice Hall Inc. N York, 2005
3. Patra, K.C, Hydrology and Water Resources Engineering, Narosa Publications, 2008
4. Singh, V.P. "Hydrologic Systems,", Prentice Hall Inc., NYork
5. Viessman, W., Lewis, G.L. and Knapp, J.W. "Introduction to Hydrology", Harper & Row Publications
6. Ponce, W.F. "Engineering Hydrology", Prentice Hall Inc. NYork.

Course Outcomes:

Upon successful completion of this course students will be able to:

1. Gain knowledge about fundamentals of hydrology and precipitation types and characteristics.
2. Analyze infiltration process, evaporation process and Calculate runoff using various measurements.
3. Analyze different components of hydrograph, derivation of various types of hydrograph using base hydrograph and formulate various models.
4. Estimate flood using various approaches, flood frequency analysis and methods and analyze flood routing.

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PE 1	IP6241	Water Resources System Planning and Management	3	0	0	3

Course Objectives:

1. To understand about the concepts of system analysis in the planning, design, and operation of water resources.
2. To formulate mathematical optimization methods and various programming models.
3. To use simulation and management techniques in water resources systems and apply this to water quantity management.
4. To analyze economical and legal aspects of Water Resources System and its effect on environment.

MODULE – I

Introduction:

General Principles of Systems Analysis to Problems in Water Resources Engineering, Water Resources Planning and Development, Nature of Water Resources Systems, Socio Economic Characteristics. Classical Optimization Techniques, Calculus method, Gradient Techniques

MODULE–II

Methods of Systems Analysis: Linear Programming Models, Simplex Method, Sensitivity Analysis, Dual Programming, Dynamic Programming Models,
Stochastic Programming, Simulation, Search Techniques, Multi Objective Optimisation.

Water Quantity Management: Surface Water Storage Requirements, Storage Capacity and Yield, Reservoir Design, Water Allocations for Water Supply, Irrigation, Hydropower and Flood Control, Reservoir Operations, Planning of an Irrigation System, Irrigation Scheduling, Groundwater management, Conjunctive Use of Surface and Subsurface Water Resources.

MODULE –III

Economic Analysis of Water Resources System: Principles of Engineering Economy, Capital, Interest and Interest Rates. Time Value of Money, Depreciation, Benefit Cost Evaluation, Discounting Techniques, Economic and Financial Evaluation, Socio-Economic Analysis.

Legal Aspects of Water & Environment Systems: Principles of Law applied to Water Rights and Water Allocation, Water Laws, Environmental Protection Law, Environmental Constraints on water Resources Development.

Text/Reference Books:

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

COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. Know about the general concepts and problems of water resource system and management.
2. Apply optimization methods to solve problems related to water resource systems.
3. Use simulation models for planning and design of Water Resources Systems.
4. perform basic economic analysis to evaluate the economic feasibility of water resources projects

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Syllabus (Effective from 2023-24)

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PE 1	IP6243	Design of Hydraulic Structure and Hydropower Engineering	3	0	0	3

Course Objectives:

1. To understand the basics of hydro power, classification of hydro plants.
2. To know the basics of Hydraulic structures along with the design of different components associated with it.
3. To analyze various hydraulic structures like concrete dam and spillway.
4. To get knowledge of various types of dam and understand different elements of dam.

MODULE –I

Introduction: Sources of Energy, Status of hydro power in the World. Transmission Voltages and Hydro-power, estimation of water power potential, General load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load.

Classification of Hydel Plants: Run off river plants, general arrangement of run off river plants, valley dam plants, diversion canal plants, high head diversion plants storage and pondage, Pumped storage plants: Types of Pumped storage plants, relative merits of two unit and three unit arrangement. Three-unit arrangement, reversible pump turbines, problems of operation, power house, efficiency of P-Splants.

Water Conveyance: Classification of penstocks, design criteria for penstocks, economical diameter of penstock, anchor blocks, conduit valves, types of valves, bends and manifolds, illustrative, water hammer, resonance in penstocks, channel surges, surge tanks.

Intakes: Types of intakes, losses of intakes, air entrainment at intakes, inlet aeration, canals fore bay, tunnels.

MODULE –II

Tidal power: Basic principle, location of tidal power plant, difficulties in tidal power generation, components of tidal power plants, modes of generation, single basin arrangement, double basin system.

Concrete Dams: Investigation and Planning. Forces on Concrete dams, Types of loads, Stability analysis. Safety criteria, Gravity analysis, Internal stress calculation and Galleries. Joints and keys and cooling arrangement. Water stops at joint, closing gaps. Buttress and Arch Dam. Mass concrete for dams: Properties and quality control. Pressure grouting.

Spillway: Types, Design principles of Ogee spillway, side channel spillway, Chute spillway, Siphon Spillway, shaft Spillway, Gates & Valves. Energy dissipators and stilling basin design. Outlet works.

MODULE –III

Earth and rock fill Dams: subsurface explorations methods, cutoff trenches, sheet piling cutoffs, upstream blankets, horizontal drainage blankets and filters, toe drains and drainage trenches, pressure relief well. Seepage through embankments, Stability analysis of slopes of homogeneous and zoned embankment type under different reservoir conditions, Upstream and downstream slope protection measures.

COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. Enhance knowledge on various concepts of hydro power generation and types of Hydel plants.
2. Select type of hydraulic structure and estimate tidal power, capacity and water load lines throughout various hydraulic structures.
3. Perform structural design and analyze the various aspects of different hydraulic structures.
4. Be able to select the type of dam, design and to construct.

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Syllabus (Effective from 2023-24)

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PE 1	IP6245	Modelling, Simulation and Optimization	3	0	0	3

Course Objectives:

1. To gain knowledge about fundamentals of systems and various models in computational field.
2. To analyze time series relation and spatial distribution aspects.
3. To apply knowledge of engineering mathematics to solve random variable problems.
4. To solve various mathematical problems using various simulation methods and optimization programming.

MODULE I

Systems and Models: Fundamentals of systemic approach, system modeling, classification of models, model structure, Linear, non-linear, time-invariant, time variant models, State-space models, Distributed parameter models, System Synthesis, Direct and inverse problems, Role of optimization, Role of computers, examples fromhydrology/water resources engineering

Regression Analysis: Linear and Multiple Regression analysis, analysis of residues,tests of goodness of fit, Parsimony criterion, role of historical data, examples from hydrology / water resources Engineering.

Spatial Distribution: Polynomial surfaces, Kirging, Spline functions,ClusterAnalysis

MODULE II

Time Series Analysis: Auto-cross correlation analysis, identification of trend, spectral analysis, identification of dominantcycles, smoothening techniques, Filters,time series of rainfall and stream flow.

Random variables: Basic concepts, probability density distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, covariance and correlation, commonly used theoretical probability distributions (uniform, normal, binomial, poisson's and negative exponential), Fitting distributions to raw data, Chi-square and Kolmogrov-Smirnov;s tests of the goodness offit, Central limit theorem, various algorithms for generation of random numbers.

MODULE III

Monte Carlo simulation: basic concepts, generation of synthetic observations,statistical interpretation of output, Evaluation of definite integrals.

Optimization: Introduction, Classical methods, Linear Programming, DynamicProgramming, Nonlinear optimization, Constrained optimization techniques.

Text/Reference Books:

1. Law, A.M. and Kelton, W.D., "Simulation Modeling and Analysis", Tata McGraw Hill, 2007.
2. Daniel, C. and Wood, P.S., "Fitting Equations to Data", John Wiley, 1980.
3. Ljung, L., "System Identification Theory for the Users", Prentice Hall, 1999.
4. Rao S. S., "Engineering Optimization,Theory and Pratice", New Age International Publishers, 2012.
5. Deb, K., "Optimization for Engineering design", Prentice Hall of India, 2006.
6. Vedula S. and Mujumdar P. P. "Water Resources Systems", Tata McGraw Hill, 2005.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

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Syllabus (Effective from 2023-24)

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PE 2	IP6242	Advanced Numerical Methods	3	0	0	3

COURSE OBJECTIVES:

1. To apply Computer oriented methods for solving numerical problems in science and engineering
2. To solve Numerically systems of simultaneous linear equations, nonlinear algebraic equations (root solving), differentiation and integration, ordinary differential equations, interpolation.

Module I:

Introduction: Introduction to numerical methods and analysis and computer programming; *Error Analysis:* Approximations; Round off and Truncation errors; Error Analysis. *Roots of Equations (single variable)*: Method of Bisection, Regular Falsi, Secant Method, Fixed point Method, Newton Raphson method, Multiple roots. Analysis and order of convergence. *Polynomials:* Mueller's method, Bairstow's method.

Solution of Linear System of Equations: Dense, Sparse and Banded systems, Direct Methods -Gauss Elimination, Gauss-Jordan, LU decomposition, Thomas Algorithm. Condition number of matrix, effect of round-off errors. Iterative improvement of solution by direct methods. Iterative methods: Jacobi and Gauss Seidel iteration, rate of convergence of iterative methods. Successive over Relaxation. *Solution of Nonlinear System of Equations*: Iterative methods, Fixed Point iteration, Newton-Raphson method.

Module II:

Approximation Theory: Approximation of Continuous functions -basis functions, norms and semi-norms, inner product, formulation of least square problem, derivation of normal equations, orthogonal basis functions. Tchebycheff and Legendre polynomials. Interpolating polynomials: Newton's divided difference polynomial, Lagrange polynomials. Interpolation using spline functions: linear, quadratic and cubic splines. *Polynomial regression* of discrete data. Transformation of nonlinear problems to linear approximation problems. *Eigenvalues and Eigenvectors*: Power method, inverse power method. *Fadeev-Leverrier method* for formulation of the Characteristic polynomials, QR decomposition.

Module III:

Numerical Differentiation: Introduction to finite difference approximations, truncation error analysis. Finite difference approximations on irregular grid. Richardson's extrapolation. *Numerical Integration*: Rectangular rule, Trapezoidal Rule and Simpson's rule. Local and global error analysis. Romberg Integartion. Gauss Quardrature, Improper Integrals. *ODE, Initial Value Problems*: Euler's method, improvement of Euler's method, Runge -Kutta Methods, Multi Steps Methods. Predictor Corrector Methods. *ODE, Boundary Value Problems*: Decomposition into Linear System of ODEs, Shooting Method, Direct Method. *Partial Differential Equations*: Elliptic, Parabolic and Hyperbolic Equations, Explicit and Implicit Methods, Crank Nicholson Method.

References

1. Jain M.K, SRK Iyenge and RK Jain, "Numerical Methods for Scientific &Engg. Computation".
2. Mathews J. H "Numerical Methods for Mathematics, Science and Engineering".
3. Gerald C.F and PO Wheatley "Applied Numerical Analysis".
4. Gupta S.C and V. K. Kapoor "Fundamentals of Applied Statistic", Sultan Chand & Sons.
5. Johnson R.A "Probability and Statistics for Engineers."
6. Rajeshwaran S, "Numerical Methods in Science & Engineering (A Practical Approach)", Willey Publication.

COURSE OUTCOMES: After the completion of the course the students will be able to

1: Familiarize with finite precision computation, numerical solutions of nonlinear equationsin a single variable.
2: Familiarize with numerical interpolation and approximation of functions, numerical integration and differentiation.
3: Familiarize with numerical solution of ordinary differential equations.
4: Familiarize with calculation and interpretation of errors in numerical methods

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Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
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PE 2	IP6244	Application of Soft Computing Techniques	3	0	0	3

Course Objectives:

1. To familiarize with soft computing concepts.
2. To gain knowledge about basics of ANN and neural network modeling.
3. To understand basics of the fuzzy logic concepts, fuzzy principles and relations.
4. To apply knowledge of neuro fuzzy application and formulate neuro fuzzy modeling.

MODULE –I

Introduction to Artificial Intelligence. Basics of MATLAB. Programming in MATLAB: Scripts and Functions, Graphics

MODULE –II

Fundamental concepts of Artificial Neural Networks: Model of a neuron, activation functions, neural processing, Network architectures, learning methods.

Neural network Models: Feed forward Neural Networks, Back propagation algorithm, Applications of Feed forward networks, Recurrent networks, Hopfield networks, Hebbian learning, Self organizing networks, unsupervised learning, competitive learning.

MODULE –III

Fuzzy Set Theory: Basic definitions and terminology and membership functions – Formulation and parameters, basic operations of fuzzy sets – complement, intersection vision, T-norm and T- conorm.

Fuzzy Reasoning and Fuzzy Inference: Fuzzy relations, Fuzzy rules, Fuzzy reasoning, Fuzzy Inference Systems, Fuzzy modeling, Applications of Fuzzy reasoning and modeling in Civil Engineering Problems.

Neuro - Fuzzy Modelling: Neuro-Fuzzy inference systems, Neuro-Fuzzy control. **Applications of Neuro-Fuzzy computing:** Hydrologic Modelling time series Analysis and modeling, , Prediction of watershed runoff, Optimal reservoir operation.

Text/Reference Books:

1. Jang, JSR, C.T. Sun and E. Mizutani (1997), "Neuro-Fuzzy and Soft Computing", Prentice Hall, NJ.
2. Haykin, S.(1994), "Neural Networks, A Comprehensive Foundation", McMillan College Publishing Company
3. Kosko, B. (1997),"Neural Networks and Fuzzy Systems", Prentice Hall of India Pvt. Ltd., New Delhi
4. Rao V and H. Rao, (1996), "C++" Neural Networks and Fuzzy Logic, BPB Publications, NewDelhi.
5. Pratap R (2010). Getting Started with MATLAB, OXFORD Publication.

COURSE OUTCOMES: Upon completion of this course students will be able to:

1. List the facts and outline the different process carried out in fuzzy logic and ANN.
2. Apply Soft computing techniques to solve character recognition, pattern classification, regression and similar problems.
3. Explain the concepts of soft computing and familiar with various computing soft wares.
4. Evaluate various techniques of soft computing to defend the best working solutions.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 2	IP6246	Advanced Irrigation Engg. and Drainage	3	0	0	3

Course Objectives:

1. To gain knowledge about various irrigation types, suitability and requirement.
2. To design various types of hydraulic structures like canals, head regulators and cross regulators using different factors.
3. To understand infiltration process and gain knowledge about fundamentals of surface irrigation hydraulics.
4. To analyze types, principle and needs of drainage system.

MODULE- I

Introduction: objectives of irrigation, type of irrigation and suitability; selection of irrigation method. Irrigation requirement, water balance, soil water relationships, water storage zone, infiltration. Flow of moisture through root zone, soil physical and chemical properties, crop evaporative and drainage requirements, irrigation efficiency and uniformity.

Design of lined and unlined channels: Design for clear and sediment laden water, principles of maximum and minimum permissible velocities, theory of sediment transport, discharge measuring devices. Design of distributaries head regulator and cross regulator: Hydraulic design principles, seepage theory, exit gradient, invert filter, protection works.

MODULE-II

Infiltration: infiltrometer, ponding methods, soil water, tensiometers, neutron probe, time Domain reflectometer, evapotranspiration, crop coefficient, leafarea index, FAO guidelineson evapotranspiration estimation.
Fundamentals of surface irrigation hydraulics, continuity equation, momentum equation Hydrodynamic model, zero inertia model, kinematic wave model.

MODULE- III

Types of drainage system, surface drains: layout and design of surface drains, their operation and maintenance. Drainage principles, need for drainage, steady state equations,. Salt balance, water and salt balance of the root zone, salt equilibrium equation and leaching requirement, leaching efficiency.

Text/Reference Books:

1. Walker, W.R., and Skogerboe, G.V., "Surface Irrigation Theory and Practice", Prentice Hall, INC.
2. Drainage Principles and Applications," International Institute for Land Reclamation and Improvement",Wageningen.
3. Michael, A.M., "Irrigation: Theory and Practice", Vikas Publishing House.
4. Asawa, G.L., "Irrigation Engineering", New Age International Publishers.
5. Majumdar, D.K., “Irrigation Water Management”, PHI Learning.
6. Luthin, J.N., "Drainage Engineering", John Wiley.

COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. Understand the concept of soil-water-plant relationship and can apply it to schedule irrigation.
2. Design various hydraulic structures.
3. Learn about infiltration process and fundamentals of surface irrigation hydraulics.
4. Know about types, principle and needs of drainage system.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

LC 2	IP6543	Hydrology Engineering Lab	0	0	4	2

Course Objectives:

1. To analyze precipitation data and determine Average rainfall for given catchment.
2. To determine water quality and parameters, hydrologic properties
3. To perform rainfall runoff studies, measurement of sediment transport.
4. To use computer programs to analyze simulation problems

List of Experiments:

1. Measurement of rainfall, evaporation, infiltration, laboratory and field tests.
2. Determination of average rainfall over a catchment.
3. Rainfall – Runoff Studies
4. Determination of Water Quality and Wastewater Parameters
5. Determination of In-situ soil Hydrological Properties
6. Measurement of sediment load; Water balance studies
7. Determination of Infiltration Characteristics
8. Determination of Hydraulic Conductivity with Constant Head Permeameter
9. Computer programs and software applications for hydrologic analysis and simulation problems.

Course Outcomes:

Upon successful completion of course students will be able to:

1. Determine average rainfall for given catchment.
2. Analyze rainfall runoff relationship.
3. Determine water quality, parameters, hydrologic properties.
4. Analyze sediment load, simulation problems of hydrology.

AC 2	Any One from the List of AC 2 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

3rd Semester

PC 3	IP6142	Applied Hydraulics	3	0	0	3

Course objectives: -

1. To develop an understanding of continuity, momentum and energy equations to uniform and non-uniform open channel flows
2. To understand the flow of water through open channels and sediment transport
3. To develop an understanding of continuity, momentum and energy equations to uniform and non-uniform open channel flows and to learn to apply conservation laws to gradually varied and rapidly varied unsteady flows.
4. To analyze hydraulics of mobile bed channel
5. To give an idea about bridge hydraulics.

Module I

Basic Concepts of Free Surface Flow, classification of flow, velocity & pressure distribution. Conservation laws, continuity equation, momentum equation, Uniform flow, Section of constant velocity, Specific energy, Specific force, Critical depth, Critical slope, limit slope, Section factor, First hydraulic exponent M, Second hydraulic exponent N, Channel Transitions, Compound section.

Module II

Non-uniform flow: Gradually varied flow, Characteristic of surface profiles, Integration of varied flow equation, Direct step method. Rapid Varied flow: Application of conservation laws, Hydraulic jump, classification, location and length of hydraulic jump, jumps in Non- rectangular channel, Jumps as energy dissipater, Surges in open channel, Positive surges, Negative surges, Dam break problem

Module III

Hydraulics of Mobile bed channel, Initiation of Motion of sediment, Critical analysis of Shield's diagram, Bed forms, and Predication of bed form. Design of stable channels: Critical tractive force approach

Bridge Hydraulics: Introduction to Bridge Hydraulics: Water ways, Afflux, Scour: Local scour, abutment scour, Indian practice of design for scour.

Text/Reference Books:

1. Chow .V.T. "Open Channel Hydraulics", McGraw Hill . New York
2. Henderson. "Open Channel Flow", McMillan Pub.London..
3. Subramanya, K "Flow in Open Channels", Tata McGraw Hill Pub., 1995
4. Garde and Ranga Raju, K.G. "Mechanics of Sediment Transportation and Alluvial Stream Problems", Wiley Eastem, New Delhi
5. Chaudhry M.H. "Open – Channel Flow", Prentice Hall of India, New Delhi
6. French, R.H. "Open Channel Hydraulics", McGraw Hill Pub Co., New York
7. Hamill L. (1999), Bridge Hydraulics, E & FN Spon,London

Course outcomes:

By the end of the course applied of hydraulics, the students will be able to --

1. Ability to apply continuity, momentum and energy equations to uniform and non-uniform open channel flows.
2. Apply conservation laws to gradually varied and rapidly varied unsteady flows .
3. Ability to analyse hydraulics of mobile bed channel.
4. Know about bridge hydraulics.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 3	IP6248	Water Quality Modeling and Management	3	0	0	3

Course objectives:-

1. To develop an understanding of monitoring the water quality.
2. To provide the knowledge on transport and transformation of contaminants in ground water.
3. To learn about Estuaries
4. To understand concept for groundwater quality management

MODULE- I

Water quality description: Various characteristics of water, water quality criteria and standards, elements of reaction kinetics, spatial and temporal aspects of contaminant transport, transportmechanism-advection,diffusion,dispersion;Riverandstreams,convective
Diffusion equation and its application.

MODULE-II

Estuaries: Estuarine hydraulics, Estuarine water quality models; Lakes and reservoirs, eutrophication; Contaminant transport in unsaturated flows, solute transport models for conservative species, solute transport in in spatially variable soils.

MODULE- III

Contaminant transports in ground water advection: Dispersion, one dimensional transport with linear adsorption, dual porosity models, numerical models, bio degradation reaction.

Water quality management: Socio-economic aspects of water quality management, management alternatives for water quality control, waste load allocation process, lake quality management, ground water remediation.

Text/Reference Books:

1. Thomann and Muller, Principles of surface water quality modeling and control
2. Chapra, Surface water quality modeling.
3. Schnoor, Environmental Modeling.
4. Thomann, System Analysis And Water Quality Management

Course outcomes: Upon successful completion of course the students will be able to:

1: Understand and interpret water quality data for beneficial uses in water quality models.
2: Have knowledge on transport and transformation of contaminants in ground water.
3: Understand the basics of groundwater quality management

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 3	IP6250	Remote sensing and GIS Application in Water Resources Engineering	3	0	0	3

Course objectives:-

1: To understand the interaction of electromagnetic interaction with matter by using remote sensing.
2: To learn to integrate remote sensing and GIS analysis.
3: To develop an understanding of remote sensing and GIS applications in water resources engineering.

MODULE- I :

Remote Sensing

Basic Concepts of Remote sensing: Definition, Principle of remote sensing, Electromagnetic spectrum, interaction of EMR, Spectral reflectance curve.
Remote sensing System: Satellite and orbit, Resolutions, Multispectral, Thermal, Hyper spectral remote sensing. Data: acquisition platforms, products, Data analysis: Visualization, interpretation, image classification.

MODULE-II :

Geographic Information System

Introduction to GIS: Definition and terminologies, GIS architecture, components of GIS, the four Ms, Advantages and disadvantages of GIS.
GIS data models: Spatial data models, Database models. Process of GIS: data capture, data sources, data encoding, data analysis.
Maps: types, scale, symbol, characteristic, use. Coordinate systems: definition, types. Map Projection: definition, types

MODULE- III :

Application in Hydrology:

Flood Mapping, surface soil study, land use-land cover, Agriculture: crop mapping and crop monitoring, Forestry: deforestation, burn mapping, Ocean and coastal monitoring: ocean features, sea-surface height and roughness. Case studies

Application in Watershed management : Flood plain mapping, Soil: soil moisture, characteristic, Planning: rban planning and Regional planning, Case studies

Text/References Books:

1. Remote Sensing and GIS by Basudeb Bhatta, Oxford; Second edition
2. Introduction to Geographic Information System by Kang-Tsung-Chang, McGraw-Hill Higher Education,4th edition.
3. Lillesand T.M. and Kiefer R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, N York.
4. Meijerink A. M. J., H. A. M. de Brouwer, C. M. Mannaerts and C. R. Valenzuela, "Introduction to the use of Geographic Information Systems for Practical Hydrology", ITC Publication, Paris.
5. Swain P.H., and S.M. Davis, "Remote Sensing – The Quantitative Approach", McGraw Hill Publishing Company, N York.
6. John G. Lyon, "GIS for Water Resource and Watershed Management", CRC Press.

Course outcomes:

Upon successful completion of course the students will be able to :
1: Integrate remote sensing and GIS analysis.
2: Know about scope of remote sensing and GIS in water resources and environmental systems.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 3	IP6252	Hydrometry, Water acts and Water services	3	0	0	3

Course Objectives:

1. To have knowledge of real time data acquisition and transmission system
2. To understand concept of procedure for water allocation and pricing

MODULE-I

Real time Data Acquisition and transmission system, Data Bank and Instant Hydro-meteorological Data Querry System for River Basins, Use of Acoustic Doppler Current Profiler (ADCP), Acoustic Doppler velocimeter, Flow Tracker for discharge measurement , Digital flow measuring devices for pipe flow.

MODULE-II

Sewer Analysis, Surface Hydrologic Modeling, Subsurface Modeling in Water Resources Environmental Flow.
Land acquisition, RR, Right to fair compensation and transparency in land acquisition, Rehabilitation and resettlement act. Critical Issues in Land Acquisition in LA and RR.
Canal Acts and Rules, Brief Introduction to IS Codes, Water Law Framework, Odisha Irrigation act and Rules, Pani Panchayat Act, Monitoring various committees, Funding Agencies and Monitoring Committees for Water resources projects. Procurement Guidelines. EPC Contract Methodology and Bidding: Appointing PEC, PMF, TPAI for Turnkey Projects for effective monitoring.

MODULE-III

Procedure for Water Allocation to Industrial / Commercial and other establishments (in different states). Pricing and recovery procedure for Industrial / Commercial and other establishments. Odisha Irrigation acts and rules. Lift Irrigation, Broad conceptual planning of a Mega Lift Scheme, Distribution network planning and design.

Texts/Reference Books:

1. Gupta S V. (2002) Practical Density Measurement and Hydrometry. Institute of Physics Publishing. Bristol.
2. IndiaWater Acts
3. Pani Panchayat Rules
4. LandAquisitionRules
5. Canal Act Rules
6. Irrigation Acts and Rules

Course Outcomes:

Upon successful completion of course the students will be able to:

1: Identify the Real Time Data Acquisition and transmission system
2: Analyze the Critical Issues in Land Acquisition in LA and RR.
3: Understand the Procedure for Water Allocation and Pricing; and recovery procedure.

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE),
Duration: 3 years (Six Semesters)

OE 1	Any One from the List of OE 1 (Appendix-I)	3	0	0	3

Refer Appendix-I for detailed Syllabus.

PR 1	IP6642	Project (Specialization Related)	0	0	4	2

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

4th Semester

PC 4	IP6144	Ground Water Hydrology	3	0	0	3

Course objectives:-

1. To get concept of various surface and subsurface geophysical methods for groundwater explorations
2. To provides an insight into forecasting and behaviour of a regional aquifer system.
3. To know about design principles of well
4. To understand concept for groundwater management and modelling

MODULE- I

Hydrogeology: Porosity and Permeability of Rocks, Groundwater in Igneous, Metamorphic, Sedimentary Rocks, Hydrogeological Regions of India.

Occurrence of ground water: Origin, Hydrologic cycle, Water balance, geological formations as aquifers, type of aquifers, groundwater basins, springs. Isotropic and anisotropic aquifer

Well Hydraulics: Darcy's Law, validity of Darcy's Law, permeability, laboratory and field measurement of permeability, groundwater Flow lines. Steady flow to a well, steady radial flow to a well in confined aquifer and unconfined aquifer

Unsteady radial flow into a confined aquifer, Non equilibriumTheis equation, Theis method of solution, Cooper-Jacob method, Chow's method, Recovery of drawdown, Cyclic discharge, partially penetrated well, well loss, step-drawdown method, Unsteady radial flow into unconfined aquifer, multiple well system, Leaky aquifer, Image well theory

MODULE-II

Well Construction: Shallow and Deep well, Methods of constructions of shallow and deep wells, Cable tool, Hydraulic rotary method, Well development, Well screen, Well completion, testing of wells for yield

Geophysical Exploration: Aerial photo interpretation, remote sensing applications to ground water exploration, test drilling, Surface and Subsurface investigations of groundwater

Groundwater Fluctuations: Seasonal and secular variations, fluctuation due to irrigation, stream flow, rainfall and miscellaneous causes.

MODULE-III

Artificial recharge of Ground water: By water spreading, through pits and shaft, recharge through other methods

Groundwater pollution: Municipal sources, liquid wastes from domestic uses, solid wastes, Industrial sources, tank and pipeline leakage, Mining activity, agricultural sources, septic tank and cesspools, saline water intrusion in coastal aquifers, methods to control saline water intrusion

Groundwater Management: Concepts of Basin management, Equation of hydrologic equilibrium, Groundwater basin investigations, conjunctive use of surface and groundwater.

Groundwater Modeling: Groundwater Flow, mathematical, Analog and Digital modeling

Text/Reference Books:

1. Todd, D.K. "Groundwater Hydrology", John Wiley & Sons,Singapore
2. Raghunath, H.M. "Groundwater", Wiley Eastern Ltd, NDelhi
3. Davis, S.N. and De Weist, R.J.M. "Hydrogeology", John Wiley & Sons, New York
4. Bear, J., "Hydraulics of Ground Water", McGraw.
5. Sharma, H.D.and Chawla, A.S."Manual on Ground water and Tube Wells",Technical Report No. 18, CBIP, New Delhi,
6. Domenico "Concepts and models in Groundwater Hydrology", McGraw Hill Inc. New York
7. Garg, S.P. "Groundwater and Tube Wells", Oxford and IBH Publishing C. New Delhi.
8. Freeze and Cherry, "Ground Water", Prentice Hall.
9. Driscoll, F.G., "Ground Water and Wells", Johnson Division.

Course outcomes: Upon successful completion of course the students will be able to:

1: Know about various surface and subsurface geophysical methods for groundwater explorations.
2: Understand about well hydraulics.
3: Know about design principles of well
4: Understand the basics of groundwater management and modeling.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 4	IP7241	Fluvial Hydraulics	2	0	0	0

Course Objectives: -

1: To understand the concepts of sediment properties, sediment transport and its assessment.
2: To introduce the flow characteristics in an alluvial channel with erodible boundary and their Hydraulic Geometry
3: To analyze hydraulics of mobile bed channel

MODULE- I

Introduction: Nature of sediment problems, origin of sediments, Fundamental properties of individual sedimentary particles, bulk properties of sediments.
Incipient motion: competent velocity, lift concept, critical tractive force.
Regime of Flow: Description of Regime of flow, Types of regimes of flow, Importance of Regimes of flow, prediction of regimes of flow.
Bed load transport: Derivation of bed load transport equation based on dimensional analysis, semi-theoretical equations. Saltation

MODULE- II

Suspended load transport: Mechanics of suspension, General equation of diffusion, sediment distribution equation.
Total load transport: Two approaches to the problem, Microscopic method, Macroscopic methods.
Alluvial Streams and their Hydraulic Geometry: Geomorphic cycle, various stages of streams, nature of bed materials, variable in stream problems.

MODULE- III

Stream Bed Variation: Continuity equations for sediments, equilibrium depth of scour in long channels, stream bed changing during floods, degradation, Aggradation
Sediment control: Methods of sediment control in canal, river training works for control of sediment in rivers and streams, reservoir sedimentation, best management practices for control of reservoir sedimentation.

Text/Reference Books:

1. Garde, R.J., “River Morphology”, New InternationalPublishers.
2. Julien, P.Y., “Erosion and Sedimentation”, Cambridge UniversityPress.
3. Jansen, P.P.H., “Principals of River Engineering”, VSSDPublications.
4. Garde, R.J. and Ranga Raju, K.G., "Mechanics of Sediment Transport and Alluvial Stream Problems", Wiley EasternLimited.

Course Outcomes:

Upon successful completion of course the students will be able to:
1: Analyze the concepts of sediment properties, its transport and assessment.
2: Understand hydraulics of mobile bed channel
3: Apply field applications in the domain of hydraulics

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 4	IP7243	Hydrologic System Modeling	2	0	0	0

Course Objectives:

1. To study occurrence movement and distribution of water that is a prime resource for development of a civilization.
2. To know diverse methods of collecting the hydrological information, which is essential, to understand surface water hydrology.
3. To analyze the concepts of probability distributions and design frequencies.

MODULE- I

Hydrologic cycle: Climate and water availability, Water balance, Precipitation mechanisms, Measurement of precipitation, Infiltration, Evaporation and transpiration, Surface run off, Hyetographs, Hydrographs, Derivation of UH, S-curve, Climatic Modeling- Regional Climate Models (RCMs) and General Circulation Models (GCMs).

MODULE-II

Application of UH: Derivation of an average UH, Conceptual models, Traditional analysis vs. hydrological simulation, Monte-Carlo simulation Generation of random numbers, Simulation of systems with random inputs, Developing synthetic unit hydrograph, Development of rainfall runoff relationship, Flow duration curves, Flood routing.

MODULE- III

Probability distributions: Probability functions for hypothesis testing, Statistical analysis for linear regression, Multiple linear regression, Method of parameter estimation, Return period flood estimation, Estimation of flood discharge for a confidence interval, Regional flood frequency analysis, Risk and reliability concepts, Binomial distribution, Poisson distribution.

Design frequencies: Peak over threshold (POT) models, Mechanical energy and fluid potential, Fluid potential and hydraulic head, Darcy's law, Gradient of hydraulic head, Aquifer properties, Equation of groundwater flow, Unsaturated Flow: Unsaturated Hydrostatics and Hydrodynamics.

Text/Reference Books:

1. K.C. Patra, Hydrology and Water resources Engineering, by Narosa publishing house, New Delhi
2. K. Subramanya, Engineering Hydrology, Tata McGraw Hill BookCompany
3. V.P.Singh,"ElementaryH ydrology", Prentice Hall of India, Pvt. Ltd., New Delhi.
4. V.T. Chow, Hand book of Applied Hydrology, Mc Graw-Hill Publishing Company, New York.
5. M.A. Kohlar, J.L.H Pauluhus, R.K.Linsely, Hudrology for Engineers, Tata Mc Graw Hill, New Delhi.

Course Outcomes:

Upon successful completion of course the students will be able to :

1. Gain knowledge about hydrological parameters and its measurement procedures.
2. Identify the problems related to hydrological variables by using hydrological tools.
3. To analyze hydrographs for its application in real world problems.
4. Design frequencies and understand probability distribution.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

PE 4	IP7245	Ground water Assessment and Development	2	0	0	0

Course Objectives:

1: To have knowledge of groundwater as an important natural resource.
2: To understand the flow towards wells in confined and unconfined aquifers. and the principle involved in design and construction of wells and well hydraulics.
3: To create awareness on improving the groundwater potential using various recharge techniques.
4: To appreciate various geophysical approaches for groundwater exploration.
5: To learn groundwater management using advanced tools.

MODULE- I

Importance of GW: Available water on earth, Hydrologic cycle, types of aquifer, storage coefficients, ground water basins, Darcy's law, permeability, well hydraulics, pumping test, water wells, test holes and well loss, Methods of Drilling of deep wells, cable tool drilling method, rotary method, pumps.

MODULE-II

Surface investigation of groundwater: Remote sensing, geophysical exploration, electrical resistivity method, seismic refraction method, gravity and magnetic methods, water witching, sub surface investigation of ground water: test drilling, geologic logging, geophysical logging, resistivity logging.

MODULE- III

Artificial recharge of groundwater:

Conjunctive use of water, managing our water resources, Erosion control and watershed development :their benefit towards conservation of national water wealth.

Rain water harvesting and recharge of ground water: Role of society and People's participation for sustainable water resource development. Mitigation strategies for flood damage: structural and non-structural measures.

Text/Reference Books:

1. Todd, D.K. "Groundwater Hydrology", John Wiley & Sons,Singapore
2. Ground Water Manuals, A water resources technical Publications, Scientific Publishers, Jodhpur
3. L. Harviland F.G. Bell, Ground Water Resources and Development, Butter worths, London.
4. H.M. Raghunath, Ground Water, New Age International Pvt. Ltd.
5. F.W. Schwartz & H. Zhang, Fundamental of Ground Water, John Willey &Sons.
6. Murty JVS, "Watershed Management", New Age International Pvt. Ltd.

Course Outcomes:

Upon successful completion of course the students will be able to:

1: Analyze radial flow towards wells in confined and unconfined aquifers.
2: Design wells and understand the construction practices.
3: Interpret geophysical exploration data for scientific source finding of aquifers.
4: Determine the process of artificial recharge for increasing groundwater potential.
5: Apply appropriate measures for groundwater management.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE), Duration: 3 years (Six Semesters)

LC 3	IP6542	Software Lab	0	0	4	2

Course Objectives:

1. To gain knowledge about satellites and visual interpretation techniques.
2. To demonstrate ARC GIS software and perform various tool work using the software.
3. To apply software techniques to prepare maps and legends.
4. To formulate various models in the field of surface water, ground water, catchment using Software

List of Experiments:

1. Study of different types of satellite data
2. Visual interpretation of satellite images of different resolutions.
3. Demo on ARC GIS
4. Extraction of thematic information from satellite images Mapping of Land use and land cover Geological and structural features
5. Digitization of Points and Lines Editing Map Elements
6. Attribute Data Entry and Manipulation
7. Building and Transformation Data Analysis – Overlay, Buffer
8. Map Generation with Patterns and Legends
9. Introduction to QGIS s/w
10. Modeling of surface water, ground water, catchment

COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. Learn about satellites, visual interpretation techniques.
2. Perform ARC GIS and QGIS software.
3. Prepare models using various techniques and software.

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE),
Duration: 3 years (Six Semesters)

5th Semester

PR 2	IP7641	Dissertation (Phase-I)	0	0	24	12

ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Infrastructure and Planning
Course: M. Tech. (SSP, Part Time), Programme: Water Resources Engineering (WRE),
Duration: 3 years (Six Semesters)

6th Semester

PR 3	IP7642	Dissertation (Phase-II)	0	0	32	16