

DEPARTMENT OF CIVIL ENGINEERING

COURSE STRUCTURE

(1ST – 4TH SEMESTER)

FOR

M. TECH PROGRAMME

SPECIALISATION

IN

WATER RESOURCES ENGINEERING

(EFFECTIVE FROM July 2019)



**VEER SURENDRA SAI UNIVERSITY OF
TECHNOLOGY**

(FORMLY, UNIVERSITY COLLEGE OF ENGINEERING)

BURLA – 768 018, SAMBALPUR, ODISHA

Vision:

To emerge as an internationally acclaimed Civil Engineering Department for imparting futuristic technical education and creation of vibrant research enterprise to create quality civil engineers and researchers, truly world class leaders and unleash technical innovations to serve the global society and improve the quality of life.

Mission:

The Department of Civil Engineering, VSSUT Burla strives to create values and ethics in its products by inculcating depth and intensity in its education standards and need based research through

- Participative learning in a cross-cultural environment that promotes the learning beyond the class room.
- Collaborative partnership with industries and academia within and outside the country in learning and research.
- Encouraging innovative research and consultancy through the active participation and involvement of all faculty members.
- Facilitating technology transfer, innovation and economic development to flow as natural results of research wherever appropriate.
- Expanding curricula to cater broader perspectives.
- Creation of service opportunities for upliftment of the society at large.

POs

- An ability to independently carry out research /investigation and development work to solve practical problems
- An ability to write and present a substantial technical report/document
- Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
- Ability to apply knowledge of mathematics, science and engineering to solve complex problems in civil engineering
- Ability to identify, formulate, and solve complex civil engineering problems using first principle of mathematics, basic science & engineering
- Ability to design and conduct complex civil engineering experiments as well as to analyze and interpret the experimental data

PEOs:

- To lead a successful career in industries, pursue higher studies and entrepreneurial endeavors.
- To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.
- To demonstrate effective communication skill, professional attitude and a desire to learn.

PSOs:

- Plan, analyze, design, prepare and execute all kinds of Water Resources Engineering projects.
- Apply latest construction techniques for successful completion of time bound Water Resources Engineering projects with optimized cost.

**Course Structure for
PG Programmes (WATER RESOURCES ENGINEERING/CE) to be introduced from July 2019**

Semester I

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-1	PPCCE105	Advanced Fluid Mechanics	3	0	0	3
2	Core-2	PPCCE106	Advanced Hydrology	3	0	0	3
3	PE-1		Programme Elective 1	3	0	0	3
4	PE-2		Programme Elective 2	3	0	0	3
5	Common		Research Methodology & IPR	3	0	0	3
6	Lab-1	PLCCE105	Hydraulic Engineering Laboratory	0	0	3	2
7	Lab-2	PLCCE106	Geoinformatics Laboratory	0	0	3	2
8	Audit -1						
Total Credits							19

Semester II

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-3	PPCCE205	Advanced Hydraulics	3	0	0	3
2	Core-4	PPCCE206	Ground Water Hydrology	3	0	0	3
3	PE-3		Programme Elective 3	3	0	0	3
4	PE-4		Programme Elective 4	3	0	0	3
5	Common		Mini project	0	0	3	2
6	Lab-3	PLCCE205	Irrigation and Drainage System Design	0	0	3	2
7	Lab-4	PLCCE206	Hydrology Engineering Laboratory	0	0	3	2
8	Audit -2						
Total Credits							18

Semester III

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	PE-5		Programme Elective 5	3	0	0	3
2	OE-1		Open Elective 1	3	0	0	3
3	Minor Project		Dissertation (Phase-I)	0	0	20	10
Total Credits							16

Semester IV

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Major Project		Dissertation (Phase-II)	0	0	32	16
Total Credits							16

GRAND TOTAL CREDITS: 19+18+16+16= 69

Sl. No.	Course Code	Programme Elective I
1	MWRPE101	Numerical Methods in Engineering
2	MWRPE102	Application of Soft Computing Techniques in Civil Engineering
3	MWRPE103	Water Resources Systems planning and Management
4	MWRPE104	Modelling, Simulation and Optimization

Sl. No.	Course Code	Programme Elective II
1	MWRPE105	Global Warming & Climate Change
2	MWRPE106	Neuro-Fuzzy Applications in Water Resources Engineering
3	MWRPE107	Hydraulic Structures and Hydropower Engineering
4	MWRPE108	Finite Element Method

Sl. No.	Course Code	Programme Elective III
1	MWRPE201	Urban Drainage Sewage System and Water Distribution System
2	MWRPE202	Water Quality Modeling and Management
3	MWRPE203	Hydrometry, Water acts and Water services

Sl. No.	Course Code	Programme Elective IV
1	MWRPE204	Remote Sensing and GIS Applications in Water Resources Engineering
2	MWRPE205	Ground Water Quality, Pollution and Control
3	MWRPE206	Computational Fluid Dynamics

Sl. No.	Course Code	Programme Elective V
1	MWRPE301	Environmental Impact Assessment
2	MWRPE302	Sediment Transport
3	MWRPE303	River Engineering

Sl. No.	Course Code	Open Elective I
1	MWROE101	Disaster Management and Mitigation
2	MWROE102	Project Planning and Management
3	MWROE103	Non-Conventional Energy
4	MWROE104	Computational and Statistical Methods

Sl. No.	Course Code	Audit course 1 & 2
1.	BCAC1001	English for Research Paper Writing
2.	BCAC1002	Disaster Management
3.	BCAC1003	Sanskrit for Technical Knowledge
4.	BCAC1004	Value Education
5.	BCAC2001	Constitution of India
6.	BCAC2002	Pedagogy Studies
7.	BCAC2003	Stress Management by Yoga
8.	BCAC2004	Personality Development through Life Enlightenment Skills.

Detailed Syllabus

Semester-1

Core-I

ADVANCED FLUID MECHANICS (PPCCE105)

L	T	P	C
4	0	0	3

Course Objectives:

1. To make the students ready for deriving the partial differential equations governing the conservation of mass, momentum, and energy of the fluid flow.
2. To gain the knowledge of potential flow and its applications.
3. 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.
4. Development of knowledge of boundary layer, various equations and applications to solve various problems.
5. To learn the phenomenon of turbulence.

MODULE- I

Brief recapitulation of some preliminary concepts of 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, vorticity, Stream lines, equipotential lines, stream function, velocity potential function, and their applications.

MODULE-II

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, D'Alembert's paradox

MODULE –III

Dynamics of viscous flow: Laminar Viscous Flow, The Viscous Stress, The viscous Force, Differential Approaches in Analysis of Viscous Flows Equations of motion for laminar flow of a Newtonian fluid – Derivation of Navier-Stokes equation, Approximate solutions to N-S Equation, Applications of the Navier-Stokes Equation

MODULE –IV

Boundary Layer Theory: Boundary Layer Concept, Prandtl's Boundary Layer Equations, Laminar Boundary Layer along a Flat Plate, Falkner-Skan Similarity Solutions of the Laminar Boundary-Layer Equations, Integral Momentum Equation, Blasius Solution. Karman-Pohlhausen approximate solution, separation in boundary layer under adverse pressure gradient, Turbulent Boundary Layer and Boundary Layer Separation, Flow past immersed bodies: Flow Due to an Oscillating Plate, Low Reynolds Number Viscous Flow Past a Sphere, Flow Past a Circular Cylinder at Low Reynolds Numbers, Moderate Reynolds Numbers, and High Reynolds Numbers; Drag and lift; Applications of Boundary layer concept to real life problems.

MODULE – V

Turbulence: Origin of turbulence, universal velocity distribution, laws of turbulence. Turbulent Flow obtained from N – S Equations, Models for Turbulence, Measurement of Turbulence, Theories of Turbulent Shear Stresses, semi-empirical theories of turbulence, and Statistical Theory of Turbulence: Isotropic and homogeneous turbulence, probability density functions, correlation coefficients, decay of isotropic turbulence.

Text Books:

Biswas, G, Som, S.K. and Chakraborty, S, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill Education Pvt. Ltd.

Jain, A. K. "**Fluid Mechanics including Hydraulic Machines**", Khanna Publishers, New Delhi

Reference Books:

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

COURSE OUTCOMES:

Upon completion of this course students will be able to:

- Apply the continuity, momentum and energy equations for fluid flow.
- Apply the approximate solutions of the Navier-Stokes equations for solving problems related to fluid flow
- Demonstrate the laws applied to fluid flow phenomena.

- Design the experiments on turbulence models.
- Apply the knowledge of boundary layer to real life problems.

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	2	2	-	-	-
CO 2	1	3	2	-	-	-
CO 3	2	3	3	-	-	-
CO 4	3	3	3	-	-	-
CO 5	3	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	3	3	0	0	0

ADVANCED HYDROLOGY (PPCCE106)

L T P C
3 0 0 3

Module I (8 hours)

Introduction, Hydrologic cycle, systems concept, hydrologic system model, hydrologic model classification, development of hydrology, Hydrologic processes, Reynolds Transport theorem, continuity equation, discrete time continuity, momentum equations, open channel flow, porous medium flow, energy balance, transport processes, atmospheric water, subsurface water, surface water, hydrologic measurement sequence, measurement of atmospheric, surface and subsurface water, hydrologic measurement systems, measurement of physiographic characteristics

Module II (8 hours)

General hydrologic system model, response functions of linear systems, unit hydrograph, unit hydrograph derivation, unit hydrograph application, unit hydrograph by matrix calculation, synthetic unit hydrograph, and unit hydrographs for different durations

Lumped flow system routing, level pool routing, Runge-Kutta method, hydrologic river routing, linear reservoir model, distributed flow system routing, Saint-Venant equations, classification of distributed flow routing models, wave motion, analytical solution of kinematic wave, finite-difference approximations, numerical solution of kinematic wave, Muskingum-Cunge method

Module III (8 hours)

Probabilistic treatment of hydrologic data, frequency and probability functions, hydrologic statistical parameters, fitting a probability distribution, probability distributions for hydrologic variables

Return period of hydrologic events, extreme value distributions, frequency analysis using frequency factors, probability plotting, U.S. Water Resources Council method for flood flow frequency studies, reliability of frequency analysis

Module IV (8 hours)

Design precipitation depths, Intensity-duration-frequency relationships, design hyetographs from storm event analysis, design precipitation hyetographs from IDF relationships, estimated limiting storms, calculation of probable maximum precipitation (PMP)

Module V (8 hours)

Hydrologic design scale, selection of hydrologic design level, first order analysis of hydrologic systems uncertainty, composite risk analysis, risk analysis of safety margins and safety factors
Storm sewer design, simulating design flows, flood plain analysis, flood control reservoir design, flood forecasting, and design for water use

Text Books:

- Chow, V.T. (2010) “Applied Hydrology”, Tata McGraw-Hill Education.
- Subramanya, K. (1994) “Engineering Hydrology”, Tata McGraw-Hill Education.

Reference Books:

- Beven, K.J. “Rainfall-Runoff Modelling-The Primer” John Wiley and Sons Ltd.
- Raghunath, H.M. “Hydrology: Principles, Analysis, Design” New Age International Publisher.

Course Outcomes:

1. Discuss Hydro-meteorological elements and hydrological processes.
2. Formulate unit hydrograph methods, applications and processes.
3. Use of probability distributions and estimation.
4. Justify different aspects of rainfall design.
5. Predict risk, uncertainties and design of hydraulic structures.

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	2	-	-	-
CO 2	3	2	3	-	-	-
CO 3	3	3	3	-	-	-
CO 4	3	3	2	-	-	-
CO 5	3	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	0	0	0

HYDRAULIC ENGINEERING LABORATORY (PLCCE105)

L T P C
0 0 3 2

Experiments:

1. Study of discharge measuring, pressure measuring, velocity measuring and depth measuring equipments.
2. Verification of Bernoulli’s theorem.
3. Determination of Darcy-Weisbach friction factor and study of Moody’s chart for pipe flow.
4. Study of flow patterns using Reynold’s apparatus.
5. Determination of coefficient of discharge for venturi meter and orifice meter.
6. Determination of coefficient of discharge for V-notch and rectangular notch.
7. Study of boundary layer growth for open channel flow using velocity profile.
8. Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for circular orifice.
9. Determination of specific energy and its applications using hump and width constriction for open channel flow.
10. Establishment of different types of hydraulic jumps and surges & determination of their characteristics.

COURSE OUTCOMES:

Upon completion of this course students will be able to:

- Calculate discharge, velocity, depth and pressure related to fluid flow.
- Distinguish flow patterns.
- Measure discharge through pipes and in open channels using various instruments.
- Use specific energy to solve different fluid flow problems.
- Design hydraulic structures against erosion using principles of hydraulic jumps and surges.

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	3	-	-	-
CO 2	3	3	3	-	-	-
CO 3	3	3	3	-	-	-
CO 4	3	3	3	-	-	-
CO 5	3	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	0	0	0

GEOINFORMATICS LABORATORY (PLCCE106)

L	T	P	C
0	0	3	2

Exercises

1. Familiarization with the GIS software
2. Defining Projection, Datum and Coordinate System of Maps
3. Reprojection and Coordinate Transformation of Maps
4. Geodatabase Creation
5. Onscreen Digitization of Point, Line and Polygon features and Creation of Point, Line and Polygon layers
6. Creation of Spatial Data from Non-spatial Data
7. Georeferencing of Spatial Data
8. Topology Creation of spatial data and Removal of Topological Error
9. Thematic Map Creation and Map Compilation for Point, Line and Polygon data
10. Attribute Data Integration with Spatial Data- Measurement of Co-ordinates of Point, Length of Line, Area and Perimeter of Polygon
11. Map Joining and Edge Matching
12. Map Designing-Layout Creation
13. Performing Vector Analysis of Spatial Data
14. Performing Raster Analysis of Spatial Data-Application of Digital Elevation Model
15. Data Conversion – Vector to Raster format and Raster to Vector format
16. Data Interchange – Conversion to Interchange Format
17. Linking External Database and Tabular Data Analysis
18. Generating Graphs, Charts and Diagrams from Tabular data

Course outcomes:

1. Use GIS concept, map and co-ordinate system of maps
2. Create vector layers

3. Illustrate georeferencing and deal with spatial data from non-spatial data
4. Practice thematic maps
5. Produce vector and raster analysis of spatial data, generation of charts, tables and other analysis.

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	3	2	2	2
CO 2	3	3	3	-	-	-
CO 3	3	3	3	2	2	-
CO 4	3	3	3	-	-	-
CO 5	3	3	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	1	1	1

NEURO-FUZZY APPLICATIONS IN CIVIL ENGINEERING (MWRPE106)

L T P C
3 0 0 3
(8 hours)

Module I

Artificial intelligence and soft computing: Introduction, constituents, characteristics, comparison between conventional artificial intelligence and computational artificial intelligence

Biological neural network, Artificial neural network: fundamental concept, definition, evolution, advantage, application scope, Comparison between biological neural network and artificial neural network

Basic models of artificial neural network: connections, learning, activation functions, weights, bias, threshold, learning rate, momentum factor, McCulloch-Pitts neuron, Hebbian network

Module II (8 hours)

Supervised learning networks: Introduction, Perceptron network, adaptive linear neuron, multiple adaptive linear neuron, back-propagation network, and radial basis function network

Associative memory networks: Introduction, Auto-associative memory network, hetero-associative memory network, bidirectional associative memory network, hopfield network, iterative auto-associative memory network

Unsupervised learning networks: Introduction, Fixed weight competitive network, Kohonen self-organizing feature map

Module III (8 hours)

Introduction to fuzzy logic

Classical set theory: Operation, properties, function mapping

Fuzzy set theory: Introduction, Basic definition and terminology, set-theoretic operations, fuzzy complement, intersection and union, parameterized T-norm and T-conorm

Fuzzy rules and Fuzzy reasoning: Introduction, Cartesian product of relation, classical relation, Extension principle, fuzzy relations, tolerance and equivalence relations, non-interactive fuzzy sets

Membership functions and their features, fuzzification, methods of membership value assignments, lambda-cuts for fuzzy sets, lambda-cuts for fuzzy relations, defuzzification methods

Truth values and tables in fuzzy logic, Linguistic variables, fuzzy propositions, fuzzy if-then rules, formation of rules, decomposition of rules, aggregation of fuzzy rules, compositional rule of inference, fuzzy reasoning

Module IV (8 hours)

Fuzzy inference systems: Introduction, construction and working principle, methods of FIS (Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models), comparison between Mamdani, Sugeno and Tsukamoto fuzzy models, input space portioning, fuzzy modelling

Neuro-Fuzzy hybrid systems: Comparison of fuzzy systems with neural networks, characteristics, classification and applications of neuro-fuzzy hybrid systems

Module V (8 hours)

Neuro-Fuzzy modelling, introduction, Adaptive neuro-fuzzy inference systems and its architecture, hybrid learning algorithm, learning methods that cross-fertilize ANFIS and RBFN, ANFIS as a universal approximator

Coactive neuro-fuzzy modelling: Introduction, framework, neuron functions for adaptive networks, neuro-fuzzy spectrum, and analysis of adaptive learning capability

Text Books:

- Jang, J.S.R. Sun, C.T. & Mizutani, E.(2014) Neuro-Fuzzy and Soft Computing, PHI Learning Private Ltd.

Reference Books:

- Deepa, S.N. & Sivanandam, S. N. (2014) Principles of Soft Computing, Wiley

Course Outcomes:

- To analyze fundamental concept of biological neural network and artificial neural network
- To express algorithms of supervised and unsupervised learning networks
- To define classical set theory and fuzzy set theory
- To apply fuzzy inference systems
- To incorporate neuro-fuzzy modelling

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2		3			1
CO 2	1		3			2
CO 3			3		1	2
CO 4	3	1	3	2		3
CO 5	3	1	3	2		3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
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CO	2	0	3	1	0	2
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HYDRAULIC STRUCTURES AND HYDROPOWER ENGINEERING (MWRPE107)

L	T	P	C
3	0	0	3

Module I (8 hours)

Diversion head works: Weirs and barrages, gravity and non-gravity weirs, layout of a diversion head work and its components

Theory of seepage and design of weirs and barrages: failure of hydraulic structures founded on permeable foundations, Bligh's and Lane's creep theory for seepage flow, Khosla's theory and concept of flow net, design of a vertical drop weir on Bligh's theory, design of modern weirs and barrages founded on permeable foundations on Khosla's theory

Module II (8 hours)

Dams Introduction, various kinds of dams, problems in dam construction, selection of type of dam and their classifications, factors governing selection of a particular type of dam, selection of dam site

Design and construction of gravity dams: Definition, typical cross section, forces acting on gravity dam, modes of failure and criteria for structural stability, stability analysis, elementary profile of a gravity dam, high and low gravity dams, profile of a gravity dam from practical considerations, design considerations and fixing the sections, design of a gravity dam, construction of a gravity dam, diversion problem in dam construction, construction of drainage galleries, cracking of concrete, joints, foundation treatment

Module III (8 hours)

Design and construction of earthen dams: Introduction, types, methods of construction, shearing strength of soil, various kinds of densities of soil and their relations, significance of pore water pressure in design of earthen dams, causes of failure, design criteria, selection of preliminary section of earthen dams, seepage analysis, seepage discharge through isotropic soil, seepage discharge through non-isotropic soil, line of seepage, stability of upstream and downstream slopes, seepage control through embankment, seepage control through foundation, design of drainage filters, upstream and downstream slopes protection works

Module IV (8 hours)

Spillways, Energy dissipators, and Spillway Crest Gates: Introduction, location of a spillway, design considerations for main spillway, controlled and uncontrolled spillways, straight drop spillway, ogee spillway, chute spillway, side channel spillway, shaft spillway, syphon spillway, energy dissipators below overflow spillways, spillway buckets, stilling basins, energy dissipators below other types of spillways, energy dissipators below sluiceways or dam outlets, hydraulic

jump and its usefulness as energy dissipator, design of stilling basins, standard stilling basins, and types of spillway crest gates

Module V

(8 hours)

Hydroelectric Power: Introduction, essential stream flow data for hydro- power studies, storage and pondage, essential stream flow data for water power studies, flow duration curve, flow mass curve, classification of hydro-power plants, principal components of a hydro-power plant, important terms and definitions connected with hydro-power, primary and secondary power, load factor, utilization factor and capacity factor, assessment of available power ,thermal power and hydropower, comparison of hydro power with thermal power costs with reference to Indian conditions, typical hydro-electric power developments in India, hydro-power potentials in India and the World

Text Books:

- S.K. Garg “Irrigation Engineering & Hydraulic Structures”, 19th Edition, Khanna Publishers.
- P. N. Modi, S. M. Seth (2002) “Hydraulics And Fluid Mechanics Including Hydraulics Machines”, Standard Book House.

Reference Books:

- Punmia, B.C., Jain, A.K., Jain, A.K., Pandey, B.B.L. “Irrigation and Waterpower Engineering” Laxmi Publication.
- Dandekar, M.M. and Sharma, K.N. “Waterpower Engineering” Vikas Publishing House.

Course Outcomes:

- To construct different diversion head works.
- To incorporate stability analysis and details of gravity dam
- To evaluate failure modes of earthen dam
- To create details of energy dissipaters
- To demonstrate hydroelectric power generation process

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	1	2	1	2
CO 2	3	3	1	2	1	1
CO 3	2	1	1	2	1	1
CO 4	3	2	1	1	1	2
CO 5	2	1	1	3	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	2	1	2	1	2

WATER RESOURCES SYSTEMS PLANNING AND MANAGEMENT (MWRPE103)

L	T	P	C
3	0	0	3

Module I (8 hours)

Water Resources Planning and Management: An overview: Introduction, Planning and Management Issues, Cause of Planning and Management, Scanty Water, Excessive Water, Polluted Water, Degradation of Aquatic and Riparian Ecosystems, Other Planning and Management Issues, System Components, Planning Scales and Sustainability, Spatial Scales for Planning and Management, Temporal Scales for Planning and Management, Sustainability Planning and Management, Approaches, Top-Down Planning and Management, Bottom-Up Planning and Management, Integrated Water Resources Management, Planning and Management Aspects, Technical Aspects, Economic and Financial Aspects, Institutional Aspects, Analyses for Planning and Management, Models for Impact Prediction and Evaluation Shared-Vision Modelling, Adaptive Integrated Policies, Post-Planning and Management Issues, Meeting the Planning and Management Challenges

Module II (8 hours)

Water Resource Systems Modelling: Its Role in Planning and Management: Introduction, Modelling of Water Resources Systems, an Example Modelling Approach, Characteristics of Problems to be Modelled, Challenges in Water Resources Systems Modelling, Challenges of Planners and Managers, Challenges of Modelling, Challenges of Applying Models in Practice, Developments in Modelling, Modelling Technology, Decision Support Systems, Shared-Vision Modelling, Open Modelling Systems, Example of a DSS for River Flood Management

Module III (8 hours)

River Basin Planning Models: Introduction, Scales of River Basin Processes, Model Time Periods, Modelling Approaches for River Basin Management, Modelling the Natural Resources System and Related Infrastructure, Watershed Hydrological Models, Classification of Hydrological Models, Hydrological Processes: Surface Water, Hydrological Processes: Groundwater, Modelling Groundwater: Surface Water Interactions, Stream flow Estimation, Stream flow Routing, Lakes and Reservoirs, Estimating Active Storage Capacity, Reservoir Storage-Yield Functions, Evaporation Losses, Over and Within-Year Reservoir Storage and Yields, Estimation of Active Reservoir Storage Capacities for Specified Yields, Wetlands and Swamps, Water Quality and Ecology, Modelling the Socio-Economic Functions In a River Basin, Withdrawals and Diversions, Domestic, Municipal and Industrial Water Demand, Agricultural Water Demand, Hydroelectric Power Production, Flood Risk Reduction, Reservoir Flood Storage Capacity, Channel Capacity, Lake-Based Recreation, River Basin Analysis, Model Synthesis, Modelling Approach Using Optimization, Modelling Approach Using Simulation, Optimization and/or Simulation, Project Scheduling

Module IV (8 hours)

Flood Management: Introduction, State-wide flood management, General History, Other Considerations, Flood Frequency and Protection, The various river basins in state-wide, Problems and Solutions, Managing Risk, Storage, Discharge-Increasing Measures, Green Rivers, Use of Existing Water Courses, The Overall Picture, Dealing With Uncertainties, Interactions Among User Groups, Creating a Flood Management Strategy, The Role of the Government and NGOs, Flood Risk Reduction, Reservoir Flood Storage Capacity, Channel Capacity, Estimating Risk of Levee Failures, Annual Expected Damage From Levee Failure, Risk-Based Analyses, Decision Support and Prediction, Floodplain Modelling, Integrated 1D–2D Modelling

Module V (8 hours)

Drought Management: Introduction, Drought Impacts, Defining Droughts, Causes of Droughts, Global Patterns, Teleconnections, Climate Change, Land Use, Drought Indices, Percent of Normal Indices, Standardized Precipitation Index, Palmer Drought Severity Index, Crop Moisture Index, Surface Water Supply Index, Reclamation Drought Index, Deciles, Method of Truncation, Water Availability Index, Days of Supply Remaining, Drought Triggers, Virtual Drought Exercises

Text Books:

- Loucks, Daniel P., van Beek, Eelco “Water Resource Systems Planning and Management”, Springer publication.

Reference Books:

- Sarah Luck “Water Resources Management”, Syrawood Publishing House.
- Ziemi Ska-Stolarska Aleksandra , Zbici Ski Ireneusz , Imbierowicz Miros Aw “Analysis of the System of Management Plans and Water Resources”, LAP Lambert Academic Publishing.

Course Outcomes:

- To define water resources planning and management issues
- To organize water resources systems
- To create river basin planning models
- To incorporate flood management models
- To implement drought management models

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	3	1		
CO 2	3	3	3		2	
CO 3		3	3		2	3
CO 4			3	3	2	
CO 5					3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	1	2	2	1	2	1

MODELLING, SIMULATION AND OPTIMIZATION (MWRPE104)

L T P C

Module I (8 hours)

Modelling Methods for Evaluating Alternatives: Introduction, Model Components, Plan Formulation and Selection, Plan Formulation, Plan Selection, Modelling Methods: Simulation or Optimization, A Simple Planning Example, Simulation Modelling Approach, Optimization Modelling Approach, Simulation Versus Optimization, Types of Models, Types of Simulation Models, Types of Optimization Models, Model Development, Managing Modelling Projects, Creating a Model Journal, Initiating the Modelling Project , Selecting the Model, Analyzing the Model, Using the Model , Interpreting Model Results , Reporting Model Results, Issues of Scale, Process Scale , Information Scale, Model Scale, Sampling Scale, Selecting the Right Scales

Module II (8 hours)

Optimization Methods: Introduction, Comparing Time Streams of Economic Benefits and Costs, Interest Rates, Equivalent Present Value, Equivalent Annual Value, Non-linear Optimization Models and Solution Procedures, Solution Using Calculus, Solution Using Hill Climbing, Solution Using Lagrange Multipliers, Approach, Meaning of the Lagrange Multiplier, Dynamic Programming, Dynamic Programming Networks and Recursive Equations, Backward-Moving Solution Procedure, Forward-Moving Solution Procedure, Numerical Solutions, Dimensionality, Principle of Optimality, Additional Applications, Capacity Expansion, Reservoir Operation, General Comments on Dynamic Programming, Linear Programming, Reservoir Storage Capacity–Yield Models, A Water Quality Management Problem, Model Calibration, Management Model, A Groundwater Supply Example, A Simplified Model, A More Detailed Model, An Extended Model, Piecewise Linearization Methods, A Review of Linearization Methods

Module III (8 hours)

Fuzzy Optimization: Fuzziness: An Introduction, Fuzzy Membership Functions, Membership Function Operations, Optimization in Fuzzy Environments, Fuzzy Sets for Water Allocation, Fuzzy Sets for Reservoir Storage and Release Targets, Fuzzy Sets for Water Quality Management

Data-Based Models: Introduction, Artificial Neural Networks, the Approach, an Example, Recurrent Neural Networks for the Modelling of Dynamic Hydrological Systems, Some Application Based Examples, Genetic Algorithms, The Approach, Example Iterations, Genetic Programming, Data Mining, Data Mining Methods

Module IV (8 hours)

Concepts in Probability, Statistics and Stochastic Modelling: Introduction, Probability Concepts and Methods, Random Variables and Distributions, Expectation, Quantiles, Moments and Their Estimators, L-Moments and Their Estimators, Distributions of Random Events, Parameter

Estimation, Model Adequacy, Normal and Lognormal Distributions, Gamma Distributions, Log-Pearson Type 3 Distribution, Gumbel and GEV Distributions, L-Moment Diagrams, Analysis of Censored Data, Regionalization and Index-Flood Method, Partial Duration Series, Stochastic Processes and Time Series, Describing Stochastic Processes, Markov Processes and Markov Chains, Properties of Time-Series Statistics, Synthetic Stream flow Generation, Introduction, Stream flow Generation Models, A Simple Autoregressive Model, Reproducing the Marginal Distribution, Multivariate Models, Multi-Season, Multi-Site Models, Disaggregation Models, Aggregation Models, Stochastic Simulation, Generating Random Variables, River Basin Simulation, The Simulation Model, Simulation of the Basin, Interpreting Simulation Output

Modelling Uncertainty: Introduction, Generating Values from Known Probability Distributions, Monte Carlo Simulation, Chance Constrained Models, Markov Processes and Transition Probabilities, Stochastic Optimization, Probabilities of Decisions, a Numerical Example

Module V

(8 hours)

Model Sensitivity and Uncertainty Analysis: Introduction, Issues, Concerns and Terminology, Variability and Uncertainty in Model Output, Natural Variability, Knowledge Uncertainty, Parameter Value Uncertainty, Model Structural and Computational Errors, Decision Uncertainty, Sensitivity and Uncertainty Analyses, Uncertainty Analyses, Model and Model Parameter Uncertainties, What Uncertainty Analysis Can Provide, Sensitivity Analyses, Sensitivity Coefficients, a Simple Deterministic Sensitivity Analysis Procedure, Multiple Errors and Interactions, First-Order Sensitivity Analysis, Fractional Factorial Design Method, Monte Carlo Sampling Methods, Performance Indicator Uncertainties, Performance Measure Target Uncertainty, Distinguishing Differences Between Performance Indicator Distributions, Communicating Model Output Uncertainty

Performance Criteria: Introduction, Informed Decision-Making, Performance Criteria and General Alternatives, Constraints on Decisions, Tradeoffs, Quantifying Performance Criteria, Economic Criteria, Benefit and Cost Estimation, a Note Concerning Costs, Long and Short-Run Benefit Functions, Environmental Criteria, Ecological Criteria, Social Criteria, Multi-Criteria Analyses, Dominance, the Weighting Method, the Constraint Method, Satisficing, Lexicography, Indifference Analysis, Goal Attainment, Goal-Programming, Interactive Methods, Plan Simulation and Evaluation, Statistical Summaries of Performance Criteria, Reliability, Resilience, Vulnerability

Text Books:

- Averill Law “Simulation Modeling and Analysis (SIE)”, McGraw Hill Education.
- Stanislaw Raczynski “Modeling and Simulation” Willey publication.

Reference Books:

- Shkelzen Cakai “Modelling Simulation and Optimization”, Intech Open Publication.

Course Outcomes:

- To incorporate modeling methods for evaluating alternatives
- To analyze various optimization methods for modelling
- To apply various data-based models and fuzzy optimization models
- To compile various modeling uncertainties
- To implement model sensitivity analysis

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	3	1	3	
CO 2				3	3	
CO 3	3	3	3			
CO 4	1	2	2	2		
CO 5	3		3	2	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	1	2	2	2	0

SEMESTER II

ADVANCED HYDRAULICS (PPCCE205)

L	T	P	C
4	0	0	3

Course Objectives:

- Fundamental concept acquisition of flow in open channels
- Understanding of resistance formulae
- Understanding of concept, formation and applications of hydraulic jump
- Development of knowledge on numerical methods for solving open channel flow problems
- Development of knowledge on design of stable channels

Module I

(8 hours)

Flow in open channels- Basic concepts, Types of channel, Classification of flow, Velocity distribution, Pressure distribution, Conservation laws of mass, energy and momentum.

Energy-depth relationships-Specific energy, Critical depth, Critical flow, Channel transitions- Channel design with hump and change in width, Sub-critical and super-critical flow transitions

Module II

(8 hours)

Uniform flow-Resistance formulae, Velocity distribution, Shear stress distribution, Computations of uniform flow, Standard lined canal sections, hydraulically efficient channel section, Compound channels

Gradually varied flow –Differential equation, Classification and features of flow profiles, Transitional depth, Computations of gradually varied flow

Module III**(8 hours)**

Rapidly varied flow- Theory and computations of rapidly varied flow, hydraulic jump
 Spatially varied flow- SVF with increasing discharge and decreasing discharge

Module IV**(8 hours)**

Unsteady flow- Gradually varied unsteady flow, rapidly varied unsteady flow-Positive surges,
 and Negative surges
 Governing equations for one-dimensional flow and two-dimensional flow, Numerical methods-
 Finite difference methods

Module V**(8 hours)**

Hydraulics of mobile bed channels - Initiation of motion of sediment, Bed forms, Sediment load,
 Design of stable channels, Regime channels

Text Books:

- Flow in Open Channels, K. Subramanya, Tata McGraw-Hill Education, 2009.

Reference Books:

- Open-Channel Flow, **Chaudhry**, M. Hanif, Springer, 2008.
- Hydraulics of Open Channel Flow, Hubert Chanson, 2nd edition, Elsevier, 2004.

COURSE OUTCOMES:

Upon completion of this course students will be able to:

- Apply fundamental concept of flow for open channels
- Apply the resistance formulae for canals and streams
- Apply the knowledge of gradually and rapidly varied unsteady flow in open channels
- Solve various flow problems with the use of concept of specific energy
- Design the most efficient channel sections

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	2	2	-	-	-
CO 2	1	3	2	-	-	-
CO 3	2	3	3	-	-	-
CO 4	3	3	3	-	-	-

CO 5	3	3	3	-	-	-
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1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	3	3	0	0	0

GROUNDWATER HYDROLOGY (PPCCE206)

L T P C
3 0 0 3

Module I

(8 hours)

Introduction: Ground water theories, Trends in withdrawal and utilization of ground water, Ground water in hydrologic cycle, Hydrologic budget

Occurrence of groundwater: Origin and age of ground water, rock properties affecting ground water, vertical distribution of ground water, zone of aeration, zone of saturation, geologic formations as aquifers, types of aquifers, storage coefficient, ground water basins, springs, hydrothermal phenomena, groundwater in permafrost regions

Module II

(8 hours)

Groundwater movement: Darcy's law, permeability, determination of hydraulic conductivity, anisotropic aquifers, groundwater flow rates, groundwater flow directions, dispersion, groundwater tracers, general flow equations, unsaturated flow, kinematic wave, the Green-Ampt method for infiltration estimation

Module III

(8 hours)

Wells: Test holes and well logs, testing wells for yield, total pumping head of well, horizontal wells, characteristic well losses and their evaluation, specific capacity and efficiency of well, well-skin effect

Groundwater and well hydraulics: Steady unidirectional flow, steady radial flow to a well, well in a uniform flow, unsteady radial flow in a confined aquifer, unsteady radial flow in an unconfined aquifer, unsteady radial flow in a leaky aquifer, location of aquifer boundary and well flow near aquifer boundary, multiple well systems, partially penetrating wells, well flow for special condition

Module IV

(8 hours)

Environmental influences on groundwater levels: Time variation of groundwater levels, streamflow and groundwater levels, groundwater level fluctuations due to evapotranspiration, meteorological phenomena and tide, urbanization, earthquake, external load, land subsidence and global climate change influences on groundwater levels

Groundwater flow modelling: Groundwater flow models (definition and types), cause of development and steps in development of groundwater flow models

Module V

(8 hours)

Management of groundwater: Fundamental concept of groundwater basin management, groundwater basin investigations and data collection, yield, conjunctive use and watershed management, water laws and policies, groundwater management models(definition and types),groundwater management modelling(hydraulic modelling, policy evaluation and allocation modelling and optimal control modelling)

Text Books:

- Todd, D.K., Mays, L.W. "Groundwater Hydrology", Wiley.

- Raghunath, H.M. “Groundwater” New Age International Publisher.

Reference Books:

- Mahajan, G. “Evaluation and Development of Groundwater” APH.
- Agarwal, V.C. “Groundwater Hydrology”, PHI Learning Pvt. Ltd.

Course Outcomes:

- To analyze occurrence of groundwater
- To define process involved in movement of groundwater
- To analyze well hydraulics
- To analyze environmental influences on groundwater levels
- To implement groundwater management models

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	3	3	2	1	1
CO 2	2	1	3	2	2	1
CO 3	3	3	2	3	3	1
CO 4	3	1	1	3	3	1
CO 5	3	2	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	2	2	3	2	1

WATER QUALITY MODELING AND MANAGEMENT (MWRPE202)

L T P C
3 0 0 3

Module I (8 hours)

Introduction, Establishing Ambient Water Quality Standards, Water-Use Criteria, Water Quality Model Use, Model Selection Criteria, Model Chains, Model Data

Module II (8 hours)

Water Quality Model Processes, Mass-Balance Principles, Advective Transport, Dispersive Transport, Mass Transport by Advection and Dispersion, Steady-State Models, Design Streamflows for Water Quality, Temperature, Sources and Sinks, First-Order Constituents, Dissolved Oxygen, Nutrients and Eutrophication, Toxic Chemicals, Adsorbed and Dissolved Pollutants, Heavy Metals, Organic Micro-pollutants, Radioactive Substances, Sediments, Processes and Modelling Assumptions, Sedimentation, Resuspension, Burial, Bed Shear Stress,

Lakes and Reservoirs, Downstream Characteristics, Lake Quality Models, Stratified Impoundments

Module III (8 hours)

An Algal Biomass Prediction Model, Nutrient Cycling, Mineralization of Detritus, Settling of Detritus and Inorganic Particulate Phosphorus, Resuspension of Detritus and Inorganic Particulate Phosphorus, The Nitrogen Cycle, Nitrification and Denitrification, Inorganic Nitrogen, Phosphorus Cycle, Silica Cycle, Summary of Nutrient Cycles, Algae Modelling, Algae Species Concentrations, Nutrient Recycling, Energy Limitation, Growth Limits, Mortality Limits, Oxygen-Related Processes

Module IV (8 hours)

Monitoring and Management: Introduction, System Status, System Status Indicators, Information Needs, Information Objectives and Priorities, Monitoring Plans, Adaptive Monitoring, Risk Assessments for Monitoring, Use of Models
Simulation Methods, Numerical Accuracy, Traditional Approach, Backtracking Approach, Model Uncertainty, Implementing a Water Quality Management Policy

Module V (8 hours)

Network Design: Site Selection, Sampling/Measurement Frequencies, Quality Control, Water Quantity Monitoring, Water Quality Monitoring, Ecological Monitoring, Early-Warning Stations, Effluent Monitoring
Data Sampling, Collection and Storage: Overview, Remote Sensing, Optical Remote Sensing for Water Quality Data Analyses, Reporting Results: Trend Plots, Comparison Plots, Map Plots, Information Use: Adaptive Management

Text Books:

- Chapra, S. C. “Surface Water-Quality Modeling”, Waveland Pr Inc Publication
- Benedini, M. and Tsakiris, G. “Water Quality Modelling for Rivers and Streams”, Springer

Reference Books:

- Manivanan, R. “Water Quality Modeling”, New India Publishing Agency

Course Outcomes:

- To analyze various water quality standards and water use criteria
- To develop processes involved in water quality modelling
- To define nutrient cycles
- To organize monitoring and management of water quality
- To incorporate water quality data

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	2	1	1	2

CO 2	3	2	3	2	1	1
CO 3	2	2	1	3	1	1
CO 4	2	1	3		2	2
CO 5	2	2	2	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	2	2	2	1	1

GROUNDWATER QUALITY, POLLUTION AND ITS CONTROL (MWRPE205)

L T P C
3 0 0 3

Module I (8 hours)

Surface and subsurface investigations of groundwater: Geologic methods, remote sensing, geophysical exploration, electrical resistivity method, seismic refraction method, gravity and magnetic method, test drilling, water level measurement, geophysical logging, resistivity logging, spontaneous potential logging, radiation logging, temperature logging, caliper logging, fluid-conductivity logging, fluid-velocity logging, miscellaneous logging techniques, other subsurface methods

Module II (8 hours)

Natural groundwater quality, sources of salinity, measurement of water quality, chemical analysis, graphic representations, physical analysis, biological analysis, groundwater samples, water quality criteria, changes in chemical composition, dissolved gases, temperature, and saline groundwater

Module III (8 hours)

Pollution of groundwater, sources and causes of groundwater(municipal, industrial, agricultural and miscellaneous),attenuation of pollution, distribution of pollution underground, mass transport of pollutants, monitoring of groundwater quality, remediation of contaminated groundwater, conventional pump and treatment systems

Module IV (8 hours)

Occurrence of saline water intrusion in aquifers, Ghyben-Herzberg relation between fresh and saline waters, shape and structure of fresh and saline water interface, effect of wells on saline water intrusion, upconing of saline water, fresh and saline relations on oceanic islands, saline water intrusion in karst terrains, control of saline water intrusion

Module V (8 hours)

Fundamental concept of artificial recharge of groundwater, recharge methods, wastewater recharge for reuse, soil aquifer treatment (SAT) systems, recharge mounds, storm water infiltration basin mound development, innovative approaches towards recharge, induced recharge

Text Books:

- Todd, D.K., Mays, L.W. “Groundwater Hydrology”, Wiley.
- Raghunath, H.M. “Groundwater” New Age International Publisher.

Reference Books:

- Maloszewski, P., Witzak, S., Malina, G. “Groundwater Quality Sustainability” Taylor & Francis.
- Bear, J., Verruijt, A. “Modelling Groundwater Flow and Pollution” Springer.

Course Outcomes:

- To analyze differential observations on surface and sub-surface investigation methods of groundwater
- To evaluate groundwater quality criteria
- To incorporate monitoring system of ground water quality
- To plan control techniques of saline water intrusion
- To implement fundamental concept of artificial recharge of groundwater

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	1	2	2	1
CO 2	3	2	1	3	3	2
CO 3	3	3	3	2	2	1
CO 4	3	2	2	2	3	2
CO 5	3	2	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	2	2	2	3	2

REMOTE SENSING AND GIS APPLICATIONS IN WATER RESOURCES ENGINEERING (MWRPE204)

L T P C
3 0 0 3

Course Content

Module I

(8 hours)

Remote Sensing

Introduction: Overview, Water Resources and GIS, Water Resources Engineering, Applications of GIS in Water Resources Engineering

Introduction to geographic Information Systems: Overview, GIS Basics, Maps and map Data characteristics, User Interfaces and Interaction Modes, GIS System planning and Implementation, GIS Software

Module II (8 hours)

GIS Data and Databases: Overview, GIS Data Development and Maintenance, GIS Data Models, Digital Data Sources for Water Resources, Geodatabases

Module III (8 hours)

GIS Analysis Functions and Operations: Overview of GIS Analysis Functions, Spatial Data Capture and Maintenance, Geometrics and Measurements, Spatial and Aspatial Queries; classification, Neighborhood Operations, Spatial Arrangement and Connectivity Functions, Surface Operations, Overlays and Map Algebra, Spatial Statistics, Image Processing, Display, Interfaces, Integration, Management Tools

Module IV (8 hours)

GIS for Surface-Water Hydrology, Groundwater Hydrology, Water-Supply and Irrigation Systems, Wastewater and Storm water Systems

Module V (8 hours)

GIS for Floodplain Management, Water Quality, Water Resources Monitoring and Forecasting, River Planning and Management

Text Books

- Lynn E. Johnson (2009) “Geographic Information Systems in Water Resources Engineering” Taylor and Francis Group, CRC Press, Boca Raton, FL.

Reference Books

- Lynn E. Johnson (2014) “GIS and Remote Sensing Applications in Modern Water Resources Engineering” Springer, New York.

Course Outcomes:

- To evaluate application of remote sensing in Water Resources Engineering
- To analyze application of GIS in Water Resources Engineering
- To write basics of GIS
- To define data development and management in GIS
- To compile functions and operations in GIS

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	1	2	1		
CO 2	3	1	2	1		
CO 3			2	1		3
CO 4		1	3		1	3
CO 5			2	1		2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
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CO	1	1	2	1	0	2
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HYDROMETRY, WATER ACTS AND WATER SERVICES (MWRPE203)

L	T	P	C
3	0	0	3

Module I (8 hours)

Flow Measurement, Hydrometric Instrumentation, Measuring up to Water Resources Assessment, Long River Flow Records, Precipitation Measuring (Weather) Radar, Satellite Remote Sensing in Hydrometry, Groundwater, Transmission of Hydrometric Data by Satellite, Tree Ring Analysis in Hydrometry, Maximizing the Utility of River Flow Data, Hydrometric Data Processing, Uncertainties.

Module II (8 hours)

Drinking water quality monitoring; public water and wastewater systems regulation; water and wastewater operation; groundwater resources management; management of allocation of water use and grant of water rights; alterations of water bodies regulation; environmental assessments; Operation and maintenance of hydrometric instrumentation, climate and water quality networks; Conduct of hydrological modelling studies and; Conduct of water use studies for all sectors.

Module III (8 hours)

The water (prevention and control of pollution) act 1974, Orissa River Pollution Act 1953, The Water Prevention and Control of Pollution Cess Act 2003, The Indian Penal Code and Pollution, The River Boards Act 1956, Right to Clean Water: a Fundamental Right, The Easement Act 1882, The Indian Fisheries Act 1897, The River Boards Act, 1956, The Merchant Shipping Act 1970, The Water (Prevention and Control of Pollution) Cess Act 197, The Water (Prevention and Control of Pollution) Cess Rules 1978, The Coastal Regulation Zone Notification 1991

Module-IV (8 hours)

Irrigation: Overview of Irrigation Development, Accelerated Irrigation Benefit Programme (AIBP), Rural Infrastructure Development Fund (RIDF), Externally Aided Projects (JICA, OIIAWMIP, OCTMP, Hydrology Project), Biju Krushak Vikash Yojana (BKVY)

Module-V (8 hours)

Irrigation: Deep Bore well, Check-dams, Repair, Renovation & Restoration of Water Bodies, 35% Irrigation Programme, Mega Lift Scheme, Canal Lining & System Rehabilitation Programme, Project Planning & Formulation, Quality Control & Quality Assurance, Land Acquisition, Rehabilitation & Resettlement, Forest & Environment Clearance

Text Books:

Reginald W. Herschy (1999) Hydrometry: Principles and Practice, 2nd Edition published by Wiley.

Annual Report, 2013-14 (c) Department of Water Resources Published under the authority of Department of Water Resources, Government of Odisha

Reference Books:

- The 5 Essential Elements of a Hydrological Monitoring Programme, Bulletin no: Vol 61 (1) - 2012, world meteorological organization
- The value of hydrometric information in water resources management and flood control, Meteorol. Appl. 7, 387–397 (2000), Susan Walker

Course Outcomes:

1. Use instrumentation for hydro-meteorological data and its application.
2. Discuss regulation, allocation and monitoring of surface and ground water for drinking and waste water.
3. Apply the acts and laws on water distribution, pollution, navigation and cess.
4. Evaluate different schemes and programmes.
5. Revise different schemes of irrigation, land acquisition, rehabilitation and resettlement.

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	3	-	-	-
CO 2	3	3	2	-	3	-
CO 3	3	2	2	-	-	2
CO 4	3	3	3	-	-	-
CO 5	3	2	3	-	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	2	3	0	1	0

COMPUTATIONAL FLUID DYNAMICS

L T P C
3 0 0 3

Module I

(8 hours)

Introduction to Computational Fluid Dynamics and Principles of Conservation: Computational Fluid Dynamics: What, When, and Why? CFD Applications, Numerical vs Analytical vs Experimental, Modeling vs Experimentation, Fundamental principles of conservation
 Classification of Partial Differential Equations and Physical Behavior: Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and

hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations

Approximate Solutions of Differential Equations: Error Minimization Principles, Functional involving higher order derivatives, Approximate solution of differential equations through variational formulation, Boundary conditions in the variational form: Primary and secondary variables, Essential and natural boundary conditions, Approximate solutions of differential equations, Properties of variational form, Weighted residual approach: trial function and weighting function, Requirement of trial function and weighting function, Least square method, Point Collocation method, Galerkin's method, Rayleigh-Ritz method

Module II

(8 hours)

Fundamentals of Discretization: Discretization principles: Preprocessing, Solution, Postprocessing, Finite Element Method, 3 Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term

Finite Volume Method: Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a 1-D steady state diffusion type problem, Composite material with position dependent thermal conductivity, Four basic rules for FV Discretization of 1-D steady state diffusion type problem, Source term linearization, Implementation of boundary conditions

Discretization of Unsteady State Problems: 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme

Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consequences of time-discretization in finite discretization, Consistency, Stability, Convergence, LAX Equivalence theorem, Grid independent and time independent study, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dufort-Frankel scheme, Stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS Schemes, Stability analysis of 2nd order hyperbolic equations: CTCS scheme

Finite Volume Discretization of 2-D unsteady State Diffusion type Problems: FVM for 2-D unsteady state diffusion problems

Module III

(8 hours)

Solution of Systems of Linear Algebraic Equations:

Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search method, Elimination method: Forward elimination and backward substitution, Assessment of number of computations, L-U decomposition technique, Tridiagonal matrix algorithm (TDMA): Thomas algorithm, Illustrative examples, Norm of a vector, Norm of a matrix, Some important properties of matrix norm, Error analysis of elimination methods, Iteration methods: Jacobi's method and Gauss Siedel method, Generalized analysis of the iterative methods, Sufficient condition for convergence, Rate of convergence, Scarborough criteria of sufficient condition for convergence in Gauss Siedel Method, Illustrative examples of Jacobi's method and Gauss Siedel method, Relaxation methods, Preferential characteristics of iterative methods, Multigrid method, Line by line TDMA, ADI (Alternating direction implicit) method, Gradient search methods: Steepest descent method and Conjugate gradient method

Module IV

(8 hours)

Discretization of Convection-Diffusion Equations: A Finite Volume Approach: Finite volume discretization of convection-diffusion problem: Central difference scheme, Upwind scheme, Exponential scheme and Hybrid scheme, Power law scheme, Generalized convection-diffusion formulation, Finite volume discretization of two-dimensional convection-diffusion problem, The concept of false diffusion, QUICK scheme.

Discretization of Navier Stokes Equations: Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm

Unstructured Grid Formulation: Discretization of the Momentum Equation using unstructured grid

Module V

(8 hours)

What is there in implementing a CFD code: The basic structure of a CFD code: Pre-processor, Solver and Postprocessor, User-defined subroutines, Solution to some basic problems in heat transfer and fluid flow

Introduction to Turbulence Modeling: Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity 2 models, Mixing length model, Turbulent kinetic energy and dissipation, The κ - ϵ model, Advantages and disadvantages of κ - ϵ model, More two-equation models: RNG κ - ϵ model and κ - ω model, Reynolds stress model (RSM), Large eddy Simulation (LES), Direct numerical simulation (DNS)

Text Books:

- Klaus A. Hoffmann, Steve T. Chiang, “Computational Fluid Dynamics”, Engineering Education System
- John D. Anderson Jr, “Computational Fluid Dynamics”, McGraw Hill Book Company

References Books:

- S. V. Patankar, “Numerical Heat Transfer and Fluid Flow”, McGraw-Hill.
- T. J. Chung, “Computational Fluid Dynamics”, Cambridge University Press.
- H. K. Versteeg & W. Malalasekera, “An Introduction to Computational Fluid Dynamics”, Longman Scientific & Technical.
- J. H. Ferziger and M. Peric, “Computational Methods for Fluid Dynamics”, Springer.
- John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, “Computational Fluid Mechanics and Heat Transfer”, Taylor & Francis.
- John D. Anderson Jr, “Computational Fluid Dynamics”, McGraw Hill Book Company.
- J. Blazek, “Computational Fluid Dynamics: Principles and Applications”, Elsevier

Course Outcomes:

- To define basics of Computational Fluid Dynamics and application of Partial Differential Equations
- **To analyze fundamentals of discretization and finite volume method**
- To incorporate linear algebraic equations
- To define discretize structured and unstructured grid using finite volume approach
- To demonstrate turbulence modeling and implementation of Computational Fluid Dynamics codes

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3		2		1
CO 2		3	2		2	
CO 3	2		3	2		1
CO 4		3				3
CO 5	3	2	3		3	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	2	2	1	1	1

HYDROLOGIC ENGINEERING LABORATORY (PLCCE206)

L **T** **P** **C**
0 **0** **3** **2**

Experiments:

1. Calibration of non-recording rain gauges and measurement of rainfall using them
2. Determination of average rainfall over a catchment and its hydrograph analysis
3. Study of effect of precipitation of varying duration or intensity on soils with different saturation
4. Study of Rainfall-Runoff model using rainfall simulator
5. Determination of in-situ soil hydrological properties
6. Investigation of the seepage flow using catchment model
7. Measurement of Canal Seepage Loss by Ponding Method
8. Measurement of Soil Suction with Tensiometer
9. Determination of Soil Intake Characteristics using Cylinder Infiltrometer
10. Frequency Analysis of Hydrologic Data by Gumbel's Method

COURSE OUTCOMES:

Upon completion of this course students will be able to:

- Use different rainfall measuring equipments.
- Analyze hydrographs for calculating and predicting runoff
- Use rainfall-runoff models for flood prediction
- Investigate seepage loss from water bodies
- Analyze flood data using frequency methods for flood prediction

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	3	-	-	-
CO 2	3	3	3	-	-	-
CO 3	3	3	3	-	-	-
CO 4	3	3	3	-	-	-
CO 5	3	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	0	0	0

IRRIGATION AND DRAINAGE SYSTEM DESIGN (PLCCE205)

L T P C
0 0 3 2

Exercises

1. Design of weir.
2. Design of barrage.
3. Design of canal head regulator.
4. Design of earthen dam.
5. Design of gravity dam.
6. Design of ogee spillway.
7. Design of Surface Drainage System
8. Design of Subsurface Drainage System
9. Design of Piped Irrigation Network
10. Design of Storm Drains

Course outcomes:

1. Design various storage structures for irrigation.
2. Use of regulators for different location of canal.
3. Evaluate design of a dam and its corresponding spillway.
4. Solve surface and sub-surface drainage system
5. Compile design of storm drains and piped irrigation network

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	3	3	-	-
CO 2	3	3	3	3	-	-

CO 3	3	3	3	-	2	-
CO 4	3	3	3	-	2	-
CO 5	3	3	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	1	1	0

SEMESTER III

SEDIMENT TRANSPORT

L T P C

Module I (8 hours)
 Introduction: Sediment and fluvial hydraulics, nature of sediment problems, Origin and properties of sediments: Introduction, origin and foundation of sediments, fundamental properties of individual sedimentary particles, bulk properties of sediments, incipient motion of sediment particles, regimes of flow

Module II (8 hours)
 Resistance to flow and velocity distribution in alluvial streams, Bed load transport and saltation, Suspended load transport, Total load transport

Module III (8 hours)
 Sediment samplers and sampling, Design of stable channels, Alluvial streams and their hydraulic geometry, Bed level variation in alluvial streams

Module IV (8 hours)
 Variation in planform of streams, Sediment control in canals, River training and bank protection, Alluvial River models, debris flows and density currents

Module V (8 hours)
 Sediment transport through pipes

Text Books:

- Garde, R.J. and Ranga Raju, K.G. (2000), Mechanics of sediment transport and alluvial stream problems, Taylor & Francis

Reference Books:

- Graf, W.H. (1998), Fluvial Hydraulics, John Wiley and Sons Ltd.
- Application of Soft-Computing Techniques in Civil Engineering
- Ross, T.J. (2010), Fuzzy Logic with Engineering Applications, John Wiley and Sons Ltd.

Course Outcomes:

- To express fluvial hydraulics and sediment transport
- To define flow resistance phenomenon
- To create stable channel designs
- To incorporate river training works
- To apply sediment transport phenomenon through pipes

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	3	2		

CO 2		3	2			1
CO 3	3	2		3		3
CO 4	2	2			3	
CO 5			3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	1	2	2	2	1	1

RIVER ENGINEERING

L T P C
3 0 0 3

Module I (8 hours)

Introduction: The fluvial system, variables for alluvial rivers, rivers ,their behavior, control and training: Importance of rivers and necessity of controlling them, types of rivers and their characteristics, Indian rivers and their classification, behavior of rivers,

Module II (8 hours)

Introduction, The problem of flow in a river, River hydraulics: The one-dimensional equations of hydraulics, Structures, controls, and boundary conditions, Measurement and analysis: Hydrometry and the hydraulics behind it, the analysis and use of stage and discharge measurements,

Computational hydraulics: steady flow, unsteady flow

Module III (8 hours)

Sediment transport: General, Initiation of motion, Bed forms and alluvial roughness, Transport formulae, unsteady aspects

Module IV (8 hours)

River morphology: Introduction, Regime concept, channel-forming discharge, hydraulic geometry, meander planform, Longitudinal stream profile, river classifications, thresholds in river morphology, bends, Channel characteristics, Bifurcations and confluences, geomorphic analysis of river channel responses

Module V (8 hours)

Control and training of rivers: Introduction, Bed regulation, Discharge control, Water level control, Water quality control, Bank protection, dikes, grade-control structures River engineering for different purposes: flood control and drainage, navigation, hydropower, water supply, waste discharge, crossing of other infrastructures, soil conservation, nature preservation and restoration

Text Books:

- Chang, H.H. (1988), Fluvial Processes in River Engineering, John Wiley and Sons

Reference Books:

- Fenton, J. (2011), River Engineering, Institute of Hydraulics and Water Resources Engineering, Vienna University of technology

Course Outcomes:

- To define the fluvial system
- To incorporate the river hydraulics
- To plan sediment transport in river
- To demonstrate river morphology
- To express control and training of rivers

Course Articulation Matrix

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2			2	
CO 2	2		3	1		2
CO 3	3	3	3	1	2	
CO 4			3	2		
CO 5		3				3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	2	2	1	1	1