DEPARTMENT OF CIVIL ENGINEERING

COURSE STRUCTURE AND SYLLABUS
(1^{ST} – 4^{TH} SEMESTER)

FOR

M. TECH PROGRAMME

SPECIALISATION

IN

WATER RESOURCES ENGINEERING

(EFFECTIVE FROM YEAR 2016-17)

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
(FORMLY, UNIVERSITYCOLLEGE OF ENGINEERING)
BURLA – 768 018, SAMBALPUR, ODISHA

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY: BURLA
CIVIL ENGINEERING DEPARTMENT
Curriculum for M.TECH –WATER RESOURCESENGINEERING(REGULAR)

First (Autumn) Semester: -

Sub No.	Subjects	L	T	P	C
	Advanced Fluid Mechanics	4	0	0	4
	Engineering Hydrology and Hydrologic Systems	4	0	0	4
	Computational and Statistical Methods	4	0	0	4
	Elective – I	4	0	0	4
	Elective – II	4	0	0	4
	Hydraulic & Hydrologic Engineering Laboratory	0	0	6	4
	Seminar –I	0	0	3	2
	Comprehensive Viva Voce – I				2
	Total =	20	0	9	28

Second (Spring) Semester: -

Sub No.	Subjects	L	T	P	C
	Open Channel Hydraulics	4	0	0	4
	Design of Hydraulic Structures	4	0	0	4
	Water Resources Systems Planning and Management	4	0	0	4
	Elective – III	4	0	0	4
	Elective – IV	4	0	0	4
	Computer Aided Design	0	0	6	4
	Seminar –II	0	0	3	2
	Comprehensive Viva Voce – II				2
	Total =	20	0	9	28

Third (Project) Semester :-

Sub No.	Subjects	L	T	P	C
	Dissertation interim evaluation	0	0	0	10
	Comprehensive Viva Voce	0	0	0	3
	Seminar on Dissertation	0	0	0	2
	Total =				15

Fourth (Project) Semester:-

Sub No.	Subjects	L	T	P	C
	Dissertation Open Defense	0	0	0	5
	Dissertation evaluation	0	0	0	20
	Total =				25
	Grand Total =				96

Electives in Group – A

1. Neuro-Fuzzy Applications in Civil Engineering
2. River Engineering
3. Groundwater Hydraulics
4. Land & Water Management
5. Environmental Evaluation of Water Resources Development Projects
6. Hydrometry, Water Acts and Water Services

Electives in Group- B

1. GIS Applications in Water Resources Engineering
2. Computational Hydrodynamics
3. Groundwater Quality, Pollution and Control
4. Sediment Transport
5. Water Power Engineering
6. Urban Drainage and Sewerage System

ADVANCED FLUID MECHANICS

(CE/WRE/)

Instruction (Hours / Week) Lectures 4-0-0

Course Objectives:

1. To acquire knowledge of fluid mechanics and apply the Mass, Momentum and Energy Conservation Principles for Fluid Flow
2. To learn the concept of boundary layer and apply to the real life hydraulic structures
3. To understand the N-S equations and to apply it to both laminar and turbulent boundary layers
4. To learn the process of Design of an Experiment, Dimensional Analysis and Dispersion of Pollutants in a Fluid Medium

COURSE CONTENT

Module I

Introduction: Survey of Fluid Mechanics, Structure of Fluid Mechanics Based on Rheological, Temporal Variation, Fluid Type, Motion Characteristic and spatial Dimensionality Consideration, Approaches in Solving Fluid Flow Problems, Fundamental idealizations and Descriptions of Fluid Motion, Quantitative Definition of Fluid and Flow, Reynolds Transport Theorem, Mass, Momentum and Energy Conservation Principles for Fluid Flow.

Potential Flow: Frictionless Irrotational Motions, 2 - Dimensional 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, method of Images in Solving Groundwater Flow problems, Method of Conformal transformations.

Module II

Viscous Flow and Boundary Layer Theory: Study of Local Behavior, Differential Approaches in Analysis of Viscous Flows, Equations of Motion of a Viscous Flow, Navier – Stokes Equations, Exact and Approximate Solution of N – S Equations, Hele – Shaw Flow, Creeping Flow past a Sphere, Boundary Layer Concept, Prandtl's Boundary Layer Equations, Laminar Boundary Layer Along a Flat Plate, Integral Momentum Equation, Blassius Solution.

Module III

Turbulence in Fluid Flow: Origin of turbulence, Statistical Analysis of Turbulence, Reynolds Equations for 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, Turbulent Boundary Layer and Boundary Layer Separation.

Module IV

Design and Testing of Models: Design of an Experiment, Dimensional Analysis, Complete Set of Dimensionless Parameters, Dimensional Analysis, Scale effect, Distorted Models, Practical Significance of Key Modeling Parameters, Design of Models and Model Tests.

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

References:

1. Wand D.J., and Harleman D.R. (91964) “Fluid Dynamics”, Addison Wesley.
2. Schlichting, H.: (1976) “Boundary Layer theory”, International Text – Butterworth
3. Lamb, H. (1945) “Hydrodynamics”, International Text – Butterworth
4. Lamb, H.R. (1945) “Hydrodynamics”, Rover Publications
5. Rouse, H. (1957), “Advanced Fluid Mechanics”, John Wiley & Sons, N York
6. White, F.M. (1980) “Viscous Fluid Flow”, McGraw Hill Pub. Co, N York
7. Yalin, M.S.(1971), “Theory of Hydraulic Models”, McMillan Co., 1971.
8. Mohanty A.K. (1994), “Fluid Mechanics”, Prentice Hall of India, N Delhi

Course Outcomes

CO1: ability to apply the Mass, Momentum and Energy Conservation Principles for Fluid Flow

CO2: ability to apply the knowledge acquired regarding the boundary layer and apply to the real life hydraulic structures

CO3: ability to know the concept of boundary layer theory and apply to the real life hydraulic structures

CO4: ability to Design an Experiment, perform Dimensional Analysis and apply the knowledge of Dispersion of Pollutants in a Fluid Medium in real life.

ENGINEERING HYDROLOGY AND HYDROLOGIC SYSTEMS

(CE/WRE/)

Instructions (Hours / Week) Lectures 4-0-0

Course Objectives

1. To understand the concept of hydrologic cycle and to quantify evaporation and infiltration processes
2. To understand the concept of unit hydrograph and to review various rational and conceptual rainfall-runoff models
3. To be able to analyse hydrologic time series
4. To be able to perform real time flood forecasting

COURSE CONTENT

Module I

Introduction: Hydrologic Cycle, Systems Concept, Hydrologic model classification. Hydrologic Processes: Reynolds Transport Theorem. Atmospheric circulation: Water Vapour, Precipitable water, Thunderstorm cell model. Evaporation: Energy balance method and Aerodynamic method. Evapotranspiration. Subsurface water: unsaturated flow, Richard's equation. Infiltration: Horton's and Phillip's equations. Green-Ampt Method, Ponding time. Surface Water: Hydrograph Analysis, SCS method, Effective Rainfall, Runoff, Runoff Components, Direct Runoff Hydrograph.

Module II

Unit Hydrograph Theory: Linear Time Invariant System, Response Functions of Linear Systems, Derivation of Non Parametric Unit Hydrograph From Single Storm and Multi Storm Events, S - Curve Hydrograph, Instantaneous Unit Hydrotherapy.

Rainfall – Runoff Analysis: Review of Rational Methods, Conceptual Models, Parametric Unit Hydrograph, Clarke, Nash and Dooge Models, Hydrologic Simulation Models, Stanford Watershed Model, Derivation of Unit Hydrograph for Ungagged Catchments, Synthetic Unit Hydrograph.

Module III

Hydrologic Time Series Analysis: Independent and Autocorrelated Data, Structure of a Hydrologic Time Series, Trend, Jump and Seasonality, Stationarity and Ergodicity, Autocovariance and Auto Correlation Function, Correlogaram Analysis, Spectral Analysis,

Analysis of Multivariate Hydrologic Series. Modelling of Hydrologic Time Series: Data Generation Techniques, Linear Stochastic Models, Autoregressive, Moving Average, ARMA Models, Modelling of Nonstationary and seasonal Series, Thomas – Feiring Model, ARIMA Models.

Module IV

Hydrologic Flood Routing: Reservoir Routing, Channel Routing, Estimation of Parameters of Flood Routing Models, Flood estimation and flood frequency studies, Real Time Flood Forecasting.

References:

1. Chow, V.T., Maidment, D.R. and Mays, L.W. (1988), "applied Hydrology", McGraw Hill Inc. N York
2. Singh, V.P. (1986), "Hydrologic Systems,", Prentice Hall Inc., N York
3. Haan C.T., (1995), "Statistical Methods in Hydrology", East West Press, New Delhi
4. Viessman, W., Lewis, G.L. and Knapp, J.W. (1989), "Introduction to Hydrology", Harper & Row Publications Inc., Singapore.
5. McCueen R.H. and Snyder, W.M. (1985), Hydrologic Modelling – Statistical Methods and Applications", Prentice Hall Inc. N York.
6. Ponce, W.F. (1987), "Engineering Hydrology", Prentice Hll Inc. N York.
7. Kottegoda (1982), "Stochastic Processes in Hydrology", Prentice Hall, Inc., N Jersey
8. Patra, K.C. Hydrology and Water resources Engineering, Narosa Publishing House, New Delhi

Course Outcomes

CO1: ability to know the concept of hydrologic cycle and to quantify evaporation and infiltration processes

CO2: ability to know the concept of unit hydrograph and to review various rational and conceptual rainfall-runoff models

CO3: ability to analyse hydrologic time series

CO4: ability to perform real time flood forecasting

COMPUTATIONAL AND STATISTICAL METHODS

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives

1. To get knowledge of ordinary and partial differential equations and finite difference methods
2. To understand concept of finite element method and its application
3. To be able to apply basic concept of probability and about probability distribution functions in Water resources engineering problems
4. To be able to apply simple and multiple linear regression analysis and correlation analysis in Water resources engineering problems

COURSE CONTENT

Module I

Numerical Solution of Ordinary Differential Equations-Solution by Taylors's Series-Euler's Method- RungeKutta Methods-Simultaneous and Higher Order Equations-Boundary Value Problems-Applications. Finite Difference Method-Finite Difference. Representation of Differential Equations-Stability-Consistency and Convergence of Partial Differential Equations-Time integration-Finite Difference Methods in Solution of Steady and Unsteady Problem-Jacobi's Method, Gauss Seidel Method, Successive Over Relaxation Method and Method of Characteristics-Application and Examples.

Module II

Finite Element Method-Basic Concepts – Solution of Discrete Problems-Steady State and Time Dependent Continuous Problems-Application of Finite Method through illustrative Examples.

Classification and Presentation of Data – Basic Concepts of Probability – Probability Axioms – Analysis and Treatment of Data – Population and Samples – Measures of Central Tendency – Measures of Dispersion- Measures of Symmetry – Measures of Peakedness.

Module III

Probability Distributions – Discrete and Continuous Probability Distribution Functions – Binomial, Poisson, Normal, Lognormal, Exponential, Gamma Distributions, Extreme Value Distributions – Transformations to Normal Distributions, Selecting A Probability Distribution,

Parameter Estimation – Method of Moments, Method of Maximum Likelihood, Probability Weighted Moments and Least Square Method, Joint Probability Distributions.

Module IV

Regression Analysis – Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypotheses – Multiple Linear Regression – Correlation and Regression Analysis

References:

1. Akai, T.J,(1994) "Applied Numerical Methods for Engineers", John Wiley Inc., New York
2. Haan C.T. (1995), "Statistical Methods in Hydrology",. East West Press, New Delhi
3. Huyorkon, P.S. and Pinder, G.F.: "Computational Methods in Subsurface Flow", Academic Press, 1983.
4. Press, W.H., Flannery B.P. and Tenklsky, S.A. and Vetterling, W.T. "Numerical Recipes-The Art of Scientific Computing", Cambridge University Paress, Ccmbridge, 1994.
5. Kosho, B (1997), "Neural Networks and Fuzzy Systems", Prentice Hall of India, N Delhi
6. Rao V and H. Rao, (1996), "C^{++} Neural Networks and Fuzzy Logic, BPB Publications, New Delhi"

Course Outcomes

CO1: Ability to know about ordinary and partial differential equations and finite difference methods

CO2: Ability to know about basic concept of finite element method and its application

CO3: Ability to know about basic concept of probability and about probability distribution functions

CO4: Ability to know about simple and multiple linear regression analysis and correlation analysis

NEURO FUZZY APPLICATIONS IN CIVIL ENGINEERING

(CE / WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives

1. To learn the basic concept of neural network models and fuzzy logic based models
2. To develop different types of neural network models

3. To apply fuzzy reasoning and fuzzy inference to solve Civil Engineering problems
4. To apply knowledge of neuro-fuzzy computing in hydrologic modelling

COURSE CONTENT

Module I

Introduction: Basic concepts of Neural Networks and Fuzzy Logic, Differences between conventional computing and Neuro-Fuzzy computing, Characteristics of Neuro-Fuzzy computing

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

Module II

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.

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

Module III

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.

Neuro - Fuzzy Modelling: Neuro-Fuzzy inference systems, Neuro-Fuzzy control

Module IV

Applications of Neuro-Fuzzy computing: Hydrologic Modelling time series Analysis and modeling, Remote sensing, Environmental Modelling, Construction Management, Fault detection and rehabilitation of structures, Water Management, Prediction of Pile capacity, Transportation/ Traffic planning.

References:

1. Jang, JSR, C.T. Sun and E. Mizutani (1997), “Neuro-Fuzzy and Soft Computing”, Prentice Hall, N J.

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. Klir, George J., T.A. Forger, (1995), “Fuzzy Sets, Uncertainty and Information”, Prentice Hall of India, Pvt. Ltd., New Delhi.
5. Rao V and H. Rao, (1996), “C++” Neural Networks and Fuzzy Logic, BPB Publications, New Delhi.

Course Outcomes

CO1: Ability to know basic concept of neural network models and fuzzy logic based models

CO2: Ability to develop different types of neural network models

CO3:Ability to apply fuzzy reasoning and fuzzy inference to solve Civil Engineering problems

CO4: Ability to apply neuro-fuzzy computing in hydrologic modelling

RIVER ENGINEERING

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives

1. To get knowledge of fluvial geomorphology
2. To understand concept of analysis of river flow hydraulics
3. To be able to analyse hydraulic geometry and to design stable alluvial channels
4. To be able to do fluvial design for river bank protection

COURSE CONTENT

Module-I

Fluvial Geomorphology: Fluvial system, variables for alluvial rivers, regime concept, river classifications, thresholds of river morphology, hydraulic geometry, meander platform, geomorphic analysis of river channel responses.

Module-II

Foundation of Fluvial Process: Hydraulics of flow in river channel, physical properties of sediments, scour criteria and scour-related problems, alluvial bed forms and flow resistance, sediment movements in Rivers, flow in curved channels

Module-III

Regime Rivers and Responses: Analytical basis for hydraulic geometry, design of stable alluvial channel, analytical river morphology, plan geometry and processes of river meanders

Module-IV

Modelling of river channel changes: Mathematical model for erodioble channels,, gradual breach morphology tidal responses of river and delta system, fluvial design of river bank protection

References:

1. Chang H. Howard, Fluvial Processes in River Engineering, John Wiley & Sons1988
2. Rozovskii L.I. , Flow of Water in Bends of Open Channels, Academy of Sciences of the Ukraine, 1957

Course Outcomes

CO1: Ability to know about fluvial geomorphology

CO2: Ability to analyse river flow hydraulics

CO3: Ability to analyse hydraulic geometry and to design stable alluvial channels

CO4: Ability to have fluvial design for river bank protection

GROUNDWATER HYDRAULICS

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives

1. To get concept of various surface and subsurface geophysical methods for groundwater explorations
2. To know about well hydraulics
3. To know about design principles of well
4. To understand concept for groundwater management and modelling

COURSE CONTENT

Module I

Hydrogeology: Porosity and Permeability of Rocks, Groundwater in Igneous, Metamorphic, Sedimentary Rocks and Non Industrated Sediments, Hydrogeological Regions of India, Surface and Subsurface Geophysical methods for Groundwater Explorations.

Module II

Well Hydraulics: Aquifers and Aquifer Parameters, Darcy's law, Hydraulic Conductivity and its Characteristics, Dupuit Equation, Groundwater Flow Direction Steady Groundwater Flow, Groundwater Flow Equation, Estimation of Aquifer Parameters from Pumping Test Data, Graphical Techniques and their Limitations, Groundwater Well Losses, Interference among Wells, Potential Flow, Image well theory and its Application in Groundwater Flow.

Module III

Water Well Design and Well Drilling: Well Screen, Development and Completion of Well, Rotary Drilling and Rotary Percussion Drilling, maintenance of Wells.

Module IV

Groundwater Management: Conjunctive Use, Alternative Basin Yields, Artificial Recharge of Groundwater, Groundwater Quality. Groundwater Modelling: Groundwater Flow, mathematical, Analog and Digital modeling, Regional Groundwater Modelling.

References:

1. Walton, W.C.(1970) "Groundwater Resources Evaluation", McGraw Hill Inc, n York
2. Todd, D.K. (1995), "Groundwater Hydrology", John Wiley & Sons, Singapore
3. Johnson, E.E. (1966),"Groundwater", E. Johnson Inc. Washington.
4. Raghunath, H.M. (1992) "Groundwater", Wiley Eastern Ltd, N Delhi
5. Sharma, H.D. and Chawla, A.S. (1977), "Manual on Groundwater and Tube Wells", Technical Report No. 18, CBIP, New Delhi,
6. Davis, S.N. and De Weist, R.J.M. (1966), "Hydrogeology", John Wiley & Sons, N York.
7. Domenico (1972),"Concepts and models in Groundwater Hydrology", McGraw Hill Inc. N York
8. Garg, S.P. (1993) "Groundwater and Tube Wells", Oxford and IBH Publishing C. N Delhi.

Course Outcomes

CO1: Ability to know about various surface and subsurface geophysical methods for groundwater explorations

CO2: Ability to know about well hydraulics

CO3: Ability to know about design principles of well

CO4: Ability to know about groundwater management and modelling

LAND & WATER MANAGEMENT

(CE/WRE)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives

1. To get knowledge of planning of irrigation projects
2. To understand concept of different methods for estimation of evapotranspiration and about irrigation scheduling
3. To know about watershed management
4. To know about irrigation management

COURSE CONTENT

Module I

Irrigation Development in India – Planning of Irrigation Projects, Command Area Development Programmes

Physical and Chemical Properties of Soil, Soil Aeration, Classification of Irrigable Soils, Soil Survey, Soil management.

Module II

Soil – Plant – Water Relationships, Capillary and Non Capillary Pores, Water Relation of Soils, Infiltration, Hydraulic Conductivity, Water Movement through Soils, Soil Water Potential, Soil. Moisture Constants.Plant Water Relations, Rooting Characteristics.Evaporation and Evapotranspiration Measurements, Different methods of Estimating Evapotranspiration, Water Requirements of Crops, Irrigation Scheduling.

Module III

Watershed Management-Objectives-Water Conservation and Harvesting-Soil Erosion-Principles and Causes-estimation of Soil Loss-universal Soil Loss Equation-Control and Conservation-Land Capability Classification.

Module IV

Irrigation management-Land Grading and Field layout, Cropping Patterns, Fertilizers, On-farm Developments, Diagnostic Analysis of Irrigation System, Water Application Methods, Rotational water Distribution, Micro Irrigation, Water Logging and Salt Problems, Rotational Water Affected Soils, Drainage, Participatory Irrigation Management.

Reference:

1. Murthy, V.V.N. (1999), "Land and Water Management Engineering", Kalyani publishers, Ludhiana.
2. Scwabe G.O., Fangmeir, D.D. and Elliot W.J. (1996), "Soil and Water Management Systems", John Wiley and Sons, N York
3. Michael, B.A.M(1990), "Irrigation", Vikas Publishing House Pvt. Ltd. N Delhi
4. Withers and Vipond,S.(1980), "Irrigation-Theory and Practice", Cornell University Press
5. Hutchinson (1973), "Irrigation, Drainage and Salinity", FAO/UNESCO Publications Rome
6. Asawa; G.L. (1996), "Irrigation Engineering", New Age International Pub. Co. N Delhi.
7. Hansen, V.E., Israelson O.S. and Stringham G.C. (1979) "Irrigation Principles and Practice", John Wiley and Sons, N York.
8. Suresh, R.L. (1999), "Soil and Water Conservation Engineering", Standard Publishing Co, Delhi.

Course Outcomes

CO1: Ability to know about planning of irrigation projects

CO2: Ability to know about different methods for estimation of evapotranspiration and about irrigation scheduling

CO3: Ability to know about watershed management

CO4: Ability to know about irrigation management

ENVIRONMENTAL EVALUATION OF WATER RESOURCES DEVELOPMENT

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives

1. To know about different methods of environmental impact assessment and water quality impact assessment
2. To know about environmental issues in water resources development

COURSE CONTENT

Module I

Introduction: Environment and its interaction with human activities – Environmental imbalances – Attributes, Impacts, Indicators and Measurements – Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA.

Module II

Principles of environmental engineering-Ecological diversity, its importance and conservation – Ecosystem evaluation, landscape- Main ecological elements- Diversity, matrices, patches, corridors – Interrelations of ecological elements in a cultural landscape –Reclamation and environmental engineering – Water resources and ecology – Saving endangered species – Wildlife laws and regulation – International and regional convention on environmental protection – Red data book.

Module III

Environmental Indicators – Indicators of r climate- Indicators for tereestrial subsystems – Indictors for aquatic subsystems – Selection of indicators – Socio-economic indicators- Basic information – Indicators for economy – Social indicators – Indicators for health and nutrition – Cultural indicators – Loss of economic options – Selection of indicators

Environmental issues in water resource development – Land use – Soil erosion and their short and long term effects – Eco system studies – Flora – Fauna – Aquatic and terrestrial ecosystems, ecosystem balance – Disturbance and long term impacts – Changes in quantity and quality of flow – Sedimentation – Environmental impact assessment of water resource development structures – Case studies.

Module IV

Water Quality Impact Assessment: Attributes to be Considered, Water Quality Impact Assessment of Water Resources Projects, Data Requirements of Water Quality Impact Assessment for Dams, Impacts of Dams on Environment, Case Studies.

Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies Adhoc, Checklist, Matrix, Network, Overlays, benefit Cost Analysis, Choosing A Methodology, Review Criteria.

References:

1. Jain, R.K., Urban, L.V., Stracy, G.S., (1991), "Environmental Impact Analysis", Van Nostrand Reinhold Co., New York.
2. Rau, J.G. and Wooten, D.C., (1996), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York.
3. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris
4. Canter, L.W., (1997), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York

Course Outcomes

CO1: Ability to know about the methods of Environmental Impact Assessment and Ecological diversity, its importance and conservation

CO2: Ability to know about Environmental issues in water resource development and Water Quality Impact Assessment

HYDROMETRY, WATER ACTS AND WATER SERVICES

(CE/ WRE /)

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

COURSE CONTENT

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), Accoustic Doppler velocimeter, Flow Tracker for discharge measurement , Digital flow measuring devices for pipe flow.

MODULE – II

Land acquisition, RR, Right to fair compensation and transparency in land acquisition, Rehabilitaion and resettlement act. Critical Issues in Land Acquisition in LA and RR.

MODULE – III

Canal Acts and Rules, Brief Introduction to IS Codes, Water Law Framework, Odisha Irrigation act and Rules, PaniPanchayat Act, Minitoring 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 – IV

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.

Reference Books:

1. Gupta S V. (2002) Practical Density Measurement and Hydrometry. Institute of Physics Publishing . Bristol.

Course Outcomes

CO1: Ability to know about the Real time Data Acquisition and transmission system

CO2: Ability to know about the Critical Issues in Land Acquisition in LA and RR.

CO3: Ability to know about the Procedure for Water Allocation and Pricing; and recovery procedure.

HYDRAULIC AND HYDROLOGIC ENGINEERING LABORATORY

(CE/WRE/)

Instructions (Hours/Week) Lectures 0-0-4

Course Objectives

1. To plot velocity distribution and visualise boundary shear in rough and smooth channels
2. To develop correlation between rainfall and runoff phenomenon

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;
4. Measurement of Shear stress from velocity distribution obtained from Acoustics Doppler Veloci-meter (ADV).
5. Measurement of rainfall, evaporation, infiltration, laboratory and field tests.
6. Characteristics of Hydraulic Jump in horizontal and Sloping Channels
7. Determination of Manning's N for Composite Sections
8. Velocity Distribution in Open Channels
9. Performance Characteristics of Centrifugal pumps
10. Measurement of Soil Water Tension and Determination of Soil moisture Potential
11. Rainfall – Runoff Studies
12. Determination of Infiltration Characteristics

Course Outcomes

CO1: Ability to know about velocity distribution and Boundary shear in rough and smooth channels

CO2: Ability to know about Rainfall – Runoff correlations and its role in flood prediction

SEMESTER -II

OPEN CHANNEL HYDRAULICS

(CE/WRE/)

Instruction (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of continuity, momentum and energy equations to uniform and non-uniform open channel flows
- To learn to apply conservation laws to gradually varied and rapidly varied unsteady flows

- To analyse hydraulics of mobile bed channel

COURSE CONTENT

Module I

Basic Concepts of Free Surface Flow, classification of flow, velocity & pressure distribution. Conservation laws, continuity equation, momentum equation, Specific energy, Application of momentum & energy equation, Channel transition, Hydraulic jump. Critical flow.

Uniform flow: flow resistance, equation of flow resistance, compound channel, Computation of normal flow depth.

Module II

Gradually varied flow, Governing equation, classification of water surface profiles, and computation of GVF. Unsteady Rapidly Varied Flow. Application of conservation laws.Positive and Negative Surges.Moving hydraulic Jump, Spillways, Energy dissipaters. Critical slope and limit slope

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. Sediment load: Suspended load, Bed load, total bed material load, measurement and estimation of sediment load.Design of Stable Channels:, Regime and Tractive force Methods.

Module IV

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

References:

1. Chow, .V.T. (1979) "Open Channel Hydraulics", McGraw Hill .N York
2. Henderson. (1966): "Open Channel Flow", McMillan Pub. London..
3. Subramanya, K (1996)"Flow in Open Channels", Tata McGraw Hill Pub., 1995
4. Garde and RangaRaju, K.G. (1980): "Mechanics of Sediment Transportation and Alluvial Stream Problems", Wiley Eastem, N Delhi
5. Chaudhry M.H. (1994), "Open – Channel Flow", Prentice Hall of India, N Delhi
6. French, R.H. (1986), "Open Channel Hydraulics", McGraw Hill Pub Co., N York
7. Hamill L. (1999), Bridge Hydraulics, E & FN Spon, London

Course Outcomes:

CO1: Ability to apply continuity, momentum and energy equations to uniform and non-uniform open channel flows
CO2: Ability to apply conservation laws to gradually varied and rapidly varied unsteady flows
CO3: Ability to analyse hydraulics of mobile bed channel
CO4: Ability to know about bridge hydraulics

DESIGN OF HYDRAULIC STRUCTURES

(CE/WRE/)

Instructions (Hours / Week) Lectures 4 – 0 – 0

Course Objectives:

- To develop an understanding of stability analysis of concrete gravity dams
- To know the methods to perform stability analysis of earth and rock-fill dams and to know about measures for their slopes protection
- To know about design principles of various types hydraulic structures e.g., spillways etc.
- To know about working principles of different components of diversion head works and canal regulators

COURSE CONTENT

Module I

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.

Module II

Spillway : Types, Design principles of Ogee spillway, side channel spillway, Chute spillway, Syphon 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.

Module IV

Diversion Headworks: Components, Weir, Design of impervious floor, Khosla's theory

Canal Regulations works: Canal Fall, its type and design methods, Canal outlets

References:

1. Varshney R.S. (1978) "Concrete Dams", Oxford & IBH Publication Co..
2. Stewart L., Flayd E. Dominy (1960) " Design of Small Dams", Oxford & IBH Publication Co..
3. Punmia B.C. Lal B.B. Pande, Jain A. K. Jain A. K. (1992), "Irrigation and Water Power Engineering", Laxmi Publications (P) Ltd.

Course Outcomes:

CO1: Ability to perform stability analysis of concrete gravity dams

CO2: Ability to perform stability analysis of earth and rock-fill dams and to know about measures for their slopes protection

CO3: Ability to know about design principles of various types hydraulic structures e.g., spillways etc.

CO4: Ability to know about working principles of different components of diversion head works and canal regulators

WATER RESOURCES SYSTEMS PLANNING & MANAGEMENT

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of systems analysis and apply to problems in Water Resources Engineering
- To learn how to apply various methods of water resources economics to problems in Water Resources Engineering
- To know about surface and sub-surface water quality management
- To learn the legal aspects of water and environment systems

COURSE CONTENT

Module I

Introduction: General Principles of Systems Analysis to Problems in Water Resources Engineering, Objectives of Water Resources Planning and Development, Nature of Water Resources Systems, Socio Economic Characteristics.

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.

Module II

Methods of Systems Analysis: Linear Programming Models, Simplex Method, Sensitivity Analysis, Dual Programming, Dynamic Programming Models, Classical Optimisation Techniques, Non-linear Programming, Gradient Techniques, Genetic Algorithm, Stochastic Programming, Simulation, Search Techniques, Multi Objective Optimisation.

Module III

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 IV

Water Quality Management: Water Quality Objectives and Standards, Water Quality Control Models, Wastewater Transport Systems, River Water Quality Models and Lake Quality models.

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.

References:

1. Loucks, D.P., Stedinger, J.R. and Haith, D.A. (1982) “Water Resources Systems Planning and Analysis”, Prentice Hall Inc. N York
2. Chaturvedi, M.C. (1987), “Water Resources Systems Planning and Management”, Tata McGraw Hill Pub. Co., N Delhi.
3. Hall. W.A. and Dracup, J.A. (1975), “Water Resources Systems”, Tata McGraw Hill Pub. N Delhi

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, N Delhi.

Course Outcomes:

CO1: Ability to know about general principles of systems analysis and apply to problems in Water Resources Engineering

CO2: Ability to apply various methods of water resources economics tovariousproblems in Water Resources Engineering

CO3: Ability to know about surface and sub-surface water quality management

CO4: Ability to know about legal aspects of water and environment systems

GIS APPLICATIONS IN WATER RESORUCES ENGINEERING

(CR/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of remote sensing and GIS applications in water resources and environmental systems
- To learn the rainfall-runoff modeling using remote sensing and GIS
- To know about watershed development and management using remote sensing and GIS
- To use remote sensing data and GIS maps for problems related to environmental issues

COURSE CONTENT

Module-I

Introduction – Scope of Remote Sensing and GIS in Water Resources and Environmental Systems – Geomorphological, Hydrological and Land Use Mapping.

Module-II

Evaluation of Water Resources Potential – Rainfall runoff modeling using remote sensing inputs.

Flood and Drought Studies – Flood plain zoning – inundated areas – evaluation models – Drought assessment and Monitoring.Command Area Studies – Cropping patterns, conditions of crops, irrigation system performance – crop yield estimation.

Module-III

GIS, Hydrology and Resources Management – Watershed development, management options, inventory.RemoteSensing in Snow Cover Studies – Snowmelt Runoff.

Module-IV

Reservoir Sedimentation – Erosion and Deposition – Catchment Area Treatment – Estimation of Sediment Load – Use of Models

References:

1. Meijerink A.M.J., H.A.M. de Brouwer, C.M. Mannaerts and C.R. Valenzuela, (1994), Introduction to the use of Geographic Information Systems for Practical Hydrology, ITC Publication No. 23, UNESCO, Paris.
2. Lillesand T.M. and Kiefer R.W., (1994) "Remote Sensing and Image Interpretation", John Wiley and Sons, N York.
3. Swain P.H., and S.M. Davis, (1987), "Remote Sensing – The Quantitative Approach", McGraw Hill Publishing Company, N York.
4. Lyon, J.G. and McLarthy, J., (1996), "Wetland and Environmental Application of GIS", Lewis Publishers, Washington.

Course Outcomes:

CO1: Ability to know about scope of remote sensing and GIS in water resources and environmental systems

CO2: Ability to perform rainfall-runoff modelling using remote sensing and GIS inputs

CO3: Ability to know about watershed development and management using remote sensing and GIS inputs

CO4: Ability to use remote sensing data and GIS mapsfor problems related to environmental issues

COMPUTATIONAL HYDRO-DYNAMICS

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of ordinary and partial differential equations and finite difference methods
- To know application of various hydrodynamic techniques to steady and unsteady flows
- To know application of finite element method to steady and unsteady flows
- To learn to develop computer programs for the computational methods

COURSE CONTENT

Module-I

Ordinary and Partial differential equations, well-posed, ill-posed problem, Finite difference schemes, Stencil diagrams, basic aspect of discretization, truncation error, implicit and explicit types, accuracy, convergence, errors and stability analysis,

Module-II

Von Neumann method, CFL condition, some hydrodynamic techniques – Lax-Wendroff, MacCormack, Crank-Nicolson, staggered grid, ADI, ADE, pressure correction.

Module-III

SIMPLE and SOLA algorithm, method of characteristics, finite element method.Variational and weighted residual formulations, applications to steady and unsteady flows.

Module-IV

Pollutant dispersion, flood wave propagation, tidal model, applications with computer programming, etc.

References:

1. Computational Fluid Dynamics: John D. Anderson, Jr.
2. Computational Fluid Dynamics: T. J. Chung
3. Computational Fluid Mechanics and Heat Transfer: Series in Computational and Physical Processes in Mechanics and Thermal Sciences: John C. Tannehill, Dale A. Anderson and Richard H. Pletcher
4. Computational Methods in Surface/Subsurface Flow & Transport Problems:

Computational Methods in Water Resources XI, Volume 1 & 2 : A.A. Aldama and J.Aparicio

5. Computational Methods in Subsurface Flow & Transport Problems: Computational Methods in Water Resources XI, Volume 2: A.A. Aldama and J. Aparicio
6. Computational Fluid Dynamics: Principles and Applications: J.Blazek

Course Outcomes:

CO1: Ability to know about ordinary and partial differential equations and finite difference methods

CO2: Ability to know application of various hydrodynamic techniques to steady and unsteady flows

CO3: Ability to know application of finite element method to steady and unsteady flows

CO4: Ability to perform computer programming of these computational methods

SEDIMENT TRANSPORT

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of properties of sediment and reservoir sedimentation
- To know the fundamentals of sediment transport and meandering of rivers

COURSE CONTENT

Module-I

Properties of sediment.Initiation of motion of sediment.Analysis of non-cohesive sediment movement.Shield's diagram. Critical shear stress, critical velocity, lift on particles, Hydraulic relations for alluvial streams.

Module-II

Sediment Sources & sediment yield: Gross erosion, sediment yield, delivery ratio, estimation of sheet erosion, Universal soil loss equation (USLE), different factors affecting erosion process

.Sediment delivery ratio from watershed, flow duration curve and sediment rating curve, reservoir sedimentation: empirical equations, trap efficiency, sediment control method.

Module-III

Fundamentals of sediment transport: general relationships. Bed forms. Wash load, suspended load and Bed load, Rouse equation for suspended sediment load. Sediment discharge formulas by DuBoys, Mayer-Peter & Muller, Schoklitsch, Einstein-Brown and Engelund-Hansen.Sediment sampling,

Module-IV

Introduction to Meandering of rivers and river engineering. Scour: local scour at a bridge & abutment, Indian Codal provision for design scour depth.

References:

1. Manuals and Reports on Engineering Practice No. 54, Sedimentation Engineering : Vito A. Vanoni
2. Sediment Transport (Theory and Practice): C.T. Yang
3. Sediment and Ecohydaulics (INTERCOH 2005): T. Kusuda, H. Yamanishi, J. Spearman, and J.Z. Gailani
4. Mechanics of Sediment Transportation and Alluvial Stream Problems: R.J. Garde, K.G. RangaRaju
5. Sediment Transport (in 3 parts), ASCE: L. van Rijn
6. Hydraulics of Sediment Transport : W.H. Graf
7. Fundamentals of Fluvial Geomorphology: Ro Charlton

Course Outcomes:

CO1: Ability to know about properties of sediment and about reservoir sedimentation

CO2: Ability to know about fundamentals of sediment transport and about meandering of rivers

GROUNDWATER QUALITY, POLLUTION AND CONTROL

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of monitoring the water quality and water quality
- To know about sources of pollution of groundwater

Module-I
Sources of salinity, measures of water quality, chemical analysis, concentration by weight, chemical equivalence, total dissolved solids, hardness, biological analysis, water samples.

Module-II
Water quality criteria, drinking water standards, industrial water criteria, irrigation water criteria, dissolved gases, changes in chemical composition, temperature, saline groundwater.

Module-III
Sources of Pollution of ground water and causes, liquid waste, municipal and industrial sources, tanks and pipe line leakages, mining activities, agriculture sources and causes, miscellaneous sources and causes, septic tank and cesspool.

Module-IV
Saline waste intrusion, attenuation of pollution, filtration, sorption, chemical processes, dilution, distribution of pollution, pollution potential and evaluation, ground water quality monitoring.

References:

1. Bear and A. Verruijit, Modelling of Groundwater flow and pollution, 1988
2. Groundwater Manuals, A water resources technical Publications, Scientific Publishers, Jodhpur
3. Water quality in catchment eco-system, A.M. Gower, John Wiley & sons.
4. Groundwater Resources Evaluation, Walton, McGraw Hill.

Course Outcomes:
CO1: Ability to monitor the water quality and water quality
CO2: Ability to know about sources of pollution of groundwater

WATER POWER ENGINEERING

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- To develop an understanding of design concept of different components and their arrangement for hydel plants of both run off river plants and pumped storage plants.
- To understand design concept of different components of water conveyance system for power plants
- To be able to design various components of different types of turbines
- To gain the knowhow of planning of a power house

COURSE CONTENT

Module-I

Instruction: 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.

Module-II

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-S plants.

Module-III

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-IV

Turbines: Introduction, types of turbines, hydraulic features, turbine size, constructional features of turbines, layout arrangements, hydraulic of turbines, basic flow equations, draft tubes, cavitations in turbines, governing of turbines, characteristics of turbines, illustrative examples.Power House Planning: Surface power stations: power house structure, power house dimensions, lighting and ventilation, variations in design of power house.Underground power station: Location of U.G. power station, Types of U.G. power stations, advantages of U.G. power house, components of U.G. power house, types of layout, limitations of U.G. power house structural design of power house.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.

References:

1. Water Power Engineering by M.M. Dandekar and K.N. Sharma, Vani Educational Books
2. Irrigation and water resources Engg. By G.L. Asawa, New Age international Publishers.

3. Irrigation and water power Engineering by B.C. Punmia, Pande B.B. Lal (Laxmi Publications Private Limited)

Course Outcomes:

CO1: Ability to design different components and their arrangement for hydel plants of both run off river plants and pumped storage plants.

CO2: Ability to design different components of water conveyance system for power plants

CO3: Ability to design various components of different types of turbines

CO4: Ability to perform planning of a power house

URBAN DRAINAGE AND SEWERAGE SYSTEM

(CE/WRE/)

Instructions (Hours/Week) Lectures 4-0-0

Course Objectives:

- *To develop an understanding of* the urban hydrological cycle
- To know about different elements of drainage system
- To design different elements of drainage system
- To learn the operation and management of urban drainage system and to develop storm water management models

COURSE CONTENT

Module I

Urban Hydrological Cycle, Effects of Urbanisation on Catchment Hydrology, Need for Urban Drainage System, Planning Objectives, Interaction of Urban and Surrounding Areas.

Approaches to Urban Drainage, Urban Wastes and Urban Runoff Options for Waste Disposal, Separate and Combined Systems open Channels and closed Conduits, Wastewater and Stormwater Reuse, Data Requirements, Master Drainage Plans.

Module II

Elements of Drainage System Conveyance Elements, Appurtenances, Overflow Structures, Runoff Control, Pumping Stations.

Design Parameters, Design Period, Catchment, Physical Parameters, Process Parameters Rainfall, Water quality Parameters, Instrumentation for Data Collection.

Module III

Quantity of Stormwater, Stormwater Analysis, Rainfall Excess and Abstractions, Calculation of Runoff Volume and Peak Flow Hydrologic and Hydrodynamic methods.

Hydraulic Design of Conveyance Elements, Sizing of sewers and drainage Channels, Design of Appurtenances, Layout of Road Drainage, Layout of Pumping Stations.

Control Runoff and Pollution, On-site Storage and Use of Stormwater, infiltration, Detention and Retention Facilities for Stromwater Treatment, Erosion Control Measures.

Module IV

Stormwater Management Models.

Operation and Maintenance of Urban Drainage Systems.Interaction of Urban Drainage and Solid waste Management, Cleansing of Sewers and Drains, Repairs and Maintenance, Planning.

Operation and AdMaintenance of Urban Drainage Projects, Administrative Structure for Drainage Planning, Design and Operation, Economic and Financial Aspects, Legal Aspects.

References:

1. Hall M.J. (1984), "Urban Hydrology", Elsevier Applied Science Publishers
2. Geiger, W.F. Marsalek, J.Zudima and Rawls, G.J. (1987 "Manual on Drainage in Urban Areas", 2 Volumes, UNESCO, Paris.)
3. Geiger, W.F. and Jayakumar, K.V. (Ed.) (1996) "Lecture Notes of the V International Course on Urban Drainage in Developing Countries", Regional Engineering Collage, Warangal..
4. Wanielista, M.P. and Yousef, Y.A. (1993), "Stormwater Management", John Wiley and Songs, Inc., New York.

Course Outcomes:

CO1: Ability to know about urban hydrological cycle

CO2: Ability to know about different elements of drainage system

CO3: Ability to design different elements of drainage system

CO4: Ability to know about operation and management of urban drainage system and to develop storm water management models

COMPUTER AIDED DESIGN

(CE/WRE/)

Instructions (Hours/Week) Lectures 0+ 3

Course Objectives:

- *To develop an understanding of Watershed Modelling and Analysis and Design of Hydraulic Structures*
- *To know gain the knowledge of Diagnostic study of Irrigation Systems and Design and Analysis of water Distribution Network*

List of Experiments

1. Estimation of Crop Water Requirements and design of an Irrigation System
2. Irrigation Scheduling
3. Watershed Modelling:
   a. Unit Hydrograph Models
   b. Synthetic Unit Hydrograph Models
4. Determination of Design Flood
5. Analysis and Design of Hydraulic Structures.
6. Design and Analysis of water Distribution Network
7. Digital Simulation of Regional Aquifers
8. Parameter Estimation Through Regression
9. Design and Operation of a Reservoir
10. Design of Sewer Network
11. Diagnostic Analysis of Irrigation Systems
12. Stream Flow Analysis and Simulation
13. Design of Urban Storm water System

Course Outcomes:

CO1: Ability to know about Watershed Modelling and Analysis and Design of Hydraulic Structures

CO2: Ability to know about Diagnostic study of Irrigation Systems and Design and Analysis of water Distribution Network