

Department of Civil Engineering

**SCHEME OF INSTRUCTION & SYLLABUS
FOR**

M.Tech. (WATER RESOURCES ENGINEERING)
(with effect from 2019-20 Admitted Batch)



Department of Civil Engineering
A.U. College of Engineering (A)
Visakhapatnam

Department of Civil Engineering
M.Tech. (Water Resources Engineering)
Scheme of Instruction and Examination
(with effect from 2019-20 Admitted Batch)

I – SEMESTER

Code No.	Course Title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam (hrs)	Ext.	Sess.		
WRE1.1	Computational Hydraulics	4	--	4	3	70	30	100	3
WRE1.2	Applied Hydrology	4	--	4	3	70	30	100	3
WRE1.3	Remote Sensing and GIS Applications for Water Resources Engineering	4	--	4	3	70	30	100	3
Program Elective –I WRE1.4	(a) Water Quality Modeling (b) Subsurface Investigations (c) Flood Modeling and Drought Assessment	4	--	4	3	70	30	100	3
Program Elective –II WRE1.5	(a) Climate Change and Water Resources Engineering (b) Planning, Management and Economics of Water Resources Projects	4	--	4	3	70	30	100	3
WRE1.6	Computational Fluid Mechanics Laboratory	-	3	3	Viva	50	50	100	1.5
WRE1.7	GIS lab	-	3	3	Viva	50	50	100	1.5
Total		20	6	26		450	250	700	18

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam. (hrs)	Ext.	Sess.		
WRE2.1	Channel and Fluvial Hydraulics	4	--	4	3	70	30	100	3
WRE2.2	Environmental Impact Assessment of Water Resource Projects	4	--	4	3	70	30	100	3
WRE2.3	Watershed Behavior and its Conservation	4	--	4	3	70	30	100	3
Program Elective –III WRE2.4	(a) Estuarine Hydrodynamics and Salinity Transport (b) Conjunctive Water Resources Planning	4	--	4	3	70	30	100	3
Program Elective –IV WRE2.5	(a) Irrigation Water Systems and Management (b) Finite Element Method of Analysis	4	--	4	3	70	30	100	3
WRE2.6	Hydraulics and Environmental Engineering Lab.	--	3	3	Viva	50	50	100	1.5
WRE2.7	Sediment Transport and Dredging	--	3	3	Viva	50	50	100	1.5
WRE2.8	Seminar	--	3	3	Viva	50	50	100	2
Total		20	9	29		500	300	800	20

III SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
Program Elective –V WRE3.1	(a) Hydroinformatics (b) Urban Storm Water Drainage (c) Ground Water Flow and Contaminant Transport	4	--	4	3	70	30	100	3
Program Elective –VI WRE3.2	(a) Hydraulic Structures (b) Flood forecasting	4	--	4	3	70	30	100	3
WRE3.3	Dissertation (Preliminary)	--	--	--	Viva	--	100	100	8
Total		8	--	8		140	160	300	14

IV SEMESTER

Code No.	Course title	Scheme of Examination			Total	Credits
		Exam. (hrs)	Ext.	Sess.		
WRE4.1	Dissertation (Final)	Viva	100	--	100	16
Total						16

Department of Civil Engineering
M.Tech. (Water Resources Engineering)

Syllabus
(with effect from 2019-20 Admitted Batch)
I – SEMESTER

WRE1.1 COMPUTATIONAL HYDRAULICS

PART – A

Statistical Methods in Hydraulics-Importance of Statistical and Probability Analysis, Statistical Variables, Frequency, Probability and Statistical Distributions for Discrete Random Variables and Continuous Random Variables.

Statistical Parameters –Measures of Central Tendency, Measures of Variability and Measures of Skewness-Statistical Moments, Statistical Homogeneity–Time Homogeneity And Space Homogeneity.

Probability And Distributions – Basic Definitions of Probability – Random Variable- Discrete Probability Distributions – Continuous - Distribution Functions – Expectation – Repeated Traits – Binomial Distribution – Poisson Distribution – Normal Distribution.

Reliability Analysis-Sampling Reliability And Prediction of Reliability; Theoretical Justifications- Type-I External Distribution, Lognormal Distribution, Exponential Distribution and Log extrenal Distribution.

Correlation and Rank Correlation – Linear Regression – Multiple Linear Regression – Curvilinear Regression.

PART – B

Introduction to programming language C-Overview of C Language- Contracts- Variables and Data Types. Operators and Expressions-Arithmetic Operators- Relational Operators- Logical Operators- Assignment Operators- Increments and Decrements Operators- Conditional Operators- Special Operators- Bitwise Operators- Managing Input and Output Operations.

Decision Making and Branching- If Statements- Switch Statement- Conditional Operator Statement. Division Making And Looping. While Loop- Do Loop- For Loop- Nested Loops.

Arrays- Single Dimensional Arrays. Handling Character String Functions. Various Built In String Functions. user Defined Functions- all Kinds of Functions. Structures and

Unions. Pointers and Pointer Operators. Files- File Handling Function Sequential Files- Random Access Files.

Text Books

1. *Handbook of Applied Hydrology* by Ven Te Chow, McGH Publishers.
2. *Higher Engineering Mathematics* by Dr. B.S. Grewal, Khanna Publishers, Nai Sarak, Delhi.
3. *Programming in ANSI C* by E. Balaguru Samy.

Reference Books

1. *Handbook of Applied Hydrology* by Ven Te Chow, McGH Publishers.
2. *Stochastic Hydrology* by Dr. P. Jayarami Reddy, Laxmi Publications, New Delhi.
3. *Engineering Hydrology* by R.S. Varshney, Nem Chand & Bros., Roorkee.
4. *Programming with C* by Vimala and Venugopal.

WRE1.2 APPLIED HYDROLOGY

Introduction- Hydrologic Cycle - The Global Phenomenon- the Hydrologic Model on a Watershed Scale- Water Balance- Water Resources And Availability; History and Scope of Hydrology.

Precipitation-Earth's Revolution- Seasons- And Atmospheric Circulation; Formulation- Types And Distribution- Presentation And Processing of Data – Consistency and Missing Data- Depth- Area and Duration- Mean Rainfall – Isohyetal and Trend Surface Methods- Confidence Limits and Comparison of Averages- Frequency Analysis – Normal and Lognormal Distributions- Frequency Plotting- Goodness of Fit- Climate Classification- Rain Gauge Network .

Evaporation- Methods of Calculation – Energy Balance- Aerodynamic Methods; Evapo-Transpiration Potential; Consumptive Use- Water Requirement of Crops; Soil Water Balance and Climate.

Subsurface Water- Unsaturated Flow- Moisture Flux- Infiltration - Rates- Capacity.- Measurement- Horton's and Philip's Equations; Green-Ampt Method- Ponding Time- Surface Runoff and Infiltration Indices.

Runoff Hydrology- Watershed Processes- New Concepts- Surface Runoff- Honton's Flow- Variable Source Area Theory – Subsurface Flow – Flow Through Matrix and Pipes; Stream Flow Components Hydrographs And Separation- Flow Recession; Unit Hydro-Graph Theory- Derivation- S-Curve and Applications- Travel Time. Catchment Response- Factors Influencing Run Off..

Groundwater Hydrology-Occurrence of Groundwater. Vertical Distribution of Groundwater- Zone Of Aeration- Zone of Saturation- Types of Aquifers- Storage Coefficient- Groundwater Movement- Darcy's Law- Permeability- Hydraulic Conductivity- Anisotropic Aquifers- Groundwater Flow Direction. Application of GIS For Hydrological Studies (Introduction Only)

Text Books

1. *Hydrology for Engineering* by Linsely R.K- McGraw Hill- 1952.
2. *Engineering Hydrology* by Linsely R.K. and others- McGraw Hill- 1949
3. *Engineering Hydrology* by Subramanya K- Tata McGraw Hill- 1998.

Reference Books

1. *Introduction to Hydrology* by Weissman (J) W.- Harper- and Row
2. *Applied Hydrology* Mutreja- K.N.- Tata McGraw Hill- 1986
3. *Hand book of Hydrology* by Chow V.T. (ed.)- McGraw Hill- 1988
4. *Applied Hydrology* by Chow V.T.- McGraw Hill- 1989
5. *Statistical methods in Hydrology* by Hann C.T.- A.E.W. Press- 1977

WRE1.3 REMOTE SENSING AND GIS APPLICATION TO WATER RESOURCES ENGINEERING

Introduction To Remote Sensing- Definition- Principle of Remote Sensing- History of Development of Remote Sensing- Stages In Remote Sensing- Electromagnetic Radiation and The Electromagnetic Spectrum- Interactions With The Atmosphere- Atmospheric Scattering- Atmospheric Absorption- Atmospheric Windows- Refraction- Interaction of EMR With The Earth's Surface- Reflection- Transmission- Spectral Signature.

Remote Sensing Systems- Remote Sensing From Space- Remote Sensing Sensors- Resolution- Imaging Sensors- Optical Infrared (OIR) Imagers- Optical Sensors- Thermal Sensors- Microwave Sensors- Active Microwave Sensors- Data Preprocessing- Remote Sensing in India.

Introduction to Image Interpretation- Basic Principles of Image Interpretation- Elements of Image Interpretation- Techniques of Image Interpretation- Interpretation Keys- Introduction to Digital Image Processing- Digital Image- Image Rectification and Registration- Geometric Correction- Image Enhancement Techniques (Only Concepts)- Image Classification - Unsupervised Classification and Supervised Classification- Digital Photo geometry- Stereo Images From Satellites-Digital Ortho Photos (Only Definitions).

Geographic Information Systems (GIS)- Definitions And Related Technology- GIS Operations- GIS Elements- GIS Concepts and Practice- Map Projection and Coordinate System.

Vector Data Model- Introduction- Vector Data Representation- Geometric Objects- Topology.

Spatial Data Editing- Introduction- Type of Digitizing Errors- Location Errors- Topological Errors- Topological And Non-Topological Editing- Topological Editing- an Overview- Correction of Errors.

Attribute Data Input and Management- Introduction- Attribute Data in GIS- Linking Attribute Data and Spatial Data- Type of Attribute Data- the Relational Database Model Normalization- Type of Relationship.

Raster Data- Introduction- Elements of the Raster Data Model- Types of Raster Data- Satellite Imagery- Digital Elevation Models- GIS Software Specific Raster Data- Raster Data Structure- Projection and Geometric Transformation of Raster Data- Data Conversion- Integration of Raster and Vector Data.

Vector Data Analysis- Introduction- Buffering- Applications of Buffering- Map Overlay- Feature Type and Map Overlay- Map Overlay Methods- Slivers- Error Propagation in Map - Overlay- Distance Measurement- Map Manipulation-

Raster Data Analysis-Introduction- Analysis Environment- Local Operations- Local Operations with a Single Grid- Local Operations With Multiple Grids- Neighborhood Operations- Zonal Operations.

Terrain Mapping and Analysis: Introduction- Data for Terrain Mapping and Analysis- DEM- TIN- Terrain Mapping- Contouring- Vertical Profiling- Hill Shading- Hypsometric Tinting- Perspective View- Terrain Analysis- Slope and Aspect- Surface Curvature- View Shed Analysis- Grid Versus TIN.

GIS Models And Modeling-Introduction- GIS Modeling- Binary Models- Index Models

Remote Sensing & GIS Application In Water Resources Engineering.

Text Books

1. *Fundamentals of Remote Sensing 2nd Ed* by George Joseph- University Press- New Delhi.
2. *Introduction to Geographic Information systems* by Kang tsung chang- Tata Mc. G. H. publications- New Delhi.

Reference Books

1. *Remote Sensing of the Environment – An earth resource perspective* by John R. Jensen- Pearson Education- New Delhi.
2. *Geographic information Systems: A Management Perspective* by Aronoff- S. 1989. Ottawa: WDL publications.
3. *Geographic Information Systems for Geoscientists: Modeling with GIS- Bonham – Carter- G-F. 1994. New York: Pergamon Press.*
4. *Principles of Geographical Information Systems* by Burrough- P.A and R.A. McDonnell. 1998- Oxford: Oxford University Press.
5. *Young concepts and Technologies of Geographic Information Systems* by Lo- C.P.- and Albert K.W.- Prentice hall of India (Pvt) Ltd- New Delhi.
6. *Remote sensing and image interpretation* by Lillesand- T.M. and Kieffer- Joh Wiley and Sons- New York- 1987.
7. *Introductory Digital Image processing* by John R Jensen- Prentice Hall- New Jersey.
8. *Application of remote sensing to hydrology including groundwater* by Farsworth- R.K.- Bawetl- E.C. & Dhanju- M.S.-- IHP- UNESCO- 1984.

WRE1.4(a) WATER QUALITY MODELLING

Introduction to Environment Overview- Components of Environment and Their Interaction- uses of Water.

Water Quality Parameters: Concepts & Analysis Impurities and Water Quality Characterization- Physical- Chemical and Biological Parameters- Analytical Estimation-

Movement of Pollutants in Aquatic Environment- Water Quality Issues- Transport and Transformation Processes in Surface and Groundwater Systems- Water Quality Modeling. Modeling Concept- Process and Classification-

Groundwater Quality Modeling: Dispersion- Flow Equations- Saturated and Unsaturated Flow. Groundwater Modeling Techniques- Porous Media Models- Analog Models- Electrical Analogy Models- Digital Computer Models.

Surface Water Quality Modeling: Completely Mixed Systems - Mass Balance and Steady State Equation/ Solutions. Euler's Method- Runge-Kutta Method. Incompletely Mixed Systems – Diffusion- Fide's First Law- Steady State Conditions- Plug Flow & Mixed Flow Systems. Time Variable Conditions- Plug Flow- Random walk and Spill Models.

Transport and Variation of Dissolved Oxygen- Streeter-Phelps Equation and Modeling of Chemical Parameters- Modeling Ph- Toxics- Metals.(Oxygen Sag- BOD- Henry's Law- Ideal Gas Law- DO Saturation- BOD Model).

Water Quality Legislation and Management Water Quality Criteria and Standards- National and International Perspective- Surface and Groundwater Quality Management

Text Books

1. *Water Quality Modeling* by Steven. C. Chapra- McGH.
2. *Groundwater Hydrology* by David Keith Todd- John Wiley & Sons.
3. *Water quality assessments* by Chapman- D.- (Ed.)- 2nd Ed.- E&FNSPON
(Imprint of Chapman & Hall- USA)- Pub. on behalf of UNESCO- WHO- UNEP- 1992.
4. *Chemistry for environmental engg* by Sawyer- C.N.- & McCarty- P.L.- 3rd Ed.- Mc Graw Hill- 1987.
5. *Environmental science & technology* by Manobam- S.E.-- Lewis Pub.- 1997
6. *Fundamentals of ecology* by Odum- H.T.-- Oxford & IBH- 1975.
7. *Groundwater Pollutions : Theory- Methodology- Modelling and Practical rules* by Fried- J.J.-Elsevier Scientific Pub. Co.- 1975.
8. *Mathematical Models in Water Pollution Control* by James- A.- John Wiely.
9. *Application of Ecological Modeling in Environmental Management* by Jorgensen- S.E.-- Part A & B- Elsevier Scientific Pub. Co.- 1983.
10. *Principles of Surface Water Quality Modeling & Control* by Thomann- R.V. & Mweller- Harper & Row- 1987.

WRE1.4(b) SUBSURFACE INVESTIGATIONS

Introduction & Broad Classification of Subsurface Methods

Direct Methods - Excavation & Pitting- Well Drilling Techniques- Drill Stem Testing- Geological Well Logs

Indirect Methods -Geophysical Well Logging -Electrical Well Logging Methods -Normal & Lateral Resistivity Logs- Self Potential Logs- Induction & Micro Focussed Logs- Electrical Logging Practices -Evaluation of Aquifer Parameters

Radiation Logging (Natural Gamma- Neutron & Gamma Gamma Logging) - Accoustic Logs - Caliper Logs & Dipmeter Surveys- & their Applications in Groundwater Prospecting

Text Books

1. *Water Well Technology* by Cambell- M.D. & Lehr- Mc Graw Hill Book Co- 1973.
2. *Groundwater & Wells* by E.E. Johnson- Inc. UOP Div-- E.E. Johnson Inc.- 1975.
3. *Application of Bore hole geophysics to Water Resources Investigations* by Keys- W.S. & McCary- L.M.- U.S. Geol. Survey. Book 2- EI.- 1971.
4. *Formation Evaluation* by Lynch- E.J.- Harper & Row- 1962.
5. *Handbook of Subsurface Geology* by Moore- C.A.- Harper & Row- 1968.
6. *Geologic Well log analysis* by Pirson- S.J.-- (Gulf Publishing Co.)- 1977.

WRE1.4(c) FLOOD MODELLING AND DROUGHT ASSESSMENT

Flood Estimation - Hydrologic extremes – Flood – Types of Flood – Effects of Flood – Design Flood - SPF/MPF - Estimation of design flood – Physical Indicators - Envelope curves - Empirical methods – Rational method - Statistical methods – Frequency analysis – Unit hydrograph method.

Flood Modeling And Management - Hydrologic and Hydraulic Routing – Reservoir and Channel Routing - Flood Inundation Modeling – HEC HMS and HEC RAS softwares - Flood control methods – Structural and non structural measures - Flood Plain Zoning – Flood forecasting – Flood Mitigation - Remote Sensing and GIS for Flood modeling and management.

Drought and Impacts - Definition – Definitions based on rainfall- stream flow- vegetation and comprehensive aspects - Characterization of Drought/water shortage /aridity

/desertification - Types of Drought – NCA classification – Impacts of Drought – Environmental- Social and Economical aspects

Drought Assessment- Drought Severity Assessment – Meteorological Hydrological and Agricultural methods – Drought Indices – GIS based Drought Information system – Drought Vulnerability Assessment and Mapping Using GIS.

Drought Monitoring and Management: DPAP Programme - Drought Monitoring – Application of Remote sensing – Drought Mitigation –Proactive and Reactive approach – Supply and Demand Oriented Measures – Long term and Short term Measures – Water Scarcity Management in Urban- Industrial and Agricultural sectors

Reference Books

1. *Applied Hydrology* by Chow V.T.- Maidment D.R.- Mays L.W.- McGraw Hill Publications- New York- 1995.
2. *Elementary Hydrology* by Vijay P.Singh.- Prentice Hall of India- New Delhi- 1994.
3. *Drought Research Needs* by Yevjevich V.- Water Resources Publications- Colorado State University- USA- 1977.
4. *Flood Routing Methods as Applied to Indian Rivers* by Rangapathy V.- Karmegam M.- and Sakthivadivel R.- Monograph Anna University Publications

WRE1.5(a) CLIMATE CHANGE AND WATER RESOURCES ENGINEERING

Definitions- Climate- Climate System- Climate Change – Drivers of Climate Change – Characteristics of Climate System Components - Green House Effect – Carbon Cycle – Wind Systems - Trade Winds and the Hadley Cell – Ozone Hole in the Stratosphere - El Nino- La Nina

Global Scenario – Indian Scenario – Observed Changes And Projected Changes of IPCC - Impacts on Water Resources – NATCOM Report –Impacts on Sectoral Vulnerabilities – SRES – Different Scenarios

Need For Vulnerability Assessment – Steps for Assessment –Approaches for Assessment – Models – Quantitative Models- Economic Model- Impact Matrix Approach - Box Models- Zero-Dimensional Models - Radioactive-Convective Models - Higher-Dimension Models - Emics (Earth-System Models of Intermediate Complexity) - GCMS (Global Climate Models or General Circulation Models) – Sectoral Models

Water-Related Adaptation to Climate Change in the Fields of Ecosystems and Biodiversity- - Agriculture and Food Security- Land Use and Forestry- Human Health- Water Supply and Sanitation- Infrastructure and Economy (Insurance- Tourism- Industry and Transportation) - Adaptation- Vulnerability and Sustainable Development Sector-Specific Mitigation - Carbon Dioxide Capture and Storage (CCS) - Bio-Energy Crops- Biomass Electricity- Hydropower- Geothermal Energy- Energy Use In Buildings- Land-Use Change and Management- Cropland Management- Afforestation and Reforestation - Potential Water Resource Conflicts Between Adaptation and Mitigation - Implications for Policy and Sustainable Development.

Case Studies: Water Resources Assessment Case Studies – Ganga Damodar Project - Himalayan Glacier Studies- Ganga Valley Project - Adaptation Strategies in Assessment of Water Resources- Hydrological Design Practices And Dam Safety- Operation Policies for Water Resources Projects - Flood Management Strategies - Drought Management Strategies - Temporal & Spatial Assessment of Water for Irrigation -Land Use & Cropping Pattern - Coastal Zone Management Strategies.

Reference Books

1. *Climate change and water- IPCC Report Technical Paper VI- 2008.*
2. *UNFCC Technologies for Adaptation to climate change- 2006.*
3. *Climate Change and India: Vulnerability assessment and adaptation by P R Shukla- Subobh K Sarma- NH Ravindranath- Amit Garg and Sumana Bhattacharya- University Press (India) Pvt Ltd- Hyderabad.*
4. *Preliminary consolidated Report on Effect of climate change on Water Resources- GOI- CWC- MOWR- 2008.*

WRE1.5(b) PLANNING, MANAGEMENT AND ECONOMICS OF WATER RESOURCES PROJECTS

(A) Planning & Management of Water Resources Projects -Introduction to the Fundamentals of Water Resource System Analysis- Involving the Determination of the Optimal Dimensions- Outputs And Operating Policies of Water Resource Projects.

Introduction- Reservoir Capacity & Yield - Flow-Duration Curve - Reservoir Planning Reservoir Sediment Distribution- Cost Benefit Analysis- Conjunctive Water-Use Planning

Flood Routing- Reservoir Operation- River Water Disputes- Integrated River-Basin Development - Inter-Basin River Water- Transfers- Environmental Aspects Overview of Methodologies of Analysis. use of Optimization and Simulation Techniques for Solving Water Resources Problems- Examples in Water Distribution Systems- Flood

Management- River Basin Planning for Irrigation and Hydroelectric Power- The Storage Yield Relationship.

(B) Engineering Economics -Objectives & Scope of Engineering Economics- Managerial Economics- Interest and Time-Value of Money- Depreciation- Economic Life.

Demand Analysis and Forecasting. Cost Concept- Annual Cost Comparison- Present Worth- Production Functions- Pricing Policies- Pricing Methods- Price Forecasting.

Profit- Measurement of Profit- Profit Planning & Forecasting- Break-Even Analysis- Return on Investment- Rate of Return. - Mathematics of Finance- Discounting Techniques- Estimation of Costs

Estimation of Benefits- Graphical Optimization- Systems Approach Multi Objective Analysis - Financial Analysis - Cost Allocation- Case Studies Capital Budgeting- Cost of Capital- Project Appraisal.

Text Books & Reference Books

1. *Principles of Water Resources Planning by Goodman- A.S.- Prentice Hall Inc.- New Jersey- 1984.*
2. *Economics of Water Resources Planning by James- L.D. and Lee- R.R.- Mc Graw Hill- 1971.*
3. *Hydropower Engineering by Warnic- C.C.-- Prentice Hall Inc.- New Jersey- 1984.*
4. *Principles of Water Resources Planning by Goodman- A.S.- Prentice Hall Inc.- New Jersey- 1984.*
5. *Economics of Water Resources Planning by James- L.D. and Lee- R.R.- Mc Graw Hill- Inc.- 971.*
6. *Water Resources Systems by Chaturvedi-- Planning & Development :*
7. *Water Resources Systems by Hall & Dracup-*
8. *Economic Analysis by . Barish N. Norman.*
9. *Managerial Economics by Varshney- R.L. & Maheshwari- K.L..*

WRE1.6 COMPUTATIONAL FLUID MECHANICS LABORATORY

Developing and Executing Programmes Using C-Language for the following Problems Related to Fluid Mechanics:

- 1) Pipe network analysis using Hardy-Cross method..
- 2) Pipe friction computations.
- 3) Gradually varied flow problems.
- 4) Hydraulic jump computations.
- 5) Unit hydrograph computations.
- 6) Flood routing. (Muskingum method)
- 7) Water hammer analysis

WRE1.7 G.I.S. LABORATORY

Students are Supposed to work on Various Problems involving the following Applications using any GIS Package.

- 1) Creation of vector maps and raster maps through digitization and rasterisation
- 2) Image processing of digital images (geometric correction- image enhancement- image classification)
- 3) Preparation of thematic maps (land use/ land cover- road maps- drainage network map etc.) From satellite image of any region.
- 4) Watershed delineation from drainage map and contour map of any region.
- 5) Development of digital elevation model (DEM) using any technique.
- 6) Any simple case study of RS & GIS Application in WRE.

**Department of Civil Engineering
M.Tech. (Water Resources Engineering)**

Syllabus
(with effect from 2019-20 Admitted Batch)

II – SEMESTER

WRE2.1 CHANNEL AND FLUVIAL HYDRAULICS

Review of Fundamentals of Hydraulics-Continuity Equation- Bernoulli's Equation and Impulse –Momentum Equation.

Introduction to Open Channel Flows- Basic Features- Uniform Flow and Computation of Normal Depth- Specific Energy-Depth Relationship- Critical Flow and Computation of Critical Depth- Hydraulic Jump.

Steady State Gradually-Varied Flow- Governing Differential Equation- Classification of GVF Profiles- Computation of Profiles.

Transient Gradually-Varied Flow- Saint Venant's Equations- Kinematic Wave Theory- Flood Routing Through Channels- Muskingum Method.

Fluvial Hydraulics- Incipient Condition- Bed Load- Suspended Load- Bed Forms & Field Measurements.

Text Books And Reference Books

1. *Flow in Open Channels* by Subramanya- K.-- Tata Mc Graw Hill- 1986.
2. *Mechanics of Sediment Transport and Alluvial Stream Problems* by Garde - R.J. and Rangaraju- K.G.
3. *Open Channel Hydraulics* by Chow-V.T.- Mc Graw Hill- Tokyo- 1959.
4. *Flow through Open Channels* by Rangaraju- K.G.

WRE2.2 ENVIRONMENTAL IMPACT ASSESSMENT OF WATER RESOURCES PROJECTS

Water Resources Development - an Overview-Impact Types- Beneficial & Adverse- Primary- Secondary- Long-Term- Short-Term- Reversible- and Irreversible Procedural Requirement for EIA and Clearance - Indian Scenario

EIA - General- Purposes Principles and Processes- Identification- Prediction and Assessment Steps in EIA - EIA Approaches And Techniques- Data Requirement for EIA- Hydro-Indices- Case Studies.

Text Books

1. *Environmental Impact Assessment for Developing Countries by Biswas- A.K. and Aggrawal- S.B.C.*
2. *Environmental Impact of Water Resources Projects by Canter- L.*
3. *Environmental Impact Assessment- Principle and Procedure by Munn- R.E.*
4. *Environmental Impact Analysis Handbook by Ray- S.G. & Wooten- D.C.*
5. *Environmental planning- policies & programmes in India by Saxena- K.D.- Shipra Publishers- Delhi.*

Reference Books

1. *Environmental Impact of Water Resources Projects by Canter- L.*
2. *Environmental Impact Assessment- Principle and Procedure by Munn- R.E.-.*
3. *Environmental Impact Analysis Handbook by Ray- S.G. & Wooten- D.C.*
4. *Environmental planning- policies & programmes in India by Saxena- K.D.- Shipra Publishers- Delhi.*
5. *Environmental Impact Assessment for Developing Countries by Biswas- A.K. and Aggrawal- S.B.C.-.*

WRE2.3 WATERSHED BEHAVIOUR AND ITS CONSERVATION PRACTICES

Soil And Water – Issues Related to Plant Life Like Composition of Soil- Water Requirement of Crops- Necessary Conditions for Plant Growth Etc. Soils- Their Origin and Classification. Land Classification for WM- Land Capability Rating- Determination of Land Capability Class- Land Capability and Suitability Surveys.

Watershed Behavior – Physical Elements of a Watershed- Effects of Land Use Changes on Hydrological Cycle Component Concept of Vegetative Management of Water Yield and Quality. Watershed Experiments- Extrapolation of Results from Representative and Experimental Basins- Regional Studies

Soil Erosion – Problem- Types- Conservation- and Control Measures in Agricultural and Non-Agricultural Land. Water Conservation and Harvesting – Agronomical Measures in Soil and Water Conservation. Examples and Critical Reviews.

Inventory Techniques for Precipitation Runoff- Soil- Timber- Range-Land and Wild Life Water Harvesting Techniques– Elements- Development of Modern Harvesting Techniques Estimation of Peak Runoff Rate Land Capability Classification

Erosion Process – Factors Affecting Erosion- Types of Erosion- Assessment of Erosion- Control Measures for Erosion

Conservative Practices – Objective and General Practices- Land and Soil Classification- Identification of Critical Areas

Watershed Management – Objectives of Planning Watershed Projects Guidelines for Project Preparation Approach in Govt. Programmes- People’s Participation- Conservation Farming- Watershed-Management Planning- Identification of Problems- Objectives and Priorities- Socioeconomic Survey- use of Tools Like GIS.

Watershed Modeling: Runoff Components –Simple Parametric Models – Curve Number Method- Variable Source Area Models- Quasi- Physically based models- a simple physically based model.

Text Books & Reference Books

- 1. Hydrology and Management of Watersheds by Brooks- K.N.- Ffolliott- P.F.- Gregerson- H.M. and De Bano- L.F.- Iowa State University Press- 1991.*
- 2. Soil and water conservation Practices by Frevert- R.K.- Schwab- G.O.- Edminster- T.W. and Barnes- K.K.- John Wiley and Sons- New York- 1990.*
- 3. Forest Hydrology by Lee. R.*

4. *Guidelines for watershed Management – F.A.O. Conservation Guide No. 1.*
5. *More Water for Arid Lands – Promising Techniques and Research opportunities – National Academy of Sciences.*
6. *Water shed Management by B.M. Tideman*
7. *Modern physical geography by Strahler A.N. and Strahler A.H*
8. *Linear programming and extensions by Dantzig- G.B.- Princeton University Press- Princeton- New Jersey- 1963*
9. *Water resources systems engineering by Hall- W.A. and Dracup- J.A.- Mc Graw Hill- 1970.*
10. *Water production functions for irrigated agriculture by Hexem- R.W. and Heady E.O.-- Iowa State University Press- 1978.*
11. *Economics of Water Resources Planning by James- L.D. & Robert- R. L.*
12. *Linear optimization for management by Lee- S.M.- Petrocelli/ Charter- New York- 1976.*

WRE2.4 (a) ESTUARINE HYDRODYNAMICS AND SALINITY TRANSPORT

Common Syllabus for HCH2.4(a) and WRE2.4(a)

Tidal Dynamics in Estuaries- Estuaries of Rectangular Section- General Review of Engineering Problems in Tidal Estuaries- General Characteristics of Estuaries- Mathematic Description of Tides Without Friction- Mathematic Description of Tides With Friction- Experimental Results on Co oscillating Tides.

Real Estuaries- Introduction- Methods of Analysis- Numerical Integration Methods- and Harmonic Method- Damped Cooscillating Tide.

The Mechanism of an Arrested Saline Wedge- Introduction- Form Characteristics of Arrested saline Wedges- The Pattern of Velocities- Mixing in Arrested Saline Wedge- Hydrodynamics of Layers- Estimation of the Length of Arrested Saline Wedges in Wide Channels.

Diffusion Processes in Stratified Flow- Introduction- Convective-Diffusion Equation for Turbulent Flow- One-Dimensional Turbulent Diffusion in Constant-Density Flow- One-Dimensional Turbulent Diffusion in Stratified Flow.

Salinity Intrusion in Estuaries- Basics Factors Governing Salinity Distribution in Estuaries- Effects of Salinity and Fresh-Water Flow on Tidal Conditions- Internal Flow

Processes- One-Dimensional Analysis of Mixed Estuaries- Experimental Results for WES Tidal Flume.

Reference Book

1. *Estuary and Coastline Hydrodynamics* by A.T. Ippen- Publisher: McGraw-Hill Inc.

WRE2.4 (b) CONJUNCTIVE WATER RESOURCES PLANNING

Introduction-Surface & Groundwater Components- System Constraints- Parameter Identification & Model Decomposition- Consumptive Water Requirement of Crops- Conjunctive Water use Model

Deterministic & Stochastic Optimization- Water Quality & Legal Aspects- Economic & Multi-Objective Analysis

Text Books

1. *Principles of water resources planning* by Goodman- A.S.-- Prentice Hall Inc. - New Jersey- 1984.
2. *Numerical methods in subsurface hydrology* by Remson- I.- Hornberger- G.M.- and Molz. F.J.- Wiley Inter Science.

WRE2.5 (a) IRRIGATION WATER SYSTEMS AND MANAGEMENT

Irrigation Systems – Major- Mini- Minor Potential Surface- Lift and GW Systems- Methods of Irrigation- Relative Merits and Demerits- Modeling

Soil Physics and Soil Chemistry- Terminology- Soil-Water and Hydraulic Conductivity. Soil Chemical Properties- Impact of Soil And Water Chemical Concentrations on Yields –Management of Soil Chemical Concentrations.

Soil Physics and Soil Agriculture- Cropping Pattern- Irrigation- Sustainable Systems Planning Irrigation Systems – Crop Water Requirements- Irrigation Frequency- Yield – Methods of Estimation of Crop Water Requirements – Methods Based on Temperature and Pan Evaporation- Combined Method- Crop Coefficient Curves.

Surface System Design- Definitions –Furrow System Design – Level Basin System Design –Graded Border System Design

Sprinkler System Design: Uniformity and adequacy of Water Application-Evaporation and Wind Drift- Components of System Design. Distribution System Design and Layout-Centre Pivot System- Linear Move System- Big Gun and Boom Sprinkler Systems. Trickle (Drip) Irrigation System Design: Concept of Trickle System- Emitters – Flow Through Laterals – Filtration and Water Treatment Systems- Fertilizer Injection Systems- Water Logging and Prevention and Efficiencies. Optimization Techniques in Planning as Applied to Irrigation.

Agricultural Hydrology- Subsurface- Unsaturated Flow- Hysteresis- Soil Moisture and Deep Percolation- Return Flows and Modeling Droughts and Mitigation of Droughts.

Text Books

1. *Water Resources Systems Planning and Management* by Chaturvedi- M.C. Tata McGraw Hill
2. *Economics of Water Resources Planning* by James L.D and Lee R.R- McGraw Hill
3. *Irrigation theory & Practice* by Maichel
4. *Irrigation System Design (An engineering approach)* by Richard H. Cuenea- Prentice Hall
5. *Water resources systems planning and analysis* by Deniel P. Louchs- Jerry R. Stedinger and Danglass. A. Haith- Prentice Hall

Reference Books

1. *Irrigation – Principles and methods* by Irstelsen and Hanesn-
2. *Hydro systems Engineering and Management* by Mays L.W. and Tung Y.K.- McGraw Hill- 1992
3. *Systems analysis for Civil Engineer* by Ossenburgen P.J.- John Wiley and Sons

WRE2.5(b) FINITE ELEMENT METHOD OF ANALYSIS

Common Syllabus for ST2.2, SMFE2.5(b), WRE2.5(b), HCH2.5(b) and TE2.5(b)

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM: Different types of elements for plane stress and plane strain analysis –Displacement models Generation of element stiffness and nodal load matrices – static condensation.

Isoparametric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

Text Books

1. *Finite Element Analysis by C.S.Krishnamoorthy, (2002), Tata McGraw Hill Publishing Co. Ltd.*
2. *Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.*

Reference Books

1. *Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu*
2. *The Finite Element Method in Engineering Science” by Zienkiewicz, P., McGraw Hill, 1971.*

WRE2.6 HYDRAULICS AND ENVIRONMENTAL ENGG. LABORATORY

1. Hydraulic Jump in horizontal and rectangular channels.
2. Gradually Varied Flow Profiles.
3. Studies on Groundwater flow and Well hydraulics.
4. Flow past Bluff bodies- Airfoil and Cylinder.
5. Principles of measurement and testing of water for parameters like pH- TDS- NO₃ . PO₄-P- Hardness- Turbidity- residual chlorine- DO- Chlorides- Jar test for coagulant dosing.
6. COD- BOD- SS- VSS- heavy metals using AAS- Microscopy.
7. Air for SPM- RSPM- NO₂ & SO₂ using High volume sampler- CO- NO_x . SO₂ using continuous analyzers- Noise measurement using SLM. (Demo only)

WRE2.7 SEDIMENT TRANSPORT & DREDGING

1. Study of Basics of Sediment Transport Phenomenon.
2. Estimation of Bed Load & Suspended Load and Reservoir Siltation
3. Sediment Samplers and Sampling: Bed Load Sampling- Suspended Load Sampling and Computation of Total Load.
4. Dredging and Disposal of Dredged Materials.
5. Case Studies of Reservoir Siltation.
6. Case Studies of Dredging in Ports and Harbours.

Reference Books

1. *Mechanics of Sediment Transportation and Alluvial stream problems by Garde- R.J. and K.G. Ranga Raju- Second Edition- Wiley Eastern Limited.*
2. *Hydraulics of Sediment Transport by Graf- W.H.- McGraw-Hill Book Co.*
3. *Loose Boundary Hydraulics by Raudkivi- A.J.-Pergamon press.*
4. *Practical Dredging by Cooper- H.R.- Brown- Son & Ferguson- Glasgow.*
5. *Dock and Harbour Engineering Vols. I- II & III by Cornick- H.F.- Charles Griffin & Co.*
6. *Dock and Harbour Engineering by Seetharaman- S. Umesh Publication.*

WRE2.8 SEMINAR

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end of the semester

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III – SEMESTER

WRE3.1(a) HYDROINFORMATICS

Overview of Numerical Engines/ Techniques Including Tools- Environments and Languages.

Integration of Different Interfaces - Spatial Decision Support Systems and GIS-Emerging Techniques in Hydro-Informatics- Hydrological Applications.

Text Books

1. *Neural Network and Fuzzy logic by Rao- V.B. and Rao- H.V.- BPB Publications- New Delhi-*
2. *Hydro informatics by Babovic- V and Larsem- L.C. AA Balkema- The Netherlands- 1998.*
3. *Geographic Information by Cadoux- J. & Heywood- D.I.- Taylor & Frances Ltd.- London- U.K.*
4. *Neural Networks and fuzzy logic by Fu- L.-- Mc Graw-Hill Inc.- 1994.*
5. *Geographic Information System by Burrough - D.A.*

WRE3.1(b) URBAN STORM WATER DRAINAGE

Introduction to Drainage Problems in Different Climates- Urbanization- its Effects and Consequences for Drainage-Interaction Between Urban and Peri-Urban Areas Process of Urbanization and Influence on Hydrologic Cycle

Planning Concepts and System Planning- Objectives of Urban Drainage and Planning Criteria- Drainage and System Layout. Planning Tools and Data Requirement- Drainage Master Plan- Examples for Drainage Structures.

Review of Hydrologic and Hydraulic Principles- Urban Hydrologic Cycle- Hydrologic Principles- Rainfall analysis in Urban Environment and Design Storm- Hydraulic Principles- Hydrodynamic Principles.

Urban Runoff Computations - Empirical- Time-Area and Unit Hydrograph approaches
Design of Drainage System Elements: Hydraulic Fundamentals- Infiltration and on-Site
Detention of Storm water- Design of Sewerage And Drainage Channels- Design of
Appurtenances- Road Drainage- Design of Pumping Stations.

Control of Storm water Pollution- Pollution Build-Up and Wash off Process with
Reference to Urban Drainage Systems. Source Control in Commercial and Industrial
Complexes- Storage Options - Dry and Wet Ponds- Biological Treatment of Wastewater-
Chemical Treatment of Storm water.

Operation and Maintenance of Urban Drainage Systems-Maintenance Requirement for
Different Structures- Maintenance Planning- Cleaning of Sewers and Drains- Inventory
of Damages- Repair Options.

Urban Drainage -Kinematic Wave Theory Approach

Introduction to Urban Watershed Software's Hydrologic Cistern- Water Conservation and
Ecological aspects Water Harvesting.

Text Books

1. *Handbook of Applied Hydrology : A Compendium of Water resources* by Chow-
V.T.
2. *Hydrology and hydraulic systems* by Gupta- R.S.-- Prentice Hall- Englewood
cliffs.
3. *Urban Hydrology* by Hall- M.J.
4. *Hydrology* by Viesmann & Knapp

WRE3.1(c) GROUND WATER FLOW AND CONTAMINANT TRANSPORT

Introduction- Hydrologic Cycle- Movement & Occurrence of Groundwater- Properties of
Groundwater- General Flow Equations- Dupuit Equation

Fundamentals of Groundwater Flow :Occurrence of Ground Water- Vertical Distribution
of G.W. Flow- Darcy's Law- Permeability- Porosity- Anisotropic Aquifers- Differential
Equations of G.W. Flow.

Potential Flow-Flow nets- Boundary Conditions- Flow-Net Construction for Confined
and Unconfined Flow Systems.

Mechanics of Well Flow- Steady & Unsteady Flow in Confined & Unconfined Aquifers- Leaky Aquifers- Partial Penetration of Wells- Multiple Well Systems- Boundary Effects & Method of Images- Well Losses.

Ground Water Modeling- Sand Tank- Heleshaw- Electrical Analogous Models- Finite Element/Difference Models.

Ground Water Development and Management- Design of Wells- Construction of Wells- Well Development- Artificial Recharge- Conjunctive Use- Salinity of G.W.- Ground Water Pollution.

Sources & Type of Groundwater Contamination- Contaminant Transport Mechanisms: Advection- Diffusion & Dispersion- Mass Transport Equations- One & Two-Dimensional Modeling

Sorption & other Chemical Reactions- Factors affecting Sorption- Sorption Isotherms- Sorption Effect on Fate & Transport of Pollutants- Estimation of Sorption

Biodegradation Reactions & Kinetics: Biological Transformations- Microbial Dynamics- Kinetics of Biodegradation

Nonaqueous-Phase Liquids- Types of Naps- General Processes- NAPL Transport Computational Methods

Groundwater Remediation and Design: Remedial Alternatives- Source Control- Hydraulic Controls- Bioremediation- Soil Vapor Extraction Systems- Remediating NAPL Sites- Emerging Technologies

Text Books

1. *Ground Water Contamination- Transport and Remediation by Bedient- Rifai & Newell-- PTR Prentice Hall*
2. *Groundwater Hydrology by D.K . Todd-- John Wiley & Sons*

Reference Books

1. *Groundwater and Seepage by M.E. Harr.*

HCH3.2(a) HYDRAULIC STRUCTURES

Common Syllabus for HCH3.2(a) and WRE3.2(a)

Dams- Types- Choice of Type of Dam- Forces Acting on Dams- Requirements of Stability- Causes of Failure.

Gravity Dams- Non-Overflow and Overflow Types- Modes Of Failure and Criteria For Structural Stability of Gravity Dams- Design of Gravity Dam- Single Step and Multistep Design- Cracks and Joints in a Gravity Dam- Foundation Treatment for Gravity Dams- Stress Concentration around Openings in Dams- Gravity Dams Subjected to Earthquakes.

Spillways- Different Types of Spillways and Their Design Principles- Energy Dissipation Below Spillways- use of Hydraulic Jump as Energy Dissipater and Design of Stilling Basins- Types of Spillway Gates.

Arch Dams- Types- Loads on Arch Dams- Cylinder Theory – Constant Radius- Constant Angle- Variable Radius types- and Principles of Elastic Theory and Trial Load method of analysis.

Buttress Dams- Components- Advantages and Disadvantages- Types- Forces- Theory of Buttress Design- Buttress Spacing and Buttress Construction Details.

Earth Dams- Types of Earth Dams- Methods of Construction- Causes of Failure of Earth Dam- Design Criteria For Earth Dams- Selecting a Suitable Section for an Earth Dam- Requirements of Safety- Seepage- Construction of Seepage Line for Different Conditions- Seepage Control Methods- Stability Analysis for Different Conditions- Factor of Safety against Foundation Shear- Details of Method of Construction of Earth Dams- Maintenance and Treatment of Common Troubles in Earth Dams.

Appurtenance Works- Design Principles of Various types of Crest Gates- Stilling Basins- and Drainage Galleries. What Hammer Analysis and Design of Surge Tanks- Penstocks- Draft Tubes and Scroll Casing.

Reference Books

1. *Theory and Design of Irrigation Structures Vol. I & II* by Varshney- R.S.- S.C. Gupta and Gupta- R.L.-Nem Chand & Brothers.
2. *Irrigation: Practice and Design – Vols. II & III* by Khushalani- K.B. and M Khushalani- Oxford of IBH Publishing Co
3. *Irrigation and Hydraulic structures* by Garg- S.K.- Khanna Publishers.

4. *Engineering for Dams – Vols. I- II & III by Creager- W.P- J.D. Justin and J. Hinds-John Wiley & Sons.*
5. *Hand Book of Applied Hydraulics by Davis- C.V. and K.E.Sorensen- Third Edition- McGraw-Hill Book Co*

WRE3.2(b) FLOOD FORECASTING

Objective- Importance- Historical Development and Classification of Hydrological Forecasts

Data Collection and Flood Forecasting Network Design- Data Transmission- Physically Based Models Graphical and Statistical Models- Stochastic Models and Adaptive Filter Models- UH and SCS Based Deterministic Models- Flood Forecasting using Artificial Neural Network- Watershed Models

Updating- Verification and Dissemination of Forecast

Text Books

1. *Manual on flood forecasting by Anderson- M.C.- Burt- T.P. - New Delhi- 1985.*
2. *Hydrological forecasting-Central Water Commission- John Willy and Sons- 1989.*
3. *Automatic collection and transmission of hydrological observations WMO-*
4. *Operational Hydrology report no. 2- Geneva- Switzerland- 1973.*
5. *Inter comparison of conceptual models used in operational hydrological forecasting*
6. *WMO- Geneva- Switzerland.*
7. *Operational Hydrology report no. 7- 1975.*

WRE3.3 DISSERTATION (Preliminary)

The student shall submit a brief report on the selected topic of his/her thesis work and attend for a formal viva-voce examination before a committee comprising the Chairman, BOS, Head of the Department and the Guide.

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IV – SEMESTER

WRE 4.1 DISSERTATION (Final)

The student shall submit his/her thesis work and attend for a formal viva-voce examination before a Committee comprising the Chairman, BOS, Head of the Department, the Guide and the External Examiner.