

**M.Tech. Degree  
PROGRAMME**

**in**

**WATER RESOURCES ENGINEERING**

**CURRICULUM**

**(w. e. f. Session 2019-2020)**



**DEPARTMENT OF CIVIL ENGINEERING  
NATIONAL INSTITUTE OF TECHNOLOGY  
KURUKSHETRA - 136119**

## **VISION AND MISSION OF THE INSTITUTE**

### **VISION**

To be a role-model in technical education and research, responsive to global challenges.

### **MISSION**

To impart technical education that develops innovative professionals and entrepreneurs and to undertake research that generates cutting-edge technologies and futuristic knowledge, focusing on the socio-economic needs.

## **VISION AND MISSION OF THE DEPARTMENT**

### **VISION**

To be a role-model in Civil Engineering Education and Research responsive to global challenges.

### **MISSION**

1. To impart quality Civil Engineering Education that develops innovative professional & entrepreneurs.
2. To undertake research that generates cutting-edge technologies & futuristic knowledge, focusing on the socio-economic needs.
3. To prepare professionals with emphasis on leadership, team work and ethical conduct.

## **VISION AND MISSION OF THE PROGRAM**

### **VISION**

To disseminate state-of-the-art education to develop competent professionals in Water Resources Engineering with capability to serve the society

### **MISSION**

To educate and train manpower engaged in cutting-edge research by offering latest in the field of Water Resources Engineering for sustainable development.

### **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

**The PG programme in Water Resources Engineering will produce post graduates that, within a few years of graduation:**

<ul style="list-style-type: none"><li>• will acquire and exhibit competence to cater to the development of water resources at the global level. <b>(PEO1)</b></li></ul>
<ul style="list-style-type: none"><li>• shall be able to utilize domain knowledge required for analyzing and resolving practical problems. <b>(PEO2)</b></li></ul>
<ul style="list-style-type: none"><li>• will be capable of adapting to ever-changing technologies in water resources. <b>(PEO3)</b></li></ul>
<ul style="list-style-type: none"><li>• will be sensitive to the needs of the society, honouring social commitments and preserving the environment. <b>(PEO4)</b></li></ul>
<ul style="list-style-type: none"><li>• shall be equipped with theoretical knowledge and practical skills to investigate/undertake complex projects of high impact and of inter-disciplinary nature. <b>(PEO5)</b></li></ul>

### **PROGRAM OUTCOMES (POs)**

**• Graduates of the Programme:**

<ul style="list-style-type: none"><li>• shall be able to utilize domain knowledge required for analyzing and resolving field problems of hydraulics and water resources. <b>(PO1)</b></li></ul>
<ul style="list-style-type: none"><li>• shall have the ability to write and present a substantial technical report of the comprehended problem and its recommended solution. <b>(PO2)</b></li></ul>
<ul style="list-style-type: none"><li>• shall demonstrate a definite higher degree of mastery in the comprehension and analysis of water resources problems. <b>(PO3)</b></li></ul>
<ul style="list-style-type: none"><li>• shall be equipped with theoretical and practical skills to investigate and undertake complex projects of inter-disciplinary nature with wide impact. <b>(PO4)</b></li></ul>
<ul style="list-style-type: none"><li>• shall imbibe social and environmental ethics, readily adapting to ever changing and transforming technical requirements and working towards sustainable development of the society. <b>(PO5)</b></li></ul>

## M.Tech Program Water Resources Engineering Scheme of Studies

S.No	Course No.	Subject	Teaching Schedule				Credits
			L	T	P	Total	
<b>Semester-I</b>							
1	<b>MCE3C01</b>	Advanced Fluid Mechanics	3			3	3
2	<b>MCE3C03</b>	Open Channel Hydraulics	3			3	3
3	<b>MCE3C05</b>	Engineering Hydrology	3			3	3
4		Elective-I	3			3	3
5		Elective-II	3			3	3
6	<b>MCE3S07</b>	Seminar-I			2	2	1
7	<b>MCE3L09</b>	Hydraulics Lab			4	4	2
			15		6	21	18
<b>Semester-II</b>							
1	<b>MCE3C02</b>	Water Resources Planning & System Engineering	3			3	3
2	<b>MCE3C04</b>	Ground Water Engineering	3			3	3
3		Elective-III	3			3	3
4		Elective-IV	3			3	3
5		Elective-V	3			3	3
6	<b>MCE3S08</b>	Seminar-II			2	2	1
7	<b>MCE3L10</b>	Water Resources Engineering Lab			4	4	2
			15		6	21	18
<b>Summer Term</b>							
SUMMER ACADEMIC ACTIVITY							
Preparatory work for dissertation/Training on Software							
<b>Semester-III</b>							
	<b>MCE3-D/P/I-11</b>	Dissertation/ Project Work/ Internship- Part-I			28	28	14
<b>Semester-IV</b>							
	<b>MCE3-D/P/I-12</b>	Dissertation/ Project Work/ Internship- Part-II			28	28	14
<b>Total</b>							
<b>64</b>							

Note:

- Elective can be opted from the list of electives/ core subjects of various specializations of Civil Engineering Department.
- Electives-V can be opted from the list of electives of other departments as well.
- List of Electives, being offered by the Department along with the number of slots and pre-requisites, if any, will be notified by the concerned department well before the registration.

## **Annexure**

### **List of Electives**

#### **Odd Semester**

- MCE3E31** Hydro Power Engineering
- MCE3E33** Embankment Dams
- MCE3E35** Advanced Irrigation Engineering and Drainage
- MCE3E37** Computational Methods in Fluid Mechanics
- MCE3E39** Wind Engineering
- MCE3E41** Remote Sensing for Water Resources Systems
- MCE3E43** Introduction to GIS for Water Resources

#### **Even semester**

- MCE3E32** Design of Hydraulic Structures
- MCE3E34** Watershed Management
- MCE3E36** Sediment Transport
- MCE3E38** Modeling Analysis and Simulation
- MCE3E40** Environmental Impact Assessment of Civil Engineering Projects
- MCE3E42** Neuro-fuzzy Applications in Civil Engineering
- MCE3E44** Climate Change and its Impact

<b>MCE3C01</b>	<b>ADVANCED FLUID MECHANICS</b>	<b>CC</b>	<b>3-0-0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Term: 50 marks</b>		<b>Total: 100 marks</b>

**Pre-requisites:** First course on Fluid Mechanics at the graduate level.

**Course Objectives:**

Introduction to concepts of fluid mechanics from both theoretical and applications perspective to the students. Introduction and analysis of Reynold's Transport Theorem as a tool to formulate mathematical tools. The students will have sufficient mathematical and physical background to formulate real life problems in fluid mechanics.

**Detailed syllabus:**

**KINEMATICS OF FLUIDS:** Methods of describing fluid motion-Lagrangian and Eulerian methods, Translation, Rotation and rate of deformation. Streamline, Path lines and streak lines, Material Derivative-local and Convective Acceleration, Fluid rotation-Vorticity Vector.

**STRESSES IN FLUIDS AND RATE OF STRAIN:** Stresses at a point fluids. Stress Tensor-Normal and shear stresses, Nature of strains. Relations between stresses and rates of strains-Stokes law of viscosity. Viscous contribution to normal stresses.

**FUNDAMENTAL EQUATIONS OF FLOW OF VISCOUS COMPRESSIBLE FLUIDS:** Reynold's transport theorem, Equations of Continuity and Momentum in integral form and applications, Differential form of continuity equation and Euler's equation of motion, Navier-Stoke's equations of viscous compressible fluids.

**TWO AND THREE DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW OF FLUIDS:** Circulation concept-Stoke's theorem, Kelvin's theorem, Stream function, Irrotational flow and velocity potential function, Integration of Euler's equation-along a stream line for irrotational flows, Momentum theorem and moment of momentum theorem. Laplace equation and Flow nets, Two dimensional flow examples-Rectilinear flow, Source/Sink, Vortex, Doublet, Dipole. Three dimensional axis - Symmetric flow examples-Uniform flow. Source / Sink, Doublet, Rankine's method of constructing flow net.

Motion of solids in a fluid superposition of source and rectilinear flow (two and three dimensional cases). Superposition of source and sink with rectilinear flow (Rankine body). Superposition of rectilinear and doublet. Cylinder and sphere in uniform flow: Superposition of vortex and doublet on uniform rectilinear flow, Presence of force of lift on the cylinder/sphere in motion with circulation, lifting vanes.

**LAMINAR FLOW OF VISCOUS INCOMPRESSIBLE FLUIDS:** Similarity of flows, Reynolds Number and its significance, Flow between parallel flat plates, Couette flow, Plane Poiseuille flow, Flow through pipes, Hagen-Poiseuille flow, Axial flow, Flow between two coaxial cylinders, Flow between two concentric rotating cylinders, Measurement of viscosity, Unsteady motion of a flat plate (plane wall).

**LAMINAR BOUNDARY LAYER:** Properties of Navier-Stoke's equations-Boundary layer concept, Prandtl's boundary layer equations in two dimensional flow. Boundary layer along a flat plate-Blasius solution for shearing stress & boundary layer thickness; Boundary layer on a surface with pressure gradient, Momentum integral theorems for boundary layer, Von Karman

integral relation from boundary layer equation and using moment law, Applications of momentum integral relation to the boundary layers-Von Karman Pohlhausen method, Separation of boundary layer flow-mathematical criterion and prediction of separation. Methods of boundary layer, Control including boundary layer suction.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1</b>	Formulate momentum, energy and mass transport models
<b>CO2</b>	Analyze Potential Flows
<b>CO3</b>	Develop approximate solutions for small and large Reynolds number flows
<b>CO4</b>	Apply turbulent flow models
<b>CO5</b>	Understand and analyse boundary layer formation and stresses acting at the boundary

**BOOKS RECOMMENDED:**

- Fox, R.W., Pitchard, P.J., and McDonald, A.T., Fluid Mechanics, Wiley India Pvt. Ltd., 2009.
- Schlichting, H., and Gresten, K., Boundary Layer Theory, Springer Publications, 2004.
- White, F.M., Viscous Fluid Flow, McGraw Hill Pub. Co, New York, 2011.
- Yalin, M.S., Theory of Hydraulic Models, McMillan Co., 1971

<b>MCE3C02</b>	<b>WATER RESOURCES PLANNING AND SYSTEMS ENGINEERING</b>	<b>CC</b>	<b>3-0-0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Term: 50 marks</b>		<b>Total: 100 marks</b>

**Pre-requisites:** Knowledge of basic water resources engineering.

**Course Objectives:**

This course attempts to give a broad background of numerical methods common to various branches. The course covers solution of initial and boundary value problem for ordinary and partial differential equation using different methods. In addition, response surface methodology is discussed to establish relationship between input and output variables and the adequacy of model is tested by various techniques.

**Detailed Syllabus:**

**INTRODUCTION:** Planning, Meaning and Significance. Need for water resources systems planning, Issues in planning. Planning process.

**PLANNING FOR WATER RESOURCES DEVELOPMENT:** Statement of objectives. Data requirements. Project formulation. Environmental considerations in planning, Systems analysis. Pitfalls in project planning. Conservation and augmentation of water resources. Multipurpose projects. Functional requirements in multi-purpose project. Compatibility of multipurpose uses.

**ECONOMIC ANALYSIS:** Equivalence of kind. Equivalence of time, Value. Cost. Benefit. Discounting factors, Discounting techniques. Measurement of cost and benefit. Benefit-cost analysis. Project evaluation, Benefit-cost variation. Limitations of benefit-cost analysis. Dynamic of project analysis.

**FINANCIAL ANALYSIS:** Role of financial analysis. Distinctions from economic analysis. Financial feasibility, Separable and non-separable costs. Cost allocation, allocation consequences. Water resources pricing.

**WATER RESOURCES SYSTEMS:** Concepts of systems engineering in water resources. Objective function, Production function and optimality conditions. Linear, non-linear and dynamic programming, Sensitivity analysis, Stochastic models, Statistical decision theory. Application of water resources systems engineering to practical problems.

**Course Outcomes:**

<b>CO1</b>	Students should be able to apply concepts of systems analysis for planning of water resources systems and minor levels
<b>CO2</b>	Students can perform basic economic analysis between alternate water resources



	projects and to evaluate the economic feasibility of water resources engineering projects
<b>CO3</b>	Students must in position to formulate and solve deterministic optimization models for design and operation of water resources systems
<b>CO4</b>	To develop analytical skills to formulate and solve stochastic problems for decision making under uncertainty

**BOOKS RECOMMENDED:**

1. Water Resources Engineering by R.K. Liniley and Franzini, McGraw-Hill Book Co.
2. Water Resources Systems Engineering by Hall and Dracup ,McGraw Hill Book Co.
3. Economics of Water Resources Engineering by L. Douglas James. and Robert R. Lee McGraw Hill BookCo.
4. Design of Water Resources Systems by Arther Mass et. Al, Harward Univ. Press Cambridge. 1967
5. Optimization Theory and Applications by S.S.Rao, Willy East. Ltd.

<b>MCE3C03</b>	<b>OPEN CHANNEL HYDRAULICS</b>	<b>CC</b>	<b>3- 0 - 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Sem: 50 marks</b>		<b>Total: 100 marks</b>

**Course Objectives:**

1. To develop an understanding of continuity, momentum and energy equations to uniform and non-uniform open channel flows
2. To learn to apply conservation laws to gradually varied and rapidly varied unsteady flows
3. To analyse hydraulics of mobile bed channel

**Detailed syllabus:**

**BASIC PRINCIPLES:** Classification of open channels, Classification of flows, Basic equations, Energy & Momentum coefficients, Pressure variation in a vertical.

**UNIFORM FLOW IN RIGID-BOUNDARY CHANNELS:** Shear stresses on the boundary, Velocity distribution, Flow over scattered roughness elements, Chezy's equation, Manning's equation, Effect of channel shape on resistance equation, Conveyance of a channel, Section factor curves. Flow in a circular channel, Relation between conveyance & depth.

**UNIFORM FLOW IN MOBILE-BOUNDARY CHANNELS:** Incipient motion condition, Regimes of flow, Equivalent roughness, Resistance to Flow in alluvial streams, Design of non-scouring erodible boundary Channels.

**SPECIFIC ENERGY, SPECIFIC FORCE AND CRITICAL DEPTH:** Specific energy, Specific force, Critical depth computations, Control section, Applications of specific energy and critical depth concepts, Critical depth flumes.

**GRADUALLY VARIED FLOW:** Types of non-uniform flow, Governing equation, Characteristics of surface curves, Classification of surface curves, Computations of GVF in prismatic channels, Direct methods, Advanced numerical methods.

**RAPIDLY VARIED FLOW:** Types of jump, Hydraulic jump in horizontal and sloping rectangular channels and its characteristics, Location of jump on horizontal floor, Forced hydraulic jump, Jump in expanding and non rectangular channels, End depth in a free overfall, Sluice gate flow.

**UNSTEADY FLOW:** Waves & their classification, Celerity of a wave, Surges (positive and negative), equation of motion. Method of characteristics, Dam breaks problems, Saint Venant equation.

**SPATIALLY VARIED FLOW AND TRANSITION:** Basic principles and assumptions, SVF with increasing and decreasing discharge, Design of Side weirs, De Marchi equations, Trench wears, Bottom racks, Subcritical and supercritical transitions.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1:</b> Compute flow profiles in channel transitions and due to hydraulic structures
<b>CO2:</b> Design channels including irrigation canals and storm water drains
<b>CO3:</b> Formulate and solve the problem of propagation of flood wave and surges in channels
<b>CO4:</b> Formulate and solve hydraulic flood routing models

**BOOKS RECOMMENDED:**

- Open Channel Hydraulics by V.T.Chow, McGraw Hill. New York.
- Flow Through Open Channels by Ranga Raju K.G., Tata McGraw Hill.
- Flow in Open Channels by K. Subramanya, Tata McGraw Hill, Delhi.
- Open Channel Hydraulics by French R.FI.

<b>MCE3C04</b>	<b>GROUND WATER ENGINEERING</b>	<b>CC</b>	<b>3 – 0 – 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Sem: 50 marks</b>		<b>Total: 100 marks</b>

**Pre-requisites:** None

**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

**Detailed syllabus:-**

**OCCURRENCE OF GROUND WATER:** Groundwater in hydrological cycle, Properties of rocks and water bearing formations affecting ground water flow, Ground water basins, Vertical distribution of ground water, Ground water potential and its exploitation in India.

**GROUNDWATER MOVEMENT:** Darcy's law, Permeability and its determination, Flow rates and directions of flow of ground water, Dispersion of tracers in ground water, Unsaturated flows, General equations governing steady/unsteady flow through confined and unconfined aquifers.

**HYDRAULICS OF WATER WELLS:**Flow in confined aquifers towards wells in steady and unsteady state. Flow through leaky or semiconfined acquifers into wells, Dupuits assumption for unconfined aquifers, Steady and unsteady flows into wells, Theis, Jacob's and Chow's methods of solution of unsteady flows, Method of superposition in groundwater flow-method of images, Solutions of flow towards wells near a recharge boundary or impermeable boundary, Use of observation wells, Multiple well systems, Partially penetrating wells.

**DESIGN AND CONSTRUCTION OF WELLS:**Selection of Aquifer, well depth and well diameter, selection of screen-type and design of well screen, Provision of artificial gravel pack and shrouded wells, Test holes and well logs, Method of construction of shallow and deep wells including drilling, Completion and development of wells, Pumping equipment, resting the wells for yield, Maintenance and protection of wells, Rehabilitation of old and abandoned wells.

**SURFACE INVENSTIGATIONS OF GROUNDWATER:** Geological methods, Remote sensing, Geophysical exploration, electrical Resistivity method, Seismic Refraction method, Gravity and magnetic methods, Water Witching.

**SUBSURFACE INVESTIGATION OF GROUNDWATER:** Test drilling measurement of water levels, Geophysical logging, Resistivity logging, Spontaneous potential logging, Radiation logging, Temperature logging, Caliper logging, Fluid conductivity logging, Fluid Velocity logging, miscellaneous logging and other subsurface techniques.

**ARTIFICIAL RECHARGE OF GROUNDWATER:** Concept of artificial recharge: Methods of artificial recharge-water spreading, Waste water recharge for reuse, Recharge mounds , Induced recharge, Artificial recharge for energy purposes.

**SALINE WATER INTRUSION IN AQUIFERS:** Occurrence of saline water intrusion, Ghyben-Herzberg Relation between fresh and saline water shape and structure of fresh water and salt water interface, upcoming saline water, fresh water and salt water relations on oceanic islands, Control of salt water intrusion, Recognition of sea water in the ground water.

**QUALITY OF GROUND WATER:**Sources of salinity, Measures of water quality, Chemical analysis-graphical representation, physical and Biological analysis, water

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1</b>	Model regional groundwater flow and design water wells
<b>CO2</b>	Formulate and solve conjunctive use of surface water and groundwater resource utilization problems
<b>CO3</b>	Identify sites for artificial recharge of groundwater and determine the consequences of artificial recharge
<b>CO4</b>	Conduct Geophysical exploration studies for groundwater source identification

**BOOKS RECOMMENDED:**

- Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering, Planning and Management, CRC Press, 2011.
- Todd, D.K., and Mays, L. W., Groundwater Hydrology, John Wiley & Sons, Singapore, 2011.
- Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York, 1966.
- Domenico, Concepts and Models in Groundwater Hydrology, McGraw Hill Inc. New York, 1972

<b>MCE3C05</b>	<b>ENGINEERING HYDROLOGY</b>	<b>CC</b>	<b>3 – 0 – 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>	<b>End Sem: 50 marks</b>	<b>Total: 100 marks</b>		

**Pre-requisites:** None

**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

**Detailed syllabus:**

**INTRODUCTION:** Systems concept, Hydrologic system model, Hydrological model classification.

**HYDROLOGIC PROCESSES:** Reynolds transport theorem, Continuity equations-integral equation of continuity, Discrete time continuity, Momentum equations, Porous medium flow, Energy balance, Transport processes.

**ATMOSPHERIC WATER:** Atmospheric circulation, Water vapor, Precipitation, Thunder-storm cell model, Evaporation-energy balance method, Aerodynamic method, Combined aerodynamic and energy balance method, Evapotranspiration.

**SUB-SURFACE WATER:** Unsaturated (low-continuity equation, Momentum equation, Infiltration, Horton's equation. Philip's equation, Green Ampt method, Green-Ampt parameters, Two layer Green Ampt Model, Ponding time.

**SURFACE WATER:** Sources of stream flow, Hortonian overland flow, Sub surface flow, Saturation overland flow. Stream flow hydrograph, Storm hydrograph, Base flow separation, Excess rainfall and direct runoff, Runoff coefficients, Abstractions using infiltration equations, SCS method for abstractions, Urbanization effect, Time distribution of SCS abstractions,

**HYDROLOGIC MEASUREMENT:** Hydrologic measurement sequence, Measurement of atmospheric water-atmospheric moisture, Rainfall. Snowfall, Interception, evaporation, evapotranspiration, Measurement of surface water-water surface elevation, Flow velocity, Stream flow rate, Discharge computation, Rating curve, Measurement of Sub-surface, Water-Soil moisture. Infiltration, Ground water.

**UNIT HYDROGRAPH:** General hydrologic system model, Linear system in continuous time, Response functions of linear systems- Impulse response function, Step response function. Pulse

response function, Unit hydrograph, Unit hydrograph derivation, Unit hydrograph application, Unit hydrograph by matrix calculation. Solution by linear regression, Solution by linear programming, Synthetic unit hydrograph, Snyder's synthetic unit hydrograph, SCS dimensionless hydrograph, Unit hydrograph for different rainfall duration, Instantaneous unit hydrograph.

**LUMPED FLOW ROUTING:** Lumped system routing, Level pool routing, Runge-Kutta method, Hydrologic river routing, Linear reservoir model, Composite models.

**FREQUENCY ANALYSIS:** Return period, Hydrologic data series, Extreme value distributions, Frequency analysis using frequency factors, Probability plotting, Probability paper, plotting positions, Water resources council method, Determination of the coefficient of skewness, Testing for outliers, Reliability of analysis- Confidence limits, Standard error, Expected probability, Time series models in hydrology, Trends in annual series, Moving average and exponential smoothing, ARMA model, Generation of synthetic flow data.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1</b>	Analyze components of hydrologic cycle
<b>CO2</b>	Predict hydrologic extreme events for hydraulic and hydrologic design
<b>CO3</b>	Develop forecasting models for operation of hydrologic systems
<b>CO4</b>	Assess surface water resources

**BOOKS RECOMMENDED:**

- Groundwater Hydrology by D.R. Todd-John Wiley & Sons.
- Ground Water by H.M. Raglumath- Wiley Eastern.
- Theory of Groundwater Flow by A. Verruijtit- Macmillan & Co.
- Groundwater and Tubewells by S.P. Garg- Oxford Pub. Co.
- Groundwater hydrology by II. Bouwer-McGraw Book Co.

<b>MCE3E31</b>	<b>HYDRO POWER ENGINEERING</b>	<b>DE</b>	<b>3 – 0 – 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Term: 50 marks</b>		<b>Total: 100 marks</b>

**Course objectives:**

1. To develop an understanding of issues pertaining to planning, analysis and design of various components of hydropower projects within an integrated Energy Planning and Management System
2. Implications of hydro projects on water resources, environment, socioeconomics and national economy.
3. To develop an understanding of the dynamic response of a hydropower generating facility to governor interventions and the resulting propagation of hydraulic transients
4. To develop an understanding of the phenomenon of mass oscillations within an integrated reservoir-surge tank-hydropower plant system

**INTRODUCTION:** Principles of water power utilization. Potential energy of surface water, development of water power, comparison with other sources of energy and future of water power, classification of water power plants, water power utilization. Load curves, load factor, load duration curve, plant capacity and capacity factor, load prediction, pondage and its effect on plant capacity, storage and benefits from storage, storage and pondage estimation.

**DESIGN DETAILS OF HYDRO PLANTS** Runoff river plants with or without pondage, diversion canal development and its components, reservoir plants, pumped storage plants, base load plants and peak load plants including their components, various types of intake structures, their location and design, losses in intakes, intakes, air entrainment at intakes, inlet aeration.

**WATER CONVEYANCE** Penstocks, types and design, economical diameter of penstocks, pressure conduits in rocks, water hammer calculations and design of surge tanks, manifolds, anchor and supports, power canals end calculation of surges in canals.

**POWER STATION DESIGN** Surface power stations power house structure, dimensions, lighting and ventilation, variations in design of power house, Underground power stations. Location of underground power stations, types of underground power stations, components of under-ground power house, types of layout, advantages and limitations of underground of underground power house. Turbines, salient dimensions of turbines, number of units and efficiency, turbine size, construction features & arrangements vis-à-vis the power station, draft tubes, cavitation, governing of turbines.

**TIDAL POWER:** Basic principle, historic development, location of tidal power plant, difficulties in tidal power generation, components of tidal power plants, modes of generation, single basin arrangement, double basin system, cooperating double basin system, constructional aspects, estimate of energy and power, regulation of power output, corrosion control and quality of concrete, economic feasibility, promising tidal power sites.



**SOME TYPICAL HYDRO-POWER** Beas project, Tarbela dam project, Iddiki arch dam, project Rance tidal plant, Revin pumped storage plant.

**PROJECT REPORT:** General report, design report, cost and estimate report, salient features of few hydroelectric projects.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1:</b> Identify different power systems and grids.
<b>CO2:</b> Understand and analyse the basic terms and definitions involved in hydro power engineering.
<b>CO3:</b> Assess the available hydro power
<b>CO4:</b> Understand the different components of hydro power plant.

**RECOMMENDED BOOKS:**

1. Water Power Engineering, Dandekar, M.M., Sharma
2. Hydro-Electric Engineering practice Vols, I, II, & III by Brown, J.G.
3. Water Power Engineering by Barrows, H.K

<b>MCE3E32</b>	<b>DESIGN OF HYDRAULIC STRUCTURES</b>	<b>DE</b>	<b>3 – 0 – 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>	<b>End Term: 50 marks</b>	<b>Total: 100 marks</b>		

**Pre-requisites:** Knowledge of hydraulic structures, and foundation engineering

**COURSE OBJECTIVES:**

The main objective of this course is to integrate the hydraulics and water resources background of the students to water structures design applications and also to develop an understanding of the basic principles and concepts of analysis and design of hydraulic structures.

**GRAVITY DAMS:** Dam parameters, Criteria for selection of dam sites, seals, Joints & keys of loads, Cooling arrangement, Water stops at joints, Closing gaps, forces acting on dams, Types of loads, Modes of failure, Elementary profile of a gravity dam, Step by step method, Stability analysis methods, Safety criteria, Gravity analysis, Galleries.

**ARCH DAMS:** Development of arch dam, Valleys suited for arch dams, Arch dams layout, Types of arch dams, Appurtenant works, Thin cylinder theory and most economical central angle, Design of arch dam, Effects of foundation elasticity on the behaviors of an arch dam.

**BUTTRESS DAMS:** Types of buttress dam, Selection of type of buttress dam, Most economical profile having no tension, Design principles, Buttress design by Unit column theory.

**SPILLWAYS AND ENERGY DISSIPATORS:** Factors affecting design, Components and profile of different types of spillways, Design principles, Non- conventional types of spillways, Hydraulic design ogee spillway, Side channel spillway, Chute spillway, Syphon spillway, Shaft-spillway, Energy dissipation below spillways, Bucket type energy dissipaters, Selection and design of various types of stilling basins.

**WEIRS AND BARRAGES:** Components of diversion head works and their functions, Design of weirs & barrages on permeable foundation, Khosla theory of independent variable, Schwarz Christoffel transformation, Upstream and downstream protection, Flownets, Design of sloping glacis weir.

**HYDRAULIC MODELS:** Theory of similarity, dimensional analysis, Basic concepts, Froude law, Reynolds law, Mach law, Cavitation number, Modeling technique, Models of weirs, Dams, Spillways and energy dissipaters.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1</b>	To analyze and design gravity dams
<b>CO2</b>	To analyze and design Arch and Buttress dams
<b>CO3</b>	To design spillways and energy dissipation structures
<b>CO4</b>	To estimate hydropower potential
<b>CO5</b>	To design of Weir and Barrages

**BOOKS RECOMMENDED:**

1. Engineering for Dams by Creager, Justin & Hinds, Willey Eastern Pvt. Ltd., Delhi
2. Concrete Dams by R.S. Varshney, Oxford & IBH Pub. Co. Delhi.
3. Dams-Part I Gravity Dams by K.B. Khushalani, Oxford & MN, Delhi.
4. Design of Weirs on Permeable Foundations, CBIP Pub. No 20, Delhi
5. Hydraulic Design of Spillways, ASCE Technical Engg. No. 12, Design guides as adapted from the US Army Corps.
6. Hydraulic Structures; P. Novak, AIB Moffat, C. Nalluri, and R.Narayanan: Taylor & Francis, New York

<b>MCE3E33</b>	<b>EMBANKMENT DAMS</b>	<b>DE</b>	<b>3-0-0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Term: 50 marks</b>		<b>Total: 100 marks</b>

**Pre-requisites:** Knowledge of basic Soil mechanics and foundation engineering.

**Course Objectives:**

1. To learn the basics of seepage theory and it's analysis for calculation of seepage amount and providing the necessary remedial measures in the embankment dam.
2. To use the basics of soil mechanics for construction and design of embankment dam.

**INTRODUCTION:** Classification of earth dams, Earth dam foundations, Causes of failure and criteria for safe design, Preliminary section.

**SEEPAGE & ITS CONTROL:** Fundamentals of seepage flow, Kozeny's solution, Cassagrande's method, Top flow line for inclined discharge faces, Transverse isotropy, Non homogeneous sections. Flowet for seepage through an earth darn, Methods of seepage control, Provision of impervious core in the embankment, Design of transition filters, Drainage of embankments, Drainage of the upstream face, Control of seepage coming out on the downstream lace, Control of seepage through rock, Clayey & pervious foundations, Cutoffs. Alluvial grouting, upstream impervious blanket, counter berm, Relief wells, Treatment of liquefying sands.

**STABILITY OF SLOPES:**General concepts, Stress relationship and shear parameters, Mohr strength theory, Mom-Coulomb's envelope, Shearing strength of cohesive & cohesionless soils, Critical 'stages for design, Construction pore pressure, Hill's method, factor affecting construction pore pressure, Steady seepage and drawdown pore pressures, Unsteady analysis, Control -of drawdown pore pressures, Location of critical slip surface, Total and effective stress methods of analysis, Stability analysis by method of slices, Accuracy of simplified !methods, Choice between Fellenus and Bishop's methods, Morgenstern- Price method, Wedge method, Three dimensional effects, Earthquakes, Application of dynamic response analysis, Deformation analysis, Suggested design procedure.

**QUALITY CONTROL AND INSTRUMENTATION:**Compaction of cohesive and cohesionless soils, Field compaction methods, Placement Control of embankment, Compaction control of embankment, Compaction control of gravelly material, Frequency oftesting, Statistical evaluation of tests,Borrow area control adjustment of moisture, Foundation preparation, Contact. treatment, Pore pressure measurements-open stand pipe piezometers,Closedhydraulic type,Pneumatic typepiezometers,Electrical typepiezometers,Vertical movement devices Tube settlement gauges,Find level devices, devices for measuring settlement gauges, Fluid level devices, Horizontal movement devices, Extensimeter sinclinometers,surfacemeasurements.Stressmeasurements,Seismicmeasurements,Choiceof instrumentation, Instrumentation problems.

**Course Outcomes:** At the end of the course the student will be able to have:

<b>CO1</b>	An understanding of the importance of slope stability in dam safety, and the basic theoretical principles supporting slope stability analysis methods
<b>CO2</b>	An understanding of the significance of adequate subsurface characterization and shear strength property selection
<b>CO3</b>	An understanding of soil stress-strain behavior and its relationship to shear strength
<b>CO4</b>	An understanding of how to select shear strength parameters from field and laboratory data
<b>CO5</b>	An understanding of slope stability rehabilitation measures
<b>CO6</b>	Awareness about the quality control and instrumentations required in it

**BOOKS RECOMMUNDED:**

1. Engineering for Embankment Dams by B. Singh and R. S. Varshney ;A. A. Balkema Publishers
2. Geotechnical Engineering of Dams by Robin Fell and Patrick MacGregor., David Stapledon, Graeme Bell., CRC Press
3. IS 7894 (1975): Code of practice for stability analysis of Earth dams.

<b>MCE3E34</b>	<b>WATERSHED MANAGEMENT</b>	<b>DE</b>	<b>3 – 0 – 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Term: 50 marks</b>		<b>Total: 100 marks</b>

**Pre-requisites:** None

**Course Objectives:**

To provide the technical, economical and sociological understanding of a watershed and also a comprehensive discourse on the engineering practices of watershed management for realizing the higher benefits of watershed management.

**Detailed syllabus:-**

**INTRODUCTION:** Water and life, Management and conservation of water, Climate data, Soil erosion and sedimentation, Conservation of soil

System models. Conceptual models of runoff hydrograph, Dynamic models.

**TIME SERIES ANALYSIS:** Determination of trend and periodic components, Analysis of stochastic components, Stationary and non-stationary series, Synthetic data generation and short term forecasting.

**SOIL EROSION AND ITS CONTROL:** Types of soil erosion wind erosion, Water erosion. Estimation of soil erosion, Soil loss models, Sediment yield models. Sediment graphs, Bed-load models, Controlling soil erosion due to wind and water, soil conservation practices, Vegetative and mechanical practices, Erosion control in torrents and gullies.

**WATER HARVESTING:** Storage structures. Yield from catchments, Diversion of runoff, Ponds and reservoirs, Earth embankments.

**WATERSHED:** Watershed programs. Mass soil movement, Afforestation, Streams. Management of saline and alkaline soils, Grassland management, Conservation of water, Augmentation of water resource, Methods of artificial Recharge.

Project Proposal and Report Writing

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1</b>	Identify causes of soil erosion
<b>CO2</b>	Plan and design soil conservation measures in a watershed
<b>CO3</b>	Plan and design water harvesting and groundwater recharge structures
<b>CO4</b>	Plan measures for reclamation of saline soils

**BOOKS RECOMMENDED:**

- Chow. V.T. Handbook of Applied Hydrology. Mc Graw-Hill, New York
- Rattan Lal. Soil Erossion in the Tropics. Mc Graw-Hill New York.
- Dutta. SK. Soil Conservation and Land Management, International Book Distributors, Dehradun. Blaisdell, F.W. and A.F. Moratz.

<b>MCE3E35</b>	<b>ADVANCED IRRIGATION ENGINEERING &amp; DRAINAGE</b>	<b>DE</b>	<b>3 – 0 – 0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>		<b>End Term: 50 marks</b>		<b>Total: 100 marks</b>

**Pre-requisites:** None

**Course Objectives:**

1. To create a potential among students in the area of irrigation management with specific enrichment to synthesis of data and their analysis.
2. To expose the students the need for an interdisciplinary approach in irrigation water management and providing a platform to work in an interdisciplinary team.
3. To provide students an ability to understand the applications of mathematical and scientific concepts to analyse intricate technical, social and environmental problems in irrigation water management and finding solutions for them.
4. To promote student awareness for a life-long learning process and inculcate professional ethics and codes of professional practice in water management.

**Detailed syllabus:-**

**CONSUMPTIVE USE:** Definition, Direct measurement of consumptive use, Methods of estimating consumptive use, Penman method, BlaneyCriddle method, Thornthwaite method, Lowery Johnsen method, Consumptive use of typical crops.

**WATER APPLICATION METHODS:** Border irrigation-details, straight & contour borders, border specifications, stream size, hydraulics of border irrigation, design of border irrigation systems, Check basin irrigation-types & design considerations, hydraulics of check basin irrigation, design of check basin irrigation system. Furrrow irrigation-characteristics & types, its hydraulics & design considerations. Sprinkler irrigation system-adaptability, limitations & types, components of sprinkler system & design, moisture distribution, uniformity, testing water distribution pattern of rotating head sprinklers, operation & maintenance of sprinkler system. Drip irrigation-components, details, nozzles, drip irrigation system design, basic hydraulics, design of laterals for uniform and non-uniform slopes, design charts for the submain and main line design, evaluation of drip irrigation system. Introduction to sub irrigation and surge flow irrigation methods and reuse of waste water for irrigation.

**WATER CONVEYANCE AND CONTROL:** Design of lined & unlined channels, Maintenance of irrigation canal, Weed and plant growth, Canal breach, closure of breach, Field channels, Water control and diversion structures. Check gates. Seals and on farm water distribution, Portable check dams, Turnouts, Types, Water conveyance through prefabricated canals. Underground pipe line, Irrigation distribution systems. Pipes used, Testing of pipes,



Installation of concrete pipe lines. Gate stands, air vents end plugs, Outlets in pipes, Riser valve, Design of underground pipe line, Irrigation system. Common problems of underground pipe lines.

**LAND GRADING SURVEY AND DESIGN:** Criteria for land levelling, Land clearing, Layout of fields and irrigation and drainage system, Land grading survey, Land levelling design methods, Plane and profile methods, Plan inspection & contour adjustment methods, Construction & maintenance, Job planning, Contour bench leveling, Bench location, Planning of bench location, contour bench construction, Equipment used for land grading & field layouts.

**SALT PROBLEMS IN IRRIGATED LAND:** Definitions, determination of the properties of saline & alkaline soils, Origin & Causes of salt built up in irrigated soils. Origin of salt in irrigated water, Causes of salt accumulation. Effect of irrigation soil management, and crop management in soil salinity, Nature and extent of salt problem in irrigated areas of India. Water logging and soil salinity & alkalinity. Influence of salts on physical properties of soils, Salt balance, leaching requirements, Leaching methods, Drainage of irrigated lands in relation to salinity control. Quality of irrigation water, its chemical analysis, water quality criteria. Classification of irrigation water, Quality of Statistical parameters, Fitting a probability distribution, Method of moments, Method of maximum likelihood, Testing the goodness of fit, Probability distributions for hydrologic variables. Normal, lognormal, exponential, Gamma, Pearson type III, Log-Pearson type III and extreme value distributions.

**FREQUENCY ANALYSIS:** Return period, Hydrologic data series, Extreme value distributions, Frequency analysis using frequency factors probability plotting, Probability paper, plotting positions, Water resources council method, Determination of the coefficient of skewness, Testing for outliers, Reliability of analysis, Confidence limits, Standard error, Expected probability. Time series models in hydrology, Trends of annual series, Moving average and exponential smoothing, ARMA model, Generation of synthetic flow data.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1</b>	Plan irrigation systems and command area development programs
<b>CO2</b>	We can Evaluate performance of an irrigation system
<b>CO3</b>	Evaluate performance of an irrigation system
<b>CO4</b>	Plan measures for reclamation of water logged lands
<b>CO5</b>	Develop strategies for conflict management in irrigation projects

**BOOKS RECOMMENDED:**

- Applied Hydrology by Chow, Maidment & Mays McGraw Hill Inter Editions.
- Applied Hydrology by K.N.Mutreja, Tata McGraw Hill.
- Hydrology H.M.Raghunath, Wiley Eastern Lt

<b>MCE3E36</b>	<b>SEDIMENT TRANSPORT</b>	<b>CC</b>	<b>3-0-0</b>	<b>3 Credits</b>
<b>Internal: 50 marks</b>	<b>End Term: 50 marks</b>	<b>Total: 100 marks</b>		

**Course Objectives:**

1. To get knowledge of fluvial geomorphology and sediment water interaction
2. To understand concept of analysis of river flow hydraulics and various sediment transport theories
3. To be able to analyse hydraulic geometry and to design stable alluvial channels
4. To analyse and appreciate the phenomenon of scouring around bridge elements and other hydraulic structures

**Detailed syllabus:**

**INTRODUCTION:** Description of sediment motion, Bed configuration, Classification of sediment load, Status of knowledge of sediment transportation.

**PROPERTIES OF SEDIMENT AND INCIPIENT MOTION:** Fundamental properties of individual sediment particle and bulk properties, Competent velocity, Lift concept, Average shear stress, Critical tractive forces, Shield's analysis, White analysis, Yatin and Kramer's Analysis, Critical tractive stress for cohesive and cohesionless soils.

**REGIMES OF FLOW:** Description, Importance, Prediction of regimes of flow, Velocity distribution and resistance in turbulent flow over rough boundaries, Basic equations, Strickler's equation, Garde-Rangaraju formula, Bank direction by Einstein, Concept of Division of resistance by Einstein Barborossa.

**BED LOAD TRANSPORT:** Basic equation Du Boys formula, Shield's formula, Meyer Peter and Mullar equation, Garde-Albertson approach, Kalinske equation, saltation.

**SUSPENDED LOAD TRANSPORT:** Mechanism of suspension, Equation of diffusion, Integration of sediment distribution equation, General considerations and derivation of method of integrating curves of concentration and velocity, Simple relation for suspended load, Wash Load.

**TOTAL LOAD TRANSPORT:** Microscopic method, Einstein method, Modified Einstein procedure based on single size and fractionwise calculation.

**SEDIMENT SAMPLING AND SAMPLERS:** Bed load sampling, Suspended load sampling, Computation of total load, Bed material sampling.

**HYDRAULICS OF ALLUVIAL STREAAMS:** Geomorphic cycle, Dominant discharge, Slope and Shape in cross section and plan, Continuity equation, Degradation: Occurrence, Effects and Control, Aggradation: Occurrence and Control, Armour coat, Sedimentation of reservoir, Control of silting, Meandering, Braided stream, Secondary currents, Local scour for jets, Piers, Hydraulic structures.

**SEDIMENT CONTROL IN CANALS:** Methods and details of sediment control, Alluvial river models.

**TRANSPORT OF SEDIMENT IN PIPES:** Scope, General application, Transportation of uniform material in horizontal pipes, Homogeneous two phase flow, Heterogeneous flow.

**Course Outcomes:** At the end of the course the student will be able to:

<b>CO1:</b> Identify different mechanisms of sediment transport
<b>CO2:</b> Estimate sediment load in streams and rivers
<b>CO3:</b> Identify management practices for sediment control
<b>CO4:</b> Design canals using regime concept and tractive force theory

**BOOKS RECOMMENDED:**

1. Mechanics of Sediment transportation and Alluvial Stream Problems by R.J. Garde and K.G. Ranga Raju, Willey Eastern, Delhi
2. Hydraulics of Sediment Transport, by W.H. Graf
3. Loose Boundary Hydraulics by Randkiv, A.j.
4. Scouring Manual, H.N.C. BREUSERS, A.J. RAUDKIVI, A.A. BALKEMA/ ROTTERDAM/ BROOKFIELD/1991

<b>MCE3E37</b>	<b>COMPUTATIONAL METHODS IN FLUID MECHANICS</b>	<b>DE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Internal:50 Marks</b>		<b>End Term: 50 Marks</b>		<b>Total:100 Marks</b>		

**Pre-requisites:** None

**Course Objectives:**

1. Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems
2. Provide the essential numerical background for solving the partial differential equations governing the fluid flow
3. Develop students' skills of using a commercial software package

**Detailed syllabus:**Review of numerical techniques like Method of characteristics, Finite difference Method, Finite Element Method, Modelling of steady state flow and hydraulic transients in pipes, Modelling of non-uniform, Transient, Spatially varied flows in open channels, Numerical solutions for Navier- Stokes equation, Boundary layer and Reynolds equations, Modelling of groundwater flow and contaminated transport in groundwater.

**Course Outcomes:**After the completion of the course, students are able:

<b>CO1</b>	To identify, formulate, and solve engineering problems by numerical techniques like Method of characteristics, Finite difference Method, Finite Element Method.
<b>CO2</b>	To learn various types of modelings like as steady state flow, hydraulic transients in pipes, non-uniform, spatially varied flows in open channels
<b>CO3</b>	To analyze and interpret data obtained from the numerical solution of fluid flow problems.
<b>CO4</b>	To use the techniques, skills, & engineering tools necessary for engineering practice by applying numerical methods to a "real-world" fluid-flow problem, integrating various numerical techniques in formulating a numerical solution method for that problem.

**BOOKS RECOMMENDED:**

1. Computational Hydraulic, by M.B. Abbot, Pitman
2. Computational Hydraulics, by C.A. Brebbia and A.J. Ferrante, Butterworths
3. Introduction to Groundwater Modelling, by H.A. Want and M.P. Anderson

<b>MCE3E38</b>	<b>MODELING ANALYSIS AND SIMULATION</b>	<b>DE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Internal:50 Marks</b>	<b>End Term: 50 Marks</b>	<b>Total:100 Marks</b>				

**Pre-requisites:** None

**Course Objectives:**

1. To develop skills of the students in software usage for simulation and water resources management.
2. To enable the students to understand application of the latest information technology to water resources engineering.

**Detailed syllabus:**

**MODELLING PROCESS:**

Taxonomy of model types, Steps in model building; Simulation, Algorithms and Heuristics, Simulation languages.

**PRIMITIVE MODELS:**

Establishing relationships via physical laws, Establishing relationships via curve fitting, Parameter estimation problems, Elementary state transition models.

**FORECASTING:**

Nature of data, Statistical attributes of data, Probability distributions and their mechanisms, Generation of random numbers, Time series.

**PATTERN RECOGNITION:**

Neighbourhood and distances, Cluster analysis, Individual and group preference patterns.

**STATIC EQUILLIBRIUM MODELS:**

Graphical models and matrix models, Input-output type models, Decomposition of large systems, Routing problems.

**LINEAR DYNAMICAL STRUCTURE:**

Block diagram, Representation of model structure, Transfer function representation, State space models, Stability, System control.

**GROWTH AND DECAY PROCESSES:**

Discrete and continuous growths, Limits to growth, Competition among species, Growth process and integral equations, Discrete event approach, Population planning.

**SIMULATION OF DISCRETE AND CONTINUOUS PROCESSES:**

Monte Carlo methods, Stochastic simulation, System identification, Inverse problems, Virtual reality, Typical example and case studies related to Civil Engineering.

**Course Outcomes:** After the completion of the course, students are able:

<b>CO1</b>	To provide a strong foundation on concept of simulation, and modeling.
<b>CO2</b>	To understand the techniques of random number generations.
<b>CO3</b>	To design simulation models for various case studies like time series, input-output, etc.
<b>CO4</b>	To practice on simulation tools and impart knowledge on building simulation systems.

**BOOKS RECOMMUNDED:**

1. I.R. Haberman, Mathematical Models. Prentice Hall.
2. D.P. Maki and M. Thompson, Mathematical Models and Applications. Prentice Hall.
3. R.E. Shannon, System Simulation: Art and Science Prentice Hall.

<b>MCE3E39</b>	<b>WIND ENGINEERING</b>	<b>DE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Internal:50 Marks</b>		<b>End Term: 50 Marks</b>		<b>Total:100 Marks</b>		

**Pre-requisites:** None

**Course Objectives:**Core objectives of this course are such as that students will be able to:

1. describe how wind energy is harnessed to create electricity
2. state the major pros and cons of using wind energy
3. demonstrate how wind energy can be utilized to create work

**Detailed syllabus:**

Atmospheric pressure and gradient wind, Wind climate and structure, Peak 3-sec, 10 min and hourly mean wind speeds. Low cycle energy and large scale pressure systems, Wind energy and turbulence, Spectral distribution and boundary layer (ABL) & its characteristics. Aerodynamilcs of bluff bodies, Vortex shedding and associated unsteady along and across wind forces. Peak factor and gust factor estimation.

Buffeting and ovaling, Gallaping and flutter, Extreme winds, Correlation and spectral function. Random vibration theory, Autocorrelation function, Power spectral density, Narrow and wide bar random processes. Response of SDF in the frequency domain to random excitation. Application to MDF systems. Experimental procedures for response studies. Wind tunnel and its salient features, ABL simulation.

Basic wind tunnel instrumentation for the measurement of flow parameters, Forces, Displacements and strains. Use of statistical methods for analysis of measured data and its interpretation. Analytical procedures for along wind and across wind forces. Wind effects on buildings, Chimneys, towers and bridges, Pressure coefficients and internal pressures. Case studies. Codal provisions, Design wind velocities, Wind resistant design- Indian Codes and other International codes of Practice.

**Course Outcomes:**After the completion of the course, students are able:

<b>CO1</b>	To wind energy conversion technology and power generation.
<b>CO2</b>	To wind resources assessment and techniques.
<b>CO3</b>	To Planning, including design of wind farms.
<b>CO4</b>	To possesses the competencies necessary for the design and implementation of complex wind energy systems.

**BOOKS RECOMMENDED:**

1. Wind Effects on Structures-An Introduction to Wind Engineering, Emil Simiu and Robert H. Scanlan, John Wiley & Sons, 3rd Ed. 1996.
2. Wind Effects on Civil Engineering Structures V.K. Ciossek, M. Pimer, O. Fiscer and J. Naprstek, Elsevier Pub. Amsterdam, 1984.
3. Wind Forces in Engineering by Peter Sachs, Pergamon Press, 2<sup>nd</sup> Ed. 1978.
4. Cook, N.J. The Designer's Guide to Wind Loading of Building Structures Part-1 Background, Damage Survey, Wind Data and Structural Classification and Part-2, Static Structures, Butterworths, 1985.



<b>MCE3E 40</b>	<b>ENVIRONMENTAL IMPACTASSESSMENT IN CIVIL ENGINEERING PROJECTS</b>	<b>DE</b>	<b>3 0 0</b>	<b>3</b>
<b>Internal:50 Marks</b>	<b>End Term: 50 Marks</b>	<b>Total:100 Marks</b>		

**Pre-requisites:** None

**Course Objectives:**

This course is aimed to have knowledge of various issues Environmental related issues by studying the Environmental Protection Act's and Environmental Protection Rules.

**Detailed syllabus:**

Introduction to environmental impact analysis, assessment and statement, evolution of EIA, national environmental policy.

EIA process: Screening and scoping criteria; Rapid and comprehensive EIA

Impact Assessment Methodologies – Matrices, overlays, network analysis.

Specialized areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; cost-benefit analysis; Expert system and GIS applications.

Legislative and environmental clearances procedures in India: Siting criteria; public participations; resettlement and rehabilitation. Environmental management plan; Post project monitoring, EIA report and EIS; Review process. Case Studies of EIA of river valley projects and thermal power projects.

**Course Outcomes:** After the completion of the course, students are able:

<b>CO1</b>	To develop an understanding of current EIA methods and the techniques and tools used.
<b>CO2</b>	To develop an understanding of current assessment methods and legislation.
<b>CO3</b>	To apply knowledge acquired to the process of environmental impact modeling and prediction as a design tool with application to a number of case studies
<b>CO4</b>	To adapt skills in GIS to environmental management systems

**Books:**

1. Canter, L.W. (1996) Environmental Impact Assessment, McGraw Hill, Inc., NY.
2. Rau and Wooten (1980) Environmental Impact Analysis Handbook, McGraw Hill, Inc., NY.
3. Jain, Urban and Stacey (1977) Environmental Impact Analysis, Van Nostrand and Reinhold Company,

<b>MCE3E 41</b>	<b>REMOTE SENSING FOR WATER RESOURCES SYSTEMS</b>	<b>DE</b>	<b>3 0 0</b>	<b>3</b>
<b>Internal:50 Marks</b>		<b>End Term: 50 Marks</b>		<b>Total:100 Marks</b>

**Course Objectives:**

1. To understand the interaction of electromagnetic interaction with matter and working of aerial and satellite remote sensing and radar
2. To learn image interpretation and satellite image processing
3. To learn to make use of aerial and satellite data for applications in hydrology, water resources, agriculture, geology, environment and snow & glacier studies
4. To learn to integrate remote sensing and GIS analysis

**Course Content:** Physics of remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme. Satellite Data analysis - Visual interpretation – Digital image processing – Image preprocessing – Image enhancement – Image classification – Data Merging. Definition – Basic components of GIS – Map projections and co-ordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology – Geo-database models: hierarchical, network, relational, object oriented models – Integrated GIS database -common sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards. Thematic mapping – Measurement in GIS: length, perimeter and areas – Query analysis – Reclassification – Buffering - Neighborhood functions - Map overlay: vector and raster overlay – Interpolation – Network analysis –Digital elevation modelling. Analytical Hierarchy Process, – Object oriented GIS – AM/FM/GIS – Web Based GIS Spatial data sources – 4M GIS approach water resources system – Thematic maps - Rainfall-runoff modelling – Groundwater modeling – Water quality modeling - Flood inundation mapping and Modelling – Drought monitoring – Cropping pattern change analysis –Performance evaluation of irrigation commands. Site selection for artificial recharge - Reservoir sedimentation. Course Outcome: Introduce the technology and principles of Satellite Imaging. Theoretical explanations on Image processing and information extraction from Satellite Data Products. Functional elucidation of GIS integrating Satellite Data Products into the GIS platform for Decision making. Potential of remote sensing and GIS is solving problems in water resources through case studies.

**Course Outcomes:** After the completion of the course, students are able:

<b>CO1:</b> Describe and discuss concepts of spatial data and remote sensing.
<b>CO2:</b> Describe and discuss concepts of remote sensing
<b>CO3:</b> Articulate the use of remote sensing for various application in water resources systems
<b>CO4:</b> Describe the process of data acquisition of satellite images and their characteristics

**Text Book/Reference Book:**

1. Lillesand, T.M. and Kiefer, R. W., Remote Sensing and Image Interpretation III Edition. John Wiley and Sons, New York. 1993.
2. Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems,.Oxford University Press. New York. 1998.
3. Ian Heywood Sarah, Cornelius and Steve Carver An Introduction to Geographical Information Systems. Pearson Education. New Delhi, 2002.

<b>MCE3E 42</b>	<b>NEURO-FUZZY APPLICATIONS IN CIVIL ENGINEERING</b>	<b>DE</b>	<b>3 0 0</b>	<b>3</b>
<b>Internal:50 Marks</b>	<b>End Term: 50 Marks</b>	<b>Total:100 Marks</b>		

**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

**Introduction-** Classification of artificial intelligence-expert systems-artificial neural networks-basic concepts-uses in functional approximation and optimization-applications in the design and analysis, building construction.

**Fuzzy logic-**basic concepts-problem formulation using fuzzy logic-applications

**Course Outcomes:** After the completion of the course, students are able:

<b>CO1:</b> Ability to know basic concept of neural network models and fuzzy logic based models
<b>CO2:</b> Ability to develop different types of neural network models
<b>CO3:</b> Ability to apply fuzzy reasoning and fuzzy inference to solve Civil Engineering problems
<b>CO4:</b> Ability to apply neuro-fuzzy computing in hydrologic modelling

**Texts/References**

1. D.E. Rumelhart, J.L. McClelland, Parallel distributed processing Vol 1, M I T Press England 1986.
2. Fuzzy logic implementation and applications, M.J. patyra, Mlynek, Wiley Teubner 1996.

<b>MCE3E 43</b>	<b>INTRODUCTION TO GIS FOR WATER RESOURCES</b>	<b>DE</b>	<b>3 0 0</b>	<b>3</b>
<b>Internal:50 Marks</b>		<b>End Term: 50 Marks</b>		<b>Total:100 Marks</b>

**Course Objectives:**

To teach the principles and applications of GPS and GIS in the context of water resources and the importance of GIS in solving the spatial problems in water resources.

**Basics of remote sensing:** Introduction to Remote Sensing, data acquisition and processing, sensor systems, Electromagnetic Radiation (EMR) and its characteristics, Radiation principles, prosperities of solar radiant energy, atmospheric windows. Interaction in the atmosphere, nature of atmospheric interaction, atmospheric effects of visible, near infra-red thermal and microwave wavelengths, interaction at ground surface, interaction with soils and rocks, effects of soil moisture, organic matter, particles, size and texture, interaction with vegetation, spectral characteristics of individual leaf, vegetation canopies, effect of leaf pigments, radiation geometry.

**Introduction with GIS:** Def. of GIS, Difference between GIS and CAD worlds, utility of GIS, various GIS packages and their salient features, essential components of a GIS, scanners and digitizers.

**Map projection and coordinate systems:** Introduction, geographic Grid, Map projection, Coordinate systems.

**Vector data models and Analysis:** vector data and its representation, topological data structure, nontopological vector data structure, TIN, Region, vector data editing and analysis.

**Raster data models and Analysis:** acquiring and handling of raster data storage, function of raster based GIS data analysis.

**Engineering applications of GIS:** applications of GIS in civil engineering.

**Course Outcomes:** After the completion of the course, students are able:

<b>CO1:</b> Describe and discuss concepts of spatial data and remote sensing.
<b>CO2:</b> Describe and discuss concepts of GIS and GIS functions
<b>CO3:</b> Articulate the use of GIS for various application
<b>CO4:</b> Apply the learnt remote sensing & GIS methods in real life problems.

## **Books**

- Remote Sensing and Image Interpretation : T.M. Lillensand and R.W. Keifer
- Principles of Remote Sensing : P.J. Curren
- Concept and Techniques of Geographical Information systems : C.P. Lo and Albert K.W. Yeung
- Introduction to Geographical Information systems : Kang-tsung Chang
- Geographical Information systems- A Management Perspective : Stan Aromoff

MCE3E 44	<b>CLIMATE CHANGE AND ITS IMPACT</b>	<b>DE</b>	3 0 0	3
<b>Internal:50 Marks</b>		<b>End Term: 50 Marks</b>		<b>Total:100 Marks</b>

**Course Objectives:**

Understanding the climate system, being aware of the impact of climate change on society, Understanding of adaptation in relation to water and climate change, Understanding possible impacts, adaptations and remedies in relation to water resources and climate change.

**Climate System:**

Definitions- Climate, Climate system, climate change – Drivers of Climate change – Characteristics of climate system components - Greenhouse effect – Carbon cycle – Wind systems - Trade Winds and the Hadley Cell – Ozone hole in the stratosphere - El Nino, La Nina.

**Impacts of Climate Change:**

Precipitation (including extremes) - water vapor - Snow and land ice - Sea level – Evapotranspiration - Soil moisture – Runoff and river discharge - Patterns of large-scale variability - Influences of hydrological changes on climate - Land surface effects- Projected changes in climate.

**Impacts and Responses:**

Observed climate change impacts - effects due to changes in the cryosphere - Future changes in water availability and demand due to climate change - Climate-related drivers of freshwater systems in the future - Impacts of climate change on water stress in the future - Impacts of climate change on costs and other socio-economic aspects of freshwater – Freshwater areas and sectors highly vulnerable to climate change - Uncertainties in the projected impacts of climate change on freshwater systems.

**Climate Change Adaptation:**

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

**Climate Change Mitigation Measures:**

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 Reforestation, - Effects of water management policies and measures on GHG emissions and mitigation - Potential water resource

conflicts between adaptation and mitigation - Implications for policy and sustainable development.

**Course Outcomes:** After the completion of the course, students are able:

<b>CO1:</b> Identify factors influencing the global climate systems
<b>CO2:</b> Assess impacts of climate change on global, regional and local scales
<b>CO3:</b> Develop strategies for adaptation and mitigation measures
<b>CO4:</b> Identify clean technologies for sustainable development

**Text Book/Reference Book:**

1. Jan C. Van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes, Cambridge University Press, 2003.
2. Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 'Climate Change and Water'. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 2008.
3. IPCC Report Technical Paper VI – Climate change and water , 2008.
4. P R Shukla, Subobh K Sarma, NH Ravindranath, Amit Garg and Sumana Bhattacharya, Climate Change and India: Vulnerability assessment and adaptation, University Press (India) Pvt Ltd, Hyderabad.



<b>MCE3EL 09</b>	<b>HYDRAULICS LAB</b>	<b>CC</b>	<b>0 0 4</b>	<b>4</b>
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**COURSE OBJECTIVES:**

- Application of principles of fluid mechanics to the solution of problems encountered in both natural and constructed water systems.
- Use of model studies in solving problems in river engineering.

**CONTENTS:**

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 using Preston Tube and from velocity.
5. Measurement of rainfall, evaporation, infiltration etc. ( laboratory and field tests)
6. Scour around bridge piers and abutments.
7. Determination of coefficient of drag of spherical, cylindrical and disc-like bodies on falling through fluid medium.

**COURSE OUTCOMES:** After having gone through the course, the student will be able to

- a) Determine velocities in natural and constructed water conveyance system.
- b) Determine shear stress in natural and constructed water conveyance system.
- c) Measure discharge in open channels.
- d) Measure the elements of rainfall.
- e) Estimate the scour depth around bridge elements.
- f) Estimate the fall velocity of sediments in water bodies.

<b>MCE3EL 10</b>	<b>WATER RESOURCES ENGINEERING LAB</b>	<b>CC</b>	<b>0 0 4</b>	<b>4</b>
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**CORSE OBJECTIVE:**

- Application of principles of fluid mechanics to the solution of problems encountered in both natural and constructed water systems.
- Use of model studies in solving problems in river engineering.

**CONTENTS:**

- Introduction to modelling and modelling techniques.
- Introduction and getting started with
  - a) Arc GIS
  - b) Auto CAD
  - c) MIKE Flood
- Some of the application software (e.g. MATLAB) as per requirement and as per the decision of the teacher.

**COURSE OUTCOMES:** After having gone through the course, the student will be able to

- a) get successfully started on computational modelling of water resources systems.
- b) get solutions on various aspects of hydraulic and hydrologic systems.