Suggestive Curriculum Structure for M. Tech. (Water Resources Engineering)

GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD

(An Autonomous Institute of Government of Maharashtra)

Department of Civil Engineering

Master of Technology (Water Resources Engineering) (Full-Time)

CBCS Course-2018-19 Onwards (As per AICTE model structure)

Teaching and Evaluation Scheme

SEMESTER-I

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total
							Test	TA	ESE			
1	GE 51001	Research Methodology	2	-	-	2	20	20	60	-	-	100
2	CE 51001	Computational and Statistical Methods	3	-	-	3	20	20	60	-	-	100
3	CE 51002	Engineering Hydrology and Hydrologic Systems	3	-	-	3	20	20	60	-	-	100
4	CE 51003 to CE 51005	Program Elective I	3	-	-	3	20	20	60	-	-	100
5	CE 51006 to CE 51009	Program Elective II	3	-	-	3	20	20	60	-	-	100
6		Audit Course	2	-	-	--						
7	CE 51010	Water Resources Software Laboratory	-	-	4	2				25	25	50
8	CE 51011	Engineering Hydrology Laboratory	-	-	4	2				25	25	50
		Total Semester I	**16**		**08**	**18**	**100**	**100**	**300**	**50**	**50**	**600**

Approved in XIXth Academic Council, dated 27/07/2018

SEMESTER-II

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total
							Test	TA	ESE			
1	CE 51012	Advanced Fluid Mechanics	3	-	-	3	20	20	60	-	-	100
2	CE 51013	Water Resources Systems Planning and Management	3	-	-	3	20	20	60	-	-	100
3	CE 51014 to CE 51017	Program Elective III	3	-	-	3	20	20	60	-	-	100
4	CE 51018 to CE 51021	Program Elective IV	3	-	-	3	20	20	60	-	-	100
5	CE 51022 to CE 51024	Program Elective V	3	-	-	3	20	20	60	-	-	100
6	CE 51025	Advanced Fluid Mechanics Laboratory	-	-	4	2				25	25	50
7	CE 51026	Water Resources Systems Planning and Management Laboratory	-	-	4	2				25	25	50
8	CE 51027	Mini Project with Seminar	--	-	4	2				50	50	100
		Total Semester II	**15**		**12**	**21**	**100**	**100**	**300**	**100**	**100**	**700**

Approved in XIXth Academic Council, dated 27/07/2018

SEMESTER III

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total
							Test	TA	ESE			
1	CE 61028	Open Elective*	3	-	-	3	20	20	60	-	-	100
2	CE 61029	Dissertation I	-	-	20	10				50	50	100
		Total Semester III	**3**		**20**	**13**	**20**	**20**	**60**	**50**	**50**	**200**

*Students going for Industrial Project/Dissertation will complete these courses through MOOCs, NPTEL, SWAYAM etc.

SEMESTER IV

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)					
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total
							Test	TA	ESE			
1	CE 61030	Dissertation II	-	-	32	16				100	150	250
		Total Semester IV	**-**	**-**	**32**	**16**				**100**	**150**	**250**
		TOTAL OF ALL SEMESTERS	**33**	**--**	**72**	**68**	**220**	**220**	**660**	**300**	**350**	**1750**

Note: Minimum 2 months and Maximum 3 months of internship/Industrial Training should be completed by the students either in vacations or in second year

Approved in XIXth Academic Council, dated 27/07/2018

GE 51001: Research Methodology

Teaching Scheme		Evaluation Scheme	
Theory	2 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	2	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the prospective researchers to basic methodologies and techniques of carrying out research work. The course provides detailed knowledge of developing a research plan and research design. Various statistical methods are included in this course which will be needed for a research work. Along with this, optimization techniques, modeling and simulation and soft computing techniques required for solution of a research problem are included in the course. At the end, Interpretation of result and technique of report writing will be taught to the students.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Develop a research plan and define the research problem
2. Analyze the data required for research
3. Solve the mathematical model developed with the help of optimization techniques
4. Apply the knowledge to write a research paper and dissertation scientifically

Detailed Syllabus:

Unit -1:	**Introduction and Research Process:** Objectives of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem, Selecting the Problem, Technique Involved in Defining a Problem, Research Design, Important Concepts Relating to Research Design, Developing a Research Plan, Literature review, Impact factor, H-index, citations.	**4 Hrs**
Unit -2:	**Statistics:** Basic Concepts of Probability, Probability Axioms, Measures of Central Tendency, Measures of Dispersions, Measures of Symmetry, Measures of Peakedness. Regression Analysis – Simple Linear Regression, Multiple linear Regression, Correlation. Tests of Hypothesis and Goodness of Fit: Definition of null and alternative hypothesis, students't' distribution: properties, application with example. Chi-square distribution: definition, constants of Chi-square distribution. Application with example. F-test: example of application.	**4 Hrs**
Unit -3:	**Optimization Techniques:** Linear Programming, Simplex Method, Dual Simplex, Sensitivity Analysis. Artificial Variable Technique, Dynamic Programming, Introductory concepts of non-linear programming.	**4 Hrs**

	Or **Modeling and simulation:** Introduction to modeling: Concept of system, continuous and discrete systems. Experimental Methods: Importance of experimental analysis, guidelines for designing experiments, uncertainty and error analysis, concept of uncertainty, propagation of uncertainty, planning experiments from Uncertainty analysis.	
Unit -4:	**Soft Computing:** Fuzzy logic: Introduction, Concepts, Basic Fuzzy Mathematical Operations, Fuzzy databases, Membership Functions, Fuzzy Linear Programming, And Neural Networks: Artificial Neural Networks, architectures and algorithms, Basic neuron models, Neural network models, Learning algorithms, Genetic Algorithms: Introduction to genetic algorithm, Operators, Applications.	**4 Hrs**
Unit -5:	**Interpretation and Report Writing:** Meaning of Interpretation, Techniques of Interpretation, Significance of Report Writing, Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Writing a technical paper, plagiarism and its implications. Introduction to patents and copyrights & filing procedure.	**4 Hrs**

References:

1. Gupta. S.P., " Statistical Methods", S. Chand & Sons, New Delhi
2. Kothari C.R., "Research Methodology-Methods and Techniques", New Age International Publishers, New Delhi.
3. Gupta S.L. and Gupta Hitesh, "Research Methodology-Text and cases with SPSS applications" International Book House Pvt. Ltd., New Delhi.
5. Rao V and Rao H., "C++, Neural Networks and Fuzzy Logic", BPB Publications, New Delhi.
6. Goldberg, D.E., "Genetic Algorithms in Search, Optimization & Machine Learning", Addison Wesley Longman (Singapore) Pte. Ltd., Indian Branch, Delhi.
7. Klir George J. and Yuan Bo, "Fuzzy Sets and Fuzzy Logic", PHI Learning Pvt. Ltd, New Delhi

CE51001: Computational and Statistical Methods

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to introduce the students to various methods of numerical solutions of ordinary differential equations such as Taylor's Series, Euler's Method, Runge Kutta Method. Course also develops the knowledge of Correlation and Regression Analysis, Skewness, Moments and Kurtosis. Students will gain an understanding of classification and presentation of data, probability theory and analysis. The course exposes students to the Finite difference methods, FEM, fuzzy and genetic algorithm and its applications to water resources engineering which are widely required to solve engineering problem.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Apply various differential equations methods to the water resources engineering.
2. Apply regression and correlation analysis.
3. Classify and present data. Apply the knowledge of probability and probability theory.
4. Develop FDM and FEM model and apply the knowledge of various soft computing tools such as fuzzy logic, neural network and genetic algorithm.

Detailed Syllabus:

Unit -1:	Numerical Solution of Ordinary Differential Equations: Solution by Taylor's Series, Euler's Method, Runge Kutta Method, Newton Raphson Method, Bisection Method. Gauss-Jordan Method, Method of Leading Coefficient. Relaxation Method	**6 Hrs**
Unit -2:	Regression Analysis : Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypothesis – Multiple linear Regression – Correlation and Regression Analysis. Skewness, Moments and Kurtosis	**6 Hrs**
Unit -3:	Classification and Presentation of data, Basic Concepts of Probability, Probability Axioms, Analysis and Treatment of Data, Population and Samples, Measures of Dispersions, Measures of Symmetry Discrete and Continuous Probability Distribution Functions	**6 Hrs**
Unit -4:	Finite difference methods and its applications to water resources Engineering. Introduction to FEM and its applications to water resources Engineering	**6 Hrs**
Unit -5:	Fuzzy logic, Fuzzy Mathematical Operations, Neural Networks, Mathematical Model of Neuron, Architecture. Introduction to genetic algorithm, Operators, Applications.	**6 Hrs**

References:

1. Gupta, S. P. (1999). "Statistical Methods", S. Chand & Sons
2. Haan C. T., (1995), "Statistical Methods in Hydrology", East West Press, New Delhi
3. Sastry, S. S. (1995), "Introductory Methods of Numerical Analysis", Prentice Hall of India (p) Ltd., New Delhi
4. Krishnaraju and Muthu, Numerical Methods for Engineering Problems, Second Edition,MacMillan India Ltd, Delhi
5. Rao V and H. Rao, (1996) "$C^{++,}$ Neural Networks and Fuzzy Logic, BPB Publications, New Delhi.
6. Goldberg, D. E. (2000), "Genetic Algorithms in Search, Optimization & Machine Learning", Addison Wesley Longman (Singapore) Pvt. Ltd., Indian Branch, Delhi.

CE 51002: Engineering Hydrology and Hydrologic Systems

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the students to system concept and hydrograph analysis. The rainfall-runoff analysis will be taught in the course, for un-gauged catchments. The hydrologic statistics will be studied for the determination of statistical parameters, frequency analysis and design flood. Geographical Information System and its applications to water resources engineering are included in the course. The climate change studies and Soil and Water Assessment Tool (SWAT) are also included in the course.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Develop unit hydrograph for a catchment
2. Do the rainfall-runoff analysis
3. Analyze the hydrologic statistics
4. Work with GIS and climate change effects on hydrology

Detailed Syllabus:

Unit -1:	Introduction: Systems Concept, Linear and Non Linear Systems, Lumped and Distributed Systems, Deterministic and Stochastic Systems, Time Invariant Systems, Unit Hydrograph Theory, S – Curve Hydrograph, Instantaneous Unit Hydrograph	**6 Hrs**
Unit -2:	Rainfall – Runoff Analysis: Review of Rational Methods, Conceptual Model, Clarke and Nash Models, Derivation of Unit Hydrograph for un-gauged Catchments, Synthetic Unit Hydrograph.	**6 Hrs**
Unit -3:	Hydrologic Statistic: Probabilistic Treatment of Hydrologic Data, Frequency and Probability Functions, Statistical Parameters, Frequency Analysis, Annual Maximum and Partial Duration Series Models, Regional Frequency Analysis, Design Flood	**6 Hrs**
Unit -4:	Hydrologic Flood Routing: Reservoir Routing, Channel Routing, Estimation of Flood Routing Models, Flood Forecasting, Analog Models, Real Time Flood Forecasting. Applications of Remote Sensing and GIS in Hydrology: Land Use and Soil Mapping Using Remote Sensing, Watershed Management Using Remote Sensing Techniques, Concepts of Geographical information Systems (GIS) and its Application in Hydrologic Studies.	**6 Hrs**
Unit -5:	Climate Change: Global Circulation Model (GCM), Regional Circulation Model (RCM), Data collection and analysis, downscaling of climate parameters, uncertainty of regional	**6 Hrs**

	climate projections, climate change impact, adaptation strategies, Risk and Vulnerability of Agriculture, climate forecasting, Soil and Water Assessment Tool (SWAT) Hydrological Model, Socioeconomic scenarios, Policy Initiatives for Climate Change Adaptation in India.	

References:

1. Chow, V.T., Maidment, D.R. and Mays, L.W. (1988), " Applied Hydrology", McGraw Hill Inc. N York
2. Singh, V.P. (1986), "Hydrologic Systems", Prentice Hall Inc., N York
3. Singh, V.P. (1992), "Elementary Hydrology", Prentice Hall of India, N Delhi
4. Haan C.T., (1995), "Statistical Methods in Hydrology", East West Press, New Delhi
5. Viessman, W., Lewis, G.L. and Knapp, J.W. (1989), "Introduction to Hydrology", Harper & Row Publications Inc., Singapore
6. Ponce, W.F. (1987), "Engineering Hydrology", Prentice Hall Inc. N York.
7. Lillesand, T.M. and Kiefer, R.H. (1994) "Remote sensing and Image Interpretation", John Wiley & Sons.
8. Subramanya, K. (2011), "Engineering Hydrology", Tata McGraw Hill Education Private Limited, New Delhi.

CE 51003: Hydraulics Structures

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Course Description: This course introduces the different aspects of hydraulic structures. It deals with earthen dam, its types, design criteria and design of earthen dam. It also deals with seepage through dam and foundation and its control. Drainage of embankment and design of filter is also covered. Gravity dam with reference to forces acting, modes of failures, design and foundation treatment is included. Aspects such as strengthening and raising of gravity dam and repairs of concrete dam are also covered. Different aspects of arch dam and buttress dam are also included. Topics ranging from capacity of spillway, types of spillway, energy dissipation below spillway, different types of spillway gates and outlet through dams are also included.

Course Outcomes: After successful completion of the course, students will be able to:

1. Demonstrate the different terminologies related with hydraulic structures.
2. Decide suitability of individual hydraulic structures in different situation.
3. Design different hydraulic structures such as dams and spillways
4. Compare and contrast suitable hydraulic structure in a particular scenario

Detailed Syllabus:

Unit-1:	Earthen Dams, types of earthen dams, choice of type of dam, causes of failure of earth dams, design criteria for earth dams, selecting a suitable preliminary section for an earth dam, design of earth dams; stability analysis of slopes: shape of slip surface, and method of slices.	**6 Hr**
Unit-2:	Seepage through Dam Section and its Control: fundamentals of seepage flow, Laplacian equation and flow net. Determination of top flow line and discharge through dam, seepage force and its effects, steady seepage. Drainage of Embankment: horizontal drain, chimney drain, design of filter, use of impervious core in seepage control. Control of seepage trough foundation, cut off trench, partial cutoff and upstream impervious blanket.	**6 Hr**
Unit-3:	Gravity dams, forces acting, modes of failure, elementary and practical profile, low and high gravity dam, design of gravity dam, drainage gallery, joints in a gravity dam, foundation treatment in a gravity dam, strengthening and raising of gravity dams, deterioration and repairs of concrete dam, deformation measurement of dam body by plumb lines and off dam reference point.	**6 Hr**
Unit-4:	Arch dams: types and its suitability, equations of cylindrical shells, general concepts about trial load method and elastic shell method. Hollow gravity dam, structural features, Buttress dam, types: flat slab type, massive head type, multiple	**6 Hr**

CE 51009: Rural and Urban water supply

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: Address issues and various techniques for rural water supply, water quality monitoring, maintenance and operations. It also covers planning, collection, treatment and disposal of waste water. It provides knowledge of compact and simple waste water treatment units and septic tank. The disposal of solid waste, biogas plant, urban water supply, public health, pollution of urban water is also covered. At the end course covers collection, treatment, storage and handling of households water and emergency water supply.

Course Outcomes: After the successful completion of this course, the student will be able to:

1. Identify techniques of rural water supply and rural water quality monitoring.
2. Plan waste water collection system, its disposal and treatment.
3. Decide suitable method of disposal of solid waste and rural sanitation.
4. Describe urban water supply, problems associated with it, monitoring water quality.

Detailed Syllabus:

Unit -1:	Issues of rural water supply –Various techniques for rural water supply- merits- National rural drinking water program- rural water quality monitoring and surveillance- operation and maintenance of rural water supplies, Introduction – Epidemiological aspects of water quality, methods for low cost water treatment - Specific contaminant removal systems	**6 Hrs**
Unit -2:	Introduction to rural sanitation- Community and sanitary latrines - Planning of wastewater collection system in rural areas- Treatment and Disposal of wastewater - Compact and simple wastewater treatment units and systems in rural areas stabilization ponds - septic tanks - Inhofe tank- soak pits- low cost excreta disposal systems Effluent disposal.	**6 Hrs**
Unit -3:	Disposal of Solid Wastes- Composting- land filling incineration- Biogas plants - Rural health - Other specific issues and problems encountered in rural sanitation.	**6 Hrs**
Unit -4:	Introduction to Urban Water Supply, urban Water and Public Health, problems associated with urban water supply, Water Sources and their Characteristics, urban Water Pollution, Water Treatment Technologies for Large-scale Water Supply, Distribution, Leakage and Illegal Connections, water meter system, MBR,ESR, Valves, Pressure relief valve,	**6 Hrs**
Unit -5:	Water Safety Plans, Duties and Responsibilities of Water Utilities, Household Water Collection, Treatment, Storage and Handling, Efficient Use of Water, Monitoring Water Quality, Financing	**6 Hrs**

	Urban Water Services, Water Emergencies and Emergency Water Supply, Public–Private Partnership and Other Commercial Opportunities	

References:

1. Hengeveld, H. and C. De Voch.t (Ed)., Role of Water in Urban Ecology, 1982.

2. Neil S. Grigg., Urban Water Infrastructure Planning, Management and Operations, John Wiley and Sons, 1986.

3.Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.

4. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall.

5. Garg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher

6. Handbook on Drinking Water Treatment Technologies, 2011, Ministry of Water and Sanitation, Government ofIndia, India

7. National Rural Drinking Water Program- Movement towards Ensuring i People's Drinking Water Security in Rural India, Framework for Implementation, Department of Drinking Water Supply, Ministry of Rural Development, Government of India, April, 2010 Source: http://swajal.uk.gov.in/files/pdENRDWP_GuidelineApril_10.pdf

8. Training Manual for Trainers of CSS,2007, Gujarat Jal Seva Training Institute, Vol. 1 & 2

9. Water and Sanitation Program Report, 2011, Towards drinking water security in India-Lessons from the field, New Delhi, India

CE 51010: WATER RESOURCES SOFTWARE LABORATORY

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs/Week	Term Work	25 Marks
Practicals	4 Hrs/Week	Viva-voce	25 Marks
Total Credits	**2**		
		Total	50 Marks

Prerequisite: Not applicable

Description: Learning of software and solving examples is expected by the students during software laboratory work. Minimum six of the following are required to perform in the software laboratory. Student will have to work on software and do the mini project.

Course Outcome: After successful completion of the course student should able to:

1) Learn different software related to water resources engineering.

2) Analyze optimization models using different softwares.

3) Solve real problems using these softwares.

4) Design the water distribution system network.

List of softwares:

1. Study on Fluid Flow software
2. Application of MATLAB and its toolboxes
3. GIS & SWAT model for water resources
4. Working in LINGO environment for water resources application
5. Working in SPSS for water resources application
6. Study on HEC-HMS/RAS model
7. Study on DAMBRK software
8. Study on River CAD model
9. Study on the SWMM Software
10. Strudy on the SPSS.
11. Study on the BRANCH, EPANET, WATERGEMS, SEWERGEMS, etc. softwares

Students are required to submit the duly completed journals at the end of semester.

CE 51011: Engineering Hydrology Laboratory

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs./Week	Term Work	25 Marks
Tutorial/Practicals	4 Hrs./Week	Viva-voce	25 Marks
Total Credits	2		
		Total	50 Marks

Prerequisite: Not applicable

Course Objectives: To teach the principles, applications and Performance of unit and synthetic hydrographs. Also the students will learn the flood frequency studies and storage capacity of reservoirs. Students have to do all the assignments mentioned below.

Course Outcome: After successful completion of the course student will be able to:

1) Determine flood discharge for different return periods

2) Analyze reservoir routing and channel routing

3) Determine unit hydrograph and synthetic unit hydrograph

4) Decide the storage capacity of reservoir

List of Assignments:

1. Determine the flood discharge for the 100 year return period using real data
2. Route any inflow hydrograph through the river reach
3. Geographical distribution and finding average precipitation over an area
4. Solve Examples based on unit hydrograph method
5. Develop S-curve hydrograph and synthetic unit hydrograph for given data
6. Flood frequency study using Gumbel's distribution.
7. Analysis of Rainfall data (double mass curve technique)
8. Determination of storage capacity of a reservoir
9. Site visit to the nearest metrological station

Candidates are required to submit the duly completed journals before the end of semester.

CE 51012: ADVANCED FLUID MECHANICS

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to introduce to students the concepts of fluid mechanics from both theoretical and applications perspective. There is a well-balanced coverage of physical concepts, mathematical operations along with example and exercise problems of practical importance. The course provides the platform for fundamental understanding of the basic principles of fluid mechanics and help to apply the basic principles to analyze fluid system.

Course Outcomes: After successful completion of the course, student will able to

1. Know and understand the basic concepts kinematics and Dynamics of fluid flow, Ideal flow, Laminar flow and Turbulent flow, Boundary layer theory, dimensional analysis and model analysis.
2. Apply the energy equations for practical problem related to fluid flow.
3. Analyze the effect of laminar and turbulent flow and boundary layer for fluid in motion.
4. Carry out dimensional analysis and model analysis for various practical problems.

Detailed Syllabus:

Unit -1:	**Properties of Fluids:** Role of fluid properties in fluid motion, types of fluids based on rheological diagram, Thermodynamic properties: Dimension of R, Isothermal process, Adiabatic Process, Universal Gas Constant **kinematics of Fluid flow**: Equation of continuity in Cartesian and cylindrical co-ordinate system, Lagrangian and Eulerian approach, stream tube, path lines, streak lines, stream lines and their equations, elements of particle motion, circulation, rotational and irrotational flows, vorticity, angular deformation, stream function, Velocity potential function, Laplace's equation, Flownets.	**6 Hrs.**
Unit -2:	**Dynamics of fluid flow**: Equations of Motions, Euler's equation of motion in Cartesian and cylindrical coordinate system, energy equation from Euler's equation, practical applications of energy equation **Ideal Flow:** uniform flow parallel to x and y axis, source flow, sink flow, Free vortex flows, Superimposed flow: Source and Sink Pair, Doublet, A plane surface flow in a Uniform flow, Source and Sink Pair in Uniform flow, A doublet in a Uniform flow	**6 Hrs.**
Unit -3:	**Laminar Flow**: Navier-Stokes equation of motion, exact and approximate solutions to Navier-Stokes equation, Relationship between shear stress and Pressure Gradient, Flow of viscous fluid in Circular Pipes-Hagen Poiseuille Law, Flow of viscous fluid between two parallel plates: One plate is moving and other at rest-Couette flow and Both plates at rest	**6 Hrs.**

	Boundary layer theory: boundary layer definitions and characteristics, displacement, momentum, and energy thickness, Momentum Equation for boundary layer by Von Karman, laminar boundary layer, boundary layer separation and its control	
Unit -4:	**Turbulent flow:** Charteristics of turbulent flow, Shear stress in turbulent flow: Boussinesq's theory, Reynolds theory, Prandtl's mixing length theory, Universal velocity distribution equation, Hydrodynamically smooth and rough boundaries: velocity distribution for turbulent flow in smooth and rough pipes, Common equation for velocity distribution for both smooth and rough pipes, resistance to flow of fluid in smooth and rough pipes	**6 Hrs.**
Unit -5:	**Dimensional analysis**: dimensions, dimensional homogeneity, Methods of dimensional analysis: Rayleigh's method and Buckingham's pi methods, limitations of dimensional analysis, **Model analysis:** Similitude, Forces influencing hydraulic phenomenon, dimensionless numbers and their significance, Model Laws, Types of models, Scale effect in models, Limitations of hydraulic similitude	**6 Hrs.**

References:

1. R. K. Rajput, (2006) "Fluid Mechanics", S. Chand and Company Limited, New Delhi, Third Edition, ISBN:81-219-1667-4.
2. S. Narsimhan (1973) "Engineering Fluid Mechanics", Orient Longman
3. Douglas J.F, Gasiorek S, waffield J.A. (2003) "Fluid Mechanics", Pearson Education (Singapore) Pvt. Ltd. Indian office at 482 F.I.E. Patparganj, Delhi.
4. Mohanthy A.K. (1994) "Fluid Mechanics, Prentice Hall of India, New Delhi

CE51013: Water Resources Systems Planning & Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the students to engineering economy of water resources project for evaluation of benefit cost analysis. Optimization techniques such as linear programming and non-linear programming are included in the curriculum. Simulation and multi-objective optimization is also included in the curriculum. Student will be exposed to the water quantity and water quality management with different models.

Course Outcomes: After successful completion of the course, students will be able to:

1) Understand principles of engineering economy
2) Optimize the water resources systems
3) analyze the water quantity and quality management
4) Understand the legal aspects of water and environment systems.

Detailed Syllabus:

Unit - 1:	Introduction: General Principles of Systems Analysis to Problems in Water Resources Engineering, Objectives of Water Resources Systems, Economic Analysis of Water Resources Systems: Principles of Engineering Economy, Capital, Interest and Interest rate, Time Value of Money, Depreciation, Benefit Cost Evaluation, Discounting Techniques, Socio Economic Analysis.	**6 Hrs**
Unit - 2:	Methods of Systems Analysis: Linear Programming Models, Simplex Method, Sensitivity Analysis, Dual Programming, Dynamic Programming Models	**6 Hrs**
Unit - 3:	Non-linear Programming, Gradient Techniques, Stochastic Programming, Simulation, Multi Objective Optimization.	**6 Hrs**
Unit - 4:	Water Quantity Management: Surface Water Storage Requirements, Storage Capacity and Yield, Reservoir Design, Water Allocations for Water Supply, Irrigation, Hydropower and Flood Control,Reservoir Operations, Planning of an Irrigation System, Irrigation Scheduling, Groundwater Management, Conjunctive Use of Surface and Subsurface Water Resources	**6 Hrs**

Unit - 5:		Water Quality Management: Water Quality Objectives and Standards, Water Quality Control Models, Flow Augmentation, Wastewater Transport Systems, River Water Quality Models. Legal Aspects of Water & Environment Systems: Principles of Law Applied to Water Rights and Water Allocation, Water Laws. Environmental Protection Law	**6 Hrs**

References:

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

CE 51014: Planning and Design of Hydro Power Schemes

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course provides an overview of hydraulic engineering design of hydroelectric plants as well as it provides a detailed analysis for the optimization of related works and the parameters that influence the performance, safety and operation. The design of a hydroelectric plant begins with a hydrological analysis and hydraulic study, followed by an estimation of available water and eventual rated power to install including the overall quantity of energy to be produced. An understanding of the principles of the hydroelectric plant operation and the associated works is essential to efficiently perform the design and maximize uses of available water.

Course Outcomes: After successful completion of the course, students will able to,

1) Analyze and design gravity dams.
2) Analyze and design Earth dams.
3) Design spillways and energy dissipation structures.
4) Design penstocks and surge shafts.

Detailed Syllabus:

Unit -1:	Introduction to Power Plant Design, Factors to Consider in Planning Hydrologic Analysis and Calculations Temporary Diversion Spillway & Riparian Flow Structures Composition of the power plant Energy production. Social Economic Research, Technical Survey, Outline of Hydropower Generation, Significance of Small Scale Hydropower Development.	**6 Hrs**
Unit -2:	Design of hydraulic structures on permeable foundation including weir and barrage; determination of afflux and discharge intensity; waterway and looseness factor; stilling basin level and length; uplift pressures and exit gradient; floor thickness and protection works.	**6 Hrs**
Unit -3:	Earth dams- homogeneous and zoned sections; filter design and stability analysis. Gravity dams- general features; forces acting on gravity dam; galleries and their functions; stability analysis; roller compacted RCC dams	**6 Hrs**
Unit -4:	Spillways-layout and design of various types of spillways; design of energy dissipaters. Intake Structures-trash racks and their cleaning and handling devices; stop log arrangements; intake entrance; aeration vent; gate control. Tunnels-classification; rock cover; hydraulic design and supporting systems; concrete lining; portals and plugs; underground cavities.	**6 Hrs**
Unit -5:	Gates- various types of gates for barrages; spillways; intakes; sluices; structural design considerations for vertical lift and radial	**6 Hrs**

	gates. Hydro power-function; classification and main components (penstocks, surge tanks, hydro turbines, etc.) of hydro power stations	

References:

1. Water Power Engineering by M.M. Dandekar and K.N. Sharma, Vani Educational Books

2. Irrigation and water resources Engg. By G.L. Asawa, New Age international Publishers.

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

4. Justinn, Creager and Hinds, "Engineering For Dams.Vol.I, II, III"

5. P.N.Modi. Irrigation and water power engineering'

6. Paulo C.F. Erbisti "design of hydraulic gates" A.A.Balkema publisher/Lisse/Abingdon/Exton (PA)/ Tokyo

7. E. Mosoni, "Water Power Development – Vol. I & II"

8. G. Brown, "Hydro-electric Engineering Practice Vol. I, II & III"

9.Creager and Justin "Hydro – Electric Hand Book"

10. Varshney "Hydro Power Structures"

11.P. K. Bhattacharya, "Water Power Engineering" Khanna Pub., Delhi

12. M. M. Deshmukh, "Water Power Engineering" Dhanpat Rai and Sons

CE 51015: Environmental Impact Analysis of Water Resources Systems

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description This course emphasizes in the curriculum for the practical means by which organizations minimize their impacts on the environment. In this course student will learn how to assess impacts at different scales, and design, implement and monitor mitigation measures. This knowledge will assist you to critically evaluate complex environmental issues and assist in the development of Environmental Impact Statements (EIA's) and the preparation, maintenance and implementation Environmental Management Systems (EMS) in accordance with relevant environmental legislation and international standards.

Course Outcomes: After successful completion of the course, students will able to,

1) Understand the ecological stability and ecological systems concept.
2) Real problem due to manmade developmental activities, Select Environmental, Economic and social indicators, collect data and conduct analysis.
3) Selecting the appropriate technique and methodology to carry out Environmental Impact Assessment.
4) Carry out Environmental Impact Assessment of the water resources components.

Detailed Syllabus

Unit -1:	Water resources development and environmental issues – Environment in water resources project planning – Environmental regulations and requirements – The EIA (Environmental Impact Assessment) notification	**6 Hrs**
Unit -2:	Environmental Impact Assessment (EIA) – EIA in Project Cycle – Legal and Regulatory aspects in India according to Ministry of Environment and Forests – Types and limitations of EIA – Cross sectorial issues and terms of reference in EIA –Participation of Public and Non-Governmental Organizations in environmental decision making	**6 Hrs**
Unit -3:	Hydrological and water quality impacts – Ecological and biological impacts – Social and cultural impacts – Soil and landscape changes – Agro economic issues – Human health impacts – Ecosystem changes.	**6 Hrs**
Unit -4:	Team formation – Development of scope, mandate and study design – Base line survey – Check lists – Ad hoc procedures – Network and matrix methods – Semi-quantitative methods – ICID checklist – Economic approaches – Environmental Impact Statement (EIS) preparation.	**6 Hrs**
Unit -5:	In-stream ecological water requirements - Public participation in environmental decision making – Sustainable water resources	**6 Hrs**

	development – Eco restoration – Hydrology and global climate change – Human ecology – Ecosystem services – Environmental monitoring programs.	

References

1. Canter, L.W., Environmental Impact Assessment. McGraw Hill International Edition, New York. 1995.

2. Barathwal, R.R., Environmental Impact Assessment. New Age International Publishers, New Delhi. 2002.

3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London. 1999.

4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Inter Science, New Jersey. 2003.

5. Arnel, N., Hydrology and global environmental change. Prentice Hall, Harlow. 2002.

6. Chari. B., Richa Sharma and S.A. Abbasi, Comprehensive Environmental Impact Assessment of Water Resources Projects : With Special Reference to Sathanur Reservoir Project (Tamil Nadu)/K. Discovery Pub., New Delhi, 2005.

7. UNEP's Environmental Impact Assessment Training Resource Manual -2 nd Edition, 2002.

CE 51016: Soft Computing Techniques

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: Introduce students to soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world problems. The field of engineering is a creative one. The problems encountered in this field are generally unstructured and imprecise influenced by intuitions and past experiences of a designer. The conventional methods of computing relying on analytical or empirical relations become time consuming and labor intensive when posed with real life problems. Travel demand modeling includes many problems having non-linear functions to solve. Soft computing techniques like Genetic Algorithms, Fuzzy logic and Artificial Neural Network can be applied effectively to solve these types of problems. This subject gives understanding of these techniques and their procedural aspects to solve the above mentioned problems

Course Outcomes: After successful completion of the course the students will be able to:

1. Understand importance of soft computing.
2. Understand different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.
3. Implement algorithms based on soft computing.
4. Apply soft computing techniques to solve engineering or real life problems.

Detailed Syllabus:

Unit -1:	Introduction to Soft Computing: Introduction, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Applications in water resources engg. Fundamentals of Neural Network: Introduction, Model of Artificial Neuron, Architectures, Learning Methods, Taxonomy of NN Systems, Single-Layer NN System, Applications.	**6 Hrs**
Unit -2:	Back Propagation Network : Background, Back-Propagation Learning, Back-Propagation Algorithm. Associative Memory : Description, Auto-associative Memory, Bi-directional Heteroassociative	**6 Hrs**
Unit -3:	Adaptive Resonance Theory : Recap - supervised, unsupervised, backprop algorithms; Competitive Learning; Stability-Plasticity Dilemma (SPD), ART Networks, Iterative Clustering, Unsupervised ART Clustering.	**6 Hrs**

Unit -4:	Fuzzy Set Theory : Introduction, Fuzzy set : Membership, Operations, Properties; Fuzzy Relations, Fuzzy Systems : Introduction, Fuzzy Logic, Fuzzification, Fuzzy Inference, Fuzzy Rule Based System, Defuzzification	**6 Hrs**
Unit -5:	Fundamentals of Genetic Algorithms : Introduction, Encoding, Operators of Genetic Algorithm, Basic Genetic Algorithm. Hybrid Systems : Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms, GA Based Back Propagation Networks, Fuzzy Back Propagation Networks, Fuzzy Associative Memories	**6 Hrs**

References:

1) Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S. Rajasekaran, G. A. Vijayalakshami, PHI.

2) Chin Teng Lin, C. S. George Lee, Neuro-Fuzzy Systems, PHI

3) TomthyRoss,Fuzzy Logic and Engineering Application, TMH

4) KishanMehrotra ,Elements of Artificial Neural Network, MIT Press

5) E. Goldberg,Genetic Algorithms: Search and Optimization, Addision-Wesley

6) Recent Articles and Research papers

CE 51017: Sustainability in River Basin Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course links engineering science with social and economic science under the frame of sustainability with focus on water resource management at river basin level. Communication and conflict management, data and information management, system thinking and hydro social modelling is also included in the curriculum. Best and worst practices of land and water management are discussed.

Course Outcomes: After successful completion of the course, students will be able to

1) Understand concept of sustainability.
2) Understand Hydrological and nutrient cycles.
3) Know water related diseases, source water protection.
4) Understand Climate change management option and tools to analyze hydrological change due to climate change

Detailed Syllabus

Unit -1:	Sustainability indicators, resources depletion, growth models Planetary System Boundaries, footprints, prosperity Globalization, inter-connected world, Stakeholders in sustainability.	**6 Hrs**
Unit -2:	Anthropocene, Climate change, climate variability, Hydrological cycle, water balance, catchment terminology, River basin management, Water availability, surplus, deficit, Water scarcity, water crisis, Stream morphology and land use, Nutrient cycles	**6 Hrs**
Unit -3:	Water and society, poverty, demography, Water governance, integrity, accountability, Pollution, water related diseases, source water protection, Water and land use, wetlands, desertification, Dams, diversions, artificial rainfall, Economic and financial instruments in water management, Hydrological change due to climate change	**6 Hrs**
Unit -4:	Protecting water resources / improving water quality, Living standards, equity, education and technology transfer, Water conservation and efficiency, Improving monitoring and data management, decision support systems, Improving management and justice, Improving administrative (transnational) structures, Improving prediction and risk assessment	**6 Hrs**
Unit -5:	Sustainability criteria (ecological, economic, institutional, social) Multi-criteria decision support	**6 Hrs**

References:

References

1. Randhir, T.O., Watershed Management Issues and Approaches, IWA 2007
2. Murty, J.V.S., Watershed management, New Age International 2009
3. Majumdar, D.K., Irrigation Water Management, Prentice Hall 2000
4. Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management,< Colorado State University, 1994.
5. American Socy. of Civil Engr., Watershed Management, American Soc. of Civil Engineers, New York, 1975.
6. Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991.
7. Michael A.M., Irrigation Engineering, Vikas Publishing House, 1992.
8. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad, 1995.
9. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

Table 1: Mapping of Course Outcome with Program Outcomes

CE 51018: Water Supply Systems

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: To educate the students in detailed design concepts related to water transmission mains, water distribution system with emphasis on computer application. Explain design concept of different water treatment units. Identify suitable method of treatment to be used for removal of impurity. Design conventional water treatment plant. Analyze water distribution system.

Course Outcome: After the successful completion of the course, student will able to do:

1) Get a basic knowledge of the design of pipe networks.
2) Analyze pipe network problems using different softwares and optimization technique
3) Familiar with the terminologies and designs of the water supply system.
4) Get a basic knowledge of water quality control techniques.

Detailed Syllabus

Unit -1:	Water requirement – sources of water – water demand – reservoir storage – nodal hydraulic gradient level values - water supply consideration, Types of water supply systems- piping system- distribution network- labeling- network components – Network models – design – optimization in practice	**6 Hrs**
Unit -2:	Conventional Treatment Processes: Sedimentation, Type of Sedimentation, Zone Setting, Filtration, Gravity Granular — Media Filtration, Head Losses, Back Washing and Media Filtration, Head Losses, Back Washing and Media Fluidization — Pressure Filters —Slow Sand Filters, Coagulation and Flocculation Coagulants, Theory of coagulation and flocculation process, coagulation kinetics, coagulant Aids, Rapid Mixing Devices, Disinfection, Disinfection Methods, Fluoridation, De-fluoridation.	**6 Hrs**
Unit -3:	Energy and hydraulic gradient lines – head loss in links – equivalent pipes – series – parallel pipes – path head loss and loop head loss – analysis of water distribution network- static node, dynamic node – network performance – flow analysis - Layout – in situ lining - pipes material – appurtenances – minimization of water losses – leak detection.	**6 Hrs**
Unit -4:	Water distribution systems, major and minor losses, head — discharge relationships, formulation of equations, pipe network analysis, Hardy cross method, Newton Raphson method, linear theory method, and finite element method. Uncertainty and	**6 Hrs**

	reliability – affecting events- assessment – reliability parameters- configurations. Design methodology - strengthening and expansion	
Unit -5:	Node flow analysis, optimization techniques in pipe networks, hydraulic design of water supply systems, pumping systems, distribution Reservoirs and Service Storage.	**6 Hrs**

References:

1. Viessman Jr., Mark 3. Hammer (1990) Water Supply and Pollution Control. McGraw Hill International Edition.

2. Fair, Geyer, Okun (1990) Water Supply Engineering. John Wiley.

3. Turbuit T H Y (1998) "Principles of Water Quality Control" Pergamon Press.

1. Bhave P. R, Optimal design of water distribution networks, Narosa publishing House, New Delhi,

2003

4. Bajwa. G. S, Practical handbook on Public Health Engineering, Deep publishers, Shimla 2003

5. Manual on water supply and treatment, CPHEEO, Ministry of Urban Development, GOI, New

Delhi, 1999

6. B.A. Hauser, practical hydraulics Hand Book, Lewis Publishers, New York, 1991

7. Moser A. P, Buried pipe Design, 3rd Edition, American Water Works Association

8. Robert van Bentum and Lan K. Smout, Buried Pipe lines for surface Irrigation, The Water,

Engineering and Development Centre, Intermediate Technology Publications,UK,1994

9. Wurbs R.A., and James W.P. Water Resources Engineering. Prentice Hall of India, Eastern

Economic Edition. ISBN: 81-203-2151-0, New Delhi, 2007

CE51019: Land and Water Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The aim of this course is to provide an understanding of issues and methods in water resources management, and is set especially within the framework of total, or integrated, catchment management. The course gives an introduction to the unique hydrology of India, major issues of water resource management, the implications of past water management practices, the principles of integrated catchment management and sustainability, and current management tools and strategies.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Understand the economic development in water resource management in India
2) Explain how the changing balance over time in water availability, demand for water and value of water, institutional arrangements, policy and management.
3) Demonstrate familiarity with a range of water and land management issues, including origins, impacts and management interventions in both rural and urban areas
4) Understand the irrigation methods, types, problems associated with the land degradation

Detailed Syllabus:

Unit -1:	Basic concepts of soil erosion; control of soil erosion; Mechanics of wind and water erosion, water and wind erosion control practices; concept of runoff and its estimation, evapotranspiration, methods of evapotranspiration estimation, Design, construction and maintenance of vegetated waterways; Planning, Design, Construction and maintenance of terraces contours and bunds; irrigation and drainage systems for efficient soil and water conservation; cost analysis.	**6 Hrs**
Unit -2:	Physics of surface irrigation; Design and evaluation procedure for border, check basin and furrow irrigation; Guidelines for operation and maintenance of surface irrigation methods. Description of Quick coupling, dragline and movable sprinkler irrigation systems and center Pivot system; Design installation, operation and maintenance of sprinkler irrigation systems; spray losses and drop size distribution in sprinkler irrigation systems and efficiency evaluation. Suitability of drip irrigation system under Indian conditions; Types of drip irrigation systems; Emitter types; Emitter construction; Discharge principles for emitters; Design of drip irrigation systems; water and salt distribution; Emitter	**6 Hrs**

	clogging; water treatment; Automation; Field performance and evaluation. Irrigated crops- Irrigated agriculture in relation to crop production; irrigated crops around the world; Soil and climatic condition; selection of irrigation methods for irrigated field condition vegetable and fruit crops; Agronomical practices for major irrigated crops in India, Drainage requirement for irrigated crops, Economic analysis of major irrigated crops, field visit.	
Unit -3:	Watershed Development and Management Concept of watershed development and management; collection of hydrological data; watershed characteristics and hydrologic cycle; problems of land degradation; Land use capability classification and topographical characteristics of watershed; Appropriate soil and water conservation measures for agricultural and non-agricultural lands; Grassland development and management, Legal aspects in water sharing and management – PC-CP - case studies.	**6 Hrs**
Unit -4:	Techniques for dry land farming based on watershed characteristics; water harvesting techniques for hilly and arid regions; Hydrological and sediment monitoring of watershed; Estimation of peak design runoff rate; Planning, management and economic evaluation of watershed development projects; case studies.	**6 Hrs**
Unit -5:	Land suitability classification according to USBR; Land suitability categories according to FAO framework; Land evaluation; Mapping of degraded soil through soil survey; Land degradation in arid and semi-arid regions, Land degradation due to erosion, Land degradation management by conservation practices; Causes, reclamation and management of water logged and salt affected soils; Rehabilitation and management of ravine lands; Selection, Design and management of irrigation and drainage systems in wastelands; Economic evaluation of wasteland development projects..	**6 Hrs**

References: 1. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008

2. Murthy, V.V.N., Land and Water Management, Khalyani Publishers, 2004

3. Muthy, J. V. S., Watershed Management, New Age International Publishers, 1998

4. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 1998

5. Majumdar, D.K., Irrigation Water Management, Prentice Hall of India, New Delhi, 2000

6. Michael, B.A.M., Irrigation, Vikas Publishing House Pvt. Ltd. New Delhi, 1990

7. Scwabe, G.O., Fangmeir, D.D., and Elliot W.J., Soil and Water Management Systems, John Wiley and Sons, N York, 1996

8. Asawa, G.L. (1996) —Irrigation Engineering", New Age International Pub. Co. N Delhi.

9. Suresh, R.L. (1999) —Soil and Water Conservation Engineering“, Standard Publishing Co. Delhi.

CE 51020: Climate Change and Water Resources

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the students to understand about climate change and to explore possible solutions. There is action that can be taken to prepare for a more variable climate. Improved understanding of our water resource will allow more efficient and flexible allocation system and better investment in infrastructure, both to improve access to water and reduce risks from climate change.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Understand the climate system, being aware of the impact of climate change on society, adaptation in relation to water and climate change.
2) Describe the possible impacts, adaptations and remedies in relation to water resources and climate change.
3) To orient towards the global climate change and its impact on water resources.
4) To understand the climate change phenomenon and its related issues on water, irrigation and its social implications.

Detailed Syllabus:

Unit -1:	Introduction to global climate; Global climatic models; Methods of reconstructing climate; Quaternary climates, sea level changes.	**6 Hrs**
Unit -2:	Glacial / interglacial cycles; Geological records of climate change, sediment logy, stable isotopes, geochemistry; Geochronology – relative and numerical methods.	**6 Hrs**
Unit -3:	Vegetation dynamics, migration history, response of vegetation to climatic reversals, Pre-quaternary climates, evolution of climate through geological time.	**6 Hrs**
Unit -4:	Indian Climatology - Different seasons, Distribution of Means Sea level pressure/temperature in different seasons, Wind circulation and temperature distribution over India in lower, middle and upper troposphere in different seasons, Indian rainfall in different seasons, Indian summer monsoon, onset, withdrawal, rainfall distribution, inter annual variability of monsoon. Main synoptic pressure systems causing weather over India in different seasons.	**6 Hrs**
Unit -5:	Climate Change & Variability -Overview of the climatic history of the earth. Long term changes (Climate of Past century, past millennium, past glacial period), Methods of determining past climate. Possible causes of climate change- External (Milankovitch variation and Solar activity) and Internal (natural and anthropogenic). General idea of internal dynamical processes	**6 Hrs**

	of the atmosphere, oceanic processes, Cryospheric processes, land processes. Man's impact on climate, Greenhouse gases and global warming, basic radiation processes, Climate feedback mechanism, Climate predictability, future climate, potential consequences, International efforts to minimize climate change and their effects on Indian scenario.	

References:

1. R.J. Barry and R.G. Chorley "Atmosphere, Weather and Climate" (Methuen Publication)

2. Y.P. Rao "South West Monsoon" (IMD Publication) .

3. S. Pettersen "An Introduction to Meteorology"

4. Miller, Thompson and Paterson "Elements of meteorology"

5. H.R. Byer "General Meteorology"

6. P.K. Das "Monsoon"

7. IPCC Report Technical Paper VI – Climate change and water , 2008.

8. UNFCC Technologies for Adaptation to climate change, 2006.

9. 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.

10. Preliminary consolidated Report on Effect of climate change on Water Resources, GOI, CWC, MOWR, 2008.

CE 51021: River Engineering and Flood Control

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description This course emphasizes in the curriculum to get knowledge of fluvial geomorphology and understand concept of analysis of river flow hydraulics so that they are able to analyze hydraulic geometry and to design stable alluvial channels. So the students will able to do fluvial design for river bank protection and flood control.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Understand theoretical concepts of water and sediment movements in rivers.
2) Inculcate the benefits of fluvial system to the society.
3) Appreciate the complex behavior of rivers.
4) Gain the skills to take up research activities in river flood management.

Detailed Syllabus:

Unit -1:	Primary function of a river – River uses and measures – Water and Sediment loads of river – Rivers in India, Himalaya and Peninsular.	**6 Hrs**
Unit -2:	Physical Properties and Equations – Steady flow in rivers – uniform and non uniform – Turbulence and velocity profiles – resistance coefficients – Boundary conditions and back waters – Transitions – Rating Curve – Unsteady flow in rivers : Preoperative of surface waves – Characteristics, flood waves – kinematic and diffusion analogy – velocity of propagation of flood waves – Flood wave –Maximum	**6 Hrs**
Unit -3:	River Equilibrium : Stability of Channel – regime relations – river bend equilibrium – hydraulic geometry of downstream - Bars and meandering - River dynamics – degradation and aggradation of river bed – Confluences and branches – River Data base.	**6 Hrs**
Unit -4:	Mapping – Stage and Discharge Measurements – Sediments – Bed and suspended load Physical hydraulic Similitude – Rigid and mobile bed – Mathematical – Finite one dimensional – multi – dimensional – Water Quality and ecological model	**6 Hrs**
Unit -5:	River training works and river regulation works-Flood forecasting – Flood plain management – waves and tides in Estuaries - Interlinking of rivers – River Stabilization	**6 Hrs**

References:

1 Janson PL.Ph.,LvanBendegamJvanden Berg, Mdevries A. Zanen (Editors), "Principles of River Engineering – The non tidal alluvial rivers" – Pitman, 1979.

2. Pierre Y. Julien ., "River Mechanics" ,Cambridge University Press, 2002.

3. K.L Rao , "INDIA"s WATER WEALTH" – Orient Longman Ltd., 1979.

4. River Behaviour and Management and Training,-CBIP publication.

5. Anderson, M.C., Burt, T.P. , 'Manual on flood forecasting', New Delhi, 1985.

6. Central Water Commission, 'Hydrological forecasting', John Willy and Sons, 1989.

CE 51022: Watershed Development and Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to solve water resources problems which include watershed management and erosion estimation such as USLE equation and modified USLE equation are included in the curriculum. Also the GIS technique and remote sensing is included in the curriculum. Student will be exposed to the watershed development and management with different models.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Understand Applications of GIS and remote sensing in water resources engineering.
2) Understand the aspects of watershed management.
3) Analyze the water quality monitoring.
4) Understand the watershed management practices and to know the sustainable use of the watershed.

Detailed Syllabus

Unit -1:	Watershed - Definition and delineation, Watershed approach, Hydrologic cycle, Watershed components, Water budget, Watershed assessment, Watershed planning, Watershed as a management unit, Total maximum daily load. Characteristics of watershed - Size, Shape, Physiography, Slope, Climate, Drainage, Land use, Vegetation, Geology and Soils, Hydrology and hydrogeology, Socio-economic characteristics, Basicdataon watersheds.	**6 Hrs**
Unit -2:	Land use and water quality issues - Land use impacts on watersheds, Residential activities, Municipal sources, Construction, Mining operations, Agriculture, Forestry practices, Recreation. Water quality monitoring – Temperature, pH, Dissolved Oxygen and Biological Oxygen demand, Nutrients, Pathogens, Turbidity, Biological monitoring methods, Species indicators, Biological integrity, Habitat index, Land use index, Water resource assessment, Water yield.	**6 Hrs**
Unit -3:	Erosion - Factors affecting erosion, Effects of erosion on land fertility and land capability, Soil Erosion Modelling, Erosivity and erodibility, Processes, USLE and modified/ revised USLE models for erosion processes. Land Management - Survey, Preparation and development, Soil and soil moisture conservation,	**6 Hrs**

	Conservation measures, Ploughing, Furrowing, Trenching, Bunding, Terracing, Gully control, Rockfill dams, Brushwood dam, Gabion, Rain water management, Reclamation of saline soils.	
Unit -4:	Water Harvesting: Rainwater harvesting, Catchment harvesting, Harvesting structures, Soil moisture conservation, Check dams, Artificial recharge, Farm ponds, Percolation tanks. Ecosystem management: Role of ecosystem, Crop husbandry, Soil enrichment, Inter, mixed and strip cropping, Cropping pattern, Sustainable agriculture, Bio-mass management, Dry land agriculture, Silvi pasture, Horticulture, Social forestry and afforestation. Model watershed – Government and NGO Projects.	**6 Hrs**
Unit -5:	**Sustainable Watershed Approach & Watershed Management Practices** Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation; Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning. **Social Aspects of Watershed Management:** Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies. Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management. Perspective on recycle and reuse, Waste water reclamation.	**6 Hrs**

References

1. Randhir, T.O., Watershed Management Issues and Approaches, IWA 2007
2. Murty, J.V.S., Watershed management, New Age International 2009
3.Majumdar, D.K., Irrigation Water Management, Prentice Hall 2000
4.Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management,Colorado State University, 1994.
5. American Society of Civil Engineers, Watershed Management, American Soc. of Civil Engineers, New York, 1975.
6. Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991.
7. Michael A.M., Irrigation Engineering, Vikas Publishing House, 1992.
8. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad, 1995.
9. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

CE 51023: Micro Irrigation

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course emphasizes for understanding the importance of micro irrigation methods. Design and operation of sprinkler and drip irrigation methods is included in the curriculum. The course also emphasize on current developments in irrigation methods and the adoption of micro irrigation in the field.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Design the micro irrigation systems
2) Analyze the factors influencing the economics of micro irrigation
3) Understand the agricultural practices for enhancement of crop production and productivity
4) Understand planning, design and construction of sustainable small- scale micro irrigation schemes

Detailed Syllabus:

Unit -1:	Importance, classification of irrigation methods – classification of micro-irrigation methods – principles and selection of micro-irrigation systems – low pressure mini spray systems – bubbler system – sprinkler and drip system – irrigation efficiencies.	**6 Hrs**
Unit -2:	Development – Use – Types – Portable, Semi portable and Permanent systems – Components – pumping – Main line – Lateral line – Sprinkler heads – Moisture distribution pattern and uniformity of coverage – Testing of water distribution pattern – Design of Sprinkler irrigation systems – Types of system and layout - Selection and spacing – Capacity of sprinkler system – Hydraulic design – Design of laterals – Cost estimation – Operation and Maintenance – trouble shooting – Application of Fertilizers – Fertilizer injection methods and Devices.	**6 Hrs**
Unit -3:	Drip effect on water use – description of drip irrigation system – types – various methods – manufacturing drip equipments – low and high density polythene – main pipe – submains – laterals – emitters – dripper with hole and socket – micro tube emitters – nozzles – self adjusting drippers – double wall pipe – leaky pipe. Principles for design of drip system – hydraulic formulae Darcy Weishbach equation – Hazen Williams formulae – factors to be consider to the design of the system – design procedure –design of emitters, laterals, submains and main lines – head works – drip layout for different crops – field crops – close spaced crops – orchard crops – drip irrigation design and layout – model design.	**6 Hrs**
Unit -4:	Effects of discharge rate of drip emitter – water movement under drip system – soil moisture distribution – soil water content –	**6 Hr**

	drainage flux – irrigation control by soil physical methods - Clogging – water quality and preventive measures – cleaning of clogged system – filtration problems and measures – gravel filters – vortex filters – other methods of filtering and prevention – clogging of outlets. Introduction and list of fertilizers – application of fertilizer – influence on general nutritional problems – fertilizers movement – fertilizing – existing fertilizer practices – continuous fertilizers – methods of applying fertilizers – volume of fertilizer tank – dilution ratio.	
Unit -5:	drip system – engineering design – Agronomic manipulation – commercial production – factors influencing economics of drip system – cost estimates – optimum farm size – economics and financial analysis – present status and application – case studies.	**6 Hrs**

References:

1. Michael, A.M., "Irrigation Theory and Practice", Vikas Publishers, New Delhi, 2000.

2. Dilip Kumar Majumdar., Irrigation Water Management, Prentice Hall Inc., 2004.

3. Dr. R. Suresh , "Principles of Micro-Irrigation Engineering", Standard Publishers Distributors, New Delhi, 2010.

4. R.K. Sivanappan, "Sprinkler Irrigation", Oxford and IBH Publishing Co, New Delhi, 1987.

5. J.Keller and D. Karmeli, "Trickle Irrigation Design", Rainbird Sprinkler Irrigation Manufacturing Corporation, Glendora, California, USA.

6. Jack Keller and RondBelisher., "Sprinkler and Trickle Irrigation", Van nastrandReinhold,New York, 1990.

CE 51024: Water Quality Monitoring and Modeling

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: These courses introduce water quality concepts, its evaluation for irrigation purposes, besides relevant environmental problems and recycle and reuse concepts. Also understand the importance of water quality for irrigation and major uses of water and the role environmental issues.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Understand the water quality and its dependence on sources of water
2) Understand and interpret water quality data for its use in water quality models
3) Solve the water quality problems.
4) Design low cost waste water treatment plant.

Detailed Syllabus:

Unit -1:	Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – major ions –. Water quality investigation – Sampling design - Samplers and automatic samplers - Data collection platforms – Field kits – Water quality data storage, analysis and inference – Software packages	**6 Hrs**
Unit -2:	Water quality for irrigation – Salinity and permeability problem – Root zone salinity - Irrigation practices for poor quality water – Saline water irrigation – Future strategies	**6 Hrs**
Unit -3:	Sources and Types of pollution – Organic and inorganic pollutants - BOD – DO relationships – impacts on water resources – NPS pollution and its control – Eutrophication control - Water treatment technologies - Constructed wetland.	**6 Hrs**
Unit -4:	Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation.	**6 Hrs**
Unit -5:	Principles of water quality – Water quality classification – Water quality standards - Water quality indices – TMDL Concepts – Water quality models.	**6 Hrs**

References:

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, "Wastewater Engineering: Treatment and Reuse", McGraw-Hill, 2002.
1. 2 Vladimir Novonty, "Water Quality: Diffuse pollution and watershed Management", 2nd edition, John Wiley & Sons, , 2003
2. Mackenzie L Davis, David A Cornwell, "Introduction to Environmental Engineering", McGrawHill 2006.
3. 4 Stum, M and Morgan, A., "Aquatic Chemistry", Plenum Publishing company, USA, 1985.

4. Lloyd, J.W. and Heathcote, J.A., "Natural inorganic chemistry" in relation to groundwater resources, Oxford University Press, Oxford, 1988.

CE51025: Advanced Fluid Mechanics Laboratory

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs./Week	Term Work	25 Marks
Tutorial/Practicals	4 Hrs./Week	Viva-voce	25 Marks
Total Credits	2		
		Total	50 Marks

Prerequisite: Not applicable

Course Objectives: This course introduces on the principles, applications and performance of experiments based on studies. Students have to perform minimum eight of following experiments in the laboratory.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Interpret the flow around immersed lamina.
2) Plot flow net.
3) Use various discharge measuring devices.
4) Perform experiment using evaporimeter.

Detailed Experiment List:

1. Flow around immersed lamina using Hele-Shaw model
2. Study on electric analogy apparatus (design experiment)
3. Verification of Bernoulli's equation
4. Study of hydraulic jump
5. Calibrations of at least two hydraulic weirs (design experiment)
6. Study experiment on infiltrometer/evaporimeter
7. Calculation of flow profiles in hydraulic channel (design experiment)
8. Behavior of sediment particles in river model
9. Experiment on wind tunnel
10. Assignment on model analysis (design experiment)

Candidates are required to submit the duly completed journals before the end of semester.

CE51026: Water Resources Systems Planning and Management Laboratory

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs./Week	Term Work	25 Marks
Tutorial/Practicals	4 Hrs./Week	Viva-voce	25 Marks
Total Credits	2		
		Total	50 Marks

Prerequisite: Not applicable

Course Objectives: This laboratory course introduces on applications and performance of different methods in economic analysis and operations research. Also the students should learn the water rights and environmental protection laws. Students have to do all the assignments mentioned below.

Course Outcomes: After the successful completion of the course, students will be able to:

1) Carry out the economic analysis of hydraulic structures
2) Solve the optimization problems in water resources engineering
3) Analyze the reservoir operation problems
4) Understand the water rights and environmental protection law

List of Assignments:

1. Carry out the cost economic analysis of any existing hydraulic structure using its data (student should work individually)
2. Solve Linear programming problems using Simplex method, dual programming
3. Solve Non Linear programming using gradient technique, Stochastic programming
4. Write the mathematical model for Multi objective reservoir operation and solve it by LINGO
5. Prepare a draft for the water rights and protection laws, Conflicts over water, environmental protection law, legal aspect
6. Redesign any small reservoir by considering requirement, future population growth for upcoming next 35 years
7. Assessment of the water quality of the any area using institutes laboratory and draft report for the implications (Group Task)

Candidates are required to submit the duly completed journals before the end of semester.

CE51027: Mini Project with Seminar

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs/Week	Term Work	25 Marks
Tutorial/Practicals	4 Hrs/Week	Viva-voce	25 Marks
Total Credits	2		
		Total	50 Marks

Prerequisite: Not applicable

Course Description: The student shall collect, review, compile, comprehend, present research literature and identify the problem for the dissertation.

Course Outcomes:

After successful completion of the course, students will be able:

1. To search literature from different sources to appraise the state-of-the-art.
2. To compile and prepare a technical report from the collected literature.
3. To present the literature in a comprehensive manner and identify the problem for the dissertation

Term Work:

The Mini Project with Seminar shall consist of collection of literature from a chosen field of Structural Engineering from various sources such as refereed journals, proceedings of national international conferences, PG/PhD theses etc. Based on the literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary the candidate shall define the problem for the dissertation.

The candidate shall prepare a technical report in a prescribed format and present before a panel of examiners consisting of guide and at least one faculty member of the department.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 10 Marks: A mid-term evaluations for 10 marks out of 25 marks shall be done as per the schedule given in the institute academic calendar. Student should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and one faculty members appointed by the DCoE as external examiners. The panel of examiner will assess the contents and presentation and give the suggestions, if any and assigns the marks out of 10. In this phase student is expected to collect and present substantial literature.

Part-II: End Semester Evaluation for 15 Marks: Student should prepare technical report in prescribed format duly incorporating suggestions of Part-I and present power point presentation before the panel of examiners and class students. The student should be able to answer the questions asked. The panel of examiner will assess the seminar contents

and seminar presentation and assigns the marks out of 15. In this phase the students is expected to define the problem for dissertation through further literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary.

CE 61028: Engineering Optimization (Open Elective)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the engineering optimization technique such as linear and dynamic programming, Transportation Model, Assignment Model and Game Theory, Goal programming and Sequencing model, stochastic programming, Multi Objective Programming. With these techniques, it is possible to determine the ultimate goal to minimize the effort required or to maximize the desired benefit.

Course Outcomes: After the successful completion of the course, students will be able to:

1. Understand optimization, concept of system and its application
2. Optimize a function using Linear and dynamic programming, sensitivity analysis,
3. Understand applications of the Transportation Model, Assignment Model and Game Theory
4. Optimize Goal programming and Sequencing model, stochastic programming, Multi Objective Programming

Detailed Syllabus:

Unit -1:	Concept of System, Types of System, Use of systems analysis in Engineering, Introduction and Applications of Optimization Techniques in Engineering for Planning, design and Construction, Model and its Various types, Objective function and constraints, convex and concave functions, regions and sets. **Linear programming:** Formulation of Linear programming models for Civil engineering applications, Solution of LP Model by Graphical Method, The Simplex method and Special cases in simplex method, Artificial Variable Techniques: Method of Big M and Two phase method	6 Hrs
Unit -2:	**Linear programming:** Duality and its Applications, Dual Simplex Method, Sensitivity analysis, Post Optimality Analysis **Deterministic Dynamic programming:** Multi stage decision processes, Principle of optimality, recursive equation, Applications and various models of D.P.	6 Hrs

Unit -3:	**Non-Linear programming:** a) Single variable unconstrained optimization–Local & Global optima, unimodal function, Sequential Search Techniques-Dichotomous, Fibonacci, and Golden section. b) Multivariable optimization without constraints-The gradient vector and Hessian Matrix, Gradient techniques, steepest ascent/decent technique, Newton's Method. c) Multivariable optimization with equality constraints-Lagrange Multiplier Technique.	6 Hrs
Unit -4:	The Transportation Model and its variants, Assignment Model and its variants, Game Theory and its variants	6 Hrs
Unit -5:	Goal Programming, Sequencing model – n jobs through 2, 3 and m machines, Introduction to stochastic programming, Multi Objective Programming, Simulation	6 Hrs

References:

1. S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International P)Ltd., New Delhi, 2000.

2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.

3. H.A. Taha, "Operations Research: An Introduction", 5th Edition, Macmillan, New York, 1992.
4. K. Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.

5. K. Srinivasa Raju and D. Nagesh Kumar, "Multicriterion Analysis in Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, India, ISBN 978-81-203-3976-7, pp.288, 2010.

CE 61029: Dissertation-I

Scheme of Teaching		Scheme of Evaluation	
Dissertation-	20 Hrs/Week	Term Work	50 Marks
Total Credits	**10**	Viva Voce	50 Marks
		Total	**100Marks**

Prerequisites: Students should have earned requisite number of credits as per the CBCS rules and regulations.

Course Description:
The dissertation work is one of the key areas of post graduate education incorporating the research component in the curriculum. The student is required to study the existing literature from various sources such as referred journals, proceedings of National/International seminar/conferences, post graduate dissertation, PhD thesis, reference book *etc.* of Civil-Water Resources Engineering. The student would identify the problem and provide solution/s through experimental/comparative study as partial fulfillment of post graduate degree in Civil-Water resources engineering.

The dissertation-I mainly focuses on literature survey, identification of problem and action plan with possible outcomes for the completion of Dissertation-II

Course Outcomes: After successful completion of the course, students will be able:

1. To carry out exhaustive literature survey on chosen field of study.
2. To formulate/define the problem for dissertation
3. To compile and prepare a technical report of the collected literature and present.
4. To understand the methodology case study.

Term Work:

The Dissertation-I shall consist of collection of literature from a chosen field of Civil-Water resources engineering from various sources. The candidate shall formulate/define analytical and/or experimental problem for carrying out dissertation work. The candidate shall prepare a technical report in a prescribed format. The evaluation of the term work shall be through submission of report of the student in prescribed format.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 25 Marks: A mid-term evaluations for 25 marks out of 50 marks shall be done as per the schedule given in the institute academic calendar. Students should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and at least one faculty member appointed by the Head of the Department as external examiner. The panel of examiner will assess the contents and presentation and gives the suggestions, if any and assigns the marks out of 25marks.

Part-II: End Semester Evaluation for 25 Marks: Students shall prepare a comprehensive report incorporating the suggestions of part-I, if any and make a power point presentation before the panel of examiners as above and class students and should be able to answer questions asked by the panel of examiners and class students. The panel of examiner will assess the contents and presentation and assigns the marks out of 25 marks.

CE 61030: Dissertation-II

Scheme of Teaching		Scheme of Evaluation	
Dissertation-II	32 Hrs/Week	Term Work	100 Marks
Total Credits	16	Viva Voce	150 Marks
		Total	250 Marks

Prerequisites: Students should have completed CE61029: Dissertation-I satisfactorily.

Course Description:

The dissertation-II is a continuation of Dissertation-I and mainly focuses on solution of the defined problem through experimental/analytical/comparative study as planned.

Course Outcomes: After successful completion of the course, students will be able:

1. To appraise the additional literature in the chosen field of water resources engineering.
2. To refine the formulated problem in the chosen field of water resources engineering.
3. To find solution to the identified problem using appropriate methodology.
4. To interpret, discuss, debate the solution and draw conclusions.
5. To write the dissertation report and present before panel of examiner and peers.

Term Work:

The Dissertation-II shall consist of a complete analytical and/or experimental work in water resources engineering containing literature survey, problem formulation, solution, results, interpretations, discussions and conclusions certified by guide and an internal evaluation committee. The candidate shall prepare a technical report in a prescribed format and submit soft bound 3-hard copies signed by the guide and submit it to the CoE for viva-voce examination. After the viva-voce examination, student shall submit 3-hard bound copies after the corrections, if any, suggested by the panel of examiners along with program exit survey in prescribed format. The evaluation of the term work shall be based on continuous assessment of the student and final submission.

Paper Publications:

A proof of publication or uploading paper to SCI, Web of Science, Scopus, Indian Citation Index journal or filling patent is mandatory requirement for submission of dissertation. However, if the dissertation work is in collaboration with industry/organization/research agency, the uploading of paper/filling a patent shall not be mandatory but desirable.

Pre submission presentation:

There shall be a pre submission presentation before a panel of experts/faculty consisting of guide and faculty/experts and PG students of the concerned class.

Viva Voce Examination:

Students should prepare a power point presentation and present it before the panel of examiners consisting of guide and the external examiner appointed by the Controller of Examination. The candidate should be able to defend his work in front of the panel of examiners and peers. The panel of examiners will assess the dissertation contents and presentation and assigns the marks out of 150.