SGT University Gurgaon

Credit Based Scheme w.e.f. 2020-2021

Curriculum
(Scheme of Examination)
&
Syllabus for

M.Tech
Water Resource Engineering

Batch 2020 onwards

Scheme of Examination for M.Tech–Water Resource Engineering Program

SEMESTER WISE COURSE STRUCTURE

First Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1	13160114	Advanced Fluid Mechanics	3	0	0	3	60	40	100
2	13160115	Surface Water Hydrology and Hydrologic Systems	3	0	0	3	60	40	100
3	13160116	Flow and Transport in Porous Media	3	0	0	3	60	40	100
4	13160103	Research Methodology and IPR	3	0	0	3	60	40	100
5	13160117	Flow and Transport in Porous Media Laboratory	0	0	2	1	40	60	100
6	13160105	Research Methodology and IPR Lab	0	0	2	1	40	60	100
7	13160106	Seminar	0	0	2	1	0	100	100
		Total	**12**	**0**	**6**	**15**	**320**	**380**	**700**

Second Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1	13160217	Water Resources systems analysis and design	3	0	0	3	60	40	100
2	13160218	Remote sensing applications in water resources engineering	3	0	0	3	60	40	100
3	13160219	Computational Hydraulics and Hydrology	3	0	0	3	60	40	100
4		Elective I	3	0	0	3	60	40	100
5	13160220	Computational Hydraulics and Hydrology Laboratory	0	0	2	1	40	60	100
6	13160221	Water Resources Systems Design Lab	0	0	2	1	40	60	100
7	13160206	Seminar	0	0	2	1	0	100	100
		Total	**12**	0	**6**	**15**	**320**	**380**	**700**

Scheme of Examination for M.Tech– Water Resource Engineering Program

SEMESTER WISE COURSE STRUCTURE

Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1	13160313	Water Quality Modelling and Management	3	0	0	3	60	40	100
2	13160314	Geographical Information Systems and its Applications in Hydrology	3	0	0	3	60	40	100
3		Elective – II	3	0	0	3	60	40	100
4		Elective – III	3	0	0	3	60	40	100
5	13160315	QGIS and SAGA GIS Laboratory	0	0	4	2	40	60	100
6	13160305	Identification of Research Problem	0	0	2	-	-	-	
		Total	**12**	**0**	**6**	**14**	**280**	**220**	**500**

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Ext.	Int.	
1	13160401	Dissertation	0	0	36	18	100	-	100
		Total	**0**	**0**	**36**	**18**	**100**	**-**	**100**

List of Program Electives

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
Elective-I									
1	13160243	Statistical Methods in Hydrology	3	0	0	3	40	60	100
2	13160244	Hydraulic Modelling	3	0	0	3	40	60	100
3	13160245	Finite Element Method in Hydro Engineering	3	0	0	3	40	60	100
4	13160246	Applied Hydraulic Modelling	3	0	0	3	40	60	100
Elective-II									
1	13160247	Hydrogeology and Groundwater Development	3	0	0	3	40	60	100
2	13160248	Environmental Impact Assessment of Water	3	0	0	3	40	60	100
3	13160249	IT Applications in Water Resources Engineering And Management	3	0	0	3	40	60	100
Elective-III									
1	13160337	Hydropower	3	0	0	3	40	60	100
2	13160338	Watershed Management	3	0	0	3	40	60	100
3	13160339	Environmental Hydraulics	3	0	0	3	40	60	100
4	13160340	Urban Hydrology and Drainage	3	0	0	3	40	60	100

Semester I

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Advanced Fluid Mechanics**	**L**	**T**		**P**	
3. Course Code	13160114	3	0		0	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	Fluid Mechanics	**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 32		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. The course provides the elements to understand the basic tools for the analysis and solution of different types of flows, from the ideal to the viscous flow, contrasting the numerical results with the experiments. The students will be able to understand and assimilate the foundations of fluid mechanics.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Formulate momentum, energy and mass transport models, Analyze Potential Flows, Develop approximate solutions for small and large Reynolds number flows, Apply turbulent flow models, Boundary layer formation and stress acts at the boundary

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**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.

Unit - 2	**Number of lectures = 8**	**STRESSES IN FLUIDS AND RATE OF STRAIN**

Stresses at a point fluids. Stress Tensior-Normal and shear stresses, Nature of strains. Relations between stresses and rates of strains-Stokes law of viscosity. Viscous Contribution to normal stresses.

Unit - 3	**Number of lectures = 8**	**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.

Unit - 4	**Number of lectures = 8**	**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.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

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

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Surface Water hydrology and hydrologic systems**	**L**	**T**		**P**	
3. Course Code	13160115	3	0		0	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 32		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: 1. To address the computational emphasis of advanced hydrology at a post-graduate level, and to provide a balanced approach to important applications in hydrologic engineering and science						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
1. To address the computational emphasis of advanced hydrology at a post-graduate level, and to provide a balanced approach to important applications in hydrologic engineering and science						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**	**Title of the unit:HYDROLOGIC PRINCIPALS**				
Hydrologic cycles and weather, weather, hydrologic losses. Philosophy of mathematical models of watershed hydrology						
Unit - 2	**Number of lectures = 8**	**Title of the unit: HYDROLOGIC ANALYSIS**				
Watershed concepts, rainfall-runoff, hydrograph analysis, unit hydrograph theory, linear and kinematic wave model, overland flow models						
Unit - 3	**Number of lectures = 8**	**Title of the unit: ROUTING**				
Lumped flow, distributed flow, dynamic wave routing, Muskingum method, Saint-Venant Equation-Reynolds transport theorem, continuity equation, momentum equation, energy equation.						

Unit - 4	Number of lectures = 8	Title of the unit: HYDROLOGIC STATISTICS
Statistical parameter estimation, probability distribution, goodness of fit, concepts of probability weighted moments and L-moments, frequency analysis, Markov chain, reliability analysis.		

11. Brief Description of self learning / E-learning component

Quiz/Assignment/ Seminar/Written Examination. The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Bras, R. L., and Rodriguez-Iturbe, 1994, "Random Functions and Hydrology", Dover Publications, New York.
2. Chow, V. T., D. R. Maidment, and L. W. Mays; "Applied Hydrology", McGraw Hill International Editions.
3. Haan, C. T., 2002, "Statistical Methods in Hydrology", 2nd ed., Blackwell Publishing, Ames, IA.
4. Hoskings, J. R. M. and J. R. Wallis, 1997, "Regional Frequency Analysis, An Approach Based on L-Moments", Cambridge University Press, New York.
5. Viessman Jr., W., and G. L. Lewis, "Introduction to Hydrology", 4th ed., Harper-Collins, New York, 1996

1. Name of the Department: Civil Engineering Department						
2. Course Name	**FLOW AND TRANSPORT IN POROUS MEDIA**	**L**	**T**		**P**	
3. Course Code	13160116	3	0		0	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 32		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. To study the basic principles of flow.
2. To study the different mapping techniques.
3. To control the seepage and to analyze the seepage with various theories and techniques.
4. To impart the knowledge of various de-watering methods and drainage methods for stability of slope.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Students should be able to analyze the seepage with various theories and techniques.
2. Students should be able to utilize basic principles of flow.
3. Students should be able to use different mapping techniques.
4. Students should be able to perform analysis of the seepage by application of seepage theories

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit:Basic Principles:**

Darcy's Law, Permeability and its field determination, equation of continuity, velocity potential, stream function Laplace's equation. Solution of Laplace's Equation: Solution by graphical method, flow nets in homogeneous soils, anisotropic soils and layered soils, computation of seepage quantity, seepage pressure, uplift pressure on structures, exit gradient, piping due to subsurface erosion and heave. Two and three dimensioned electrical analogy method, relaxation method.

Unit - 2	**Number of lectures = 8**	**Title of the unit: Seepage through Earth Dams**

Determination of phreatic line, Dupuit's solution, Casagrande's solution, Kozeney parabola, entrance and exit corrections, flow nets for zoned earth dams and earth dams on pervious foundations under steady seepage conditions, flow nets for homogeneous sections under sudden drawn down, introduction to control of seepage, filters -type, selection and design.

Unit - 3	Number of lectures = 8	Title of the unit:Solution by Mapping Techniques:
Conformal mapping of elementary function, Kozeney's basic parabola, Schwarez-Christoffel transformation, Khosla's solution, Velocity hydrograph, flow characteristics at singular points, examples of velocity hydrograph, solution by complex velocity, solution of triangular dam.		
Unit - 4	**Number of lectures = 8**	**Title of the unit:Seepage in Foundations:**
Construction dewatering-Methods of dewatering, Design of dewatering for foundation excavations, foundation improvement by drainage, drainage in retaining structures, influence of seepage on stability of slopes, drainage methods for stability of slopes.		
11. Brief Description of self learning / E-learning component Quiz/Assignment/ Seminar/Written Examination. The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended		
1. Harr, M.E. " Ground Water & Seepage" 2. Cedergren "Seepage, Drainage & Flownets"		

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Flow and Transport in Porous Media Laboratory**	**L**	**T**		**P**	
3. Course Code	13160117	0	0		2	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✔)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			
8. Experiments						
1. To study the basic principles of flow. 2. To study the different mapping techniques. 3. To control the seepage and to analyze the seepage with various theories and techniques. 4. To impart the knowledge of various de-watering methods and drainage methods for stability of slope						
9. Brief Description of self-learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.						

1. Name of the Department		CIVIL ENGINEERING				
2. Course Name	Seminar	L	T		P	
3. Course Code	13160106	0	0		2	
4. Type of Course		✓ Core ()	PE()		OE()	
5. Pre-requisite (if any)	Nil	**Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical						
Lectures = 0		Tutorials = 00	Practical = 28			

7. Brief Syllabus:

Depending upon their area of interest, students will choose any topic.

8. Learning objectives:

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analyze the various topologies for the selected topic of interest.
4. To conclude the advantages, drawbacks and future scopes of the technique.

9. Course Outcomes:

On completion of this course, the students will be able to

1. Get familiarity with the recently advanced techniques.
2. Get detailed information about the topic of interest.
3. Know how to do literature survey.
4. Develop the interest in different research areas of Structures.

10. Unit wise detailed content

Unit	Number of lectures =28	Title of the unit: Seminar

To make literature survey for various recently emerging technologies.To selects any topic of interest and to review the related literature in detail. To compare and analyze the various topologies for the selected topic of interest. To conclude the advantages, drawbacks and future scopes of the technique.

11. Brief Description of self learning / E-learning component:

i. https://www.sciencedirect.com/
ii. https://www.elsevier.com/en-in

12. Books Recommended

i. https://onlinecourses.nptel.ac.in/noc16_ge01/preview
ii. https://www.che.iitb.ac.in/online/resources/academic-resources/technical-guides-and-

tools/report-writing/guidelines-presentation-seminar

1. Name of the Department		CIVIL ENGINEERING				
2. Course Name	Research Methodology and IPR	L	T		P	
3. Course Code	13160103	3	0		0	
4. Type of Course (use tick mark)		Core (√)	PE-()		OE()	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = **32**		Tutorials = 00	Practical = 10			

8.Brief Syllabus:

The aim of the course is to make students understand the importance of Research Paper Writing. Also, it covers all the concepts which involved in writing the Research Paper.

9Learning objectives:

The objectives of the course are:

1. The students are able to recognize the steps involved in doing research work.
2. The students will be able to collect data using various media and using the best possible sample available.
3. The students would learn to propose their Hypothesis and build models for the problem.
4. The students would be able to correctly document their findings in the form of a report.

10.Course Outcomes:

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

1. Recognize the various steps involved in research.
2. Collect datca from samples, Examine and Analyze the data.
3. Develop models for problems.
4. Explain the entire process in the form of a report.

11.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction

Research - Types, Research process and steps, Hypothesis, Research Proposal and aspects.

Research Design- Need, Problem Definition, Variables, Research Design concepts, Literature survey and review, Research design process, Errors in research. Research Modeling- Types of models, model

building and stages, Data consideration.		
Unit - 2	Number of lectures = 08	Title of the unit: Sampling
Sampling and data collection- Techniques of sampling, Random, Stratified, Systematic, Multistage-sampling, Primary and secondary sources of data. Design of questionnaire.		
Unit - 3	Number of lectures = 08	Title of the unit: Data Collection and Experiments
Design of Experiments- Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles-replication, randomization, blocking, guidelines for design of experiments.		
Unit - 4	Number of lectures = 08	Title of the unit: Models and Hypothesis & Report writing
Single factor experiment- Hypothesis testing, analysis of Variance component (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effect model, estimation of variance components, Model adequacy checking. Structure and components of Scientific Reports, Types of Report, Technical Reports and Thesis; Different steps in the preparation – Layout, structure and Language of typical reports; Illustrations and tables, Bibliography, Referencing and foot notes.		
12.Brief Description of self learning / E-learning component https://research-methodology.net/research-methodology/ https://gradcoach.com/what-is-research-methodology/		
13.Books Recommended **Text Book:** 1. Research Methodology – Methods and Techniques – C.R. Kothari, New Age International, New Delhi, 2004. **Reference Book:** 1. Design and Analysis of Experiments – Douglas C. Montgomery, Wiley India, 8th Edition, 2012. 2. Practical Research: Planning Design – Paul D. Leddy, London, 1980.		

1. Name of the Department		**CIVIL ENGINEERING**				
2. Subject Name	**Research Methodology and IPR Lab**	**L**	**T**		**P**	
3. Subject Code	13160105	0	0		2	
4. Type of Subject		**Core (√)**	**PE()**		**OE()**	
5. Pre-requisite (if any)	**Research Methodology and IPR**	**Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
6. Total Number of Lectures, Tutorials, Practical, Assuming 14 weeks in semester						
Lectures = 00		**Tutorials = 00**	**Practical =28**			

1. Learning objectives:

The objectives of the course are:

2. The students are able to recognize the steps involved in Identifying research problem.
3. The students will be able to collect data using various media and using the best possible sample available.
4. The students would learn to propose their Hypothesis and build models for the problem.
5. The students would be able to correctly document their findings in the form of a report.

Outcomes:

On completion of this course, the students will be able to

1. Choose the topic for writing research paper.
2. Develop models for problems.
3. The students would learn to write the research paper.

7. Lab Content

Sr. No.	Title	CO covered
1	How to choose topic for research	1,2
2	How to collect data for the particular research problem	1,2
3	Writing Abstract	1,2
4	Writing Literature review	1,2
5	Explaining and writing methodology	1,2
6	How to analyze the data collected	1,2
7	Presentation of analysis and findings	1,2
8	How to write result and conclusion	2,3
9	References in research article	2,3

Semester II

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Water resources system analysis and design**	**L**	**T**		**P**	
3. Course Code	13160217	3	0		0	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem (✔)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. Students should be able to apply concepts of systems analysis for planning of water resources systems and minor levels
2. Students can perform basic economic analysis between alternate water resources projects and to evaluate the economic feasibility of water resources engineering projects

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Students must in position to formulate and solve deterministic optimization models for design and operation of water resources systems
2. To develop analytical skills to formulate and solve stochastic problems for decision making under uncertainty

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit:INTRODUCTION**

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

Unit - 2	**Number of lectures = 8**	**Title of the unit: PLANNING FOR WATER RESOUCES 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

Unit - 3	**Number of lectures = 8**	**Title of the unit: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.		
Unit - 4	**Number of lectures = 8**	**Title of the unit:FINANACIAL ANALYSIS:**
Role of financial analysis. Distinctions from economic analysis. Financial feasibility, Separable and non-separable costs. Cost allocation, allocation consequences. Water resources pricing.		

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. 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.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Remote sensing applications in water resources engineering**	**L**	**T**		**P**	
3. Course Code	13160218	3	0		0	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem (✔)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. The techniques of Remote Sensing and Geographic Information System (GIS)

2. Different types of remotely sensed images

3. Application of Remote Sensing in water resources engineering

4. Application of GIS in water resources engineering

9. Course Outcomes (COs):

At the end of the course, the student will be able to

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

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	

Principles of remote sensing, Remote sensing platforms and data acquisition systems, Wavebands, Radiometric quantities, Spectral reflectance and spectral signature. Interaction of electromagnetic radiation with land surface features, hydrosphere and atmosphere, Data capture for simulation of land surface processes

Unit - 2	Number of lectures = 8	
Photographic and image interpretation, Satellite image processing, Earth surface features inventory, Geomorphology, Land use classification, Land use planning and landcover mapping, Flood plain mapping and flood plain zoning.		
Unit - 3	**Number of lectures = 8**	
Remote sensing applications in water resources, agriculture, geology and environmental monitoring, Applications in snow and glacier studies, Snow line, Ice cover, Snow-pack properties, Integrated use of remote sensing and GIS, Database preparation and Decision support analysis		
Unit - 4	**Number of lectures = 8**	
Estimation of damages due to hydrologic extremes and preparation of contingency plans, Case studies.		

11. Brief Description of self-learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

(1) Lillesand, T., Kiefer, R. W., Chipman, J., Remote Sensing and Image Interpretation, 6th Ed., Wiley, 2007.

(2) Curran, P.J., Principles of Remote Sensing, ELBS, 1988

(3) Rees, W.G., Physical Principles of Remote Sensing, 2nd Edition, Cambridge University Press, 2001

(4) Keshari, A.K., Satellite Remote Sensing, Ane Books, 2015

(5) Keshari, A.K. and Singh, R.P., Use of microwave radiometry for monitoring the alpine environment. Snow, Hydrology and Forests in High Alpine Areas, IAHS Publ. No. 205, 81-89, International Association of Hydrological Sciences, 1991.

(6) Ambast, S.K., Keshari, A.K. and Gosain, A.K., An operational model for estimating regional evapotranspiration through surface energy partitioning (RESEP). International Journal of Remote Sensing, 23(22): 4917-4930, 2002

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Computational Hydraulics and Hydrology**	**L**	**T**		**P**	
3. Course Code	13160219	3	0		0	
4. Type of Course (use tick mark)		**Core (✔)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✔)	Odd ()	Either Sem (✔)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: The purpose of this course is to obtain knowledge on various soft computing techniques widely used in water resources engineering.						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
To forecast the complex systems in water resources engineering using soft computing techniques.						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**					
Introduction, need for soft computing techniques, components of soft computing. Artificial Neural Networks (ANN), types of ANN and learning algorithms, tasks performed by ANN.						
Unit - 2	**Number of lectures = 8**					
Basic concepts of feed forward neural networks, perception learning rule, back propagation learning algorithm, application of feed forward ANN for function approximation and prediction. Hebbian learning and hopified networks , pattern association, radial basis function networks, Kohonen networks and self-organization maps, applications of ANN in pattern classification						
Unit - 3	**Number of lectures = 8**					
Information and uncertainty, chance versus ambiguity, classical sets and fuzzy sets, logic and reasoning. Fuzzy set operations and fuzzy relations, Membership Functions, fuzzy numbers and fuzzy arithmetic. Fuzzy Systems, fuzzy relations, fuzzy interface systems, Decision making with fuzzy information, Fuzzy classification and pattern recognition, Neuro-Fuzzy Systems.						
Unit - 4	**Number of lectures = 8**					

Evolutionary computing , concepts of genetic algorithm, components of genetic algorithm, Hybrid soft computing techniques, Applications in Hydrology and Water Resources Engineering.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Neural Networks, A Comprehensive Foundation- Haykin, Prentice Hall India.
2. Neuro-Fuzzy and Soft Computing, A Computational Approach to learning-Jang, J.R., Sun Chuen-tsaiand MizutaniEiji, Prentice Hall.

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Computational Hydraulics and Hydrology Laboratory**	**L**	**T**		**P**	
3. Course Code	13160220	0	0		2	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Content

1. Kohonen networks and self-organization maps, applications of ANN in pattern classification.
2. Fuzzy Systems, fuzzy relations, fuzzy interface systems, Decision making with fuzzy information, Fuzzy classification and pattern recognition, Neuro-Fuzzy Systems.
3. Applications in Hydrology and Water Resources Engineering.

9. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

10. Books Recommended

4. Neural Networks, A Comprehensive Foundation- Haykin, Prentice Hall India.
5. Neuro-Fuzzy and Soft Computing, A Computational Approach to learning-Jang, J.R., Sun Chuen-tsaiand MizutaniEiji, Prentice Hall.

1. Name of the Department: Civil Engineering Department						
2. Course Name	Water Resources Systems Design Lab	**L**	**T**		**P**	
3. Course Code	13160221	0	0		2	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Content

1. Using software and analyzing open channel flow over different paths condition.
2. Design of flow system by software like HEC-RAS Systems.
3. Applications in Hydrology and Water Resources Engineering.

9. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

10. Books Recommended

1. HEC-RAS Manual.
2. E-Learning courses by different portal.

<table>
<tr><td colspan="8">1. Name of the Department: Civil Engineering Department</td></tr>
<tr><td colspan="2">2. Course Name</td><td>Seminar</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE()</td><td colspan="2">OE()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="8">8. Learning objectives:
1. To make presentation on any of various topics of last semester course.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analyze the various topologies for the selected topic of interest.
4. To conclude the advantages, drawbacks and future scopes of the technique.</td></tr>
<tr><td colspan="8">9. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">At the end of the course, the student will be able to</td></tr>
<tr><td colspan="8">1. Get familiarity with the recently advanced techniques.</td></tr>
<tr><td colspan="8">2. Get detailed information about the topic of interest.</td></tr>
</table>

Semester III

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Water Quality Modelling and Management**	**L**	**T**		**P**	
3. Course Code	13160313	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: *1.* Meaning of important parameters for measuring water quality, water quality criteria and standards, and their relation to public health, environment and urban water cycle. *2.* Water quality tests and to determine how the parameters relate to each other						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
1. Principles and the practical approaches and techniques required to effectively monitor the chemical, hydrological, microbiological and aquatic elements of water quality. 2. Water quality tests and to determine how the parameters relate to each other.						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**					
Introduction: Quality parameter and classification of natural water, Physico-Chemical and biological water quality classification of aquatic systems. Sources of pollution: characteristics of point and non-point sources of pollution						
Unit - 2	**Number of lectures = 8**					
Eutrophication in natural water bodies: causes processes and control Toxic wastes: Sources, transportation and management strategies						
Unit - 3	**Number of lectures = 8**					
Thermal pollution: causes, model and control. Acid rains: Occurrences, impacts and strategies for control						
Unit - 4	**Number of lectures = 8**					

Water quality monitoring: Objectives, requirements, planning and various techniques. Case studies related to water quality monitoring under various river actions plans including Ganga and Yamuna Action plans

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Reckhow and Chapra (1983) Engineering Approaches for Lake Management, Vol. 1, Butterworth, Boston.
2. Thomson and Mueller (1987) Principles of Surface Water Quality Modelling and Control, Harper and Row, NY.
3. Tchobanoglous and Schroeder (1987) Water Quality: characteristics, Modelling and modification, Addition – Wesley Pub. Co., US
4. APHA (1998) Standard Methods for Examination of Water and Wastewater, 20th Edition, Washington, D.C
5. Velz, C.J.(1970) Applied Stream Sanitation, Wiley Interscience, NY

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Geographical Information Systems and its Applications in Hydrology**	**L**	**T**		**P**	
3. Course Code	13160314	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. Conduct hydrologically related calculations using map algebra on raster grids;

2. Build a geometric network for streams and rivers;

3. Analyze a digital elevation model of land surface terrain to derive watersheds and stream networks;

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Principles of Satellite-based Remote Sensing
2. Derivation of surface reflectance, and biophysical variables including vegetation indices
3. Landuse Maps, and surface temperature maps.

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	

Course Overview. Introduction to GIS in Water Resources. Introduction to ArcGIS software, Geodesy, Map projections, Reprojection, and Coordinate systems

Unit - 2	**Number of lectures = 8**	

Data sources for GIS in water resources, Building a Base Map, Spatial analysis using grids Spatial analysis (Model Builder geoprocessing capability to program a sequence of ArcGIS functions/Raster Calculator to calculate watershed attributes/Spatial Interpolation)

Unit - 3	**Number of lectures = 8**	

The Concept of Reference Evapotranspiration/ASCE-Standardized Reference Evapotranspiration Equation, Weather data and Quality Assessment and Control of Automated Weather Data		
Unit - 4	**Number of lectures = 8**	
Watershed and Stream Network Delineation, Remote Sensing: Principles of Electromagnetic Radiation/ Spectral Characteristics of Vegetation & Water bodies/Creating Color Composites from individual bands Working with Landsat Imagery, NLCD, and DEM, Estimation of Evapotranspiration from Landsat NDVI. Evapotranspiration- Energy Balance Algorithms/EEFLUX (Earth Engine Flux)		
11. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended (2 Books+ 4 References)		
(1) Lillesand, T., Kiefer, R. W., Chipman, J., Remote Sensing and Image Interpretation, 6th Ed., Wiley, 2007. (2) Curran, P.J., Principles of Remote Sensing, ELBS, 1988 (3) Rees, W.G., Physical Principles of Remote Sensing, 2nd Edition, Cambridge University Press, 2001 (4) Keshari, A.K., Satellite Remote Sensing, Ane Books, 2015 (5) Keshari, A.K. and Singh, R.P., Use of microwave radiometry for monitoring the alpine environment. Snow, Hydrology and Forests in High Alpine Areas, IAHS Publ. No. 205, 81-89, International Association of Hydrological Sciences, 1991. (6) Ambast, S.K., Keshari, A.K. and Gosain, A.K., An operational model for estimating regional evapotranspiration through surface energy partitioning (RESEP). International Journal of Remote Sensing, 23(22): 4917-4930, 2002		

1. Name of the Department: Civil Engineering Department						
2. Course Name	QGIS and SAGA GIS Laboratory	**L**	**T**		**P**	
3. Course Code	13160315	0	0		4	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Content

1. QGIS is the most popular GIS tool with an impressive trajectory and a vibrant community. It also even has a particular ecosystem of complements called “plugins”.

2. SAGA GIS is a GIS platform oriented to spatial analysis. SAGA GIS is a simple but powerful tool, with a big library focused on spatial analysis and characterization of basins. The interpolation options in SAGA GIS are better implemented than in other free and commercial software.

9. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

10. Books/courses Recommended

1. Manuals available at http://www.saga-gis.org/ and http://www.qgis.org/
2. QGIS and SAGA GIS are completely open source alternative that reduces the cost barriers since it does not need a paid license and can be executed in any operative system.

<table>
<tr><td colspan="8">1 Name of the Department CIVIL ENGINEERING</td></tr>
<tr><td>2 Subject Name</td><td colspan="2">Identification of Research Problem</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>3 Subject Code</td><td colspan="2">13160305</td><td colspan="2">0</td><td colspan="2">0</td><td>4</td></tr>
<tr><td colspan="2">4Type of Subject (use tick mark)</td><td colspan="2">Core (√)</td><td colspan="2"></td><td>OE()</td></tr>
<tr><td>5Pre-requisite (if any)</td><td>Nil</td><td colspan="2">1. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">6Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="2">Lectures = 00</td><td colspan="2">Tutorials =00</td><td colspan="4">Practical =48</td></tr>
<tr><td colspan="8">Detailed Syllabus: Students are required to search, collect and review various research articles published in chosen area of research and identifying research Problems. A student must analyze research related problems, based on Water resource engineering research area.</td></tr>
<tr><td colspan="8">8 Course Outcomes:
1. Identify topics in thrust areas of Water resource engineering.
2. Take up critical review of literature on the chosen topic.
3. Carry out independent research work on the topic by experimental / analytical approaches.
4. Document and present the results of research problems</td></tr>
</table>

Semester IV

1. Name of the Department: Civil Engineering						
2. Course Name	Dissertation	L 0	T 0		P 18	
3. Course Code	13160401					
4. Type of Course (use tick mark)		Core (√)	PE()		OE()	
5. Pre-requisite (if any)	Nil	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		Tutorials = 00	Practical = 00			

8. Brief Syllabus

Depending upon their area of interest, students will choose any topic.

9. Learning objectives:

It will provide a strong fundamental scientific and technical knowledge related to topics of Civil Engineering. They will get the concept of theories and methodologies needed to plan, design, analyse, develop, organise and manage Civil Engineering topics / fields.They will get the expertise in the major areas of Civil Engineering, structural analysis, design and reliability, transportation system engineering, water resources and environmental engineering etc. with the knowledge of their projects and presentation. It will inculcate a deep understanding of engineering principles. It will also develop the capacity for independent studies and thinking.

10. Course Outcomes (COs):

Students will possess the ability to apply the basic mathematical and scientific concepts that underlie the modern field of Civil Engineering. They will be able to design, analyse and interpret experimental data. They will be capable of designing major Civil Engineering projects. They will possess the problem solving abilities and familiarity with the computational procedures essential to the field. They will have the skills and motivations for their professional growth. They will get the indepth of knowledge of their selected topic or subjects of their project. The presentation of their project will enhance communication skills and confidence about their knowledge in that subject topic. They will have the strong fundamental scientific and technical knowledge.

11. Course content

Depending upon their area of interest, students will choose any topic.

12. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT ELearning portal and choose the

relevant lectures delivered by subject experts of SGT University.
The link to the E-Learning portal:
https://elearning.sgtuniversity.ac.in/course-category/general/

13. Books Recommended

TEXT BOOKS

Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal.

REFERENCE BOOKS

Depending upon their area of interest, students may choose any reference book of relevant field

Program Electives

1. Name of the Department: Civil Engineering Department						
2. Course Name	**HYDROGEOLOGY AND GROUNDWATER DEVELOPEMENT**	**L**	**T**		**P**	
3. Course Code	13160247	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

- To create a simple conceptual model of an area's hydrogeology that can be used to guide a site investigation or engineering design project.
- To compare methods for solving groundwater flow equations under a variety of situations, selecting the most appropriate modeling techniques based on an engineering project's goals and evaluating how their weaknesses may impact the final conclusions.
- To develop a preliminary consulting report for a groundwater development or remediation project.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Model regional groundwater flow and design water wells
2. Formulate and solve conjunctive use of surface water and groundwater resource utilization problems
3. Identify sites for artificial recharge of groundwater and determine the consequences of artificial recharge.
4. Conduct Geophysical exploration studies for groundwater source identification.

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit: OCCURRENCE AND MOVEMENT 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. 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.

Unit - 2	**Number of lectures = 8**	**Title of the unit: HYDRAULICS OF WATER WELLS:**

Flow in confined aquifers towards wells in steady and unsteady state. Flow through leaky or semi confined aquifers 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.

Unit - 3	**Number of lectures = 8**	**Title of the unit: 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..

Unit - 4	**Number of lectures = 8**	**Title of the unit: SURFACE AND SUBSURFACE INVENSTIGATIONS OF GROUNDWATER:**

SURFACE:- Geological methods, remote sensing, Geophysical exploration, electrical Resistivity method, Seismic Refraction method, Gravity and magnetic methods, Water Witching.
SUBSURFACE:- 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.

11. Brief Description of self learning / E-learning component

Quiz/Assignment/ Seminar/Written Examination , The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 2 References)

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

1. Name of the Department: Civil Engineering Department						
2. Course Name	**HYDRAULIC MODELLING**	**L**	**T**		**P**	
3. Course Code	13160244	2	0		4	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 40	**Tutorials = 0**	**Practical = 0**

8. Learning objectives:

1. To able the students to model the domain.
2. To impart the knowledge of establishing the relationship between the model and the constraints.
3. To impart the knowledge to model the dynamic structures.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Students are able to model the domain.
2. Students are able to establish the relationship between the model and the constraints.
3. Students are able to model the dynamic structures

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit:MODELLING PROCESS AND PRIMITIVE MODELS:**

Taxonomy of model types, Steps in model building; Simulation, Algorithms and Heuristics, Simulation languages. Establishing relationships via physical laws, Establishing relationships via curve fitting, Parameter estimation problems, Elementary state transition models.

Unit - 2	**Number of lectures = 8**	**Title of the unit: FORE CASTING AND PATTERN RECOGNITION:**

Nature of data, Statistical attributes of data, Probability distributions and their mechanisms, Generation of random numbers, Time series. Neighborhood and distances, Cluster analysis, Individual and group preference patterns

Unit - 3	**Number of lectures = 8**	**Title of the unit: STATIC EQULLIBRIUM MODELS AND LINEAR DYNAMICAL STRUCTURE:**

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

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

Unit - 4	Number of lectures = 8	Title of the unit:GROWTH AND DECAY PROCESSES
Discrete and continuous growths, Limits to growth, Competition among species, Growth process and integral equations, Discrete event approach, Population planning.		
11. Brief Description of self learning / E-learning component Quiz/Assignment/ Seminar/Written Examination. The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended		
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		

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Finite Element Method in Hydro Engineering**	**L**	**T**		**P**	
3. Course Code	13160245	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. Learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations.

2. To understand importance of finite element analysis in civil engineering

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Learn how to implement the finite element method efficiently in order to solve a particular equation.
2. Application of methodologies to a wide range of engineering problems and connection with the laws of continua.

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	

Introduction: Brief history of the development, general description of the method, advantages and disadvantages of finite element method, displacement approach, Basic Principles of Structural Mechanics: Equilibrium conditions, strain displacement relations, linear constitutive relations, Principle of virtual work, energy principle, application to finite element method

Unit - 2	**Number of lectures = 8**	

Element Properties: Displacement models, relation between the modal degrees of freedom and generalized coordinates, convergance requirements, natural coordinate systems, shape functions (interpolation functions), element strains and stresses, element stiffness matrix, equivalent nodal loads and static condensation

Unit - 3	**Number of lectures = 8**	

lsoparametric Elements: Two and three dimensional isoparametric elements, evaluation of stiffness matrix using numerical integration techniques, convergence criteria Analysis of Framed Structures: Two and three dimensional truss elements, two and three dimensional beam elements, shear deformation in beams and beams on elastic foundation

Unit - 4	**Number of lectures = 8**	

lsoparametric Elements: Two and three dimensional isoparametric elements, evaluation of stiffness matrix using numerical integration techniques, convergence criteria Analysis of Framed Structures: Two and three dimensional truss elements, two and three dimensional beam elements, shear deformation in beams and beams on elastic foundation

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended

1. Applied Numerical Methods for Engineers by Akai
2. Statistical Methods in Hydrology by Haan
3. Computational Methods in Subsurface Flow by Huyorkon, Pinder
4. Numerical Recipes – The Art of Scientific Computing by Press, Flannery, Tenklsky, Vetterling

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Applied Hydraulic Modelling**	**L**	**T**		**P**	
3. Course Code	13160246	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. To make the students to know various hydraulic engineering problems like open channel flows and hydraulic machines.
2. To understand the concepts and the students should be able to relate theory and practice of problems in hydraulic engineering.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

2. The students will be able to apply their knowledge of fluid mechanics in addressing problems in open channels.
3. They will possess the skills to solve problems in uniform, gradually and rapidly varied flows in steady state conditions.
4. They will have knowledge in hydraulic machineries (pumps and turbines).

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	

Dynamic equations of gradually varied and spatially varied flows - Water surface flow profile classifications: Hydraulic Slope, Hydraulic Curve - Profile determination by Numerical method: Direct step method and Standard step method, Graphical method - Applications.

Unit - 2	**Number of lectures = 8**	

Application of the energy equation for RVF - Critical depth and velocity - Critical, Sub-critical and Supercritical flow - Application of the momentum equation for RVF - Hydraulic jumps - Types - Energy dissipation - Surges and surge through channel transitions.

Unit - 3	**Number of lectures = 8**	

Impact of Jet on vanes - Turbines - Classification - Reaction turbines - Francis turbine, Radial flow turbines, draft tube and cavitation - Propeller and Kaplan turbines - Impulse turbine - Performance of turbine - Specific speed - Runaway speed - Similarity laws.

Unit - 4	Number of lectures = 8	
Centrifugal pumps - Minimum speed to start the pump - NPSH - Cavitation in pumps - Operating characteristics - Multistage pumps - Reciprocating pumps - Negative slip - Flow separation conditions - Air vessels, indicator diagrams and its variations - Savings in work done - Rotary pumps: Gear pump		

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended

1. Jain. A.K., "Fluid Mechanics", Khanna Publishers, Delhi, 2010.
2. Modi P.N. and Seth S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2002.
3. Subramanya K., "Flow in open channels", Tata McGraw Hill, New Delhi, 2000
5. . VenTe Chow, "Open Channel Hydraulics", McGraw Hill, New York, 2009.
6. Rajesh Srivastava, "Flow through open channels", Oxford University Press, New Delhi, 2008.
7. . Bansal, "Fluid Mechanics and Hydraulic Machines", Laxmi Publications, New Delhi, 2008.
8. Mays L. W., "Water Resources Engineering", John Wiley and Sons (WSE), New York, 2005

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Statistical Methods in Hydrology**	**L**	**T**		**P**	
3. Course Code	13160243	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: To make the student investigating the causes, consequences and possible solutions to problems associated with degradation of environmental resources and analyses the potential non-sustainability of certain types of economic activities using economic analysis as a tool.						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
1. Students would be able to apply finite difference and finite element method for analyzing behavior of geotechnical structures 2. Students would be able to solve linear and non-linear equations using numerical technique						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**					
Numerical Solution of Ordinary Differential Equations: Solution by Taylor's Series- Euler's Method – RungeKutta Methods – Simultaneous and Higher Order Equations- Boundary Value Problems – Applications						
Unit - 2	**Number of lectures = 8**					
Economic significance and causes of environmental degradation - The concepts of policy failure, externality and market failure - Economic analysis of environmental degradation – Equi. marginal principle.						
Unit - 3	**Number of lectures = 8**					
Economics of Pollution - Economics of optimal pollution, regulation, monitoring and enforcement - Managing pollution using existing markets: Bargaining solutions - Managing pollution through market intervention: Taxes, subsidies and permits.						

Unit - 4	**Number of lectures = 8**	
Probability Distribution: Discrete and Continuous probability Distribution Functions – Binomial, Poisson, Normal, Lognormal, Exponential, Gamma Distribution, Extreme Value Distribution - Transformations to Normal Distributions, Selecting a Probability Distribution, Parameter Estimation – Method of Moments, Method of Maximum Likelihood, Probability Weighted Moments and Least Square Method, Joint Probability Distributions. 6. Regression Analysis: Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypotheses – Multiple Linear Regression – Correlation and Regression Analysis		
11. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended		
1. Applied Numerical Methods for Engineers by Akai *2.* Statistical Methods in Hydrology by Haan *3.* Computational Methods in Subsurface Flow by Huyorkon, Pinder *4.* Numerical Recipes – The Art of Scientific Computing by Press, Flannery, Tenklsky, Vetterling		

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Environmental Impact Assessment of Water**	**L**	**T**		**P**	
3. Course Code	13160248	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives: *1.* To know the various types of environmental pollution *2.* To make aware the impact due to various types of pollutants and their assessment technique.						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
1. The students will gain basic knowledge of various pollution sources and their impacts						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**					
INTRODUCTION: Classification of Pollution and Pollutants, – Evolution of EIA (Global and Indian Scenario)- Elements of EIA — Screening – Scoping - Public Consultation - Environmental Clearance process in India - Key Elements in 2006 EIA(Govt. of India) Notification						
Unit - 2	**Number of lectures = 8**					
Standards for Water, Air and Noise Quality - Environmental Management Plan- EIA- Case studies of EIA , AIR POLLUTION: Primary and Secondary Types of Pollutants, sulfur dioxide- nitrogen dioxide, carbon monoxide, WATER POLLUTION: Point and Non-point Source of Pollution, Major Pollutants of Water, Impact of pollutants						
Unit - 3	**Number of lectures = 8**					
SOLID WASTE: Classification and sources of Solid Waste, Characteristics, effects, e waste, : Effects of urbanization on land degradation, pesticide pollution NOISE POLLUTION: Sources of Noise, Effects of Noise						
Unit - 4	**Number of lectures = 8**					

Impacts of pollutants, types, scale of impact-Global, local pollutants. Climate change, Ozone layer depletion, Deforestation, land degradation , Impact of development on vegetation and wild life.

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. A K Srivastava, Environment impact Assessment, APH Publishing, 2014 2.
2. John Glasson, Riki Therivel & S Andrew Chadwick "Introduction to EIA" University College London Press Limited, 2011
3. Larry W Canter, "Environmental Impact Assessment", McGraw Hill Inc. , New York, 1995.
4. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification
5. Rau G J and Wooten C.D "EIA Analysis Hand Book" Mc Graw Hill
6. Robert A Corbett "Standard Handbook of Environmental Engineering" McGraw Hill, 199

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Hydropower**	**L**	**T**		**P**	
3. Course Code	13160337	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. The objective of this course is to understand the concept of hydropower projects including investigation, planning and design aspects.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. To learn the elements of hydropower scheme.
2. To study the estimation of hydropower potential
3. To gain knowledge on water conveyance system by studying intake structures, power canals, surge tanks and penstocks.
4. To understand the force exerted by a jet on a fixed target, moving target, and by a jet on a series of curved vanes.
5. To gain knowledge on Francis turbine and Miscellaneous hydraulic machines

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	**Title of the unit:HYDROPOWER PLANT DEVELOPMENT**
Sources and forms of energy Hydropower plants classificationLayout and components, Development of hydropower schemesComparison of Hydro and Thermal power, Survey and Investigation		
Unit - 2	**Number of lectures = 8**	**Title of the unit: POWER POTENTIAL**
Estimation of Hydropower potential Flow duration curve, Firm power, Secondary power, Load and Load duration curves, Load factor, Firm capacityReservoir capacity, Capacity factor		
Unit - 3	**Number of lectures = 8**	**Title of the unit:WATER CONVEYANCE SYSTEM**
Intake structures: Location function and types of intakes, Energy losses at intake trash rock Power canals , Alignment, Design of power canals Penstocks, Alignment, types of penstock, Economic diameter of penstocks and Anchor blocks Water hammer pressure. Behavior of surge tanks, Types of surge tanks. Hydraulic design of simple surge tank.		

Unit - 4	Number of lectures = 8	Title of the unit:IMPACT OF JET ON VANES
Introduction to Impulse Momentum equation and its applications Force exerted by a Jet on a fixed, Force exerted by a Jet on a moving target, Force exerted by a Jet on a serious of curved vane		
11. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended (2 Books+ 4 References)		
1. Modi .P.N. and Seth .S.M, "Hydraulics and Fluid Mechanics", Standard Book House, 2005. 2. Rajput .R.K, "Fluid Mechanics and Hydraulic Machines", S.Chand and Company Ltd., 2013. 3. Bansal .R.K, "Fluid Mechanics and Hydraulic Machines", Laxmi Publications 2010 4. M.M.Dandekar and K.N.Sharma, "Water Power Engineering", Vikas ublications 1		

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Watershed Management**	**L**	**T**		**P**	
3. Course Code	13160338	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. Identify causes of soil erosion

2. Plan and design soil conservation measures in a watershed

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. Plan and design water harvesting and groundwater recharge structures
2. Plan measures for reclamation of saline soils

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	

Water and life, Management and conservation of water, Climate data, Soil erosion and sedimentation, Conservation of soil, System and conceptual models of runoff hydrograph, System models. Conceptual models of unit hydrograph, Conceptual models, Dynamic models.

Unit - 2	**Number of lectures = 8**	

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

Unit - 3	**Number of lectures = 8**	

Types of soil erosion wind erosion, Water erosion. Estimation of soil erosion, Soil loss models, Sediment yield models. Sediment graph, Bed-load models, Controlling soil erosion due to wind and water soil conservation practices, Vegetative and mechanical practices, Erosion control in torrents and gullies.

Unit - 4	**Number of lectures = 8**	

Storage structures. Yield from catchment, Diversion of runoff, Ponds and reservoirs, Earth embankments. Watershed programs. Mass soil movement, Afforestation, Streams. Management of saline and alkaline soils, Grassland management, Watershed water sources, Conservation of water, Augmentation of water resource, Methods of artificial recharge. Project Proposal and Report Writing

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended (2 Books+ 4 References)

1. Chow. V.T. Handbook of Applied Hydrology. Mc Graw-Hill, New York
2. Rattan Lal. Soil Erossion in the Tropics. Mc Graw-Hill New York.
3. Dutta. SK. Soil Conservation and Land Management, International Book Distributors, Dehradun. Blaisdell, F.W. and A.F. Moratz
4. Soil and Water Conservation- Erosion Control Structures. Agricultural Engg. Handbook. Mc Craw Hill. New York.
5. Whiny, V.V. N. Land and Water Management Engineering Kalyani Publishers, New Delhi
6. Glianshyant -Das. Hydrology and Soil Conservation Engineering. Prentice Hall of India. New Delhi

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Environmental Hydraulics**	**L**	**T**		**P**	
3. Course Code	13160339	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. Learning objectives:						
1. Solve a range of hydraulic problems, from sizing pipes, selecting pumps, measuring flow in the field, and calculating open channel hydraulic profiles						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to						
1. Think more intuitively (through laboratory experience) about hydraulic phenomena						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**					
Introduction. Outline of course and review of syllabus. Fluid definition and basic properties. Hydrostatics, Pascal's principle, pressure and application						
Unit - 2	**Number of lectures = 8**					
Hydrostatics (conclusion) Basic concepts of Energy and Head in Flow, Basic Applications of Energy, Head and Pressure						
Unit - 3	**Number of lectures = 8**					
Concepts, equations of energy degradation (head loss), Head loss, flow computations for single conduits, Introduction to network models, Open Channel Flow and Level Measurement						
Unit - 4	**Number of lectures = 8**					
Head Loss and Flow Measurement, Pipelines in Series and parallel, Calculations on simple systems, Introduction to network models, Treatment Plant Hydraulics Problem-solving and review						
11. Brief Description of self learning / E-learning component						
The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.						

12. Books Recommended (2 Books+ 4 References)

(1) Schaum's Outline of Fluid Mechanics and Hydraulics (3rd Edition) by R.V. Giles, J.B. Evett, and C.Liu (1994). McGraw-Hill, New York.

(2) Laboratory Work in Hydraulic Engineering, by G.L. Asawa (2006). New Age International Publishers, New Delhi

(3) Practical Hydraulics, A.L. Simon (1976). John Wiley & Sons, New York.

(4) Open Channel Flow, by F.M. Henderson, (1966). MacMillan, New York.

(5) Open-Channel Flow, by Subhash C. Jain, (2001), John Wiley & Sons, New York

1. Name of the Department: Civil Engineering Department						
2. Course Name	**IT Applications in Water Resources Engineering And Management**	**L**	**T**		**P**	
3. Course Code	13160249	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			
8. **Learning objectives:** Solve a range of hydraulic problems, from sizing pipes, selecting pumps, measuring flow in the field, and calculating open channel hydraulic profiles						
9. Course Outcomes (COs):						
At the end of the course, the student will be able to Think more intuitively (through laboratory experience) about hydraulic phenomena						
10. Unit wise detailed content						
Unit-1	**Number of lectures = 8**					
Numerical integration, Numerical Solution of Ordinary Differential equations, Runge-Kutta methods, Classification of Quasi-linear partial differential equations (PDE),						
Unit - 2	**Number of lectures = 8**					
Solution methods for parabolic, elliptical and hyperbolic equations, Finite difference, finite volume and finite element methods, applications of computational methods for open channel flow, pipe flow, flow through porous media and pollution transport						
Unit - 3	**Number of lectures = 8**					
Information and uncertainty, Chance versus ambiguity, Classical sets and fuzzy sets, Logic and reasoning, Fuzzy set operations and fuzzy relations, Membership Functions, Fuzzy Systems,						

Unit - 4	Number of lectures = 8	
Decision Making with Fuzzy Information. Fuzzy Classification and Pattern Recognition, Artificial Neural Networks (ANN), Types of ANN, Learning algorithms, Neuro-Fuzzy Systems, Applications in Civil Engineering.		

11. Brief Description of self learning / E-learning component

The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.

12. Books Recommended

1. Haykin (2008), "Neural Networks: A Comprehensive Foundation", Prentice Hall India, New Delhi

2. Rajasekaran S., and Vijayalakshmi Pai G.A. (2003), Nueral Neworks, Fuzzy Logic and Genetic Algorithms – Synthesis and Applications, Prentice-Hall India, New Delhi

3. Jang, J.R., Sun Chuen-tsai, and Mizutani Eiji, (2009), "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", PHI Learning

1. Name of the Department: Civil Engineering Department						
2. Course Name	**Urban Hydrology and Drainage**	**L**	**T**		**P**	
3. Course Code	13160340	3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem (✓)	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 40		**Tutorials = 0**	**Practical = 0**			

8. Learning objectives:

1. To learn urban water management practices and its effect on urban water infrastructure, hydrology and groundwater regime.

9. Course Outcomes (COs):

At the end of the course, the student will be able to

1. To understand urban water cycle and its role in the designs of urban water infrastructures water supply, storm water drainage, sanitation, sewerage and wastewater conveyance infrastructures and its rehabilitation and augmentation
2. To understand sustainability concepts and how to carry out sustainable urban designs.
3. To learn about emerging sustainable materials and its hydraulic, structural strength and resilience properties, and design procedures for water supply and sewer pipelines.

10. Unit wise detailed content

Unit-1	**Number of lectures = 8**	

Urban water cycle, Urban water infrastructures - water supply, storm water drainage, sanitation, sewerage and wastewater conveyance infrastructures.

Unit - 2	**Number of lectures = 8**	

Water supply and sewerage network hydraulics, SCADA systems, Sustainable urban designs, Methodologies for assessing sustainability of urban water infrastructures, Emerging sustainable materials and design procedures for water supply and sewerage pipelines

Unit - 3	**Number of lectures = 8**	

Hydraulic performance and structural strength, chemical resistance and resilience characteristics of emerging materials based water and sewer pipelines, Rehabilitation and augmentation technologies for water supply and sewerage networks, Analytic hierarchy process and optimization techniques for

arriving at the best appropriate rehabilitation/ augmentation technology		
Unit - 4	**Number of lectures = 8**	
Urban water management, Rain water harvesting, Managed aquifer recharge, Constructed/engineered wetlands, Sprinkler and drip irrigation, Water use efficiencies, Effect of water management practices on urban water infrastructure, hydrology and groundwater regime, Surface and subsurface mapping of water supply and sewerage networks, Structural safety and mitigating plans against natural and human caused threats		
11. Brief Description of self learning / E-learning component The online platform, will involve the NPTEL and SWAYAM portal system. Lecture series and assignments will be beneficial for the students. Seminars will be conducted with the students. Online means will be explored for broad outlook in the syllabus.		
12. Books Recommended (2 Books+ 4 References)		
(1) Grigg, N.S., Water, Wastewater, and Stormwater Infrastructure Management, Second Edition, CRC Press, 2012 (2) Lazaro, T.R., Urban Hydrology, CRC Press, 1990 (3) WEF and ASCE, Existing Sewer Evaluation and Rehabilitation, McGraw-Hill, 2009 (4) Keshari, A.K., Rainwater Harvesting. Water Digest, 1(2): 46-50, 2006. (5) Smith, S.W., Landscape Irrigation: Design and Management, 1st Edition, Wiley, 1996 (6) Mays, L.W., Hydraulic Design Handbook, McGraw-Hill, 1999		