

## PG Program [M. Tech. Environmental and Water Resources Engineering] Curriculum Structure

**W.e.f AY 2019-20 and Applicable for batches admitted from AY 2019-20 to 2022-23**

### List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.9%
PSBC	Program Specific Bridge Course	1	3	4.4%
DEC	Department Elective Course	3	9	13.2%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	6	22	32.4%
LC	Laboratory Course	2	2	2.9%
IOC	Interdisciplinary Open Course	1	3	4.4%
LLC	Liberal Learning Course	1	1	1.5%
SLC	Self Learning Course	2	6	8.8%
SBC	Skill Based Course	2	18	26.5%

**Semester-I**

Sr. No.	Course Type	Course code	Course name	Teaching scheme			Credits
				L	T	P	
1.	PSMC	EW-19001	Statistical Methods in Hydrology and Environment Engineering	3	1	-	4
2.	PSBC	EW-19002	Applications of Geoinformatics in Environmental and Water Resources Engineering.	3	-	-	3
3.	DEC	EW(DE)-19001	Departmental elective-I 1. Principles of Water and Air Quality Legislation	3	-	-	3
		EW(DE)-19002	2. Decentralized Liquid Waste Management				
		EW(DE)-19003	3. Irrigation and Drainage				
		EW(DE)-19004	4 Channel and River Hydraulics				
4.	PCC	EW-19003	1. Advanced Water and Wastewater Treatment	3	-	-	3
5.	PCC	EW-19004	2. Advanced Hydrology and Hydraulics	3		-	3
6.	PCC	EW-19005	3. Ground Water Hydrology	3	-	-	3
7.	LC	EW-19006	Seminar	-	-	2	1
8.	LC	EW-19007	Environmental and Water Resources Engineering Lab	-	-	4	2
Total credits							22

### Semester-II

Sr. No.	Course Type	Course code	Course name	Teaching scheme			Credits
				L	T	P	
1.	IOC		Application of Geoinformatics in Water Management. or Plumbing Engineering	3	-	-	3
2.	DEC	EW(DE)	Departmental Elective-II	3	-	-	3
		EW(DE)-19005	1. Computational Fluid Dynamics				
		EW(DE)-19006	2. Land and Water Management				
		EW(DE)-19007	3. Design of Reactor and Environmental Chemistry				
		EW(DE)-19008	4. Water and Air Quality Models				
3.	DEC	EW(DE)	Departmental Elective-III	3	-	-	3
		EW(DE)-19009	1. Climate Change and Water Resources				
		EW(DE)-19010	2. Water Resources Planning, Management and Economics				
		EW(DE)-19011	3. Transport of Water and Wastewater				
		EW(DE)-19012	4. Industrial Wastewater Management				
4.	LLC	LL-19001	Liberal Learning Course	1	-	-	1
5	MLC	ML-19011	Research Methodology and Intellectual Property Rights	2	-	-	-
6.	MLC	ML-19012	Effective Technical Communication	1	-	-	-
7.	PCC	EW-19008	1. Solid and Hazardous Waste Management	3		-	3
8.	PCC	EW-19009	2. Urban Hydrology and Drainage	3	-	-	3
9.	PCC	EW-19010	3. Environmental Impact Assessment	3	-	-	3
10.	LC	EW-19011	Mini project	-	-	2	1
11.	LC	EW-19012	Computational lab in Environmental and Water Resources Engineering	-	-	4	2
Total credits				Max22			22

Dept offers “Application of Geoinformatics in Water Management or Plumbing Engineering” as IOC for students of other departments.

### Semester-III

Sr. No.	Course code	Course Name	Teaching scheme			Credits
			L	T	P	
1.	SBC EW-19013	Dissertation phase-I	-	-	18	9
2.	SLC EW-19014	Massive Open Online Course	3	-	-	3
Total credits			Max12			12

### Semester-IV

Sr. No.	Course code	Course Name	Teaching scheme			Credits
			L	T	P	
1.	SBC EW-19015	Dissertation phase-II	-	-	18	9
2.	SLC EW19016	Massive Open Online Course	3	-	-	3
Total credits			Max12			12

### Semester-I

**PSMS (EW19001) Statistical Methods in Hydrology and Environment Engineering**

**Teaching Scheme:**

Lectures: 3 Hr/Week  
Tutorial : 1Hr/ Week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. To understand the basic knowledge on sampling and its types.
2. To gain basic knowledge probability concept and its application.
3. To Identify the appropriate regression model to apply on environment and water resource
4. To understand and apply statistical model.
5. To use appropriately time series analysis for prediction of environment and climate change
6. To explain the pattern of human behavior in term of mathematics and geometry.

**Syllabus Contents:**

Sampling, Data collection and recording, concept; arithmetic mean, mode, median for ungrouped and grouped data. Measures of dispersion: absolute and relative measures; range, standard deviation (grouped and ungrouped data), variance, quartile deviation, coefficient of variability. Skewness, Kurtosis . Probability - normal, Gamma, Exponential, Gumbels, Weibull, poisson and binomial distribution. Statistical Methods: Hypothesis testing, significance and correlation. Correlation. Linear models and regressions. Pearson and other correlation coefficients. Multiple regressions. Matrices, simultaneous linear equations; tests of hypothesis and significance. Time series analysis - moving averages. Distribution- Normal, t and Chi-square test. Difference among means: F-test: 1 way ANOVA; F-test: 2 ways ANOVA. Auto regression models, moving average model, ARMA and ARIMA models, Thomas-Fiering model, Kolmogorov-Smirnov method, Application of statistical method to environment and water resources related problems. Time series methods, Spatial Methods.

**References:**

1. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5 th edn.
2. MacMillan, N.Y.
3. Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, CRC Press.
4. Vic Environmental Statistics Methods and Applications, Wiley Series in Probability and
5. Statistics.
6. P Jaya Rami Reddy, Stochastic Hydrology, Laxmi Publication (P) Limited, New Delhi

**PSBC (EW19002) Applications of Geoinformatics in Environmental and Water Resources**

**Engineering**

**Teaching Scheme:**

Lectures: 3 Hr/Week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. gain fundamental understanding of the remote sensing, GIS, GPS technologies
2. become familiar with the GIS-based analytical and problem-solving techniques
3. understand the basic principles underlying the RS-GIS based modeling of the hydrological systems
4. apply the Geoinformatics tools for sustainable planning and management of water resources and environmental systems.

**Syllabus Contents:**

**Fundamentals of Geoinformatics (Remote Sensing- GIS-GPS)**

Introduction to Geoinformatics (RS- GIS-GPS) \* Fundamental of Remote Sensing • History • Type of Remote Sensing • Remote Sensing platforms and sensors • Data acquisition through various platforms • Cameras and sensor parameters • Elements of satellite images • Concept of bands, pixel, digital number, metadata • Multispectral Remote Sensing • False color composite • Interpretation of multispectral image • Combination of sensors • Image interpretation parameters • Digital image processing • Atmospheric, radiometric, geometric corrections • Histograms, Density slicing, Contrast stretching, • Principle component analysis • Ground truths. Introduction to GIS • Components of GIS • Hardware and software • GIS functionality • Data capture, management, analysis and visualization • Projections and georeferencing • Concepts of projections • Types of projections and their applications • Topological data model • TIN, spaghetti, polygon structure data models • Digitization • Introduction to GPS • Fundamental concepts • Coordinates and reference systems • Components of GPS system • GPS for land navigation and survey reconnaissance • Static / Differential Positioning • Dynamic / Kinematic Positioning • GPS equipment • National GPS applications.

**Geoinformatics applications**

Geoinformatics applications \* Systems Approach \* Use of Software Packages \* Synoptic and integrated approach \* GIS based river basin morphological analysis • GIS based hydrological modelling • Flood estimation-SCS • GIS based river basin modelling • Modelling parameters • Spatio-temporal basin simulation model development • Water uses and users, different stake holders and their relative importance \* water supply / demand parameters • Surface / Ground Water • Environmental, agriculture, irrigation, PWS demands • Socio-economic parameters \* Model optimization. Presentation of GIS based modelling project.

**References:**

1. Water Resources Systems Planning and Management, Jain S.K. and Singh V.P., Elsevier, The Netherlands, 2003.
2. Remote Sensing and Image Interpretation by Thomas M. Lillesand , Ralph W. Kiefer , Jonathan W. Chipman
3. Geographic Information Systems and Environmental Modeling by Clarke, Keith C., Bradley

O. Parks, and Michael P. Crane. Upper Saddle River, NJ: Prentice Hall, 2002.

4. Principles of Remote Sensing- Edition: ITC Educational Textbook Series 2, Publisher: ITC, nschede Editors: N. Kerle, L.L.F. Janssen, G.C. Huurneman
5. 'Water Resources Systems: Modelling Techniques and Analysis', Vedula S. and Mujumdar P.P., Tata-McGraw Hill, 2005.

## Departmental Elective -I

EW(DE)-19001 DE- I Principles of Water & Air Quality Legislation	
<b>Teaching Scheme:</b> Lectures: 3 Hr/Week	<b>Examination Scheme</b> T1, T2 – 20 marks each, End-Sem Exam – 60 marks
<b>Course outcomes:</b> At the end of the course, students will demonstrate the ability to <ol style="list-style-type: none"><li>1. Know all the laws related to water</li><li>2. Determine pollution status of in river basin</li><li>3. Analyse quality of water through appropriate models</li></ol>	
<b>Syllabus Contents:</b> Water law – riparian rights, Groundwater ownership, Prior appropriation, Permit systems, acquisition and use of rights, Uncertainty concepts in Water Resources Planning - methods for uncertainty analysis and applications. Water quality monitoring, Water pollution, Sources of pollution, Nature of pollutants, Existing approaches of control/abatement of water quality degradation, Water quality monitoring in river basins Water quality modelling – Modelling and Monitoring, evolution of water quality models, types of water quality models, DO and BOD in streams, Transformation and transport processes, Oxygen transfer, Turbulent mixing, Non – Point source pollution, Modelling approaches for modelling non – point sources Water quality objectives and standards, Water quality control models, Flow augmentation, Waste water transport systems, River and lake water quality models, Groundwater quality models, Wastewater transport systems Water Quality Management in rivers, streams, and other water bodies. Water law – riparian rights, Groundwater ownership, Prior appropriation, Permit systems, acquisition and use of rights, Uncertainty concepts in Water Resources Planning - methods for uncertainty analysis and applications. Legal aspects of environment systems, Principles of law applied to water rights and water allocation, Environmental Protection Law, Water pollution control acts and legislation, Air pollution act, Legislation in India, Control Acts	
<b>References:</b> <ol style="list-style-type: none"><li>1. Tebutt T.H.Y. “Principles of Water Quality Control”, Pergamon Press, Oxford</li><li>2. Gerard Kiely “Environmental Engineering”, McGraw Hill Publications</li><li>3. Viessman W. Jr. and Hammer M.J. “Water supply and Pollution control”, Harper &amp; Row Publications Inc., Singapore</li><li>4. Jerald L. Schnoor “Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil”, John Wiley &amp; Sons Inc. New York</li></ol>	



**EW(DE)-19002 DE-I Decentralized Liquid Waste Management**

**Teaching Scheme:**

Lectures: 3 Hr/Week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. To understand the benefits, objective and options for liquid waste management
2. to understand the concept of fecal waste management
3. To identify, locate and quantify contamination contributed by onsite system
4. To get insight into the treatment options for toilet system and domestic liquid waste
5. To design and analyzes the decentralized waste management system
6. To promote appropriate treatment for safe urban/or rural sanitation

**Syllabus Contents:**

Introduction to the various sources of wastewater, brief about conventional, centralized and decentralized treatment options. Consequences of options, Benefits of options, Challenges in operating decentralized approaches. Need of rural and urban sanitation, Problems associates with fecal waste management, Various option for fecal waste management. Toilet options, Sewer system for wastewater conveyance Basics on Sanitation and Liquid Waste Management. Introduction to Grey water and black water treatment options, Various decentralized options such as fluidized aerobic bed reactor, packed bed reactor, phytoremediation, constructed wetland, phytoremediation in constructed wetland, duckweed pond, hybrid reactor system, upflow anaerobic sludge blanket reactor, biogas plant link with toilet, sullage stabilization pond, gray water treatment and re-use at household level

**References:**

1. Handbook on Scaling up Solid and Liquid Waste Management in Rural Areas,
2. Water and Sanitation Program, World Bank New Delhi and Ministry of Drinking Water & Sanitation, Gol, New Delhi
3. Handbook for Managing Onsite and Clustered (Decentralized) Wastewater
4. Treatment Systems, An Introduction to Management Tools and Information for Implementing EPA's Management Guidelines.
5. Technology Options for Household Sanitation, Rajiv Gandhi National Drinking
6. Water Mission, Department of Drinking Water Supply, Ministry of Rural development, Government of India, New Delhi and UNICEF (United Nations Children's Fund).
7. Kara L. Nelson, Small and Decentralized System for Wastewater Treatment and Reuse, Proceeding

## EW(DE)-19003 DE I Irrigation and Drainage

### Teaching Scheme

Lectures: 3hrs/week

### Examination Scheme

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

### Course Outcomes:

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

1. Decide suitable method of irrigation
2. Design micro irrigation.
3. Compare and contrast suitable drainage and salinity control measures.
4. Design and management of drainage system.

### Syllabus Contents:

Water Conveyance System: Canals, open channel, lined and unlined channels, canal losses, types of lining, and economics of lined channels. Cross drainage works, Regulating structures, Types of cross drainage works, aqueduct, super passage, siphon, culverts etc. Layout and design concepts. Lift Irrigation: General concepts, Elements of lift irrigation system, Design considerations involved in Intake well, Jack well, rising main, and distribution system, Concepts and economics. Drip irrigation, General concept, Advantages, limitations, elements of drip irrigation system, design. Sprinkler irrigation, General concept, advantages and limitations, Components of the system, types of sprinklers, design concept. Drainage and Salinity Control: Factors to be considered in land drainage, combined irrigation and drainage system, water balance equation, drainage survey, effect of field drainage system on agriculture. Salinity in the relation to irrigation and drainage, salt balance of the root zone, Salinization due to capillary rise, leaching process, reclamation of salt affected soil, bio-drainage. Design and management of drainage system, drainage materials, surface drainage system, their components and applications in sloping areas, subsurface drainage system, mole drainage, management and application of drainage system.

### References:

1. Michael, BAll. "Irrigation", Vikas Publishing House Pvt. Ltd. N Delhi.
2. Asawa, G.L. "Irrigation Engineering", New Age International Pub. Co. N Delhi.
3. Michael A M "Irrigation -Theory and Practice" Vikas Publishing House Pvt. Ltd. N Delhi.2009
4. Murthy, V.V.N. (1999) "Land and Water Management Engineering", Kalyani Publishers, Ludhiana.
5. Bhattacharya A.K. and Michael A.M. "Land Drainage Principles, Methods and Applications" Konark Publishers Pvt. Ltd, New Delhi, 2003.

<b>Teaching Scheme:</b> Lectures: 3 hrs/week	<b>Examination Scheme</b> T1, T2 – 20 marks each, End-Sem Exam – 60 marks
<b>Course Outcomes:</b> At the end of the course, students will demonstrate the ability to <ol style="list-style-type: none"> <li>1. Analyze &amp; Calculate parameters governing the flow through open-channels and types of water surface profiles.</li> <li>2. Compute flow profiles in channel transitions and due to hydraulic structures</li> <li>3. Analyze gradually-varied flow, rapidly-varied flow, unsteady flow and sediment transport in open channel</li> <li>4. Design stable channels, erodible and lined channels for clear and sediment flows</li> </ol>	
<b>COURSE CONTENT:</b> Basic concepts of free surface flow, Flow regimes, Velocity and Pressure distribution, Energy principles and its applications, Specific energy, Critical flow computations, Momentum equations and its applications, Specific force diagram, Theoretical concepts of surface roughness, Velocity equation, Uniform flow computation. Steady gradually varied flow, Dynamic equation, Characteristics of flow profile and methods of computation, Practical problems, gradually varied flow classification, analysis and computations, Compound channels, Canal delivery problem, Channel networks. Steady rapid varied flow, Hydraulic jump analysis and location, Jump in sloping channels and Oblique jump, Surge analysis, Design of spillways, Energy dissipaters, Channel transitions. Unsteady rapidly varied flow, Monoclonal rising wave, Dam break problem, Moving hydraulic jump, Positive and Negative surges, Hydraulic flood routing. Fluvial hydraulics, Basic characteristics of river beds and sediments, Initiation of motion, Bed load, suspended load, total load and sediment measurements, Regimes of flow, Plan form and stream bed variations of rivers, Sediment control. Design of stable channels, Design of erodible and lined channels for clear and sediment – laden flows – CBI & P method, Regime method, Tractive force methods, Reservoir sedimentation, Erosion and deposition, Sediment transport in pipes. Similitude and models, Dimensional analysis and similitude, Scale ratios, Fixed – bed and movable bed models.	
<b>References:</b> <ol style="list-style-type: none"> <li>1. Chow V.T. “Open Channel Hydraulics”, McGraw Hill, Inc. New York.</li> <li>2. Henderson “Open channel flow”, McMillan Pub. London</li> <li>3. Subramanya K. “Flow in Open Channels”, Tata McGraw Hill Pub.</li> <li>4. Garde and RangaRaju K.G. “Mechanics of sediment transportation and Alluvial Stream Problems”, Wiley Eastern, New Delhi</li> <li>5. Chaudhry M.H. “Open – Channel Flow”, Prentice Hall of India, New Delhi</li> <li>6. French R.H. “Open Channel Hydraulics”, McGraw Hill Pub Co., New York</li> </ol>	

**PCC (EW-19003) Advanced Water and Wastewater Treatment**

**Teaching Scheme**

Lectures: 3 hrs./week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

**Course outcomes:**

1. At the end of the course, students will demonstrate the ability to
2. Analyze quality of water and waste water
3. Select appropriate technology for treatment of water and wastewater
4. Design a treatment facility for treatment of water and wastewater

**Syllabus Contents:**

Water Quality – Physical, chemical and biological parameters of water, Water quality requirement, Potable water standards, Waste water effluents standards, Waste water effluent standards, Water quality indices. Water purification systems in natural systems – Physical, chemical and biological processes, Primary, Secondary and Treatment - Unit operations and unit processes, Design of primary, secondary and tertiary treatment units. Mixing, clarification – Sedimentation, types of sedimentation units, Aeration and gas transfer, Coagulation and Flocculation, Coagulation processes – stability of colloids, Destabilization of colloids, Transport of colloidal particles, Clariflocculation. Filtration – theory of granular media filtration, Classification of filters, Slow sand filter and rapid sand filter, Mechanism of filtration, Modes of operation and operational problems, Negative head and air binding, Dual and multimedia filtration. Adsorption, Adsorption equilibrium, Adsorption isotherms, Disinfection- Chlorine dioxide, Chloramines, Ozonation, UV radiation. Ion exchange processes, Application Membrane Processes, Reverse Osmosis, Ultra filtration, Electrodialysis

**References:**

1. Weber W.J. “Physicochemical processes for water quality control”, John Wiley and Sons, New York
2. Peavy H.S., Rowe D.R. and Tchobanglous G. “Environmental Engineering”, McGraw Hills, New York
3. Metcalf and Eddy “Waste water Engineering, Treatment and Reuse”, Tata Mc- GrawHill

<b>Teaching Scheme:</b> Lectures: 3Hr/Week	<b>Examination Scheme</b> T1, T2 – 20 marks each, End-Sem Exam – 60 marks
<b>COURSE OUTCOME:</b> At the end of the course, students will demonstrate the ability to <ol style="list-style-type: none"> <li>1. measure and carry out analysis of data related to various hydrological parameters.</li> <li>2. apply advance method to perform hydrological modeling for estimation of various hydrological parameters such as water availability, design flood, sedimentation etc used for development and management of water resources projects.</li> <li>3. analyze problems related to laminar flow and boundary layer theory.</li> <li>4. determine the various losses and other parameters in pipe flow problems.</li> </ol>	
<b>COURSE CONTENT:</b> <b>I.HYDROLOGY:</b> <ul style="list-style-type: none"> <li>• Hydrologic Cycle,hydrologic processes, precipitation, evaporation, surface flow, infiltration and percolation.</li> <li>• Hydrometry: Measurement and analysis of meteorological and hydrological parameters: precipitation, evaporation, infiltration, runoff, sediment, humidity, temperature, wind, sunshine etc</li> <li>• Water availability: Rainfall- runoff data processing, Frequency analysis, Areal rainfall estimation, Depth area duration relationships, Intensity Duration frequency relationship. Dependability analysis. Low flow analysis.</li> <li>• Design Flood: Methods of peak flood estimation,Designflood, Deterministic and stochastic models, Theory of Unit Hydrograph,Derivation and application of UH. Instantaneous Unit Hydrograph(IUH), Linear reservoir, Derivation of IUH using Clark Model and Nash Model ,Storm analysis, SPF and PMF (Probable Maximum Flood),</li> <li>• Hydrologic and hydraulic routing,Reservoir Level pool routing,Estimation of spillway length and MWL, Channel routing.</li> <li>• Estimation of Sediment load in reservoirs and its distribution. IS codes for Sedimentation,</li> <li>• Estimation of dead storage levels/ outlet level.</li> </ul>	
<b>II HYDRAULICS:</b> <ul style="list-style-type: none"> <li>• Laminar flow, Navier-Stoke's equation of motion for laminar Flow; Laminar flow between two parallel plates, laminar flow through pipes, Dimensional Analysis &amp; Modal Studies.</li> <li>• Boundary Layer Theory: Introduction, Development of boundary layer over a flat plate, boundary layer thickness, displacement, momentum and energy thicknesses, Application of momentum equation to boundary layer flow, local and mean drag coefficients, Hydro-dynamically rough and smooth surfaces, boundary layer separation and its control.</li> <li>• Pipe Flow Problems: Losses in pipe flow, pipes in series, pipes in parallel, branching pipes, siphons, multi-reservoir problems, pipe networks, unsteady flow in pipes, water hammer analysis.</li> </ul>	

**REFERENCES:**

1. K. Subramanya, "Engineering Hydrology", TMH, New Delhi, India.
2. Chow V.T, "Hand book of Applied Hydrology", Mc Graw-Hil, N.Y., USA.
3. A.K. Jain "Mechanics of fluids", Khanna Publisher., Delhi.
4. P.N. Modi and S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulics Machines", Rajsons Publications Pvt. Ltd.

## PCC (EW-19005) Groundwater Hydrology

### Teaching Scheme

Lectures: 3 hrs/week

### Examination Scheme

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

### Course outcomes:

At the end of the course, students will demonstrate the ability to

1. Demonstrate the different terminologies related with groundwater hydrology
2. Identify suitable method of determination of aquifer parameters
3. Choose suitable ground water exploration techniques and assess ground water potential
4. Compare and contrast suitable ground water quality management methods and ground water model.

**Ground Water:** porosity, specific yield and specific retention of water in rocks/aquifers, compressibility of rock, zone of aeration and saturation, fluctuation of water table and piezometric surfaces, storage coefficients of aquifers, specific yield, specific retention, unconfined and confined aquifer, ground water potential in India, geophysical methods for groundwater explorations.

**Ground water flow:** Laminar and turbulent flow, Darcy's law, Reynolds number, permeability and transmissibility, Groundwater flow potential, Ground water theory for one, two and three dimensional problem, Differential equations governing groundwater flow for steady and unsteady state problems, Theim and Dupuit's theory for unconfined and confined aquifers, use of finite difference method to solve simple ground water flow problem.

**Evaluation of Aquifer Properties:** aquifer tests, control well, observation well, Solution of aquifer parameters for confined aquifer by Theis method, Jacob and Chow's method, Theis' recovery method, bounded aquifer, interference among wells, aquifer properties for bounded aquifers by theory of images.

**Construction of Wells:** Types of wells and method of construction, tube well design and well drilling: well screen, development and completion of wells, well performance test, well loss, Rotary drilling and Rotary percussion drilling, maintenance of wells.

**Ground Water Modeling:** Groundwater Modeling: Groundwater flow, sand models, membrane model, thermal model, electric analog model and mathematical models.

**Groundwater Recharge, Development and Management:** Components of ground water balance, estimation of recharge component, ground water storage changes, conjunctive use, artificial recharge of groundwater- different methods, subsurface dam, recharge by urban storm runoff, percolation from tanks, recharge from irrigated fields, groundwater quality, estimation of ground water discharge, ground water resource evaluation in India.

### References:

1. Todd, D.K. "Ground Water Hydrology", John Wiley & Sons, Singapore.
2. Raghunath, H.M. "Ground Water" New Age International (P) Limited, New Delhi.
3. Karanth, K. R. "Ground Water Assessment Development and Management", Tata McGraw Hill Publishing Company Limited, New Delhi
4. Domenico "Concepts and Models in Groundwater Hydrology", McGraw Hill Inc., NewYork
5. L. Harvil and F. G. Bell, *Ground Water Resources and Development*, Butterworth's, London.
6. Herbert F Wang and Mary P. Anderson "Introduction to Ground Water Modeling", W.H. Freeman and Company, NewYork
7. Garg S.P. "Groundwater and Tube wells", Oxford and IBH Publishing Co. New Delh
8. Waltin W.C "Groundwater Resources Evaluation", McGraw Hill Inc. N York

**(EW-19006) Seminar**

**Teaching Scheme**

Lectures: 2 hrs/week

**Examination Scheme**

End-Sem Exam – 100 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. Identify a topic for study and carry out literature survey
2. Write a technical report related to selected topic
3. Present outcome of the study with the help of ppt.

**Syllabus Contents:**

Seminar is to be performed and reported by the end of the first semester



## Laboratory Course (LC)

### LC (EW-19007) Environmental and Water Resources Engineering Laboratory

**Teaching Scheme**

Lectures: 2 hrs/week

**Examination Scheme**

End-Sem Exam – 100 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. Measure the flow through pipe and the calibration of hydraulic structures.
2. Perform the basic as well as advance tests on water and waste water.

**Syllabus Contents:**

Following experiments have to be performed

Sr. No	Name of Experiment
<b>Part A- Water Resources Engineering</b>	
1	Reynolds Experiment
2	Verification of Bernoulli's Equations
3	Calibration of Venturimeter
4	Calibration of Orifice Meter
5	Study of Uniform Flow of Open Channel
6	Calibration of Standing Wave Flume
7	Study of Hydraulic Jump
<b>Part B- Environmental Engineering</b>	
8	Determination of Sulphate by Gravimetric Method
9	Determination of MPN index (Statistical Method)
10	Determination of IRON by Spectrophotometer
11	Determination of Phosphate by Spectrophotometer
12	Study of Adsorption Column
13	Determination of Color by Colorimeter

## SEMESTER- II

<b>IOC Geoinformatics for WaterManagement</b>	
<b>Teaching Scheme:</b> Lectures: 3 Hr/Week	<b>Examination Scheme</b> T1, T2 – 20 marks each, End-Sem Exam – 60 marks
<b>Course outcomes:</b> At the end of the course, students will demonstrate the ability to <ol style="list-style-type: none"><li>1. Gain fundamental understanding of the remote sensing, GIS,GPS technologies</li><li>2. Become familiar with the GIS-based analytical and problem-solving techniques</li><li>3. Understand the basic principles underlying the RS-GIS based modeling of water management systems</li><li>4. Apply the Geoinformatics tools for sustainable planning and management of water resources</li></ol>	
<b>Syllabus Contents:</b> <b>Geoinformatics (Remote Sensing- GIS-GPS)</b> Introduction to Geoinformatics (RS- GIS-GPS) * Fundamental of Remote Sensing History Type of Remote Sensing Remote Sensing platforms and sensors Data acquisition through various platforms Cameras and sensor parameters Elements of satellite images Concept of bands, pixel, digital number, metadata Multispectral Remote Sensing False color composite Interpretation of multispectral image Combination of sensors Image interpretation parameters Digital image processing Atmospheric, radiometric, geometric corrections Histograms, Density slicing, Contrast stretching, Principle component analysis Ground truths. Introduction to GIS Components of GIS Hardware and software GIS functionality Data capture, management, analysis and visualization Projections and georeferencing Concepts of projections Types of projections and their applications Topological data model TIN, spaghetti, polygon structure data models Digitization Introduction to GPS Fundamental concepts Coordinates and reference systems Components of GPS system GPS for land navigation and survey reconnaissance Static / Differential Positioning Dynamic / Kinematic Positioning •GPS equipment National GPS applications. <b>Geoinformatics for Water Management</b> Basic water management principles Systems Engineering approach Synoptic and integrated water management Use of Software Packages River basin delineation GIS based river basin morphological analysis Runoff estimation-SCS GIS based river basin modelling Modelling parameters Spatio-temporal basin simulationmodel development Surface /Ground Water Environmental, agriculture, irrigation, PWS demands Socio-economic parameters Basin spatial- temporal water supply / demand management Model optimization. Presentation of GIS based modelling project.	
<b>References:</b> <ol style="list-style-type: none"><li>1. Remote Sensing and Image Interpretation by Thomas M. Lillesand , Ralph W. Kiefer , Jonathan W. Chipman</li><li>2. Geographic Information Systems and Environmental Modeling by Clarke, Keith C., Bradley O. Parks, and Michael P. Crane. Upper Saddle River, NJ: Prentice Hall, 2002.</li><li>3. Principles of Remote Sensing- Edition: ITC Educational Textbook Series 2,Publisher: ITC, nschedeEditors: N. Kerle, L.L.F. Janssen, G.C. Huurneman</li></ol>	

## Departmental Elective Course (DEC) -II

### [EW(DE)-19005] DE- II Computational Fluid Dynamics

**Teaching Scheme**

Lectures: 3hrs/week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam - 60

**Course Outcomes:**

At the end of the course, students will demonstrate the ability to:

1. Know CFD as an engineering analysis tool.
2. Derive of flow governing equations; turbulence modeling; modelling approaches for multiphase flow; initial and boundary conditions;
3. Discretize the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for unsteady transport equation.
4. Find Solution of discretized equations; direct methods; classical iterative methods; advanced methods for structured matrices; conjugate gradient techniques; multigrid methods.
5. Find Solution of coupled equations: methods for compressible flows; evaluation of pressure in incompressible flows; pressure-velocity coupling algorithms.

**Syllabus Contents:**

Introduction to Computational Fluid Dynamics and Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations, Classification of Partial Differential Equations and Physical Behaviour, Approximate Solutions of Differential Equations: Error Minimization Principles, Variational Principles and Weighted Residual Approach, Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Finite Volume Method: Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems, Boundary Condition Implementation and Discretization of Unsteady State Problems, Important Consequences of Discretization of Time Dependent Diffusion Type Problems and Stability Analysis : Consistency, Stability and Convergence, LAX Equivalence theorem, Grid independent and time independent study, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dufort-Frankel scheme, Stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS Schemes, Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Linear Algebraic Equations: Elimination. Methods, Iterative Methods, Gradient Search Methods, Discretization of Convection-Diffusion Equations: A Finite Volume Approach, Discretization of Navier Stokes Equations: Stream Function Vorticity approach and Primitive variable approach, SIMPLE Algorithm, SIMPLER Algorithm, Unstructured Grid Formulation, Introduction to Turbulence Modelling.

**References:**

1. Computational Fluid Dynamics by *John D. Anderson*.
2. Computational Fluid Flow and Heat Transfer by *K. Murlidhar and T. Sundararajan*. (The first few chapters are good for introductory approach of Finite volume method. 12th chapter which is about semi-explicit method is written by Prof. Atul Sharma, IITB)
3. Introduction to CFD by *SuhasPatankar*. (Good for Finite difference method).
4. An Introduction to Computational Fluid Dynamics by *HK Versteeg and W Malalasekera*. (I did not refer to this book because it would create confusion as different authors have different styles of explaining. The book is on Finite Volume method).

[EW(DE)-19006] DE- II Land and Water Management

**Teaching scheme:**

Lectures:3hrs/week

**Examination Scheme:**

T1, T2–20 marks each

End semester exam: 60marks

**Course outcomes:**

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

1. Identify and implement suitable method of land and water management.
2. Design soil and water conservation structures.
3. Estimate water requirements of crops and decide suitable method of irrigation.
4. Carryout land suitability classification and suggest suitable methods of dry land farming

**Syllabus contents:**

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. 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 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. 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. 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. 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.

**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. Swabe, 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.

[EW(DE)-19007] DE- II Design of Reactors and Environmental Chemistry

**Teaching scheme:**

Lectures:3hrs/week

**Examination Scheme:**

T1, T2–20 marks each

End semester exam: 60marks

**Course outcomes:**

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

1. Ability to overcome/minimize the river pollution problem
2. Ability to make decisions regarding the design of storm water line and sewer line
3. Ability to design the various primary waste water treatment units their effectiveness.
4. Ability to design the various aerobic secondary waste water treatment units their effectiveness
5. Ability to understand the various anaerobic secondary units their design criteria and applicability
6. Ability to demonstrate a firm understanding of various emerging technologies for a wastewater treatment and their suitability and in order to provide an effective and efficient and economics; wastewater treatment process

**Syllabus contents:**

Fundamental of reaction kinetics, rate of reaction, order of reaction, effect of temperature on reaction. Types of reactors batch reactor plug flow reactor, continuous stirred tank reactor packed bed reactor, fluidized bed reactor. Mass balance principle, molar balance equation, Molar balance mass equation for batch reactor, plug flow reactor and continuous stirred tank reactor. Levee spiel plot, sizing of reactor. Analysis of non-ideal flow reactor using tracer, Need for tracer, Analysis of tracer response curve. Ideal plug flow reactor. Continuous stirred tank reactor connected in series, plug flow reactor connected in series. Review on basic concepts in chemistry, chemical thermodynamics, concepts of chemical equilibrium, equilibrium concept and activity, acid, base buffer, solubility product. Electro chemistry and electrochemical cell, Nuclear chemistry, Nernst equation, nitrogen fixation, Henry laws. Chemistry of process in the atmosphere, introduction to Langmuir and freundlitch adsorption isotherm separation factor criteria for the best fit of adsorption, isotherm models and electro coagulation.

**References:**

1. Octave Leve spiel, "Chemical Reaction Engineering" (3rdEdition),1999, John Wiley & Sons
2. Gilbert. Froment and Kenneth B. Bischoff, "Chemical Reactor Analysis and Design" (2ndEdition),1990, John Wiley Sons
3. H. Scott Fogler, "Elements of Chemical Reaction Engineering" (4thEdition), 2005, Prentice Hall
4. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse" (4th Edition),2003, McGraw-Hill

[EW(DE)-19008] DE- II Water and Air Quality Models

**Teaching Scheme:**

Lectures/ Lab : 3 hrs / week

**Examination Scheme:**

T1: 20 marks T 2: 20 marks

End Sem. Exam: 60 marks

**Course Outcomes:**

At the end of the course, students will demonstrate the ability to

1. Design models for analysing stream water quality and quantity
2. Develop air quality models under different atmospheric stability conditions
3. Design and analysis of Models for micro-organisms studies.

**Course Content:**

Physical Phenomena, Transport, Gas transfer, Thermal phenomena, Sedimentation, Chemical phenomena, Solution equilibriums, Reaction kinetics, Carbonate equilibriums, Colloidal behaviour. Biological phenomena, Organic materials, Growth kinetics, Biochemical oxygen demand, Aerobic and Anaerobic decomposition, Photosynthesis, Enzymic reactions Natural transport systems, Dissolved Oxygen system, D.O. Models for Streams - Dissolved oxygen model for streams - sources and sinks of dissolved oxygen, Estimation of system parameters, Streeter - Phelps model, Oxygen 'sag' curve, Determination of deoxygenating and re-aeration coefficients. Bethnal oxygen demand - mass transport mechanisms, Advective and diffusive mass transport - Models by O'Connor, Dobbins and Thomann. Streams, Estuaries, Transport in the Air nvironment. Models for Estuary and Lakes - Physical chemical and biological processes in estuaries, Water quality distribution in estuaries - dispersion coefficient, Modelling estuaries and lakes for water quality, Temperature models for lakes and rivers, Microbiology and Ecology, Types of microorganisms, Models for microorganisms decay, nitrogen and phytoplankton, Metabolism, Ecological Principles, Food chains, Food webs, Ecological pyramids, Pesticide concentration, Eutrophication, Population Growth models . Air quality models - Micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, Stack height computation, Regional air quality models, Source inventories and significance.

**References:**

1. Rich L.G. "Environmental Systems Engineering", McGraw Hill Inc.
2. Sincero A.P., Sincero G.A. "Environmental Engineering – A Design Approach", Prentice Hall of India, New Delhi
3. Gerard Kiely "Environmental Engineering", McGraw Hill Publications
4. Peavy H.S., Rowe D.R., Tchobanglous G., "Environmental Engineering", McGraw Hills, New York
5. Jerald L. Schnoor "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley & Sons Inc. New York
6. Gillbert M. Masters "Introduction to Environmental Engineering and Science", Prentice Hall



## Departmental Elective Course (DEC) -III

<b>[EW(DE)-19009] DE-III Climate Change and Water Resources</b>	
<b>Teaching Scheme:</b>  Lectures: 4 Hr/Week	<b>Examination Scheme</b>  T1, T2 – 20 marks each, End-Sem Exam – 60 marks
<b>Course outcomes:</b> At the end of the course, students will able 1. To orient towards the global climate change and its impact on water resources. 2. To understand the climate change phenomenon and its related issues on water, irrigation and its social implications.	
<b>Syllabus Contents:</b> <p><b>The Climate System</b> Definitions- Climate, Climate system, climate change – Drivers of Climate change – Characteristics of climate system components - Green house effect – Carbon cycle – Wind systems - Trade Winds and the Hadley Cell – Ozone hole in the stratosphere - El Nino, La Nina – ENSO, Teleconnections.</p> <p><b>Impacts of Climate Change – Observed and Projected</b> Global Scenario – Indian Scenario – Observed changes and projected changes of IPCC - Impacts on water resources – NATCOM Report –Impacts on sectoral vulnerabilities – SRES – Different scenarios</p> <p><b>Tools for Vulnerability Assessment</b> Need for vulnerability assessment – Steps for assessment – Approaches for assessment – Models – Quantitative models, Economic model, Impact matrix approach - Box models - Zero-dimensional models - Radioactive-convective models - Higher-dimension models - EMICs (Earth-system models of intermediate complexity) - GCMs (global climate models or general circulation models) – Sectoral models</p> <p><b>Adaptation and Mitigation</b> Water-related adaptation to climate change in the fields of Ecosystems and biodiversity, - Agriculture and food security, land use and forestry, Human health, water supply and sanitation, infrastructure and Economy (insurance, tourism, industry and transportation) - Adaptation, vulnerability and sustainable development Sector-specific mitigation - Carbon dioxide capture and storage (CCS) , Bio-energy crops, Biomass electricity, Hydropower, Geothermal energy, Energy use in buildings, Land-use change and management, Cropland management, Afforestation and Reforestation - Potential water resource conflicts between adaptation and mitigation - Implications for policy and sustainable development.</p> <p><b>Case Studies</b> Water resources assessment case studies – Ganga Damodar Project , Himalayan glacier studies, Ganga valley project - Adaptation strategies in Assessment of water resources- Hydrological design practices and dam safety- Operation policies for water resources projects - Flood management strategies - Drought management strategies-Temporal &amp; spatial assessment of water for Irrigation -Land use &amp; cropping pattern - Coastal zone management strategies</p>	
<b>References:</b> 1. IPCC Report Technical Paper VI – Climate change and water , 2008. 2. UNFCC Technologies for Adaptation to climate change, 2006. 3. 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. 4. Preliminary consolidated Report on Effect of climate change on Water Resources, GOI, CWC, MOWR, 2008.	

**[EW(DE)-19010] DE-III Water Resources Planning, Management and Economics**

**Teaching Scheme:**

Lectures: 3 Hr/Week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. Demonstrate various concepts in Water resources planning , management and economics.
2. Plan and operate reservoir for irrigation, hydropower, flood control and water supply
3. Determine benefits due to irrigation, flood control, Hydropower, recreation and sedimentation control.
4. Select the most economical option from various alternatives available..

**Syllabus Contents:**

Water Resources Planning and Management: General principles of systems analysis to problems in Water resources and Environment, Objectives of water resources planning and development, Socio – Economic characteristics, Data requirements and various survey, Environmental constraints on Water Resources development, determination of Reservoir capacity and yield, flood routing methods, reservoir sediment distribution and its necessity, Reservoir Planning for irrigation, Evapotranspiration methods, determination of gross irrigation requirement, reservoir regulation, Reservoir Planning for hydropower- load duration curve, planning of run- of- river hydropower plant, storage hydropower plant, base load and peak load plant, reservoir regulation of hydropower plant, Reservoir operation – standard operating policy, Hedging rules, rule curves,

Economics of Water Resources: planning period and time horizon, Economic-demographic projections, Integrated and disaggregated analysis and model building, Demand resilience and consumer behavior, Basic economic concepts - present worth, future worth, annuities, discounting techniques, depreciation, Production function and cost curves - components of cost curves, long term and short term, Tangible and intangible values, Indifference curves, Economic analysis - Principles of engineering economics and mathematics of economic analysis, price theory and resource allocation, conditions of project optimality, Benefit – cost analysis of projects, Dynamics of project analysis Principles, Water pricing and water allocation, Principles of planning and financing water resources projects, Pricing concepts - oligopolies, Kinked demand curve model, Skimming price and penetration price, Economics of natural resources management, Financial analysis, Economic and financial models, Risk considerations, Capital budgeting and cost allocation. Economic planning for irrigation, flood control, Sediment control, water supply and hydroelectric power, Cost allocation in multipurpose projects

**References:**

1. Loucks D.P., Stedinger J.R. and Haith D.A. "Water Resources Systems Planning and Analysis", Prentice Hall Inc. New York.
2. Chaturvedi M.C. "Water Resources Systems Planning and Management", Tata McGraw Hill Publication Co., New Delhi.
3. Hall W.A. and Dracup J.A. "Water Resources Systems", Tata McGraw Hill Publication Co., New Delhi.
4. James L.D. and Lee R.R. "Economics of Water Resources Planning", McGraw Hill Publication Co., New York.
5. Kuiper E. "Water Resources Development, Planning, Engineering and Economics", Butterworth, London.
6. S. K. Jain and V. P. Singh, "Water Resources Systems Planning and Management," Elsevier Science B.V, Amsterdam, 2003.
7. S. Vedula and P. P. Mujumdar, "Water Resources Systems Modelling Techniques and Analysis," Tata-McGraw Hill, New Delhi, 2005.

**[EW(DE)-19011] DE- III Transport of Water and Wastewater**

**Teaching Scheme:**

Lectures/ Lab : 3 hrs / week

**Examination Scheme:**

T1: 20 marks T 2: 20 marks

End Sem. Exam: 60 marks

**Course Outcomes:**

At the end of the course, students will demonstrate the ability to

- 1.Design water storage and transmission system including pumping of water
- 2.Computer applications in distribution network analysis
- 3.Design of storm drains-storm water inlets
- 4.Decide maintenance requirement of sanitary sewage and storm drainage systems.

**Course Content:**

Water Storage and Transmission - Storage requirements, impounding reservoirs, intakes, pressure conduits, Hydraulics, pumps and pumping units, Capacity and selection of water pumps, Economic design of pumps and economic design of gravity and pumping mains Materials for pipes - Specification for pipes, pipe appurtenances, Types of loads and stresses, Water hammer - causes and prevention, control devices. Distribution Systems - Principles of design, Analysis of distribution networks, Hardy Cross, equivalent pipe and Newton Raphson methods, Computer applications in distributions network analysis, Optimal design of networks, Maintenance of distribution systems, Methods of control and prevention of corrosion, Storage, distribution and balancing reservoirs. Sanitary Sewerage - Sanitation technology selection, sanitary sewage flow estimation, Sanitary sewer materials, Hydraulics of flow in sanitary sewers - partial flows, sewer design, sewer layouts, Concept of model-based design - hydraulic fundamentals of design models, Basic properties and model formulations for the design of wastewater of collection system, Transitions in flow of sewage. Storm Drainage - Basic philosophy in storm drainage, drainage layouts, Storm runoff estimation, Rainfall data analysis, Hydraulics of flow in storm water drains, Storm water drain materials and sections, Design of storm drains - storm water inlets. Maintenance requirements of sanitary sewerage and storm drainage systems, Manpower requirement, Equipment requirement, Preventive maintenance - monitoring safety requirements, Corrosion in sewers - prevention and control, Specific problems related to waste water pumping - pumping - pump selection - wastewater pumping networks.

**Reference**

1. Mohanty A.K. "Fluid Mechanics", Prentice Hall of India, New Delhi
2. Tebutt T.H. Y. " Principles of Water Quality Control", Pergamon Press, Oxford.

**[EW(DE)-19012] DE- III Industrial Wastewater Management**

**Teaching Scheme:**

Lectures: 3 Hr/Week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60 marks

**Course outcomes:**

At the end of the course, students will demonstrate the ability to

1. To impart students with strong knowledge base through theory courses that makes them suitable for industries, academics, research and consultancies
2. To analyze the effects of disposal of untreated and treated industrial wastes on environment.
3. To define about the fundamental concepts of industrial wastewater treatment
4. To design and conduct experiments and the ability to analyse the data, interpret results and draw conclusions.
5. To identify and design treatment options for handling industrial wastewater.
6. To inculcate among students sensitivity towards social and corporate responsibilities.

**Syllabus Contents:**

Sources of Pollution, Physical, Chemical, Organic & Biological properties of Industrial Wastes, Difference between industrial & municipal waste waters, Effects of industrial effluents on sewers and Natural water Bodies. Pre & Primary Treatment, Equalization, Proportioning, Neutralization, Oil separation by Floating-Waste Reduction-Volume Reduction-Strength Reduction. Waste Treatment Methods - Nitrification and De-nitrification-Phosphorous removal -Heavy metal removal - Membrane Separation Process - Air Stripping and Absorption Processes - Special Treatment Methods - Disposal of Treated Waste Water. Characteristics and Composition of waste water and Manufacturing Processes of Industries like Sugar, Characteristics and Composition of Industries like Food processing Industries, Steel, and Petroleum Refineries. Characteristics and Composition of Industries like Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries – Joint Treatment of Raw Industries waste water and Domestic Sewage – Common Effluent Treatment Plants(CETP) – Location, Design, Operation and Maintenance Problems – Economical aspects.

**References:**

1. Metcalf & Eddy, “Wastewater Engineering Treatment disposal reuse”, Tata McGraw Hill. 2. Eckenfelder, W.W., “Industrial Water Pollution Control”, McGraw-Hill
2. M.N. Rao and Dutta – Industrial Waste. 2. Mark J. Hammer, Mark J. Hammer, Jr., “Water & Wastewater Technology”, Prentice Hall of India.
3. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.
4. C.G. Gurnham –Principles of Industrial Waste Engineering

## LL-19001 Liberal Learning

### Course Outcomes

At the end of course, Students will be able to

1. Develop capacity to understand multidisciplinary sciences in a friendly manner.
2. Create openness to diversity.
3. Acquire ability to lead and examine life and value the need for life learning.

### Course Content

Student will be able to choose and enhance practical learning and application in the subject of his/her choice. One credit course spread over the semester to enhance practical learning and application.

- Agriculture
- Business
- Clay Art & Pottery
- Corporate Culture
- Defense
- French
- Geography
- Holistic Health
- Modern Film Making
- Music (Instrumental)
- Photography
- Political Science
- Music (Vocal)
- Wood and Metal Art
- Japanese
- Painting

## ML- 19011 Research Methodology

### Course Outcomes:

At the end of the lab course, the students will demonstrate the ability to:

1. Understand research problem formulation and approaches of investigation of solutions for research problems
2. Learn ethical practices to be followed in research
3. Apply research methodology in case studies
4. Acquire skills required for presentation of research outcomes (report and technical paper writing, presentation etc.)

### Syllabus Contents:

Unit1: (05 Hrs)

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Unit2: (05 Hrs)

Effective literature studies approaches, analysis

Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype

Analyze your results and draw conclusions or Build Prototype, Test and Redesign

Unit3: (05 Hrs)

Plagiarism, Research ethics

Effective technical writing, how to write report, Paper.

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

### Reference Books

1. Raman Sharma, "Technical Communication", Oxford University Press.
2. Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock "English Pronunciation in Use" Cambridge University Press.
4. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

## ML- 19011Intellectual Property Rights

Teaching Scheme  
Lectures: 1 hr/week

Evaluation Scheme  
Continuous evaluation  
Assignments/Presentation/Quiz/Test

### Course outcomes:

At the end of course, Students will be able to

1. Infer that tomorrow's world will be ruled by ideas, concept, and creativity.
2. Gather knowledge about Intellectual Property Rights which is important for students of engineering in particular as they are tomorrow's technocrats and creator of new technology.
3. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario.
4. Study the national & International IP system.
5. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits.

### Course Content

Unit 1 : [03]  
Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 2 : [07]  
Understanding the types of Intellectual Property Rights: -  
Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification, Plant Patenting, Idea Patenting, Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

Unit 3 : [04]  
New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development,  
International Scenario: WIPO, TRIPs, Patenting under PCT

### References:

1. Aswani Kumar Bansal : Law of Trademarks in India
2. B L Wadehra : Law Relating to Patents, Trademarks, Copyright, Designs and Geographical Indications.
3. G.V.G Krishnamurthy : The Law of Trademarks, Copyright, Patents and Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents
6. Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Resisting Intellectual Property by Halbert ,Taylor & Francis
10. Industrial Design by Mayall, Mc Graw Hill



11. Product Design by Niebel, Mc Graw Hill
12. Introduction to Design by Asimov, Prentice Hall
13. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

<b>MLC (ML -19011) Effective Technical Communication</b>	
<b>Teaching Scheme:</b> <b>Lectures: 1hr / week</b>	<b>Evaluation Scheme:</b> <b>100M: 4 Assignments</b> <b>(25M each)</b>
<b>Course Outcomes</b> After successful completion of the course, students will be able -	
<ol style="list-style-type: none"> <li>1. To produce effective dialogue for business related situations</li> <li>2. To use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively</li> <li>3. To analyze critically different concepts / principles of communication skills</li> <li>4. To demonstrate productive skills and have a knack for structured conversations</li> <li>5. To appreciate, analyze, evaluate business reports and research papers</li> </ol>	
<b>Course Content</b>	
<b>Unit 1: Fundamentals of Communication</b>	<b>[4 Hrs]</b>
7 Cs of communication, common errors in English, enriching vocabulary, styles and registers	
<b>Unit 2: Aural-Oral Communication</b>	<b>[4 Hrs]</b>
The art of listening, stress and intonation, group discussion, oral presentation skills	
<b>Unit 3: Reading and Writing</b>	<b>[4 Hrs]</b>
Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers	
<b>Reference Books</b>	
<ol style="list-style-type: none"> <li>1. Raman Sharma, "Technical Communication", Oxford University Press.</li> <li>2. Raymond Murphy "Essential English Grammar" (Elementary &amp; Intermediate) Cambridge University Press.</li> <li>3. Mark Hancock "English Pronunciation in Use" Cambridge University Press.</li> <li>4. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall</li> <li>5. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.</li> </ol>	

## Program Core Course (PCC)

### PCC (EW-19008) Solid and Hazardous Waste Management

<b>Teaching Scheme</b> Lectures: 3 hrs./week	<b>Examination Scheme</b> T1 and T2 20 marks each, End-Sem Exam – 20 marks
<b>Course outcomes:</b> At the end of the course, students will demonstrate the ability to <ol style="list-style-type: none"><li>1. Identify key sources, typical quantities generated, composition, and properties of solid and hazardous wastes;</li><li>2. Identify waste disposal or transformation technics (landfills and incinerators);</li><li>3. Recognize the relevant regulations that apply for facilities used for disposal, and destruction of waste;</li><li>4. Conduct invasive and non-invasive site investigation and understand permitting process for constructing landfills;</li><li>5. Identify and design Solid and Hazardous Waste Landfills (RCRA Subtitle D and C) including closure, post-closure, and rehab issues;</li><li>6. Estimate typical waste disposal costs; and Identify recycling and reuse options (composting, source separation, and re-use of shredded tires, recycled glass, fly ash, etc.)</li></ol>	
<b>Course contents</b> Solid waste: Definition, types of solid waste, sources of solid waste, Physical and Chemical characteristics of solid waste, classification of hazardous waste, Sources, types and quantity of hazardous waste in MSW, significance of hazardous waste in MSW, Impact of solid waste and hazardous on health, air, water, soil, legislation, Collection of solid waste, Design of transfer station, waste allocation. Treatment of solid waste (Landfill method, incineration, composting), Site selection, Land filling including the area filling, trench filling and depression filling, Elements of closure plan of landfill, occurrence of gases and leachate in landfill, Control of landfill gases, Control and treatment of leachate, Environmental monitoring system, Revegetation on landfill, Factor affecting the growth of revegetation on landfill, Selection of site condition, Design of landfill, Leachate analysis, Introduction to physical/chemical/biological process of hazardous waste management, Onsite technologies for hazardous waste site cleanup, Ground water contamination, Storage tank, Oily waste and oil spills, Hazardous waste management guidelines, Waste minimization, Metal pollution, NOAEL, LOAEL, ADI, RFD, Hazard index, Daily intake, Ecotoxicology, Toxikinetics, Control of release of heavy metal.	
<b>References</b> <ol style="list-style-type: none"><li>1. Nag, K. Vizayakumar, "Environmental Education and Solid Waste Management" New Age International Publishers.</li><li>2. Donald R. Rowe, George Techobanoglous, Howard S. Peavy, "Environmental Engineering", McGraw-Hill Book Company.</li><li>3. George Techobanoglous, Hilary Thesien, Samuel Vigil, "Integrated Solid Waste Management Engineering Principles and Management Issues" McGraw-Hill Inc.</li></ol>	

**PCC (EW-19009) Urban Hydrology and Drainage**

**Teaching Scheme**

Lectures: 3hrs/week

**Examination Scheme**

T1, T2 – 20 marks each,  
End-Sem Exam – 60

**Course Outcomes:**

At the end of the course, students will demonstrate the ability to:

1. Identify factors affecting urban hydrological cycle
2. Flow Estimate urban water demand and urban stormwater quantity.
3. Plan and design stormwater control and disposal system.
4. Develop integrated urban water management system.

**Syllabus Contents:**

Introduction to urban system, functional elements of urban system, urbanisation effects on water cycle, trends in urbanization, hydrological problems, challenges and issues of urban area. Urban water resources management model,

Type of models- Physically based-conceptual based –Urban surface runoff model. Rainfall analysis in urban environment, importance of short duration rainfall and runoff data, urban runoff computations- empirical, Time-area and Unit Hydrograph approaches, rational method, SCS peak flow method runoff modeling.

Introduction to urban drainage and sewerage network, Storm water management, Storm Systems-information needs, design criteria, rational method design, hydraulic analysis and designs, Storm water drainage channels- rigid-lined channels, flexible lined channels,

Storm water control: street and highway drainage- design considerations, flow in gutters. Storm Water Detention- types of surface detention sizing detention, detention basin routing,

Subsurface disposal of storm water and best management practices (BMP's). Operation and maintenance in urban system. Introduction of standard packages such as SWMM.

Urban water supply: introduction, importance and necessity for planned water supplies, Estimates of demand, design period, population data and population growth. Types of water supply system, design of water distribution system, ground and elevated service reservoir capacity estimation. .

**References:**

1. Hall , M. J., Urban Hydrology, Elsevier Applied Science Publishers, 1984
2. Chow,V.T., Handbook of Applied Hydrology:A compendium of water technology, Mc,Hill, NY1964
3. Larry W. Mays. " Water Resources Engineering", John Wiley & Sons, inc NY, ISBN0-471-29783-6
4. Philip B. Bedient and Wayne C. Huber. "Hydrology and flood plain analysis", Addison- Wesley Publication Company, Inc ISBN 0-201-12056-9
5. P. R. Bhave. Optimal Design of Water Distribution Networks Narosa Publishing house.ISBN 81-7319-505-6
6. Warren Viessmann, Jr. Gary L. Lewis. "Introduction to Hydrology" Eastern Economy Edition, PHI learning Pvt. Ltd. New Delhi. ISBN978-81-203-3368-0
7. Allen P. Davis and Richard H. Mc Cuen" Storm water Management for Smart Growth", Springer, ISBN 10: 0-387-26048-X, ISBN-13: 9780387275932

## PCC (EW-19010) Environmental Impact Assessment

### Teaching Scheme

Lectures: 4 hrs/week

### Examination Scheme

T1, T2 – 20 marks each,  
End-Sem Exam – 60

### Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Understand the ecological stability and ecological systems concept and formulate the real problem due to manmade developmental activities
2. Select Environmental, Economic and social indicators, collect data and conduct analysis.
3. Select appropriate technique and methodology to carry out Environmental Impact Assessment.

### Syllabus Contents:

Environment and its interaction with human activities – Environmental imbalances, attributes, impacts, Indicators and Measurements, Environmental Impact Assessment (EIA) – concepts, objectives of EIA, advantages and limitations of EIA, Screening and scoping, Rapid EIA and comprehensive EIA Environmental Indicators – Indicators of climate, Indicators of terrestrial subsystems, Indicators of aquatic subsystems, Selection of indicators, Socio – economic indicators – basic information, Indicators for economy – social indicators, Indicators for health and nutrition, Cultural indicators – selection Methodologies for carrying Environmental Impact Assessment – Overview of methodologies, Environmental risk analysis - Adhoc, Checklist, Matrix, Network, Overlays, Fault free analysis, Benefit Cost Analysis, Choosing a methodology, Review criteria, Case studies on EIA Environmental issues in water resources development – Land use, soil erosion, their long term and short term effects, Disturbance and long term impacts, Changes in quantity and quality of flow, Environmental impact assessment of water resource development structures – Case studies. Water Quality Impact Assessment – attributes, Water Quality Impact Assessment of Water Resources Projects, Data requirements of water quality impact assessment for dams, Impacts of dams on environmental, Case studies Environmental Issues in Industrial Development – On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development.

### References :

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

<b>(EW-19011) MINI PROJECT</b>	
<b>Teaching Scheme</b> Lectures: 2 hrs/week	<b>Examination Scheme</b> End-Sem Exam – 100 marks
<p><b>Course outcomes:</b></p> <p>At the end of the course, students will demonstrate the ability to</p> <ol style="list-style-type: none"> <li>1. Identify a topic for study and carry out literature survey</li> <li>2. Write a technical report related to selected topic</li> <li>3. Present outcome of the study with the help of ppt.</li> </ol>	
<p><b>Course content:</b></p> <p>Mini project presentation is to be performed and reported by the end of the second semester</p>	

<b>LC (EW-19012) Computational Laboratory in Environmental and Water Resources Engineering</b>	
<b>Teaching Scheme</b> Lab Practice: 2 hrs./week	<b>Examination Scheme</b> End Sem Presentation :100 marks
<p><b>Course outcomes:</b> at the end of the course, students will demonstrate the ability to</p> <ol style="list-style-type: none"> <li>A. Use software's related to environment and water resources</li> <li>B. Apply software for solution of problems</li> <li>C. Prepare models based on software</li> </ol>	
<p><b>Syllabus Contents:</b></p> <p>Following experiments have to be performed in Computer lab using software packages such as HEC-RAS1, HEC-HMS, EPANET, SWMM, MODFLOW, QUAL2EU, CROPWAT,</p> <ol style="list-style-type: none"> <li>1. Watershed Simulation Flood Control</li> <li>2. Optimization Design of water distribution system</li> <li>3. Storm drainage design</li> <li>4. Detention basin design</li> <li>5. Water quality modeling in rivers</li> <li>6. Groundwater flow simulations</li> <li>7. Rainfall runoff modeling</li> <li>8. Crop water management</li> </ol>	

### Semester-III

SBC EW-19013	Dissertation phase-I
SLC EW-19014	Massive Open Online Course

### Dissertation I and II

#### Course Outcomes

At the end of course, Students will be able to

1. Identify and carry out research in key areas of construction and management
2. Analyze data collected and interpret the same
3. Develop conclusions based on the analysis which are useful to the society at large

### Semester-IV

SBC EW-19015	Dissertation phase-II
SLC EW19016	Massive Open Online Course