COEP Technological University Pune

(A Unitary Public University of Govt. of Maharashtra)

School of Civil Engineering and Planning

Curriculum Structure

M.Tech (Environmental and Water Resources Engineering)

(Regular)

Civil Engineering

(Effective from: A.Y. 2023-24)

Programme Educational Objectives (PEOs)

I. Graduates of the programme will have in-depth knowledge to identify and formulate challenging environmental andwater resources problems, apply appropriate research methodologies, use modern engineering tools and provide technically sound,economical and sustainable solutions.

II. Graduates will have ability for higher studies and undertake high value research on environmental,water resources and other related issues.

III. Graduates of programme will have sound analytical and lateral thinking ability to engage in lifelong learning for professional advancement to cope up with multidisciplinary and changing technologies in environmental and water resources engineering.

IV. Graduates of the programme will have sense of social responsibility, will demonstrate ability to communicate and work effectively as a team member in an ethical way, and will play leadership roles in their profession, public services and community.

Programme Outcomes (POs)

On completion of the Programme, students will be able to

PO1: Apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude, independently carrying out research /investigation and development works.

PO2: Write and present a substantial technical report / document.

PO3: Demonstrate a degree of mastery in environmental and water resources engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor Programme.

PO4: Gain knowledge / skill in integrating environmental and water resources concepts for collaborative multidisciplinary solutions and carry out planning and management of projects as a member and a leader in a team considering economic and financial factors.

PO5: Recognize the need for and have ability in lifelong learning independently for professional advancement, demonstrate professional ethics, work culture and understanding of responsibility to contribute to community for sustainable development of society.

PO6: Recognize the need for and have ability in lifelong learning independently for professional advancement, demonstrate professional ethics, work culture and understanding of responsibility to contribute to community for sustainable development of society.

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.88
PSBC	Program Specific Bridge Course	1	4	5.88
PEC	Program Elective Course	3	9	13.25
MLC	Mandatory Learning Course	2	0	0
PCC	Program Core Course	5	16	23.53
LC	Laboratory Course	6	7	10.29
UOE	University Open Elective	1	3	4.41
CCA	Course-Curricular Activity	1	1	1.47
SLC	Self Learning Course	2	6	8.82
VSEC	Vocational Skill Based Enhancement Course	2	18	26.47

M.Tech. in Environmental and Water Resources Engineering

[Regular]

Semester -I

Sr. No.	Course Code	Course Title	L	T	P	S*	Cr	Category
01	EW-23001	Statistical Methods in Hydrology and Environment Engineering	3	1	-	1	4	PSMC
02	EW-23002	Applications of Geoinformatics in Environmental and Water Resources Engineering.	4	-	-	1	4	PSBC
03	EW(PE)-23001	Departmental elective-I 1. Principles of Water and Air Quality Legislation	3	-	-	1	3	PEC
	EW(PE)-23002	2. Decentralized Liquid Waste Management						
	EW(PE)-23003	3. Irrigation and Drainage						
	EW(PE)-23004	4. Channel and River Hydraulics						
04	EW-23003	Advanced Water and Wastewater Treatment	3	1	-	1	4	PCC
05	EW-23004	Ground Water Hydrology	3	-	-	1	3	PCC
06	EW-23005	Environmental Engineering Lab-1	-	-	2	-	1	LC
07	EW-23006	Water Resources Engineering Lab-1	-	-	2	-	1	LC
08	EW-23007	Mini Project	-	-	1	1	1	LC
		Total	**16**	**02**	**05**	**06**	**21**	

* Faculty Incharge should declared syllabus which will be studied by students in self learning mode. Teacher should declaresyllabus and give references for the same

Semester -II

Sr. No.	Course Code	Course Title	L	T	P	S*	Cr	Category
01	UOE	Application of Geoinformatics in Water Management. or Plumbing Engineering	3	-	-	1	3	UOE
02	EW(PE) -23005	Departmental Elective-II 1. Computational Fluid Dynamics	3	-	-	1	3	PEC
	EW(PE) -23006	2. Land and Water Management						
	EW(PE) -23007	3. Air Pollution Control and Industrial wastewater Treatment						
	EW(PE) -23008	4. Water and Air Quality Models						
03	EW(PE) -23009	Departmental Elective-III Climate Change and Water Resources	3	-	-	1	3	PEC
	EW(PE) -230010	2.Water Resources Planning, Management and Economics						
	EW(PE) -230011	3. Transport of Water and Wastewater						
	EW(PE) -230012	4. Advance Environmental Engineering Practices						
04	LL	Course-Curricular Activity	1	-	-	1	1	CCA
05	ML-23001	Research Methodology and Intellectual Property Rights	2	-	-	1	-	MLC
06	EW-23008	1. Solid and Hazardous Waste Management	3		-	1	3	PCC
07	EW-23009	2. Urban Hydrology and Drainage	3	-	-	1	3	PCC
08	EW-23010	3. Environmental Impact Assessment	3	-	-	1	3	PCC
09	EW-23011	Seminar	-	-	2	1	2	LC
10	EW-23012	Environmental Engineering Lab-2	-	-	2	-	1	LC
11	EW-23013	Water Resources Engineering Lab-2	-	-	2	-	1	LC
		Total	**21**	**00**	**06**	**09**	**23**	

Note: After completion of first year, for PG diploma exist option, it is mandatory to all the students to complete 8 weeks training course of 1 credit for the award of PG diploma in Civil-EWRE (Environment and Water Resource Engineering)

Semester -III

Sr. No.	Course Code	Course Title	L	T	P	S*	Cr	Category
01		Dissertation phase-I	-	-	18	2	9	SBC
02		Massive Open Online Course	3	-	-	2	3	SLC
		Total	**03**	**00**	**18**	**04**	**12**	

Semester -IV

Sr. No.	Course Code	Course Title	L	T	P	S*	Cr	Category
01		Dissertation phase-II	-	-	18	2	9	SBC
02		Massive Open Online Course	3	-	-	2	3	SLC
		Total	**03**	**00**	**18**	**04**	**12**	

* Faculty Incharge should declared syllabus which will be studied by students in self learning mode. Teacher should declaresyllabus and give references for the same

Course Structure for M.Tech (Environmental and Water Resources Engineering)

FIRST YEAR

Semester I

EW-23001 Statistical Methods in Hydrology and Environment Engineering	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
Tutorial: 1 Hrs/ week	**End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Acquire foundational knowledge of sampling and its various types
CO 2: Develop a basic understanding of probability concepts and their practical applications
CO 3: Apply appropriate regression models for environmental and water resource analysis
CO 4: Comprehend and utilize statistical models effectively.
CO 5: Apply time series analysis appropriately for predicting environmental and climate change trends.
CO 6: Interpret human behavior patterns in terms of mathematics and geometry.

Syllabus Contents:

Stochastic hydrology, Need for statistical methods in hydrology Probability axioms, Total probability theorem and Bayes theorem, Independence and independent events, Construction of probability paper, Probability plotting, Flood frequency analysis, Parameter estimation Nature of hydrologic data, Sampling errors, Graphical presentation of data, Random numbers, Discrete distribution, Binomial distribution, Poisson distribution, Continuous distributions used in hydrology, Normal distribution, Lognormal distribution, Exponential distributions, General extreme value distributions, Moments and expectations of distributions, Frequency analysis of hydrologic variables, Sampling distributions, Confidence interval estimation of population parameters, Hypothesis testing, Large sample tests for mean and proportion, Test for goodness of fit of data to probability distributions, Chi – square and K – S test, Curve fitting method of least squares, Regression analysis, Simple and multiple linear regression, Evaluation of regression, Multivariate regression analysis, Correlation coefficient and its significance in regional analysis, Hydrologic time series analysis – nature, Stationarity and ergodicity, Components of time series, Trend and periodicity, Auto-variance and auto-correlation functions, Cross correlation, Correlogram analysis, Analysis of multivariate hydrologic series, Modelling of hydrologic time series, Data

generation techniques, Autoregressive processes and models, Moving average models, ARMA models, Non – stationary models, Thomas – Fiering model, ARIMA models, Modeling the trend, Multi-site modeling, Disaggregation models.

Text Books:

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

EW-23002 Applications of Geoinformatics in Environmental and Water Resources Engineering

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:

CO 1: Acquire a foundational understanding of remote sensing, GIS, and GPS technologies.

CO 2: Develop proficiency in GIS-based analytical and problem-solving techniques.

CO 3: Comprehend the basic principles underlying RS-GIS based modeling of hydrological systems.

CO 4: Apply 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 modeling, Flood estimation-SCS, GIS based river basin modeling, Modelling parameters, Spatio-temporal basin simulationmodel 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:

- Water Resources Systems Planning and Management, Jain S.K. and Singh V.P., Elsevier, The Netherlands, 2003.
- Remote Sensing and Image Interpretation by Thomas M. Lillesand , Ralph W. Kiefer , Jonathan W. Chipman
- Geographic Information Systems and Environmental Modeling by Clarke, Keith C., Bradley O. Parks, and Michael P. Crane. Upper Saddle River, NJ: Prentice Hall, 2002.
- Principles of Remote Sensing- Edition: ITC Educational Textbook Series 2,Publisher: ITC, nschedeEditors: N. Kerle, L.L.F. Janssen, G.C. Huurneman.
- 'Water Resources Systems: Modelling Techniques and Analysis',Vedula S. and Mujumdar P.P., Tata-McGraw Hill, 2005.

EW(PE)-23001 Principles of Water & Air Quality Legislation	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks
Course Outcomes: At the end of the course, the students is able to:	
CO 1: Analyze water law principles and uncertainty concepts in water resources planning	
CO 2: Apply water quality monitoring and modeling techniques for pollution control	
CO 3: Develop strategies for water quality management in various water bodies	
CO 4: Integrate legal aspects and environmental protection laws into water management plans	

Syllabus Contents:

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.

References:

1. Tebutt T.H.Y. "Principles of Water Quality Control", Pergamon Press, Oxford
2. Gerard Kiely "Environmental Engineering", McGraw Hill Publications.
3. Viessman W. Jr. and Hammer M.J. "Water supply and Pollution control", Harper & Row Publications Inc., Singapore.
4. Jerald L. Schnoor "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley & Sons Inc. New York.

EW(PE)-23002 Decentralized Liquid Waste Management

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Analyse the benefits, objective and options for liquid waste management
CO 2: Comprehand the concept of fecal waste management
CO 3: Identify, locate and quantify contamination contributed by onsite system
CO 4: Get insight into the treatment options for toilet system and domestic liquid waste
CO 5: Design and analyzes the rector
CO 6: 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, 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.

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, GoI, 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 Guidlines.
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 NationsChildren's Fund).
7. Kara L. Nelson, Small and Decentralized System for Wastewater Treatment and Reuse, Proceeding

EW(PE)-23003 Irrigation and Drainage

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Evaluate appropriate methods of irrigation
CO 2: Create a design for micro-irrigation systems
CO 3: Analyze and differentiate between drainage and salinity control measures
CO 4: Develop designs and strategies for managing drainage systems

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, BAIl. "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.

EW(PE)-23004 Channel and River Hydraulics

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:

CO 1: Analyze & Calculate parameters governing the flow through open-channels and types of water surface profiles.

CO 2: Compute flow profiles in channel transitions and due to hydraulic structures

CO 3: Analyze gradually-varied flow, rapidly-varied flow, unsteady flow and sediment transport in open channel.

CO 4: Design stable channels, erodible and lined channels for clear and sediment flows

Syllabus Contents:

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, Monoclinal 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.

References:

1. Chow V.T. "Open Channel Hydraulics", McGraw Hill, Inc. New York.
2. Henderson "Open channel flow", McMillan Pub. London.
3. Subramanya K. "Flow in Open Channels", Tata McGraw Hill Pub.
4. Garde and RangaRaju K.G. "Mechanics of sediment transportation and Alluvial Stream Problems", Wiley Eastern, New Delhi.
5. Chaudhry M.H. "Open – Channel Flow", Prentice Hall of India, New Delhi.
6. French R.H. "Open Channel Hydraulics", McGraw Hill Pub Co., New York.

EW-23003 Advanced Water and Wastewater Treatment

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
Tutorial: 1 Hrs/ week	**End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Analyze quality of water and waste water
CO 2: Select appropriate technology for treatment of water and wastewater
CO 3: Design a treatment facility for treatment of water and wastewater
CO 4: Investigate advanced water and wastewater treatment methods

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.

EW-23004 Groundwater Hydrology

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Demonstrate the different terminologies related with groundwater hydrology
CO 2: Evaluate methods for determining aquifer parameters
CO 3: Analyze groundwater exploration techniques and appraise groundwater potential
CO 4: Compare and contrast suitable ground water quality management methods and ground water model.

Syllabus Contents:

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 Delhi.
8. Waltin W.C "Groundwater Resources Evaluation", McGraw Hill Inc. N York.

EW-23005 Environmental Engineering Lab-I

Teaching Scheme	Examination Scheme
Practical: 2 Hrs/ week	**End Sem. Exam.** - 100 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Analyse the characteristics of the water
CO 2: Demonstrate the techniques and procedures for accurately measuring contaminanent concentrations in water samples
CO 3: Acquire practical skills in analyzing contaminant levels in water samples and interpreting the results.
CO 4: Impliment appropriate method to control the characteristics of water.

Syllabus Contents:

1. To determine pH of the sample
2. To determine sodium dodecyl sulphate in water
3. To determine nitrate contents in water
4. To determine fluoride content in water
5. To determine arsenic concentration in water
6. To determine hardness and alkalinity in water sample
7. To determine sulphate concentration in water
8. To determine iron content present in water

References:

1. APHA (2017) Standard methods for the examination of water and wastewater. Rodger B. Baird, Andrew D. Eaton, Eugene W. Rice American Public Health Association 1-1545

EW-23006 Water Resources Engineering Lab-1

Teaching Scheme	Examination Scheme
Practical : 2 Hrs/ week	**End Sem. Exam.** - 100 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Measure the flow through pipe and the calibration of hydraulic structures.
CO 2: Perform the basic as well as advance tests on water and waste water
CO 3:
CO 4:

Syllabus Contents:

1. To determine Reynolds number
2. To verify Bernoulli's equation
3. To measure the flow by venturimeter
4. To measure the flow by orifice meter
5. To study the uniform flow in open channel
6. To study the standing wave flume
7. To study the hydraulic jump

References:

1.

EW-23007 Mini Project	
Teaching Scheme	**Examination Scheme**
Practical : 1 Hrs/ week	**End Sem. Exam.** - 100 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Identify a topic for study and carry out literature survey.
CO 2: Write a technical report related to selected topic
CO 3: Present outcome of the study with the help of ppt.
CO 4:

Syllabus Contents:

Mini project presentation is to be performed and reported by the end of the second semester.

Semester II

UOE Geoinformatics for Water Management	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Attain a foundational grasp of remote sensing, GIS, and GPS technologie
CO 2: Acquire proficiency in utilizing GIS-based analytical and problem-solving techniques
CO 3: Comprehend the fundamental principles that underlie RS-GIS-based modeling of water management systems.
CO 4: Apply the Geoinformatics tools for sustainable planning and management of water resources

Syllabus Contents:

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 for Water Management 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.

References :

1. Remote Sensing and Image Interpretation by Thomas M. Lillesand , Ralph W. Kiefer , Jonathan W. Chipman
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.
3. Principles of Remote Sensing- Edition: ITC Educational Textbook Series 2,Publisher: ITC, nschedeEditors: N. Kerle, L.L.F. Janssen, G.C. Huurneman

EW (PE)- 23005 Computational Fluid Dynamics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Acquire knowledge of Computational Fluid Dynamics (CFD) as an engineering analysis tool.
CO 2: Apply the derivation of flow governing equations; implement turbulence modeling; utilize modeling approaches for multiphase flow; establish initial and boundary conditions
CO 3: Discretize the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for unsteady transport equation.
CO 4: Apply techniques to solve discretized equations; employ direct methods, classical iterative methods, advanced methods for structured matrices, conjugate gradient techniques, and multigrid methods
CO 5: Employ methods to solve coupled equations, including techniques for compressible flows, evaluation of pressure in incompressible flows, and pressure-velocity coupling algorithms.

Syllabus Content:

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 (PE)- 23006 Land and Water Management	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Implement suitable method of land and water management.
CO 2: Design soil and water conservation structures
CO 3: Estimate water requirements of crops and decide suitable method of irrigation.
CO 4: Execute land suitability classification and recommend appropriate methods for dry land farming.

Syllabus Content:

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. Scwabe, G.O., Fangmeir, D.D., and Elliot W.J., Soil and Water Management Systems, John Wiley and Sons, N York, 1996
8. Asawa, G.L. (1996) —Irrigation Engineering", New Age International Pub. Co. N Delhi.
9. Suresh, R.L. (1999) —Soil and Water Conservation Engineering", Standard Publishing Co. Delhi.

EW (PE)- 23007 Air Pollution Control and Industrial Wastewater Treatment	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Analyze the sources, classification, and combustion processes of air pollutants, assessing their impact on health, vegetation, materials, and the atmosphere.
CO 2: Evaluate the reactions of pollutants in the atmosphere and their effects on the environment
CO 3: Assess the methods and instruments for air sampling and pollutant measurement, applying principles of ambient air quality and emission standards to ensure effective contro
CO 4: Apply various techniques for the removal of gaseous pollutants and particulate emission control methods
CO 5: Analyze the sources and characteristics of industrial wastewater, distinguishing between physical, chemical, and biological properties, and develop strategies for treatment and disposal, considering the specific needs of different industrial sectors and joint treatment approaches

Syllabus Content:

Air Pollution Control: Air pollutants-Sources, classification, Combustion processes and pollutant emission, Effect on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects- Smoke, smog and ozone layer disturbance, Atmospheric diffusion of pollutants and their analysis, Transport, transformation and deposition of air contaminants on a global scale, Air sampling and pollutant measurement methods, principles and instruments, ambient air quality and emission standards, control, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods, Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal method.

Industrial wastewater treatment: 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. 2. Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hill
3. M.N. Rao and Dutta – Industrial Waste.
4. Mark J. Hammer, Mark J. Hammer, Jr., "Water & Wastewater Technology", Prentice Hall of India.
5. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.
6. C.G. Gurnham –Principles of Industrial Waste Engineering

EW (PE)- 23008 Water and Air Quality Models

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students are able to:

CO 1: Design models for analysing stream water quality and quantity.

CO 2: Develop air quality models under different atmospheric stability conditions

CO 3: Design and analysis of Models for micro-organisms studies

CO 4: Evaluate reaction kinetics, carbonate equilibriums, and biological processes

Syllabus 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.

EW (PE)- 23009 Climate Change and Water Resources	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Analyze climate change drivers and impacts, including water resources, through different phenomena
CO 2: Assess vulnerability using quantitative and economic models, applying IPCC findings for adaptation strategies.
CO 3: Develop adaptation plans for sectors like agriculture and infrastructure, considering potential conflicts with mitigation efforts
CO 4: Examine various Project for insights into water resource management and adaptation approaches
CO 5: Evaluate strategies for water resource management, flood, and drought management, based on case studies and scenario assessments

Syllabus Content:

The Climate System 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.

Impacts of Climate Change – Observed and Projected Global Scenario – Indian Scenario – Observed changes and projected changes of IPCC - Impacts on water resources – NATCOM Report –Impacts on sectoral vulnerabilities – SRES – Different scenarios

Tools for Vulnerability Assessment 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

Adaptation and Mitigation Water-related adaptation to climate change in the fields of Ecosystems and biodiversity, - Agriculture and food security, land use and forestry, Human health, water supply and sanitation, infrastructure and Economy (insurance, tourism, industry and transportation) - Adaptation, vulnerability and sustainable development Sector-specific mitigation - Carbon dioxide capture and storage (CCS) , Bio-energy crops, Biomass electricity, Hydropower, Geothermal energy, Energy use in buildings, Land-use change and management, Cropland management, Afforestation and Reforestation - Potential water resource conflicts between adaptation and mitigation - Implications for policy and sustainable development.

Case Studies Water resources assessment case studies – Ganga Damodar Project , Himalayan glacier studies, Ganga valley project - Adaptation strategies in Assessment of water resources- Hydrological design practices and dam safety- Operation policies

for water resources projects - Flood management strategies - Drought management strategies-Temporal & spatial assessment of water for Irrigation -Land use & cropping pattern - Coastal zone management strategies.

References :

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 (PE)- 23010 Water Resources Planning, Management and Economics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Apply various concepts in water resources planning, management, and economics
CO 2: Implement reservoir planning and operation for irrigation, hydropower, flood control, and water supply.
CO 3: Evaluate benefits arising from irrigation, flood control, hydropower, recreation, and sedimentation control
CO 4: Analyze and choose the most cost-effective option from a range of alternatives available

Syllabus Content:

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", Buttersworth, London.
6. S. K. Jain and V. P. Singh, "Water Resources Systems Planning and Management," Elsevier Science B.V, Am sterdam, 2003.
7. S. Vedula and P. P. Mujumdar, "Water Resources Systems Modelling Techniques and Analysis," Tata-McGraw Hill, New Delhi, 2005

EW (PE)- 23011Transport of Water and Wastewater	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Design water storage and transmission system including pumping of water
CO 2: Computer applications in distribution network analysis
CO 3: Design of storm drains-storm water inlets
CO 4: Assess the maintenance needs of sanitary sewage and storm drainage systems

Syllabus 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.

References :

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 (PE)- 23012 Advanced Environmental Engineering Practices	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Establish a strong theoretical knowledge base to equip students for roles in industries, academia, research, and consultancies
CO 2: Evaluate the environmental impacts of industrial waste disposal, both untreated and treated
CO 3: Explore fundamental concepts integral to industrial wastewater treatment
CO 4: Apply experimental design to conduct research, analyze data, interpret results, and draw conclusions.

Syllabus Content:

Advanced water treatment

Modification of Rapid Sand Filter- Up flow Filters. Dual Media, Multimedia and mixed bed filters. Diatomaceous filters. Application Membrane Processes, Reverse Osmosis, Ultra filtration, Electrodyalisis, Defluridation (Causes of fluorides in water, significance of high and low fluorides in water, methods of de fluoridation), arsenic removal (Introduction, sources, effects and treatment process).

Advanced Waste management

Modification in conventional wastewater treatment (MBBR and SBR), sources, treatment of grey and black water, treatment of mixed grey and black water, used of treated wastewater, minimum and maximum velocity in sewer, USBR, FAB reactor, Constructed wetland, Duckweed pond process, Rural Sanitation, Feacal Sludge Treatment Plant, Ecosan Toilet, Twin Pit system, Solid and Hazardous waste management: Definition, Types, effects and Treatment, waste minimization, transfer station, break even analysis, bio-mining of old dumped solid waste, sustainable solid waste management, Dose response relationship, measurement of toxic substances, E-waste management.

Air Pollution:

Meteorological Aspects: Parameters influencing air pollution, measurement of parameters plume behavior, transport, and diffusion. Formulae for stack heights, Gaussian diffusion models for finding ground level concentration. Design problems of height of chimney and ground level concentration. Photochemistry of air pollution, Photochemical smog reactions involved in its formation, Factors influencing its reactions. Effects on man, animals, vegetation and property, Economics of loss due to pollution, Episodes, Air Pollution index. Cost / benefit ratio, optimization, Control of Pollution: By process modification, Change of raw materials, Fuels, process equipment and process operation by use of air pollution control equipments, For particulate pollutants, Air Pollution control by using Equipments, Design of control equipments as ESP, Scrubber, Bag filter, Cyclones etc Control of gaseous pollutants Absorption devices, Adsorption Devices, Combustion devices, Condensation devices Land use

planning: As a method of air pollution control, Sampling and Analysis: Air Pollution survey, Basic and statistical considerations of sampling sites, Devices and methods used for sampling gases and particulars, Stack sampling, Iso kinetic sampling Analysis of air samples, Chemical and instrumental methods, Ambient air quality standards and emission standards.
Noise and Odor pollution and Environmental Impact Assessment
Odors: Sources, measurement and control, Noise characteristics, measurement of noise, Effects of noise, Control of noise, Environmental Impact Assessment: Definition, Broad Goals, Objectives, Phases in EIA, Contents of Application form, Advantages & Disadvantages of EIA, Environmental management plan, Environmental Impact of Industries, Urbanization and Agricultural activities.

References :

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

LL Coursre curricular Activity (Liberal Learning Course)	
Teaching Scheme **Lectures:** 1 Hrs/ week	**Examination Scheme** **T1 and T2 -** **End Sem. Exam.**

Course Outcomes: At the end of the course, the students are able to:
CO 1: Develop capacity to understand multidisciplinary sciences in a friendly manner.
CO 2: Create openness to diversity.
CO 3: Acquire ability to lead and examine life and value the need for life learning
CO 4:
CO 5:

Syllabus 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

References :

1.

ML-23001 Research Methodology and Intellectual Property Rights

Teaching Scheme	Examination Scheme
Lectures: 2 Hrs/ week	**End Sem. Exam.** 100 marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Analyze research problems and ethical research practices
CO 2: Apply research methodology and enhance presentation skills
CO 3: Apprehend the importance of Intellectual Property Rights in engineering
CO 4: Explore the role of IPR in national wealth and global market leadership.
CO 5: Evaluate national and international IP systems as incentives for innovation and economic growth.

Syllabus Content:

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. 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, 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.Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights. 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. New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT

References :

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.
6. Aswani Kumar Bansal : Law of Trademarks in India
7. B L Wadehra : Law Relating to Patents, Trademarks, Copyright,Designs and Geographical Indications.
8. G.V.G Krishnamurthy : The Law of Trademarks, Copyright, Patents andDesign.
9. Satyawrat Ponkse: The Management of Intellectual Property.
10. S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents

EW-23008 Solid and Hazardous Waste Management

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -**20 Marks each
	End Sem. Exam.-60 Marks

Course Outcomes: At the end of the course, the students are able to:

CO 1: Analyze key sources, quantities, composition, and properties of solid and hazardous wastes.

CO 2: Apply waste disposal or transformation techniques, such as landfills and incinerators.

CO 3: Comprehend relevant regulations governing waste disposal and destruction facilities.

CO 4: Design Solid and Hazardous Waste Landfills (RCRA Subtitle D and C), considering closure, post-closure, and rehabilitation issues.

Syllabus Content:

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.

References :

1. Nag, K. Vizayakumar, "Environmental Education and Solid Waste Management" New Age International Publishers.
2. Donald R. Rowe, George Techobanoglous, Howard S. Peavy, "Environmental Engineering", McGraw-Hill Book Company.
3. George Techobanoglous, Hilary Thesien, Samual Vigil, "Integrated Solid Waste ManagementEngineering Principles and Management Issues" McGraw-Hill Inc.

EW-23009 Urban Hydrology and Watershed Management

Teaching Scheme	Examination Scheme
Lectures: 3 Hrs/ week	**T1 and T2 -**20 Marks each
	End Sem. Exam.-60 Marks

Course Outcomes: At the end of the course, the students are able to:
CO 1: Recognize factors affecting urban hydrological cycle.
CO 2: Flow Estimate urban water demand and urban stormwater quantity.
CO 3: Plan and design stormwater control and disposal system
CO 4: Develop integrated urban water management system.

Syllabus Content:

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
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EW-23010 Environmental Impact Assessment

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -**20 Marks each
	End Sem. Exam.-60 Marks

Course Outcomes: At the end of the course, the students are able to:

CO 1: Analyze environmental imbalances and impacts of human activities using indicators and measurements.

CO 2: Evaluate Environmental Impact Assessment (EIA) concepts, objectives, advantages, and limitations.

CO 3: Apply environmental indicators and methodologies for EIA

CO 4: Assess environmental issues in water resources and industrial development, utilizing case studies for understanding

Syllabus Content:

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 scooping, 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, Imapcts 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", WNESCO/UNEP, Paris
4. Canter L.W. "Environmental Impact Assessment", McGraw Hill Pub. Co. New York

EW-23011 Seminar	
Teaching Scheme	**Examination Scheme**
Practical : 1 Hrs/ week	**End Sem. Exam.** - 100 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Identify a topic for study and carry out literature survey.
CO 2: Write a technical report related to selected topic
CO 3: Present outcome of the study with the help of ppt.
CO 4:

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

EW-23012 Environmental Engineering Lab-II

Teaching Scheme	Examination Scheme
Practical: 2 Hrs/ week	**End Sem. Exam.** - 100 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Analyse the characteristics of the wastewater
CO 2: Demonstrate the techniques and procedures for accurately measuring parameters of wastewater samples
CO 3: Acquire practical skills in analyzing characteristics of wastewater samples and interpreting the results.
CO 4: Impliment appropriate method to control the characteristics of wastewater.

Syllabus Contents:

1. 1. To determine dissolved oxygen
2. To determine BOD
3. To determine TOC
4. To determine the salt concentration wastewater
5. To measure the dye concentration in wastewater
6. To study the SEWER GEM software
7. To determine the SVI
8. To determine the solids

References:

1. APHA (2017) Standard methods for the examination of water and wastewater. Rodger B. Baird, Andrew D. Eaton, Eugene W. Rice American Public Health Association 1-1545

EW-23013 Water Resources Engineering Lab-II

Teaching Scheme	Examination Scheme
Practical : 2 Hrs/ week	**End Sem. Exam.** - 100 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Utilize software's related to environment and water resources
CO 2: Apply software for solution of problems
CO 3: Prepare models based on software
CO 4:

Syllabus Contents:

Following experiments have to be performed

1. Watershed Simulation Flood Control
2. Optimization Design of water distribution system
3. Storm drainage design
4. Detention basin design
5. Water quality modeling in rivers
6. Groundwater flow simulations
7. Rainfall runoff modeling
8. Crop water management

References:

2.

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