FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

M.E., WATER RESOURCES ENGINEERING & MANAGEMENT PROGRAMME

VISION

To become

School of Excellence in Civil Engineering

With **Conformity, Quality and Standards**

in **teaching, research, training** and **consultancy**

towards producing globally competent Civil Engineers**.**

MISSION

M1: To Promote quality in education, research and professional training for satisfying the needs of industry and society.

M2: To provide state-of-the-art facilities and resources that contributes to a congenial learning environment.

M3: To establish Centers of Excellence in emerging areas of Civil Engineering for the students to acquire domain specific expertise and also facilitate Industry- Institution interaction.

M4: To inspire the students to pursue higher education and take competitive examinations and various career enhancing programs.

M5: To instill the professional ethics and their role for sustainable development and corruption-free country.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1	To promote student's aptitude in all Water Resources Engineering & Management subjects such as Hydrology, Watershed Management, Flood Control, Remote Sensing & GIS, Integrated Irrigation systems, Climate Change, etc.
PEO 2	To build professional knowledge in Water Resources Engineering & Management through class room teaching, laboratory practice for analysis of attributes and field demonstration for sampling of attributes and monitoring.
PEO 3	To develop soft skill through numerical modelling tools, Spatial Models and expert systems for data acquisition, prediction analysis and design of systems.

PEO 4	To impart subject specific knowledge with objective information on the challenges ahead like Flood Control and Integrated Water resources Management with methodologies towards solutions.
PEO 5	To sensitize the need and importance to pursue for higher studies, research and training to remain competent to face any future challenges of Water Resources Engineering & Management

Pos for PG Programme	
P01	**Scholarship of Knowledge** Acquire in-depth knowledge of specific discipline or professional area, including wider and glob perspective, with an ability to discriminate, evaluate, analyse and synthesis existing and new knowledge and integration of the same for enhancement of knowledge
P02	**Critical Thinking** Analyse complex engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
P03	**Problem Solving** Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise
P04	**Research Skill** Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually in group(s) to the development of scientific/technological knowledge in one or more domains of engineering
P05	**Usage of modern tools** Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
P06	**Collaborative and Multidisciplinary Work** Possess knowledge and understanding of group dynamics. recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self- management and teamwork. decision-making

	based on open-mindedness. objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others
P07	**Project Management and Finance** Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.
P08	**Communication** Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
P09	**Life-long Learning** Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously
P010	**Ethical Practices and Social Responsibility** Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
P011	**Independent and Reflective Learning** Observe and examine critically the outcomes of one's actions and make correctiv measures subsequently, and learn from mistakes without depending on externa feedback.

PSO1	Enable the student to acquire knowledge in the area of water resource engineers and imbibe the benefit of simulationtools
PSO2	Offer a role todevelop innovative methodologies for independently solving challenging problems
PSO3	Ensure a degree of mastery with an exposure to the state of the art practices and exhibit professional and intellectual integrity

	M1	M2	M3	M4	M5
PEO_1	**2**			**3**	
PEO_2	**3**	**1**			**2**
PEO_3	**1**			**2**	
PEO_4	**3**		**3**	**1**	**1**
PEO_5				**3**	**1**

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}
PEO_1	3	1	2				1		3		
PEO_2	3	2	2		3						
PEO_3	1	1									
PEO_4	3	2	3		1		3				
PEO_5				3					1	1	

SEMESTER I

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
23CEWRPC11	**PC**	Surface Hydrology	3	-	-	25	75	100	3
23CEWRPC12	**PC**	Open Channel Hydraulics	3	-	-	25	75	100	3
23CEWRPE13	**PE**	Program Elective-I	3	-	-	25	75	100	3
23CEWRPE14	**PE**	Program Elective-II	3	-	-	25	75	100	3
23CEWRMC15	**MC**	Research Methodology and IPR	2	-	-	25	75	100	2
23CEWRCP16	**CP**	Water Quality Laboratory	-	-	4	40	60	100	2
23CEWRCP17	**CP**	Hydrologic Modelling Laboratory	-	-	4	40	60	100	2
23CEWRAC18	**AC**	Audit Course-I	2	-	-	-	-	-	0
					Total	205	495	700	**18**

SEMESTER II

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
23CEWRPC21	**PC**	Ground Water Hydrology	3	-	-	25	75	100	3
23CEWRPC22	**PC**	Remote Sensing & GIS	3	-	-	25	75	100	3
23CEWRPE23	**PE**	Program Elective-III	3	-	-	25	75	100	3
23CEWRPE24	**PE**	Program Elective-IV	3	-	-	25	75	100	3
23CEWROE25	**OE**	Open Elective (Inter Faculty)	3	-	-	25	75	100	3
23CEWRCP26	**CP**	RS & GIS Laboratory	-	-	3	40	60	100	2

23CEWRTS27	**TS**	Industrial Training and Seminar/ Mini Project		Tr 2	S 2	40	60	100	2
23CEWRAC28	**AC**	Audit Course-II	2	-	-	-	-	-	0
					Total	205	495	700	**19**

SEMESTER III									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
23CEWRPE31	**PE**	Program Elective-V	3	-	-	25	75	100	3
23CEWROE32	**OE**	Open Elective (Inter Faculty)	3	-	-	25	75	100	3
23CEWRPV33	**TH-I**	Thesis & Viva-voce Phase-I	-	Pr 16	S 4	40	60	100	10
					Total	**90**	**210**	**300**	**16**

SEMESTER IV									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
23CEWRPV41	**TH-II**	Thesis & Viva-voce Phase-II	-	Pr 24	S 6	40	60	100	15
					Total	**40**	**60**	**100**	**15**

GRAND TOTAL CREDITS: 68

PC	**Program Core**	**CP**	Core Practical	**AC**	Audit Course
PE	**Program Elective**	**TS**	Industrial Training and Seminar	**TH**	Thesis & Viva-voce
OE	**Open Elective**	**MC**	Mandatory Learning Course	**CE**	Branch code
				WR	M.E Specialization Code

Note: * - Four weeks during the summer vacation at the end of II Semester.

PROGRAMME ELECTIVES (PE)

Course Code	Name of Elective Courses
23CEWRPEXX	Statistics for Water Resources Engineering
23CEWRPEXX	Hydrosystems Engineering
23CEWRPEXX	Computational Methods for Water Resources Engineering
23CEWRPEXX	Water Quality Modelling
23CEWRPEXX	Environmental Impact Assessment
23CEWRPEXX	Hydraulic Structures
23CEWRPEXX	Ground Water System Planning and Management
23CEWRPEXX	Urban Hydrology
23CEWRPEXX	Watershed Management
23CEWRPEXX	River Engineering
23CEWRPEXX	Soft Computing in Water Resources Management
23CEWRPEXX	Water Quality Management for Agriculture
23CEWRPEXX	Flood Modelling and Draught Assessment
23CEWRPEXX	Advanced Hydrological Analysis and Design
23CEWRPEXX	Climate Change and Adaptation

OPEN ELECTIVES (OE)

Course Code	Name of Elective Courses
23CEWROE XX	Water Quality Modelling
23CEWROE XX	Integrated Water Resources Management
23CEWROE XX	Groundwater Contaminant Transport Modelling
23CEWROE XX	Coastal Engineering

23CEWROE XX	Composite Materials
23CEWROE XX	Business Analytics
23CEWROE XX	Industrial Safety
23CEWROE XX	Operations Research
23CEWROE XX	Cost Management of Engineering Projects
23CEWROE XX	Waste to Energy

AUDIT COURSES (AC)

Course Code	Name of Audit Courses
23CEWRACXX	English for Research Paper Writing
23CEWRACXX	Disaster Management
23CEWRACXX	Sanskrit for Technical Knowledge
23CEWRACXX	Value Education
23CEWRACXX	Constitution of India
23CEWRACXX	Pedagogy Studies
23CEWRACXX	Stress Management by Yoga
23CEWRACXX	Personality Development through Life Enlightenment Skills.

FIRST SEMESTER

23CEWRPC11	SURFACE HYDROLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the relevance of various components of hydrologic cycle, which are responsible for spatial and temporal distribution of water availability in any region.
- To study the various aspects of precipitation and abstractions and their analysis
- To understand the concepts of catchment and the factors influencing runoff
- To know the various techniques of streamflow measurement and understand hydrograph analysis
- To enable the students to gain knowledge in flow routing.

Hydrologic Processes : Hydrologic cycle – Concept – Hydrologic systems model – Classification – Hydrologic Process– Continuity equations – Momentum equations – Energy balance. Hydrometeorology. Atmosphere – constituents - structure– General circulation – Transitory system – Transport processes. Climate and Weather– Meteorological Observations.

Precipitation **:** Precipitation –Formation - Types – characteristics- Rainfall hyetograph, Intensity-Duration analysis- Frequency analysis- Intensity-duration-frequency (IDF) relationships- Average areal rainfall - Depth-Area –Duration analysis (DAD) –-Estimating missing rainfall data –PMP - Gauge consistency.

Evaporation, Evapotranspiration and Infiltration : Evaporation–Process- Factors affecting evaporation- Measurement –Estimation- Energy balance method, aerodynamic method, combination method – Evapotranspiration – Reference evapotranspiration – Penman – Monteith method – Crop coefficients. Interception- Infiltration – Process, Factors affecting infiltration, Measurement, Modeling — Horton's equation , Richard's equation, Green Ampt model, Philip Two Term model, SCS model- Depression storage.

Runoff Estimation, Stream Flow Measurement and Hydrograph Analysis: Concepts of catchment -Runoff process –Factors affecting Runoff - Estimation- Infiltration, Strange and SCS methods - Rain fall - Runoff modeling. Stream flow measurement- Stage- velocity - Discharge-measurement - Gauges– Current meter- Stage Discharge relationship – Selection of a Stream Gauging Site - Hydrograph — Base flow separation - Unit Hydrograph –derivations- Synthetic Hydrograph- IUH - Applications.

Flow Routing: Floods- Flow routing – Lumped system routing – Level pool routing – Hydrologic river routing – Linear–reservoir model – Distributed flow routing – Saint-Venant's equations – Classification of distributed flow routing models - Hydrologic design – Hydrologic design scale – Selection of the design level –Flood control measures.

REFERENCES

1. Chow V.T., Maidment D.R., Mays L.W., "Applied Hydrology", McGraw Hill Publications, New York, 1995.
2. Singh, V.P., “Elementary Hydrology”, Prentice Hall, 1991
3. Jaya Rami Reddy.P, "Hydrology”, Laxmi Publications, New Delhi, 2004
4. Bedient, P.B., Huber, W.C., Vieux, B.E., “Hydrology and Floodplain Analysis”, Pearson Education India, 5th Edition, 2012
5. McCuen, R.H., “Hydrologic Analysis and Design”, Prentice Hall, 2004
6. Patra.K.C, "Hydrology and Water Resources Engineering", Narosa Publications, 2nd Edition, New Delhi, 2008.

NPTEL LINK :

1. https://onlinecourses.nptel.ac.im/noc23_ce38/preview

WEB REFERENCE:

1. .https://www.docsity.com/en/surface-water-hydrology-civil-and-environmental-engineering-lecture-slides/293023/

COURSE OUTCOMES

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

1. Obtain the complete knowledge on hydrologic cycle, hydrometeorology and formation of precipitation and analysis of precipitation data.
2. Apply the various methods of field measurements and empirical formulae for estimating the various abstractions from precipitation.
3. Understand the various methods of stream flow measurement
4. Know the various methods of runoff estimation and construction of hydrographs.
5. Understand the aspects of flow routing in rivers and channels.

Mapping of COs with Pos &PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2		1		1		1	1		1		
CO2	1	1	3	2	1		1		1	1	1	1		
CO3	1	1	3	2	1		1		1	1	1	1		
CO4	1	1	3	2	1		1		1	1	1	1		
CO5	1	1	3	2	1		1		1	1	1	1		

23CEWRPC 12	OPEN CHANNEL HYDRAULICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the principles of fluid mechanics with reference to open channels
- To solve problems encountered in both natural and constructed water systems.
- To use model studies and computers in solving a host of problems in hydraulic engineering

Definition, comparison with pressure flow; discussion on pressure and velocity distributions – Pressure and velocity distribution coefficients. Energy principles for prismatic and non-prismatic channels – Specific energy; Critical flow Computations and applications; controls, Transitions.

Uniform flow – Basic concepts of uniform flow - computations. Specific energy and specific force concepts – applications. best hydraulic sections. Design of irrigation canals.

Gradually varied flow – theory, the basic equation, various forms; profiles, combination of slopes and sections; computation of gradually varied flow- Direct step method and direct integration methods.

Rapidly varied flows - Momentum principle; Hydraulic Jump in prismatic channels; uses of hydraulic jump – Energy dissipation and stilling basins. Basic Introduction to spatially varied flows and unsteady flows. Unsteady flows -Equations of motion- Uniformly progressive wave -Rapidly varied unsteady flow – positive and negative surges. Dam break problem.

Sediment Transport - Sediment properties – inception of sediment motion – bed forms. Bed load suspended load – Total sediment transport. Design of stable channels and regime channels. Reservoir sedimentation and trap efficiency.

REFERENCES

1. Chaudhry M. H., "Open Channel Flow", Springer Publishers, 2008.
2. French, R. H., "Open Channel Hydraulics", Water Resource Publication, First Edition, 2007
3. Henderson, K.M. , "Open Channel Flow"- Macmillan, Pearson Publishers,1966
4. Ranga Raju, K.G., "Flow through open channels" – Tata-McGraw Hill Education, 1981.
5. Srivastava R, "Flow through Open Channels", Oxford University Press, New Delhi, 2007.
6. Sturm T.W., "Open Channel Hydraulics", Tata-McGraw Hill Education, 2nd Edition, New Delhi, 2009
7. Subramanya, K., "Flow in open channels" – Tata-McGraw Hill Education, 4th Edition, New Delhi, 2005
8. VenTe Chow, "Open channel Hydraulics" –The Blackburn Press, 2009

9. Wurbs R.A., and James W.P. "Water Resources Engineering", Pearson Publishers, 2001.

WEB REFERENCE:

1. https://esenotes.com/open-channel-flow-introduction/

COURSE OUTCOMES

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

1. Acquire a knowledge of the principles of mechanics of open surface flow of fluids, and express these in terms of mathematics
2. Analyze problems associated with flow of water in streams and design of canals
3. Arrive gradually varied flow profiles by computation.
4. Know the various aspects of rapidly varied flows.
5. Understand the process of reservoir sedimentation.

Mapping of COs with Pos &PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2					2							
CO2	3	2				3		3				2		
CO3	3	3	2		2	2		2						
CO4	3	3	3		3	3		3		2			3	2
CO5	3	3	3	3	3	3		3	2		3			

23CEWRMC15	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

- To understood control of today's world by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- To understood IPR protection in research work and investment in R & D

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 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

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

REFERENCES:

1. Pannerselvam. R Research Methodology, Prentice-Hall of India Private Ltd., New Delhi, 2007.
2. Upagade. V and A.Shende, Research Methodology, S.Chanda& Co., New Delhi, 2010.

WEB REFERENCE:

1. https://www.researchgate.net/publication/328161728_INTELLECTUAL_PROPERTY_RIGHTS_IPR

NPTEL LINK:

1. https://onlinecourses.swayam2.ac.in/nou23_cm06/preview

COURSE OUTCOMES

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyse research related information and follow research ethics
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Mapping of COs with POs&PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1		3	2								3	2	1
CO2			2	3	1							2	3	1
CO3				2				3				1	2	3
CO4									1	3	2	3	2	1
CO5										3	2	1	2	3

23CEWRCP16	**WATER QUALITY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES

- To have hands on experience on analyzing the samples of water and also contaminated water to understand the quality parameters for its suitability for its user area.
- The learn metrics of IS 10500 of Potable Quality Standards and WHO Standards for domestic use and apply to test the samples to evaluate the suitability for intended use.

Experiments for evaluating primary level parameters to analyze Physico-Chemical and Bio-Chemical characteristics will be conducted through set protocols, instruments, procedures and interpretation.

Microbial examination for evaluating critical parameters will also be used to test the samples of water and contaminated water sources.

REFERENCES

1.https://www.mpcb.gov.in/sites/default/files/waterquality/reports/LSDNEER%20Water%20Quality% 20Analysis.pdf.

2. IS 10500 : 2012- Indian Standard DRINKING WATER — SPECIFICATION (Second Revision)

COURSE OUTCOMES

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

1. To take representative samples of water and contaminated water from the respective sources and to understand different quality Metrics of Water
2. To characterize the suitability of water using Standard Metrics
3. To work on different set of instruments using Standard methods and procedures
4. To interpret the experimental results to characterize and evaluate the developmental policy of any specific source of water.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1			2		1		1		3				
CO2	3		1		1		2	2			1		1	
CO3	1	1			2		1		2	3				
CO4	2		1	2			1	3		1		3		2

23CEWRCP17	**HYDROLOGIC MODELLING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES

- To develop and improve computer programming and data manipulation skills
- To gain experience in the development and programming of stochastic and deterministic hydrologic models
- To introduce commonly employed rainfall-runoff models and modeling techniques, and to investigate the performance of some of these models
- To provide an introduction to physics based and empirical models for hydrologic phenomenon, such as: Precipitation Infiltration Evapotranspiration Groundwater Discharge Runoff Mechanisms and Streamflow

An exploration of deterministic and stochastic hydrologic models, model development, and the use of computer programming to construct, calibrate, manipulate, and interpret hydrologic models. Theoretical and analytical approaches to describing hydrologic processes, including precipitation, evapotranspiration, infiltration, surface runoff, percolation, and groundwater discharge. Stochastic techniques include frequency, trend, and regression analyses.

Develop fundamentals of modeling concepts, model calibration and error/uncertainty analysis applied to watershed scale and incorporating representations of land surface and hydrologic processes. Applications of *remote sensing, digital elevation models* (*DEMs*), other distributed databases (e.g. *NDVI* for vegetation and *STATSGO* for soils) within geographic information systems (*GIS*) to hydrologic modeling. Demonstrations and "hands-on" experience with watershed modeling procedures including *HBV-Light* (Univ. of Zurich), *TOPMODEL* (Univ. of Lancaster), Soil Water Assessment Tool (SWAT, UT), Envision (OSU), and depending upon timing and interest, Hydrologic Modeling System (*HEC-HMS*) (Hydrologic Engineering Center, USACE), Distributed Hydrology Soil Vegetation Model (*DHSVM*) (PNNL, U. of WA), *MIKE SHE* (Danish Hydraulics Institute), as well as other watershed models.

REFERENCES

1. Maidment's Handbook of Hydrology, McGraw-Hill, 1993
2. Clarke, R. T." Statistical modelling in hydrology" John Wiley & Sons, UK, 1994

HANDBOOK:

1. Maidment's Handbook of Hydrology, McGraw- Hill, 1993.

WEB REFERENCES:

1. https://www.usgs.gov/centers/california-water-science-center/science/hydrologic-modeling

COURSE OUTCOMES

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

1. Quantitative Reasoning: Students will be able to effectively describe, interpret, apply, and evaluate quantitative information.
2. Communication: Students will be able to formulate and present ideas that reflect critical thinking skills and show awareness of audience, context, and purpose, and present a well developed argument
3. Technological and Information Literacy: use critical thinking skills to determine the information needed to solve a problem, access information using appropriate technologies, and effectively and appropriately use information to accomplish a specific purpose.
4. Critical Thinking: identify, analyze, evaluate, and develop well reasoned arguments.
5. Understand the modelling concept

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1	2	3		3									
CO2	1	3			3								3	
CO3	3	3	2		3			2			2			
CO4	3	3			3					2				
CO5	3	2		3	3				3					2

SECOND SEMSTER

23CEWRPC 21	**GROUNDWATER HYDROLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the groundwater movement and aquifer characteristics.
- To study the causes and impact on groundwater level fluctuations
- To know the methods of construction, completion, protection and rehabilitation of water wells

- To explore the groundwater pollution, quality analysis, geophysical exploration and appropriate methods for Artificial Recharge

Groundwater Introduction and Occurrence - Scope, historical background, utilization of groundwater, groundwater in the hydrologic cycle, groundwater budget, groundwater level fluctuations and environmental influences.

Origin and age of groundwater, rock properties affecting groundwater, vertical distribution of groundwater, flow and storage characteristics of aquifers.

Groundwater movement and well hydraulics -Darcy's law, anisotropy and heterogeneity, groundwater flow rates, groundwater flow directions, dispersion, general flow equations in rectangular and radial co-ordinates, well flow near aquifer boundaries, multiple well systems, partially penetrating wells, well completion, well development, well protection, rehabilitation, testing for yield.

Groundwater pollution and quality analysis - Municipal, industrial, agricultural and miscellaneous sources & causes of pollution, attenuation, underground distribution and potential evaluation of pollution, groundwater contaminant transport, remediation of contaminant groundwater, saline water intrusion, Ghyben-Herzberg relation between fresh and saline waters, fresh-salt water interface, physical, chemical and biological analysis of groundwater quality, criteria and measures of groundwater quality, groundwater salinity and samples, graphical representations of ground water quality.

Groundwater Investigation and Artificial Recharge - surface and subsurface investigations of groundwater, application of Remote Sensing, Concept & methods of artificial groundwater recharge, recharge mounds and induced recharge, wastewater recharge for reuse, research on water spreading.

Groundwater augmentation and conservation- groundwater augmentation through natural and artificial methods, rainwater harvesting, recharge through ponds and percolation tanks, Groundwater conservations methods and techniques, floodwater harvesting methods

REFERENCES

1. "Groundwater Manual", "A water resources Technical Publication", U.S. Department of the interior - Edition. 1985
2. KARANTH,K. R., A TEXT BOOK ON "GROUND WATER ASSESSMENT: DEVELOPMENT AND MANAGEMENT" TATA MCGRAW-HILL EDUCATION, 1987
3. Raghunath H.M , "A text book on Groundwater", IIIrd Edition, New age Publications,2007
4. Todd, D.K., "Groundwater Hydrology", John Wiley & Sons edition, 1980
5. Walton, W.C., Groundwater Resources Evaluation", McGraw Hill.1978.
6. Bear,J.," Hydraulics of Groundwater", McGraw.1979

7. Karanth, K. R., A text book "Ground Water Assessment: Development andManagement" Tata McGraw-Hill Education, 1987
8. Dingman, S.L. and Dingman, S.L. 2015. Physical hydrology (Vol. 575). Upper Saddle River, NJ: Prentice Hall.
9. Fetter, C.W. 2018. Applied hydrogeology. Waveland Press.

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc23_ge13/preview

COURSE OUTCOMES

At the end of the course, the student should be able;

1. Evaluate the groundwater resources and aquifer parameters for different hydro-geological boundary conditions.
2. Apply the techniques of detaining how much groundwater can be safely withdrawn from the aquifers.
3. Understand the different methods of well design, well construction and well maintenance
4. Estimate the groundwater potential and groundwater real life problems in the region under consideration.
5. Application of surface and sub-surface groundwater investigation
6. Identified the appropriate sites for different Artificial Recharge methods

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1	2							1	1		1		
CO2	1	1	1	1	2		1	1	1	1		1		
CO3	1	2	1	1	2		1	1	1	1		1		
CO4	1	2	1	1	2		1	1	1	1		1		
CO5	1	2							1	1		1		
CO6	1	2							1			1		

23CEWRPC22	REMOTE SENSING AND GIS	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- To learn the principles and applications of spatial information technologies namely remote sensing, GPS and GIS in the context of water resources.
- To understand the basic concepts of Remote sensing and GIS in Spatial modeling
- To educate the students on application of remote sensing and GIS in solving the spatial problems in water resources.

Spatial data source: Remote sensing, GPS surveying, topomap and other secondary sources. Physical principles of Remote sensing, classification of Remote sensing system-concepts of microwave remote sensing - Remote sensing platforms- LANDSAT, SPOT, IRS, ERS, INSAT, IKONOS and others – types of aerial photography-methods of viewing aerial photographs- scanning systems – passive and active – Digital processing of Remote sensing data- Image enhancement – Image classification.

Definition- basic components of GIS-standard GIS packages-maps, mapping process, projections, coordinate systems-spatial data –spatial data model-spatial relationship-topology-spatial data structure: raster, vector – attribute data- database-database management systems-database models: Hierarchical, network, relational, object oriented models-data input, editing-integrated GIS database.

Thematic mapping-measurement in GIS: length, perimeter and areas- Query analysis-Reclassification-Buffering-Neighborhood functions-Integrating data: map overlay, overlay functions, vector overlay and raster overlay – Interpolation-Network analysis-Data output types- Output devices-Error- Types of errors.

Application of Remote sensing: Evaluation of water resources- water penetration and depth measurement- water quality-water temperature-soil moisture-study of Geology, geomorphology, drainage, morphological and land use\land cover of watersheds-groundwater resources.

Application of GIS: Base map preparation - catchment survey - regional rainfall mapping-Flood inundation mapping, drought monitoring - surface water resources-Inventory-groundwater potential mapping, water quality assessment - site selection for artificial recharge - reservoir sedimentation - water quality mapping - performance evaluation of irrigation commands, Agricultural management - National, Regional and Local water resources planning .

REFERENCES

1. Anji Reddy, M, “Remote Sensing and Geographical information systems”, B.S Publications-2001
2. BasudebBhatta , “Remote Sensing and GIS”, Oxford University Press, 2nd Edition, 2011.

3. Bernhardesen. T., "Geographic Information Systems: An Introduction", John Willy and Sons, inc. 1999.
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5. Ian Heywood Sarah, Cornelius and Steve Carver "An Introduction to Geographical Information Systems". Pearson Education. New Delhi. 2002.
6. Lillesand, T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation" III Edition. John Wiley and Sons, New York. 1993.
7. Lo,C.P. and Yeung, A.K.W., "Concepts and Technologies of Geographic Information System", Prentice-Hall of India, New Delhi. 2004.
8. Introduction to Remote Sensing", (5th Ed.), The Guildford Press, New York, 2012.
9. Joseph, G. and Jeganathan, C. (2018), Fundamentals of Remote Sensing, Third Edition, Universities Press

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1. https://onlinecourses.nptel.ac.in/noc23_ce15/preview

WEB REFERENCE:

1. https://www.researchgate.net/publication/267159917_An_overview_of_integrated_remote_sensing_and_GIS_for_groundwater_mapping_in_Egypt

COURSE OUTCOMES

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

1. Apply Remote sensing, GPS and GIS tools to solve the spatial problems in water resources
2. Understand the technology and principles of Satellite Imaging
3. Know the functional explication of GIS and integrating Satellite data products into the GIS platform for decision making
4. Understand the application of Remote Sensing and GIS on solving a host of problems in Water Resources Engineering through case studies.
5. Apply suitable methodology for evaluating strategies for water resources management in GIS environment.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1		3			3		1						2	1
CO2	1		2		3				2			2	2	1
CO3											1	3	3	1
CO4		3		2					3			3	2	2
CO5	2					2			3		2	2	2	2

23CEWRCP26	REMOTE SENSING AND GIS LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

- To have hands on experience on different steps of visual Interpretation of satellite images and photographs and digital interpretation of photographs.
- To learn basics of Remote sensing and GIS
- To Design the map
- To Develop GIS database and Integrated analysis of spatial and Non spatial data attributes data

REMOTE SENSING AND GIS EXERCISES

1. Map reading - Survey of India Topo sheets.
2. Preparation of Base Map from Survey of India Topo sheets
3. Preparation of Land use/land cover map using Satellite Data / Aerial Photograph
4. Preparation and analysis of spectral signatures using handheld spectroradiometer for
   (a) Vegetation
   (b) Soil
   (c) Water
5. Map compilation and Design
6. Data Input – Onscreen Digitization – Creation of Point, Line and Polygon layers
6. Projection, Re- projection and Coordinate Transformation of Maps
7. Attribute data input and Measurement of Distance and Area
8. Linking of External Database and Tabular Data Analysis using SQL commands
9. Generating Graphs, Charts and Diagrams from Tabular data
10. Data Conversion – Vector to Raster and Raster to Vector
11. Map Joining, Edge Matching and Layout Design
12. Open source GIS software such as QGIS, ect.

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1. Arthur, H. Robinson et al, Elements of Cartography, 7 th Edition, John Wiley and Sons, 2004.
2. Lo Albert C.P., Yeung K.W., "Concepts and Techniques of Geographic Information Systems", Prentice Hall of India Publishers, 2006
3. Basudeb Bhatta, “Remote Sensing and GIS” second edition, Oxford University press, 2008.
4. Peter A. Burrough and Rachael A. Mc Donnell, “Principles of Geographical Information System”, Oxford University press, 2004.
5. Lillesand, T.M. and Kiefer, R.W., “Remote Sensing and Image Interpretation” III Edition. John Wiley and Sons, New York. 2003.
6. Srinivas, M.G., “Remote Sensing Applications”, Naosa Publishing House-(Edited By) 2010

WEB REFERENCE:

1. https://www.pdfdrive.com/fundamentals-of-remote-sensing-gis-lab-e6042161.html

COURSE OUTCOMES

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

1. Acquire skills to carry out the Lab Exercises independently on visual interpretation of satellite images and digital processing of aerial photographs and imageries
2. To design and produce thematic maps with suitable projection, symbols and color codes
3. To compile and develop digital maps
4. To create and analyse spatial and non-spatial database in GIS environment and generate reports, maps
5. Application of GIS in Civil Engineering

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1				2					3				
CO2		2			3				2		2		1	
CO3	1	2				3						3		
CO4	1	2	3		3				3	3				2
CO5	1		3		2		2		3	3				

THIRD SEMESTER

23CEWRPV33	**PROJECT WORK & VIVA-VOCE PHASE-I, DISSERTATION-I**	**L**	**T**	**P**	**C**
		-	**Pr/16**	**S/4**	**10**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Take up any challenging practical problems and find solution.
2. Learn to adopt systematic and step-by-step problem solving methodology.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	3	3	3	3					2				3	
CO2	3	3	3	3					1			3		

FOURTH SEMESTER

23CEWRPV41	**PROJECT WORK & VIVA-VOCE PHASE-II, DISSERTATION-II**	**L**	**T**	**P**	**C**
		-	**Pr/24**	**S/6**	**15**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Take up any challenging practical problems and find solutions.
2. Learn to adopt systematic and step-by-step problem solving methodology.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	3	3	3	3					2				3	
CO2	3	3	3	3					1			3		

PROGRAMME ELECTIVES

23CEWRPEXX	STATISTICS FOR WATER RESOURCES ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide the fundamentals of statistical hydrologic modelling, present the commonly used probability distributions and the fundamentals of statistical analysis
- To provide commonly used hypothesis tests, analysis of variance, and confidence intervals on sample statistics
- To present univariate statistical methods, provide methods for gaining a preliminary understanding of a multivariate data base
- To discuss the commonly used bivariate and multivariate regression methods, and contrasting methods for calibrating multivariate models
- To introduce the basics of times series modeling

Fundamentals of Modeling & Probability Distributions - Fundamentals of modelling – Concepts of statistical hydrologic models – Development of models – Model evaluation – Problems and models – Modelling and information content of data; Probability Distributions - Poisson distribution – Uniform, normal, lognormal, exponential, triangular, gamma and Pearson Type-III distributions – Statistical probability distributions – Students' t, Chi-square and F distributions – Extreme value distributions – Gumbel, Frechet and Weibull distributions

Fundamentals of Statistical Analysis & Hypothesis Testing - Fundamental of statistical analysis – Samples and populations – Estimation of parameters- properties of estimators: bias, precision, accuracy, MSE, consistency, sufficiency and efficiency – Estimation of moments – Method-of-moments estimation – Maximum-likelihood estimation – Sampling distributions – Sampling distributions of the mean and variance; Hypothesis testing – General procedure – Hypothesis tests of means – Hypothesis tests of variances – One – sample Chi-square test, Two-sample F Test – tests of distributions – Chi-square test of goodness of fit, Kolmogorov-Smirnov One-sample test

Analysis of Variance - Analysis of Variance – Test of Population means – Steps in the ANOVA – Rationale of the ANOVA test – Multiple comparisons in the ANOVA test- Duncan multiple range test, Scheffe test – Test of population variances – Randomized Block Design – RBD model – Two-way analysis of variance – ANOVA2 model; Confidence Intervals and Sample Size Determination – Confidence intervals on sample statistics namely mean, variance – Sample size determination

Linear Bivariate Correlation and Regression, Multiple and Non-Linear Regression - Correlation and regression - Correlation analysis – graphical analysis – bivariate correlation – separation of variation – explained variation – correlation coefficient -

Regression – zero-intercept model – principle of least squares- solution procedure- least-squares analysis – evaluation of the reliability of the regression equation – correlation coefficient, SEE, ANOVA, standardized partial regression coefficients – assumptions underlying the regression models; Multiple and Non-linear regression - Multiple regression – calibration of the multiple linear model – standard model – intercorrelation – criteria for evaluating a multiple regression model – analysis of residuals - Non-linear regression – polynomial regression analysis – structure of polynomial models – calibration of polynomial models – Analysis of variance of polynomial models – power models – fitting a power model – goodness of fit

Time Series Analysis - Components of a time series – moving-average filtering – autocorrelation analysis – Cross-correlation analysis – identification of the random component – autoregression and cross-regression

REFERENCES

1. Richard H. McCuen and William M. Snyder, "Hydrologic Modelling: Statistical Methods and Applications", Prentice-Hall, Englewood Cliffs, New Jersey, USA, 1986
2. Bilal M. Ayyub and Richard H. McCuen, "Probability, Statistics and Reliability for Engineers and Scientists", Chapman & Hall/CRC, Washington D.C. 2003
3. Kottegoda, N. T and Rosso, R, Applied Statistics for Civil and Environmental Engineers, Wiley-Blackwell, Second edition,2008.
4. Richard H McCuen, Microcomputer Applications in Statistical Hydrology, Prentice-Hall, Englewood Cliffs, N.J., 1993
5. Richard H McCuen, Statistical Methods for Engineers, Prentice-Hall, Englewood Cliffs, N.J., 1985
6. Gupta, S.C. and Kapoor, V. K., Fundamentals of Applied Statistics, Fourth Edition (Reprint), Sultan Chand & Sons, 2014
7. Gupta, S.C. and Kapoor, V. K., Fundamentals of Mathematical Statistics, Eleventh Edition (Reprint), Sultan Chand & Sons, 2014

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1. https://pubs.er.usgs.gov/publication/tm4A3

COURSE OUTCOMES

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

1. Understand the types of problems that arise in Water Resources Engineering and the modelling that is associated with the problem type
2. Recognize that statistical methods are decision-making tools and will view them as a part of a process.
3. Use a different example to illustrate each statistical method, the student will recognize that there are a great many possible applications of statistical methods

4. To explore the use of statistical methods for solving real-time problems in Water Resources Engineering
5. Overall, at the end of the course, the students will realize that the course contains the statistical methods necessary to solve a wide array of real-world problems in Water Resources Engineering.

Mapping of COs with POs &PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1	2	3			2			2	3	2	3	1	2
CO2		3	3		3							1	3	
CO3			3						2		1	3	3	1
CO4		2	3				1					3	3	3
CO5		3	2			2		2	1		2	2	3	1

23CEWRPEXX	**HYDROSYSTEMS ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To gain a better understanding of the complex interactions among all the hydrologic, ecologic, economic, engineering and social components of water resource systems, analyses based on systems perspectives
- To introduce the science and art of developing and applying various modeling approaches in support of water resources planning and management
- To emphasize the practice of developing and using models to address specific water resources planning and management issues and problems.
- To provide relevant, objective, timely and meaningful information to those who are responsible for deciding how we develop, manage, and use our water resources.

Introduction to Hydrosystems - Introduction Concept of system – Issues in hydrosystems engineering – Comparison between conventional and optimization procedures – Introduction to various uncertainties in hydrosystem design and analysis – Application of optimization in hydrosystem Economics for hydrosystem - Engineering economic analysis – discount factors – Benefit - Cost analysis

Linear Programming - Linear programming - Concept – Assumptions – Forms of LP - Solution algorithms for LP –Formulation of LP models for water resources engineering projects - Dynamic programming - Elements of a DP model – Bellman's

principle of optimality – Recursive equations for forward and backward dynamic programming techniques – Application of DP to Hydrosystems

Non-Linear Programming and Water Resources Planning Under Uncertainty - Nonlinear programming - Applications to Hydrosystems – Unconstrained nonlinear optimization – Constrained optimization – Constrained non-linear optimization - Water resources planning under uncertainty - Planning with uncertainty – Sensitivity analysis – Utility theory. Water resources planning objectives - Economic Benefit –Cost objectives – Benefit and Cost estimation – Long –and Short-run Benefit functions

Deterministic Modelling - Deterministic river basin modeling - Estimating reservoir storage and requirements for water supply – flood control alternatives - hydroelectric power production - Integer programming models

Stochastic Modeling - Stochastic planning models - Reservoir operation – SDP operating model – Single reservoir design and operation – SLP Design model

REFERENCES

1. Vedula, S., and Mujumdar, P. P., "Water Resources Systems – Modelling Techniques and Analysis", Third Reprint 2007, Tata McGraw-Hill Publishing Company Limited, New Delhi, Edition 2005.
2. Daniel P. Loucks, Jery R. Stedinger and Douglas A. Smith, "Water Resource Systems Planning and Analysis", Prentice-Hall, Inc, Englewood Cliffs, New Jersey, USA, Edition, 1981
3. Larry W Mays and Yeou-koung Tung, "Hydrosystems Engineering and Management", McGraw-Hill Inc., International Edition, 1992
4. Chaturvedi, M. C., "Water Resources Systems Planning & Management", McGraw-Hill Inc., US, second edition,1992.
5. Daniel P. Loucks and Eelco Van Beek, "Water Resources systems Planning and Management – An Introduction to Methods, Models and Applications" Studies and Reports in Hydrology, UNESCO Publishing, Edition, Paris. 2005
6. Pramod R. Bhave , "Water Resources Systems", Alpha Science International Limited, 2011.

WEB REFERENCE:

1. https://iopscience.iop.org/article/10.1088/1757-899X/1030/1/012111

COURSE OUTCOMES

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

1. Learn the art of systems modeling and analyses
2. Gain the knowledge to make appropriate choices regarding model complexity
3. Develop their skills in the use of quantitative methods of identifying and evaluating effective water resources management plans and policies.
4. Become a skilled water resources systems modeler, analyst and planner through the modelling approaches
5. Examples and case studies they have learnt

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1		3			3		1						2	1
CO2	1		2		3				2			2	2	1
CO3											1	3	3	1
CO4		3		2					3			3	2	2
CO5	2					2			3		2	2	2	2

23CEWRPEXX	**COMPUTATIONAL METHODS FOR WATER RESOURCES ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To learn iterative methods for the solution of a system of linear equations and to learn direct and indirect methods for finding the roots of transcendental and polynomial equations.
- To know Numerical differentiation and partial differentiations methods of characteristics and to learn single step and multistep methods for solving first order initial value problems.
- To discuss the shooting method, finite difference methods and finite element methods for solving boundary value problems.
- To make the students have a feel of application of relevant numerical methods covered in the course to pertinent hydraulics, hydrology and water resources engineering problems

Introduction – Sources of errors in numerical solutions: truncation error, round off error – significant digits and numerical stability. Transcendental and Polynomial equations: Direct and indirect methods – initial approximation – Bisection method, Secant and Regula-Falsi methods, Newton-Raphson method, Muller method, Chebysheve method – Solving system of nonlinear equations-Applications in determination of flow depth in Manning's equation.

System of linear algebraic equations – Direct methods: Crammer rule, Gauss elimination method, Gauss-Jordan elimination method, Triangulation method, Cholesky method, Partition method; iteration methods: Jacobi method, Gauss-Seidel method, SOR method – convergence criteria-Application of iteration methods to determine the potential infiltration rate in Green Ampt method.

Numerical differentiation: Methods based on integration, methods based on finite difference operation and methods based on undetermined coefficients – optimal choice of

step length – extrapolation methods-Application of finite difference methods to solve the linear kinematic wave equation in flood routing.

Ordinary differential equations: Initial value problems – Reduction of higher order equation to the system of first order differential equations – existence and uniqueness of solution – test equation – numerical solution of differential equations – Euler method, Backward Euler method, Mid-point method; Solution of the initial value problem: Taylor series method, Runge-Kutta methods of second order and fourth order, Predictor-Corrector methods-Applications to route the inflow hydrograph and computation of surface profile for GVF.

Ordinary differential equations: Boundary value problems- Shooting method - Finite difference methods – Use of finite difference approximations in development of dynamic response equations of groundwater systems - Finite element method – Method of weighted residuals – Galerkin model – Applications in Water resources engineering.

REFERENCES

1. Balagurusamy, E, "Numerical methods", Tata McGraw-Hill Education, First edition, 1999.
2. Desai, Y. M., Eldho, T. I, Shah,A. H, "Finite Element Method with Applications in Engineering", Pearson,2011.
3. Jain M. K, Iyengar, S. R. K, Jain, R. K, "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, New Delhi, Fifth Edition, Reprint 2008.
4. Rajasekaran, S, "Numerical Methods in Science and Engineering", S. Chand and company, Second edition, 2003.
5. Robert Willis and William W-G. Yeh, "Groundwater Systems Planning and Management", Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632, 1987.
6. Subramanya, K., "Flow in Open Channels", Tata McGraw-Hill 4th Edition, New Delhi, 2015
7. VenTe Chow, David. R. Maidment, Larry W, Mays, "Hydrology", Tata McGraw Hill Education Limited, 2010.

WEB REFERENCE:

1. https://www.uvm.edu/cems/cee/advanced-computational-methods-water-resources-management

COURSE OUTCOMES

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

1. Know the solution procedures of direct and indirect methods for finding the roots of transcendental and polynomial equations and apply them in relevant problems in open channel hydraulics
2. Apply the direct and iterative methods for the solution of a system of linear equations and use them in relevant hydrological applications.

3. Understand the methods of Numerical Differentiation and partial differentiations-Methods of Characteristics.
4. Have hands on experience in applying numerical differentiation methods for solving Initial value problems.
5. To explore the shooting method, finite difference methods and finite element methods for solving boundary value problems.
6. At the end of the course the student will recognize the importance of Computational methods and also able to solve any types of problems which are all applicable to Water resource Engineering.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1	2	3	2		1				1	2	3	3	2
CO2	2		2			2	2					2	3	2
CO3		3		2						2		3	2	2
CO4	1	3			2	1			2		2	3	3	2
CO5		2	3			2			3	2		3	3	2
CO6	2	2	3				1			2	1	2	3	2

23CEWRPEXX	**WATER QUALITY MODELING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide a fundamental understanding of formulation of water quality models, so that the students are able to adapt existing models to new situations.
- To provide the students with direct exposure to models currently used in environmental engineering practice for predicting water quality in rivers and lakes.
- To equip the students to apply such models to solve simple waste load allocation problems.
- To instruct as to how water quality data can be analyzed and interpreted.
- To show how water quality models may be calibrated, verified, and applied to environmental engineering problems, such as total maximum daily loads or fate and transport modeling of toxic organic chemicals.

Introduction, Water Quality-Fundamental Quantities-Mathematical models, Historical Development of Water-Quality Models. Basic modeling concepts - Reaction

Kinetics-Reaction fundamentals - Analysis of Rate - Data-Stoichiometry – Temperature Effects.

Transport phenomena – Advection, diffusion, dispersion- simple transport models –Diffusive transport: Diffusion and Fick's first law, Calculation of molecular diffusion coefficients, Plug flow models- Application of PFR and MFR model - Steady state and time variable solutions-completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feedback reactor systems.

Water quality modeling of Streams, Lakes and impoundments and Estuaries – Water quality– model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelps model for point and distributed sources - Modified Streeter Phelps equations -Toxicant modeling in flowing water.

Groundwater flow and mass transport of solutes, Degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion.

Basic concepts and modeling - Exposure to surface water and groundwater quality modeling software – MIKE 21, QUAL2E and MODFLOW Models and their application - Case studies.

REFERENCES

1. Benedini, Marcello, Tsakiris, George, “Water Quality Modelling for Rivers and Streams”, Springer Netherlands, 2013.
2. Jacob Bear, A, Cheng, H.D, “Modelling Groundwater Flow and Contaminant Transport”, Springer Science & Business Media, 2010.
3. Steven C. Chapra, “Surface Water Quality Modelling”, The McGraw-Hill Companies, Inc., New Delhi, 1997.
4. Thomann, V, John A. Mueller, “Principles of Surface Water Quality Modeling and Control”, Harper & Row, 1987.
5. Desai, Y. M., Eldho, T. I, Shah, A. H, “Finite Element Method with Applications in Engineering”, Pearson,2013.
6. Jain M. K, Iyengar, S. R. K, Jain, R. K, “Numerical Methods for Scientific and Engineering Computation”, New Age International Publishers, New Delhi, Fifth Edition, Reprint 2013

WEB REFERENCE:

1. https://www.tandfonline.com/doi/full/10.1080/23311916.2021.1891711?cookieSet=1

COURSE OUTCOMES

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

1. Understand the context of water quality management and engineering.
2. Apply mass balance principles to develop and solve simple water quality models.
3. Understand eutrophication, the principal of biochemical and physical factors affecting algae growth, management problems and solutions
4. Understanding and development of modelling approaches and their limitations.
5. Get exposed to surface water and ground water quality modelling software and case studies in water quality modelling.

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1		2	2	1		2			1	2	2	2	1
CO2		2	3									2	3	2
CO3	2	2	3		1				2		1	3	1	1
CO4				1		2						2	3	1
CO5		3	2	2			2		1	2	2	2	3	3

23CEWRPEXX	**ENVIRONMENTAL IMPACT ASSESSMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To study the fundamentals and concepts of environmental impact assessment of water resources projects
- To study the various Environmental impacts on Ecosystem
- To study the methods of EIA and environmental management
- To assess the impact of Water Resources development on the environment

Environmental Issues: Water resources development issues – Environment in water resources project planning – Environmental regulations and requirements – EIA (Environmental Impact Assessment) Notification, 2006 – MoEF & CC Guidance document an major Hydroelectric and Irrigation Projects – ESA (Ecologically Sensitive Area) Notification.

EIA Fundamentals: Environmental impact Assessment (EIA) - Environmental impact statement – EIA in project cycle – Legal and regulatory aspects in India according to Ministry of Environment and Forests – Types and limitations of EIA – Cross sectoral issues and Terms of References in EIA – Due Diligence Survey – Value Environmental components – Flora & Fauna; Endanger Species

Environmental Impacts: Hydrological and water quality impacts – Ecological and biological impacts – Social and cultural impacts – Soil and landscape changes – Agro economic issues – Human health impacts – Ecosystem changes.

Methods of EIA: EIA team formation – Development of scope, mandate and study design – Base line theory – Check lists – Network and matrix methods – Semi-quantitative methods – ICID check list – Economic approaches – Environmental Impact Statement (EIS) preparation.

Environmental Management: In-stream ecological water requirements – Public participation in environmental decision making – Sustainable water resources development – Ecorestoration – Hydrology and global climate change – Afforestation – R & R (Resettlement & Rehabilitation) Programmes - Environmental monitoring programs.

REFERENCES

1. Biswas, A.K and Aggarwal, S.B.C, "Environmental Impact Assessment for developing Countries", Oxford Butterworth – Heinemann, 1992.
2. Canter, L.W, "Environmental Impact Assessment", McGraw Hill International Edition, New York,2008.
3. Lawrence, D.P, "Environmental Impact", Wiley-Interscience, New delhi, 2003.
4. Petts, J, "Handbook of Environmental Impact Assessment", Blackwell Science London, 1999.

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WEB REFERENCE:

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COURSE OUTCOMES

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

1. Understand and analyse the various methods of Environmental Impact Assessment
2. Prepare EIA repots of Water Resources and Environmental projects
3. Prepare checklist and EIA using various tools for water resources development projects
4. Understand the various aspects of EIA on environmental management.
5. Understanding the impact of water resources development on the environment

Mapping of COs with POs&PSOs

	PO 1	PO 2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PS 01	PS0 2	P S 0 3
CO1	2	3	3	2							3	2	1	3
CO2	3	2	3				2		2		2	2	2	3
CO3	3	2	3		1		2		3	2		2	2	3
CO4		2	3	2	1							2	1	3
CO5	2		2			1			3		1	2	1	3

23CEWRPEXX	HYDRAULIC STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide planning and engineering design concepts
- To apply to various structures in hydropower projects including turbines and other structures.
- To design and analyse the various types of weirs and barrages
- To understanding the concept of natural channels

Reservoir Planning: Classification of reservoirs, storage zones of a reservoir, fixing capacity of reservoirs, life of a reservoir.

Dams: Investigation surveys, selection of dam site, selection of types of dam, classification of dams. Gravity Dams, Forces acting on a dam, combination of forces for design, design parameters, design of gravity dam, profiles of a dam, stability analysis, foundation treatment, galleries in gravity dams.

Earth and Rock fill Dams: Types, design criteria for earth dams, design consideration in seismic region, phreatic line, flow net, stability analysis, methods of analysis, slope protection, seepage, dam section to suit available materials and foundation, causes of failure of earth dams, safety measures.

Spillways: Components factors affecting type and design of spillway, types, energy dissipation below spillways, hydraulic jump type stilling basins spillway gates, types.

Weirs and Barrages: Design of impervious floor on pervious foundation. Bligh's, Lane's creep theories, potential theory cut offs, weir design, Khosla's method. Unlined irrigation channels: Design parameters, transmission losses, determination of water losses, design formulae, Kennedy's and Lacey's theories, channels on non-alluvial soils.

REFERENCES

1. Creager, W.P, Justin, J and Daud Hinds, "Engineering for Dams", Vol. I-III, Wiley, N.Y, USA.
2. Satyanarayana Murthy, C, "Design of Minor Irrigation and Canal Structure",Wiley Eastern, 1990.
3. Sharma, R.K, "Text Book of Irrigation Engineering and Hydraulic Structures ", - Oxford & IBH, 1984
4. Sharma, S.K, "Design of Irrigation Structures", S. Chand & Co, 1988.
5. Varshney,R, S, "Theory and Design of Irrigation Structures",Nem Chand & Bros,2009
6. Dey, S. (2014). Fluvial Hydrodynamics. Springer- Verlag
7. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House, 2010

8. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill, 2013.

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc23_ce35/preview

WEB REFERENCE:

1. https://www.intechopen.com/books/7587

COURSE OUTCOMES

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

1. Understand Reservoir planning and analysis
2. Design Major irrigation structures like dams, spillways,
3. Design minor irrigation structures like weirs and barrage structures
4. Get a wide knowledge on design of unlined irrigation channels
5. Understanding the various theories of related seepage analyse of dams

Mapping of COs with POs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS 03**
CO1	2	3	3	2		2			2	2	2	2	2	1
CO2	2	2	3	3	1					3	1	2	1	2
CO3	2	2	3	2		1	1		2	2		1	2	2
CO4		3	2			2				2		3	2	2
CO5	1	2	2		2				2		2	1	2	1

23CEWRPEXX	**GROUNDWATER SYSTEM PLANNING AND MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide the fundamental know-how on groundwater flow and transport processes, Sources of pollution, techniques for groundwater resources assessment, environmental issues of overcharging and overexploitation of groundwater development, management of groundwater resources augmentation and remedial measures of groundwater pollution.
- To know the groundwater systems and development
- To study the groundwater transport problems and quality modeling

- To know the technical programming and field level assessment of groundwater system.

Introduction – An overview of groundwater systems – Model formulation and development. Groundwater flow equations – Darcy's Law – the Continuity equation – Partially saturated flow – Partially unsaturated flow – Conservation of mass in a deforming porous medium – Groundwater flow equations for a confined or leaky aquifer and unconfined aquifer. Groundwater quality – the mass transport problem – Mass transport equation – Groundwater quality model – Vertically averaged mass transport equations – Boundary and initial conditions – Non conservative processes – Partially saturated flow systems.

Numerical methods in Groundwater Management – the response equation – Finite difference numerical models – Finite element models – the method of weighted residuals – Solution methods for the dynamic response equation – Nonlinear systems – Matrix method for the solution of linear system of equations – Finite difference stability analysis – Finite element analysis.

Optimization methods for Groundwater Management – Preliminaries of mathematical programming – Linear programming – Stochastic linear programming – Quadratic programming – Dynamic programming – Stochastic dynamic programming – Nonlinear programming – Unconstrained optimization – Constrained optimization – Multi-objective programming. The Inverse Problem in Groundwater Systems – Parameter estimation problem – Parameter dimension and parameterization – Parameter identification methods – Equation error criterion – Parameter estimation model – Output error criterion parameter estimation model – Gauss-Newton algorithm – Computation of sensitivity coefficients – Parameter uncertainty and optimum parameter dimension – Bayesian estimation – Statistical methods.

Groundwater Supply Management Models – Groundwater allocation model – Groundwater operation model – Capacity expansion model – Conjunctive groundwater and surface water planning model .Groundwater Quality Management Modeling – Groundwater quality simulation models – Solution methods for the groundwater quality prediction problem – Optimal groundwater quality management model – Solution algorithms for the conjunctive management model.

Field assessment and evaluation methods – In-situ methods of Groundwater assessment – Volumetric quantification – Natural and artificial recharging – Hydrogeological mapping interpretation – Decision making – social awareness and involvement, monitoring and maintenance planning and retrofitting at fields level observation and assessment – Inventories and field level condition assessment – cost appraised of modified and retrofitted field level installations – management and mitigation planning.

REFERENCES

1. Dantzig, G.B, "Linear programming and extensions", Princeton University Press, Princeton, New Jersey, 1963.

2. Huyakorn, P.S. and Pinder, G.F, "Computational methods in subsurface flow", Academic Press.
3. Lee, S.M, "Linear optimization for management", Petrocelli/ Charter, New York, 1976.
4. Rastogi, A.K, "Numerical Groundwater Hydrology", Penram International Publications, 2007.
5. Remson, I, Hornberger, G.M. and Molz, F.J, "Numerical methods in subsurface Hydrology", Wiley-Interscience, New York
6. Robert Williams and William W-G. Yeh, "Groundwater System Planning and Management", Prentice – Hall Inc, 1987.
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WEB REFERENCE:

1. https://ngwa.onlinelibrary.wiley.com/journal/17456584

COURSE OUTCOMES

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

1. Understand the groundwater systems management
2. Solve problems in groundwater modeling
3. Know and apply the technical programming to the groundwater management
4. Evaluate the problems on groundwater development.
5. Understand the various types of methods and analysis

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1		2	2				3					2	2	1
CO2	2	3	3	2	2				2		1	3	3	1
CO3	1		3			1				2		2	2	2
CO4	2	2	3	2			2		2	3	2	3	3	2
CO5	2	3	2			2			3		2	3	3	2

23CEWRPEXX	URBAN HYDROLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce to the concepts of urbanization and its impact on the natural water cycle.
- To prepare Master plans for urban water management.
- To knowledge about entire urban hydrological cycle
- To acquire knowledge on appropriate management techniques for planning, operating and maintaining urban water management
- To acquire knowledge on socio economic and financial aspects

Urban hydrologic cycle: Water in the urban eco-system - Urban water resources - Major problems – Urban hydrological cycle - Storm water management - Objectives and limitations - Storm water policies - Feasibility consideration.

Urban Storm Water Management: Storm water management practices (Structural and Non- structural Management measures) - Detention and retention concepts – Modelling concept - Types of storage - Magnitude of storage - Hydraulic analysis and design guidelines - Flow and storage capacity of urban components - Temple tanks.

Urban Water Resources Management Models: Types of models - Physically based - conceptual or unit hydrograph based -Urban surface runoff models - Management models for flow rate and volume control rate - Quality models.

Master plans: Planning and organizational aspects - Inter dependency of planning and implementation of goals and measures - Socio - economics financial aspects - Potential Costs and benefit measures - Measures of urban drainage and flood control benefits - Effective urban water user organizations.

Operation and Maintenance: General approaches to operations and maintenance - Complexity of operations and need for diagnostic analysis - Operation and maintenance in urban water system - Maintenance Management System - Social awareness and involvement.

Quantification of urban drainage utilization – capacity building and in-situ utility assessment - augmentation methods – urban in-situ rainwater harvesting planning, construction features – natural and artificial in-situ techniques. Pre and post urban layouts and rehabilitation retrofitty – Learning lessons from failure cases studies – modern in-situ methods and modification for urban drainage and utilization layouts. Inventories and condition assessment – learning from heritage methods and its applicability to modern urban hydrology. Direct storage and utilization of rainwater for urban utilization – social awareness and involvement.

REFERENCES

1. Geiger.W.F.,Marsalek.F., Rawls.W.J., and Zuidena.F.C., (Ed), manual on drainage in urbanized areas - Vol.I and Vol.II, UNESCO, 1987.

2. Hengeveld H. and C.DeVoch.t (Ed)., “Role of Water in Urban Ecology”, 1982.
3. Martin P.Wanelista and Yousef A.Yousef., “Storm Water Management”, John Wiley and sons, 1993.
4. Neil S.Grigg., “Urban Water Infrastructure planning, management and Operations”, John Wiley and Sons, 1986.
5. Overtens D.E. and Meadows M.E., “Storm Water Modelling”, Academic Press, New York, 1976.
6. Warren Viessman, “Introduction to Groundwater Hydrology”, Pearson, Fifth edition, 2002.

WEB REFERENCE:

1. https://link.springer.com/referenceworkentry/10.1007/1-4020-4513-1_227

COURSE OUTCOMES

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

1. Apply appropriate management techniques for planning, operating and maintaining the different components of urban and drainage systems.
2. Gain knowledge in operation and maintenance of urban water systems.
3. Solve the problems on socio-economic financial aspects.
4. Know about urban eco-system and urban hydrological cycle.
5. To understand urban hydrology, master plan

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2	3	2		2			2	2	3	2	3	2	2
CO2		2	1	2	3		2		2			3	3	3
CO3	2	3	3				1		1	2	2	3	3	2
CO4	3	1										2	3	2
CO5	2	3			1		2			2	1	3	1	1

23CEWRPEXX	**WATERSHED MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the watershed based water resources development
- To implementation of conservation practices
- To implant the sustainable management of natural resources of the watershed

Introduction: Watershed – Definition and Classification – Components- Basic factors influencing watershed development – Codification - Watershed delineation - Characteristics of watershed: size, shape, physiography, slope, climate, drainage, land

use, vegetation, geology and soils, hydrology and hydrogeology – Socio - economic characteristics.

Soil conservation measures: Types of Erosion – Water and Wind Erosion: Causes, Factors, Effects and Control – Estimation of Soil Erosion- Soil Loss Models-Sedimentation - Soil Conservation Practices: Vegetative and Mechanical.

Water harvesting and conservation: Types of storage Structures-Water yield from Catchments-Losses of stored water- Water Conservations Methods-Water harvesting methods and Techniques-Rainwater Harvesting-Catchment, Harvesting structures, Roof water harvesting-Soil Moisture Conservation-Check Dams-Artificial Recharge-Farm Ponds-Percolation tanks.

Watershed management: Project Proposal Formulation - Watershed Development Plan – Entry Point Activities – Estimation – Watershed Economics - Agroforestry – Grassland Management – Wasteland Management – Watershed Approach in Government Programmes –Developing Collaborative know how – People's Participation – Evaluation of Watershed Management

Watershed management plan: Methodology of planning a watershed management, identification of watershed problems, socio-economic issues - application of Remote Sensing and GIS in watershed management.

REFERENCES

1. Dhuruvanarayana.V.V, Sastry.G and Patnaik.U.S, "Watershed Management", Publications and information division, Indian Council of Agriculture Research, New Delhi, 1990.
2. Gelnn O. Schwab, "Soil and Water Conservation Engineering", john Wiley and sons, New York, 1981.
3. Ghanashyam Das, "Hydrology and Soil Conservation engineering", Prentice Hall of India Private Limited, New Delhi, 2000.
4. Murthy J.V.S, "Watershed Management in India", Wiley Eastern Limited, New Delhi, 1995.
5. Suresh, R., "Soil and Water Conservation Engineering", Standard Publishers.
6. Tideman E.M., "Watershed Management", Omega Scientific Publishers, New Delhi, 1996.

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1. https://onlinecourses.swayam2.ac.in/cec23_ge01/preview

WEB REFERENCE:

1. https://nap.nationalacademies.org/read/5589/chapter/8

COURSE OUTCOMES

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

1. Suggest technical measures for soil erosion and water harvestings
2. Apply the knowledge of overall concepts of watershed which would help to comprehend and analyze for better management and conservation.

3. Understanding rainwater harvesting and methods in water resources management
4. People participation in water resources management
5. Assess better watershed management plan for applications of Remote Sensing and GIS

Mapping of COs with POs&PSOs													
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS0 3**
CO1	2	3	2		1				2	3	2	2	3	1
CO2	3	3	2	2			2					2	3	2
CO3	3	2	1	3				1		2	1	3	2	2
CO4		3		3		1			3			3	3	1
CO5	2	1	2			3				1	2	3	3	3

23CEWRPEXX	**RIVER ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand theoretical concepts of water and sediment movements in rivers
- To understand the river hydraulics
- To inculcate the benefits of fluvial system to the society
- To conduct the river survey and create model development

River Functions**:** Primary function of a river – River uses and measures – Water and Sediment loads of river – Rivers in India, Himalaya and Peninsular.

River Hydraulics**:** Physical Properties and Equations – Steady flow in rivers – uniform and non-uniform – Turbulence and velocity profiles – resistance coefficients – Boundary conditions and back waters – Transitions – Rating Curve – Unsteady flow in rivers : Propagative of surface waves – Characteristics, flood waves – kinematic and diffusion analogy – velocity of propagation of flood waves – Flood wave –Maximum

River Mechanics: River Equilibrium: Stability of Channel – regime relations – river bend equilibrium – hydraulic geometry of downstream - Bars and meandering - River dynamics – degradation and aggradations of river bed – Confluences and branches – River Data base.

River Surveys and Model**:** Mapping – Stage and Discharge Measurements – Sediments – Bed and suspended load Physical hydraulic Similitude – Rigid and mobile bed – Mathematical – Finite one dimensional – multi – dimensional – Water Quality and ecological model

River Management**:** River training works and river regulation works – Flood plain management – waves and tides in Estuaries - Interlinking of rivers – River Stabilization

REFERENCES

1. Janson PL.Ph., LvanBendegamJvanden Berg, Mdevries A. Zanen (Editors), Principles of River Engineering – The non tidal alluvial rivers – Pitman, 1979.
2. Pierre Y. Julien ., River Mechanics ,Cambridge University Press, 2002.
3. Rao. K.L, India's Water Wealth – Orient Longman Ltd., 1979.
4. Garde. R. J., River Morphology, New Age International (P) Limited, Publishers New Delhi 2011.
5. Garde. R.J.and Ranga Raju. K.G., Mechanics of Sediment Transportation and Alluvial Stream Problems New Age International (P) Limited Publishers New Delhi 2000

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1. https://www.cambridge.org/core/books/abs/rivermechanics/riverengineering/4449F3BA99C55FA7273B2CBB9B6FE3F0

COURSE OUTCOMES

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

1. Understand the complex behavior of rivers.
2. Gain the skills to take up research activities in river engineering.
3. Understand the characteristics of the river hydraulics
4. Understand the water quality and ecological model in river survey
5. Understand the flood mitigation and management techniques

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1	2	2		2	1			3	2	1	3		3
CO2			3										3	
CO3	2	2							1	2	2	1		
CO4	1	1	3	1		2			3				2	1
CO5	2	2	1		1			1		1	2	3	3	3

23CEWRPEXX	**SOFT COMPUTING IN WATER RESOURCES MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To enable students to understand application of the latest information technology to Water Resources Engineering.
- To provide the mathematical background for carrying out optimization associated with neural network and fuzzy logic learning.
- To develop skills of students in software usage for Water Resources Management.

Introduction: Basic concepts of Neural Networks and Fuzzy Logic – Difference between conventional computing and Neuro-Fuzzy computing – Characteristics of Neuro- Fuzzy Computing.

Fuzzy Set Theory: Basic definitions, terminology and membership functions – formulation and parameters – basic operations of fuzzy sets – complement, intersection, vision – T – norm and T – conorm. Fuzzy Reasoning and Fuzzy Inference: Fuzzy rules – Fuzzy reasoning – Fuzzy Inference Systems – Fuzzy modeling – Applications of Fuzzy reasoning and modeling in Water Resources Engineering.

Fundamental concepts of Artificial Neural Networks: Model of a Neuron – Activation functions – neural processing – Network architectures – learning methods.

Neural Network Models: Feed forward Neural Networks – Back propagation algorithm – Applications of Feed forward networks – Recurrent networks – Hopfield networks – Hebbian learning – Self organizing networks – unsupervised learning – competitive learning.

Neuro-fuzzy computing: Hydrologic Modelling – Time series Analysis and Modelling in Water Management. Basic concepts of few other soft computing algorithms – Genetic algorithms – Evolutionary algorithms – Simulated Annealing – Honeybee mating algorithms –Applications to water resources engineering problems.

REFERENCES

1. Daniel. P. Loucks and Eelco Van Beek with contributions from Jery R. Stedinger Jos. P.M. Dijkman and Monique. T. Villars, “Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications”, UNESCO Publishing Company., 2005
2. Jang, JSR, Sun, C.T. and Mizutani, E. “Neuro-Fuzzy and Soft Computing”, Prentice Hall, NJ., 1997
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4. Kosko, B. (, “Neural Networks and Fuzzy Systems”, Prentice Hall of India Pvt.
5. Ltd., New Delhi.,1997
6. Rajasekaran, S. and Pai, G.A.V., “Neural Networks, Fuzzy Logic and Genetic algorithms", PHI., 2003
7. Rao. V and H. Rao, “C++, Neural Networks and Fuzzy Logic”, BPB Publications, New Delhi., 1996
8. Simon Haykin, “Neural Networks, A Comprehensive Foundation”, McMillan College Publishing Company.,1994
9. Villars, “ Water Resources Systems Planning and Management- An Introduction to Methods, Models and Applications”, UNESCO Publishing Company., 2005

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COURSE OUTCOMES

At the end of the course students will be able to

1. Understand and apply the concepts of Artificial Neural Networks for computations.
2. Adopt Fuzzy logic in modeling water resource systems and evolve optimum solutions.
3. Employ Neuro-Fuzzy computing to Water resource problems in finding quick solutions.
4. Appreciate the advantages of soft computing techniques to real time water systems
5. Choose appropriate soft computing algorithms for various Water Resource Engineering problems.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	3	3	2	2		1		1	2	3	1		3	1
CO2	2	2	1					2		3	2	2	2	2
CO3	3	1	2			2			2		3	3	2	1
CO4	2	2							3				2	2
CO5	1	1	2		1	2	1		1	2	1	3	2	2

23CEWRPEXX	**WATER QUALITY MANAGEMENT FOR AGRICULTURE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce water quality concepts, its evaluation for irrigation purposes.
- To understand the scientific approach to crop productivity, besides relevant environmental problems and recycle and reuse concepts.
- To understand the importance of water quality and Management for irrigation and major uses of water and the role in environmental issues.

Water quality evaluation – Water quality problems – Approach to evaluating water quality – Water quality guidelines - Salinity problem – Build up of soil salinity - salinity effects on crops – Management of salinity Problems.

Infiltration problems – Problem evaluation – Management of infiltration problems – Soil and water amendments – blending water supplies – Cultivation and deep tillage – Irrigation management.

Toxicity Problems – Specific ions and their effects – Management of toxicity problems – leaching – Crop selection – Cultural practices – Blending water supplies – Toxicity effects due to sprinkler Irrigation.

Miscellaneous Problems – Excess Nitrogen – Abnormal pH, Scale deposits – Magnesium problems – Trace elements and their toxicity – Nutrition and water quality – Clogging problems in localized drip irrigation systems – Corrosion and incrustation – Vector problems.

Experiences using water of various qualities – Reuse of agricultural drainage water – High carbonate water used for overhead sprinkler irrigation – High salinity water use – Use of marginal quality water – Agricultural use of treated waste – Wastewater irrigation.

REFERENCES

1. Ayers, R.S. and Westcott, D.W, "FAO Irrigation and Drainage paper"– 29 (Revised), FAO, Rome, Italy, 1985
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5. Vladimir Novonty, "Water Quality: Diffuse pollution and watershed Management", 2nd edition, John Wiley & Sons, 2003.

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1. https://www.frontiersin.org/articles/10.3389/fsufs.2020.624066/full

COURSE OUTCOMES

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

1. Relate water quality and its dependence on sources of water supplies.
2. Understand and interpret water quality data for beneficial uses and in water quality management to increase crop yield.
3. Understand the trace elements and the toxicity including drip irrigation system
4. Understand the use of treated waste water for irrigation
5. Know the experiences /conservation of using water of various qualities

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1			2		2			2		2	2	3	1
CO2	2	2	3						2	2	1	3	3	2
CO3	2	3	2	1			2		2	2		3	3	1
CO4	1	3	3	2		2				2		2	2	2
CO5	1	3	2	1		2			1		1	2	3	3

23CEWRPEXX	FLOOD MODELLING AND DROUGHT ASSESSMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the hydrologic extremes of floods and droughts
- To combat them for estimation of severity and extent of damages and the mitigation measures
- To understand flood estimation and control

Flood Estimation: Flood – Types of Flood – Effects of Flood - Methods of estimation of flood discharge frequency – stage–frequency curves – design storm – design flood.

Flood Control: Methods of controlling floods – dams, storage reservoirs, levees, improved channel ways, flood ways – flood plain zoning – Non-structural methods of flood damage reduction – flood proofing, flood forecasting, flood warning and flood fighting.

Flood Modelling and Management : Hydrologic and Hydraulic Routing – Reservoir and Channel Routing - Flood Inundation Modelling – HEC HMS and HEC RAS software - Flood control methods – Structural and non-structural measures - Flood Plain Zoning – Flood forecasting – Flood Mitigation - Remote Sensing and GIS for Flood modelling and management

Drought Assessment: Drought indices – Drought severity assessment – meteorological, hydrological and agricultural aspects – IMD, Palmer, Herbst, Aridity Indices and Ramaprasad Methods.

Drought Monitoring and Management :Drought monitoring – Supply and demand oriented measures – Traditional water conservation – Drought Prone Areas Programme (DPAP) – Integrated drought management – Remote sensing applications for drought mitigation – NDVI concepts- Water Scarcity Management in Urban, Industrial and Agricultural sectors

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1. Chow V.T., Maidment D.R., Mays L.W., "Applied Hydrology", McGraw Hill Publications, New York, 1995.
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1. https://www.researchgate.net/publication/332183462_Flood_and_Drought_Risk_Management_in_the_Mekong_Basin_Contribution_of_International_and_Regional_Actors

COURSE OUTCOMES

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

1. Know the different methods of design flood estimation and perform channel reservoir routing.
2. Carryout flood inundation modeling and suggest suitable flood control measures.
3. Acquire the knowledge about different types of drought and their impacts and asses the severity, duration and frequency of drought using drought using drought indices.
4. Get exposed to various approaches, measures and case studies of drought indices.
5. Understand the Remote sensing application for drought mitigation

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2	2		2					2	1	1	2	2	1
CO2	2	2	2		1	2			3			2	2	3
CO3	3	2	3	2		1	1			1	1	3	3	3
CO4		2	2		2		1		2		1	3	3	1
CO5	2	3	2				1		2			3	2	3

23CEWRPEXX	**ADVANCED HYDROLOGICAL ANALYSIS AND DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the concepts of systems approach to hydrological modeling.
- To analyze hydrologic time series and stochastic hydrologic models.
- To study the types and classes of hydrologic simulation models.
- To design safe and effective passage of flood flows and discuss the design methods.

Hydrologic cycle – System concept – Hydrologic system Model – Classification of Hydrologic Models – Statistical, Stochastic and Deterministic Approaches – Statistical characteristics of Hydrological Data – Probability distribution of Hydrologic Variables -

Correlation Analysis – Developing Prediction Equation by Simple and Multiple Linear Regression – Reliability of the Model.

Stochastic Process – Classification – Stationary Process – Time series – Classification – Component of Time series – Method of Investigation – Auto Correlation coefficient – Moving Average Process – Auto Regressive Process - Auto Regressive Moving Average Process - Auto Regressive Integrated Moving Average Process – Thomas Fiering Model – Box Jenkins Model – Model formulation – Parameter Estimation – Calibration and Validation – Application to hydrologic data - Generation and Forecasting.

Classification of Deterministic Model – Black Box, Conceptual and Physically based Models – Rational method - Models of IUH, Nash and Chow-Kulandaiswamy Models – Lumped and Distributed Conceptual Models – Single event and Continuous Conceptual Models – HEC HMS, Tank Model, WBNM and other Models – Physically based Models – SWAT and MIKE SHE – Model Calibration and Validation

Hydrologic Design Scale – Estimating Limiting Value – Hydrologic Design level – Hydrologic Design Data - Hydraulic structure Design methods - Estimation of PMP - Computation of Design Storm - IDF Relationships - Design Flows - Hydrologic Risk, Reliability and Safety Factor.

Hydrologic Design Standards and Criteria - Design storms for Minor and Major structures – Hydrologic Design of Culverts, Highway and Railway Bridges - Urban Storm Drainage Design – SWMM – Airport Drainage Design - Detention Storage Design – Design of Spillway.

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1. Charles T. Haan, “Statistical method in Hydrology”,Iowa State University Press, first edition,1977.
2. Jayarami Reddy P, Stochastic Hydrology, Laksmi Publications, New Delhi, 1995
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4. Makauidakis, Mc Gee and Wheel Wright, Forecasting methods, John Wiley and Sons, New York, 1992
5. Vente chow, David R. Maidment, Larry w. mays, “Applied Hydrology”,McGraw-Hill Science, first edition, 1988
6. Vijay P.Singh, Elementary Hydrology, Prentice Hall of India, New Delhi,1994

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COURSE OUTCOMES

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

1. Develop prediction equation between hydrologic variables using simple and multiple linear regression.

2. Apply the time series models for hydrologic data generation and forecasting.
3. Identify the different types and procedures for calibration and validation of deterministic simulation models.
4. Apply the hydrologic design concepts
5. Methods for estimating the design flows for minor, medium and major hydraulic structures

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2	2	1	1	2						2	2	2	2
CO2	3	3	3			2	2		2			2	3	2
CO3	2	2	3		2					2	2	2	1	1
CO4	3	3	2			2			2		1	3	2	2
CO5	1	2	2	2	2		2				2	2	1	1

23CEWRPEXX	**CLIMATE CHANGE AND ADAPTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the earth's climate change and its system classification
- To introduce the observed changes in the climate
- To concept of modelling and Institutional arrangements existing for monitoring this phenomenon

Earth's Climate System**:** Introduction – Climate in the spotlight - The Earth's Climate Machine–Climate Classification–Global wind systems–Trade Wind Systems Trade Winds and the HadleyCell–The Westerlies–Cloud formation and Monsoon Rains–StormsandHurricanes–TheHydrologicalCycle–GlobalOceanCirculation–EINinoanditsEffect–SolarRadiation–TheEarth'sNaturalGreenHouseEffect– Green House Gases and Global Warming– Carbon Cycle.

Observed Changes and Its Causes :Observation of Climate Change– Changes in pattern of temperature, precipitation and sea level rise–Observed effects of Climate Changes–Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks–The Montreal Protocol–UNFCCC–IPCC– Evidences of Changes in Climate and Environment–on a Global Scale and in India–Climate Change modelling.

Impacts of Climate Change: Impacts of Climate Change on various sectors– Agriculture ,Forestry and Ecosystem– Water resources– Human Health– Industry, Settlement and Society–Methods and Scenarios –Projected Impacts for different regions – Uncertainties in the Projected Impacts of Climate Change – Risk of irreversible changes.

Climate Change Adaptation and Mitigation Measures: Adaptation Strategy/options in various sectors– Water–Agriculture–Infrastructure and Settlement including coastal zones. Human Health–Tourism–Transport–Energy– Key Mitigation Technologies and practices– Energy supply–Transport– Buildings– Industry– Agriculture–Forestry– Carbon sequestration– Carbon Capture and Storage (CCS)–Waste (MSW & Bio waste, Biomedical, Industrial waste–International and Regional co-operation.

Clean Technology and Energy: Clean Development Mechanism– Carbon Trading– Examples of future Clean Technology–Biodiesel– Natural Compost–Eco-friendly Plastic–Alternate Energy–Hydrogen–Bio-fuels–Solar Energy–Wind–Hydroelectric Power–Mitigation Efforts in India and Adaptation funding

REFERENCES

1. Dash SushilKumar, "Climate Change– An Indian Perspective", Cambridge University PressIndiaPvt.Ltd,2007
2. IPCC Fifth Assessment Report–www.ipcc.ch
3. JanC.vanDam,Impactsof"ClimateChangeandClimateVariabilityonHydrological Regimes",CambridgeUniversityPress,2003

NPTEL LINK:

1. https://onlinecourses.swayam2.ac.in/nou23_ge20/preview

WEB REFERENCE:

1. https://nap.nationalacademies.org/read/12782/chapter/22

COURSE OUTCOMES

At the end of the course students will be able to

1. Understand the earth's climate change and its system classification
2. Introduce the observed changes in the climate and concept of modeling and Institutional arrangements existing for monitoring this phenomenon
3. Show the impact of climate change on various sectors and its irreversibility
4. Prepare the adaptation and mitigation measures of climate change on various sectors.
5. Choose the clean Technology for the Fuel and energy through natural and eco friendly techniques.

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1	2			3				2			3	1	2
CO2	3	2	2				2					2	2	3
CO3	2	1	3									3	2	3
CO4	2	3	2								2	2	1	3
CO5	2	2	1		2					2		3	2	1

OPEN ELECTIVES

23CEWROE XX	WATER QUALITY MODELING	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

- To provide a fundamental understanding of formulation of water quality models are formulated, so that the students are able to adapt existing models to new situations.
- To provide the students with direct exposure to models currently used in environmental engineering practice for predicting water quality in rivers and lakes.
- To equip the students to apply such models to solve simple waste load allocation problems.
- To instruct as to how water quality data can be analyzed and interpreted and show how water quality models may be calibrated, verified, and applied to environmental engineering problems, such as total maximum daily loads or fate and transport modeling of toxic organic chemicals.

Introduction, Water Quality-Fundamental Quantities-Mathematical models, Historical Development of Water-Quality Models. Basic modeling concepts - Reaction Kinetics-Reaction fundamentals - Analysis of Rate - Data-Stoichiometry – Temperature Effects.

Transport phenomena – Advection, diffusion, dispersion- simple transport models –Diffusive transport: Diffusion and Fick's first law, Calculation of molecular diffusion coefficients Plug flow models- Application of PFR and MFR model - Steady state and time variable solutions-completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feedback reactor systems.

Water quality modeling of Streams, Lakes and impoundments and Estuaries – Water quality– model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelps model for point and distributed sources - Modified Streeter Phelps equations -Toxicant modeling in flowing water.

Groundwater flow and mass transport of solutes, Degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion

Basic concepts and modeling - Exposure to surface water and groundwater quality modeling software – MIKE 21, QUAL2E and MODFLOW Models and their application - Case studies.

REFERENCES

1. Benedini, Marcello, Tsakiris, George, “Water Quality Modelling for Rivers and Streams”, Springer Netherlands, 2013.

2. Jacob Bear, A, Cheng, H.D, "Modeling Groundwater Flow and Contaminant Transport", Springer Science & Business Media, 2010.
3. Steven C. Chapra, "Surface Water Quality Modelling", The McGraw-Hill Companies, Inc., New Delhi, 1997.
4. Thomann, V, John A. Mueller, "Principles of Surface Water Quality Modeling and Control", Harper & Row, 1987.

WEB REFERENCE:

1. https://study.unisa.edu.au/courses/101308

COURSE OUTCOMES

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

1. Understand the context of water quality management and engineering.
2. Apply mass balance principles to develop and solve simple water quality models.
3. Understand eutrophication, the principal of biochemical and physical factors affecting algae growth, management problems and solutions, and modelling approaches and their limitations.
4. Get exposed to surface water and ground water quality modelling software and case studies in water quality modelling.
5. To learn surface water and groundwater quality modelling software

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	1		2	2	1		2			1	2	2	3	1
CO2		2	3										2	
CO3	2	2	3		1				2			3	3	3
CO4				1		2							2	2
CO5			3	2	2		2		1	2	2			2

23CEWROEXX	INTEGRATED WATER RESOURCES MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the role of disciplines of ecology and socio-economic play in management of water resources.
- To expose to global food security and public-private participation issues
- Legal and regulatory settings, in the context of IWRM

ontext for IWRM**:** Water as a global issue: key challenges and needs – Definition of IWRM within the broader context of development – Complexity of the IWRM process – Examining the key elements of IWRM process.

Water Economics**:** Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments, policy options for water conservation and sustainable use – Case studies. Pricing: distinction between values and charges – Private sector involvement in water resources management: PPP objectives, PPP options, PPP processes, PPP experiences through case studies – Links between PPP and IWRM.

Water supply and Health within the IWRM consideration**:** Links between water and human health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Health impact assessment of water resources development.

Agriculture in the Concept of IWRM: Water for food production: 'blue' versus 'green' water debate – Virtual water trade for achieving global water security – Irrigation efficiencies, irrigation methods and current water pricing.

Water Legal and Regulatory Settings**:** Basic notion of law and governance: principles of international and national law in the area of water management. Understanding UN law on non-navigable uses of international water courses – Development of IWRM in line with legal and regulatory framework.

REFERENCES

1. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
2. Technical Advisory Committee, Poverty Reduction and IWRM, Technical Advisory Committee Background paper no: 8. Global water partnership, Stockholm, Sweden, 2003.
3. Technical Advisory Committee, Regulation and Private Participation in Water and Sanitation section, Technical Advisory Committee Background paper No: 1. Global water partnership, Stockholm, Sweden, 1998.

4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Water as social and economic good: How to put the principles to practice". Technical Advisory Committee Background paper No: 2. Global water partnership, Stockholm, Sweden, 1998.
6. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.
7. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
8 Mollinga .P, "Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

WEB REFERENCE:

1. https://slideplayer.com/slide/5105254/

COURSE OUTCOMES

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

1. Paradigm shift in attitude of the students towards interdisciplinary research.
2. Gain knowledge about economic aspects of water.
3. Understanding of the complexities of dealing with water resources problems.
4. Understand concept of IWRM in agriculture
5. Understand the principles of International and national laws in the area of water management

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	3	2		3						2	2	3	1	2
CO2	3	1				2	1			2		3		
CO3		3	3						2			3	2	1
CO4			3			2			2	3		2	3	
CO5	1		3				2		2			3		

23CEWROE XX	**GROUNDWATER CONTAMINANT TRANSPORT MODELING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the different methodologies for contaminant transport modeling with emphasis on groundwater

- To introduce software modules
- To introduce the various software codes available for various solution schemes in contaminant transport modeling.

Review of Groundwater Principles: Aquifer Properties – Darcy's Law – Principal Directions – Partial Differential Equation (PDE) for Groundwater Flow.PDE for Mass (contaminant) Transport: Hydrodynamic dispersion – Advective Transport – Advection Dispersion Equation – Principal Directions – Conservative versus Reactive Transport.

Modeling Chemical Reactions: Types of Geochemical Reactions – Adsorption – Desorption Reaction – Freundlich Isotherm – Radioactive Decay – Hydrolysis – Equilibrium Reactions and Law of Mass Action – Microbial Degradation – Modeling Multi Component contaminant Transport. Natural Attenuation / Intrinsic Bioremediation: Bioremediation of petroleum hydrocarbons – Electron Acceptors/ Donors – Bioavailability – Equilibrium Chemical reactions Technical Protocol for Implementation. Soil/ Groundwater Remediation Systems: Soil Vapor Extraction (SVE) – Air Sparging Systems (AS) – Pump and treat Systems (PT).

Numerical Groundwater Contaminant Transport Modeling: Finite difference Method (FDM): Numerical dispersion – Stability analysis – Implicit and Explicit Finite difference solutions – Mixing Cell Approach. Method of Characteristics (MOC): Characteristics Equations – Particle Tracking solutions - Stability Considerations – Advantages and Disadvantages. Random Walk Method (RWD): Theoretical Basis – Advantages /Disadvantages Finite Element Method (FEM) - Modified Method of Characteristics (MMOC) - Total Variation Diminishing (TVD) Method.

Analytical Solutions: Transformed Advection/Dispersion Equation – Fundamental solution – Continuous Point Solution – Instantaneous Line Solution – Normal Distribution of Contaminants. Major Numerical Modeling Codes: ModFlow Companion Models: MT3D (Modular 3D Transport) – RT3D (Reactive 3D Transport) – SEAWAT (Seawater intrusion)

USGS Codes: MOC (Method of Characteristics) – Bio MOC (MOC Biodegradation Reactions) – Other – PHAST (Multi component Geochemical reactions) – SUTRA (Variable Density Variable Saturation) – VS2DT (Variable Saturated 2D Transport) – RUNSAT (Reactive Unsaturated).EPA/CMOS Codes: Bio Plume (Oxygen limited biodegradation) – MOFAT (Multiphase Multi component Transport). Modeling usingMODFLOW, contaminate transfer modeling with AMT3DMS, RT3D, PHD3D and ArcGIS andSimulators using MatLab nonpoint source (NPS) pollution in groundwater aquifers.

REFERENCES

1. Chunmiao Zheng and Gordon D. Bennett, "Applied contaminant transport Modeling", Wiley Inter science, 2nd Edition, 2002.
2. Fetter C.W, Contaminant Hydrology, Prentice Hall, 2nd Edition, 1998.

3. Gadeon Dagan, “Flow and Transport in Porous Formations”, Springer Verlag, 1989.
4. James Dragun, “The soil Chemistry of Hazardous materials”, 2nd Edition, Hazardous materials Control Research Institute, 2001.
5. Martin Alexander, “Bioremediation and Biodegradation”, Academic Press, 2nd Edition, 1999.
6. Phillip Bedient, HandadiRifai, and Charles Newell, “Groundwater Contamination Transport and Remediation”, Prentice Hall ,1999
7. Randall Charbeneau, “Groundwater Hydraulics and Pollutant Transport”, Prentice Hall, 2000.
8. Todd Widemeier, HandaiRifai, Charles Newell, and John Wilson, “Natural attenuation of Fuels and Chlorinated solvents in the Subsurface”, Wiley, 1999.
9. Free software resources :https://water.usgs.gov/software/lists/groundwater

WEB REFERENCE:

1. https://water.usgs.gov/software/lists/groundwater/

COURSE OUTCOMES

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

1. Gain the knowledge on principles of groundwater flow and various governing equations
2. Understand the concept of groundwater contaminant transport
3. Learn the different methods of analysis and modeling of contaminant transport in aquifers.
4. Learn the modelling of chemical reactions
5. Apply USGS standard codes for groundwater contaminant modelling

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	3	2	2									3	2	3
CO2	2	3		2	2						2	2	1	2
CO3	2	3		2	2						2	3	2	3
CO4	2	3		2	3							2	2	3
CO5		3		2	3							3	1	2

23CEWROE XX	COASTAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the importance to protect harbors and improve navigation.
- To expose students to the diverse topics as wave mechanics, wave climate, shoreline protection methods
- Laboratory investigations using model studies.

Introduction to Coastal Engineering: Indian Scenario – Classification of Harbors. Introduction - wind and waves – Sea and Swell - Introduction to small amplitude wave theory – use of wave tables- Mechanics of water waves – Linear (Airy) wave theory, Introduction to Tsunami.

Wave Properties and Analysis: Behavior of waves in shallow waters, Introduction to non-linear waves and their properties – Waves in shallow waters – Wave Refraction, Diffraction and Shoaling –Hind cast wave generation models, wave shoaling; wave refraction; wave breaking; wave diffraction random and 3D waves- Short term wave analysis – wave spectra and its utilities - Long term wave analysis- Statistics analysis of grouped wave data.

Coastal Sediment Transport: Dynamic beach profile; cross-shore transport; along shore transport (Littoral transport), sediment movement

Coastal Defense: Field measurement; models, groins, sea walls, offshore breakwaters, artificial nourishment - planning of coast protection works - Design of shore defense structures –Case studies.

Modeling in Coastal Engineering: Physical modeling in Coastal Engineering – Limitations and advantages – Role of physical modeling in coastal engineering – Numerical modeling – Modeling aspects – limitations – Case studies using public domain models, Tsunami mitigation measures.

REFERENCES

1. "Coastal Engineering Manual (CEM)". US Army Coastal Engineering Research Center, 2002-2006.
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3. Dean, R.G. and Dalrymple, R.A., "Water wave mechanics for Engineers and Scientists", Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
4. Ippen, A.T., "Estuary and Coastline Hydrodynamics", McGraw-Hill, Inc., New York, 1978.
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8. Sorensen, R.M., “Basic Coastal Engineering”, 3rd Edition, Springer, 2006.
9. Sorenson, R.M., "Basic Coastal Engineering", A Wiley-Interscience Pub. New York, 1978.

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1. https://www.studocu.com/row/document/comsats-university-islamabad/introduction-totransportation-engineering/lecture-9-coastal-engineering/4648955

COURSE OUTCOMES

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

1. Understand coastal engineering aspects of harbors methods to improve navigation, shoreline protection
2. Understand laboratory investigations using model studies.
3. Use the skills and techniques in ICM.
4. Modelling in coastal Engineering
5. Learning different case studies using public domain models

Mapping of COs with POs&PSOs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2	2										2	1	3
CO2		2	3	2				2				2	2	2
CO3		2	3	2				2				2	2	1
CO4	2	3		2	2							2	2	2
CO5	2	2		2					2		2	2	2	2

23CEWROEXX	**COMPOSITE MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURESE OBJECTIVES

- To understand the importance of Composite Materials as a subject that revolutionized modern day technologies.
- Manufacturing of different materials and composites
- To understand the significance of material science in the development of new materials and devices for all branches of Engineering.

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix

Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications. Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

REFERENCES

1. Cahn. R.W., Material Science and Technology, Vol 13 – Composites – VCH, West Germany.
2. Callister, WD Jr., Adapted by R. Balasubramaniam, Materials Science and Engineering, An introduction John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Chawla. K.K. , Composite Materials
5. Deborah D.L. Chung. Composite Materials Science and Applications
6. Danial Gay, Suong V. Hoa, and Stephen W. Tasi. Composite Materials Design and Applications
7. Modern Composite Materials" by L J Broutman and R M Krock
8. Mechanisms and Mechanics of Composite Fracture" by R B Bhagat and S G Fishman

WEB REFERENCE:

1. https://onlinelibrary.wiley.com/doi/full/10.1002/9781118985960.meh110

COURSE OUTCOMES

At the end of the course students will be able to

1. Understand the characteristics and structure of microbes.
2. Isolate and identify different microbes present in various sources.
3. Acquire knowledge on soil, aquatic and air microbiology.
4. Learn different types of various composites materials.
5. Understand the strength studies of composite materials

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2				2							1	2	3
CO2		2	2	2								2	1	2
CO3					3		2					1	1	2
CO4	2			2	3		2					1	1	2
CO5		2	2	3					2		2	2	1	2

23CEWROEXX	**BUSINESS ANALYTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURESE OBJECTIVES

- To Understand the role of business analytics within an organization. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data and use decision-making tools/Operations research techniques.
- Manage business process using analytical and management tools. Analyze and solve problems from different industries such as manufacturing, service, retail, Software, banking and finance, sports, pharmaceutical, aerospace etc.

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

REFERENCES

1. Marc J. Schniederjans, Dara G. Business analytics Principles, Concepts, & Applications by Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. James Evans, Business Analytics, persons Education
3. Business Analysis - Revised Edition, by Debra Paul, James Cadle
4. Business Analysis Techniques - Revised Edition, by Paul Turner, James Cadle, Debra Paul
5. The Business Analysis Handbook: Techniques and Questions to Deliver Better Business Outcomes, by Helen Winter

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc23_mg54/preview

WEB REFERENCE:

1. https://www.techtarget.com/searchbusinessanalytics/definition/business-analytics-BA

COURSE OUTCOMES

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

1. Demonstrate knowledge of data analytics.
2. Develop the ability to think critically in making decisions based on data and deep analytics.
3. Use technical skills in predicative and prescriptive modeling to support business decision-making.
4. To translate data into clear, actionable insights.
5. Learn the model trends

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2		2		3							1	2	3
CO2		3		3	2							1	1	2
CO3				2	2							1	2	2
CO4		2	3	2	2		2		3		2	1	2	3
CO5			2			3					3	2	2	3

23CEWROEXX	**INDUSTRIAL SAFETY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURESE OBJECTIVES

- To know the Standards and Guidelines for Workplace safety for all inmates and also people outside the premises.
- To learn about Personal Safety Systems to safeguard the workers from Occupational health hazards
- To Understand System specific Protocols and Procedures for overall industrial safety.

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv.

Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

REFERENCES

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.
5. Loss Prevention in Process Industries" by F P Lees
6. Industrial Hazards and Safety Handbook" by R W King and J Magid
7. Management of Disasters and How to Prevent them" by O P Kharbanda and E A Stallworthy

WEB REFERENCE:

1. https://www.osha.gov/topics/general-references/reference-texts

COURSE OUTCOMES

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

1. To demonstrate knowledge Safety measures and personal safety systems
2. Gain knowledge on National and International Practices for Industrial Safety.
3. Study the different types of weir and corrosion and their prevention
4. Learn Periodic and preventive maintenance
5. Learn the concept of repair cycle and their importance

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	3	1				3		2		2	2	1	1	2
CO2	3					2	2					1	2	2
CO3	3				2		2					1	1	2
CO4	2		2		2							1	1	2
CO5		2						2	2			2	2	2

23CEWROE32	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand and gain the skill to apply all optimization techniques and Models
- To understand on working with CPM and PERT
- To know the methodologies of Scheduling and Sequencing.

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

REFERENCES

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

WEB REFERENCE:

· 1. https://pubsonline.informs.org/journal/opre

COURSE OUTCOMES

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

1. To apply the dynamic programming to solve problems of discreet and continuous variables.
2. To apply the concept of non-linear programming
3. To carry out CPM/PERT analysis
4. To model the real world problems and simulate it.
5. Scheduling and sequencing

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2		3	3								2	1	3
CO2		3	2	3	2							2	2	2
CO3		3	2	3	2							2	2	3
CO4				2		2	3					1	1	2
CO5		3	2		2	3			2			2	2	3

23CEWROE32	**COST MANAGEMENT OF ENGINEERING PROJECTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To gain the knowledge and skill to work on data base for operation control
- To learn to apply Cost Behavior and Profit Planning
- To get exposed to TQM and its value in Cost management

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram.

Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning.

Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation Problems, Assignment problems, Simulation, Learning Curve Theory.

REFERENCES

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. Vohra, N.D. Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.
6. Cost Accounting: Texts and Problems Reference Book By M. C. Shukla

WEB REFERENCE:

1. https://maaw.info/CostManagementArticles.htm

COURSE OUTCOMES

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

1. Apply the cost management methodologies using technology options and financial management
2. Appreciate the importance of TQM and tools to apply the same in any organization.
3. Understand Project commissioning
4. Standard costing and variants analysis
5. Learn to quantitative techniques for cost management

Mapping of COs with POs&PSOs														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2	2									1	1	2	1
CO2	2	2	3									1	1	2
CO3		2	2	2			2		2		2	1	2	2
CO4		2	2	2					2			2	1	2
CO5		2	2	3								2	2	3

23CEWROEXX	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the ways and scientific means to reclaim energy from the waste
- To understand the importance of source segregation for effective processing of waste in WTE system. Students
- To know all technological options of WTE.

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

REFERENCES

1. Desai, Ashok V., Non Conventional Energy, Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology - A Practical Hand Book Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Challal, D. S., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.
4. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons,1996.
5. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation",Elsevier Store.
6. Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons.

7. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press

NPTEL LINK:

1. https://onlinecourses.nptel.ac.in/noc23_ch05/preview

COURSE OUTCOMES

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

1. Understand the importance of Energy reclamation from Waste.
2. Gain knowledge on all technological options of WTE including some proprietary systems as case studies.
3. Concept of Energy from waste
4. Understand to biomass pyrolysis
5. Design and constructional features of Biogas

Mapping of COs with POs													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PS01**	**PS02**	**PS03**
CO1	2						1		2			2	1	2
CO2		3	2			1	2					2	1	3
CO3		3	2			1	2					2	1	3
CO4		3	2				2					2	2	2
CO5			2	3			2					2	2	2

23CEWRACXX	**ENGLISH FOR RESEARCH PAPER WRITING**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSE OBJECTIVES

- To understand that how to improve your writing skills and level of readability
- To Learn about what to write in each section
- To understand the skills needed when writing a title to ensure the good quality of paper at very first-time submission

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing, Redundancy, Avoiding Ambiguity and Vagueness.

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions.

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

COURSE OUTCOMES

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

1. Gain writing skills and improve level of readability
2. Understand on when and what to write and how.
3. Acquire skills needed when writing a title to ensure the good quality of paper at very first - time submission
4. Understand the planning and preparation of research paper writing
5. Skills required to writing the methods

CEWRACXX	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- To critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- To develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- To critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Introduction : Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease And Epidemics, War and Conflicts.

Disaster Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special REFERENCES to Tsunami; Post-Disaster Diseases and Epidemics.

Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Risk Assessment: Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival.

Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs of Disaster Mitigation In India.

REFERENCES

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" , Deep &Deep Publication Pvt. Ltd., New Delhi.

COURSE OUTCOMES

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

1. Understood the disaster risk reduction and humanitarian response.
2. Gain knowledge on the disaster management approaches, planning and programming
3. Learn disaster prone areas in India
4. Risk assessment
5. Disaster mitigation

23CEWRACXX	SANSKRIT FOR TECHNICAL KNOWLEDGE	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- To improve brain functioning
- To develop the logic in mathematics, science & other subjects enhancing the memory power
- To explore the huge knowledge from ancient literature

Alphabets in Sanskrit - Past/Present/Future Tense /Simple Sentences - Order - Introduction of roots -Technical information about Sanskrit Literature - Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

REFERENCES

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

COURSE OUTCOMES

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

1. Understand basic Sanskrit language
2. Understand Ancient Sanskrit literature about science & technology
3. Develop logic in students
4. To develop logic in mathematics and science
5. Technical concepts of Engineering

23CEWRACXX	VALUE EDUCATION	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To understand value of education and self- development
- To imbibe good values in students
- To know about the importance of character

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments.

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature , Discipline.

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour - Universal brotherhood and religious tolerance. True friendship - Happiness Vs suffering, love for truth - Aware of self-destructive habits - Association and Cooperation - Doing best for saving nature.

Character and Competence –Holy books vs Blind faith- Self-management and Good health - Science of reincarnation- Equality, Nonviolence ,Humility, Role of Women- All religions and same message- Mind your Mind, Self-control- Honesty, Studying effectively

REFERENCES

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

COURSE OUTCOMES

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

1. Gain the overall Knowledge of self-development
2. Learn the importance of Human values
3. Understand the importance for developing the overall personality
4. Personality and behavior development
5. Character and competence

23CEWRACXX	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) - Philosophy of the Indian Constitution: Preamble Salient Features

Contours of Constitutional Rights & Duties: Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation -Right to Freedom of Religion -Cultural

and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties.

Organs of Governance: Parliament – Composition - Qualifications and Disqualifications - Powers and Functions – Executive – President – Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

Local Administration: District's Administration head: Role and Importance, - Municipalities: Introduction, Mayor and role of Elected Representative, - CEO of Municipal Corporation - Pachayati raj: Introduction, PRI: ZilaPachayat - Elected officials and their roles, CEO ZilaPachayat: Position and role - Block level: Organizational Hierarchy (Different departments) - Village level: Role of Elected and Appointed officials - Importance of grass root democracy.

Election Commission: Election Commission: Role and Functioning - Chief Election Commissioner and Election Commissioners.

State Election Commission: Role and Functioning - Institute and Bodies for the welfare of SC/ST/OBC and women.

REFERENCES

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Busi, Dr. S. N. Ambedkar Dr. B. R. framing of Indian Constitution, 1st Edition, 2015.
3. Jain, M. P. Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. Basu, D.D. Introduction to the Constitution of India, Lexis Nexis, 2015.

COURSE OUTCOMES`

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

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.
5. Understand the role of Election commission

23CEWRACXX	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- To identify critical evidence gaps to guide the development.
- Research gaps and future direction

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum and Teacher education.

Evidence on the effectiveness of pedagogical practices - Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

Professional development: alignment with classroom practices and followup support - Peer support - Support from the head teacher and the community- Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

Research gaps and future directions: Research design –Contexts - Pedagogy - Teacher – education - Curriculum and assessment -Dissemination and research impact.

REFERENCES

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basicmaths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE OUTCOMES

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

1. Know what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
2. Understand the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. Appreciate how teacher education (curriculum and practicum) and the school curriculum and guidance materials can best support effective pedagogy.
4. Understand professional development
5. Curriculum assessment

23CEWRACXX	STRESS MANAGEMENT BY YOGA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress
- To study various asana

Definitions of Eight parts of yoga (Ashtanga)

Yam and Niyam - Do`s and Don't's in life i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Asan and Pranayam - i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam

REFERENCES

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

COURSE OUTCOMES

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

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency in every activity
3. Understand the definitions of eight parts of yoga
4. To benefits for mind and body
5. Learn the regularization of breathing techniques

23CEWRACXX	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Neetisatakam-Holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) - Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

Approach to day to day work and duties - Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48, - Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35 - Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 - Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, - Chapter 4-Verses 18, 38,39 - Chapter18 – Verses 37,38,63

REFERENCES

1."Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Gopinath, P. Bhartrihari's Three Satakam (Niti-sringar-vairagya)
3. Rashtriya Sanskrit Sansthanam, New Delhi

COURSE OUTCOMES

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

1. To develop his personality and achieve the highest goal in life
2. To lead the nation and mankind to peace and prosperity.
3. To acquire skill in developing versatile personality of students.
4. Approach to day to day work and duties
5. Statements of basic knowledge and personalities of role model