DEPARTMENT OF CIVIL ENGINEERING

ANNA UNIVERSITY, CHENNAI

OUR VISION

Department of Civil Engineering, Anna University, shall strive hard to develop and impart technical knowledge and professional skills required for Civil Engineering practice through excellence in teaching, research and consultancy to address sustainable infrastructure development needs at local, national and International levels.

OUR MISSION

Department of Civil Engineering, Anna University shall contribute to technological and social development by

1. Providing a firm scientific and technological base in Civil Engineering to achieve self-reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas of Civil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

M.E. IRRIGATION WATER MANAGEMENT (FULL-TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the Programme M E Irrigation Water Management will

PEO1	Gain knowledge and skills in Water Resources engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations
PEO2	Become consultants in Water Resources Engineering and solve complex real life issues related to analysis, design and maintenance of structures under various environmental conditions
PEO3	Contribute to the enhancement of knowledge in Water Resources Engineering by performing quality research in institutions of international repute or in Research organizations or Academia.
PEO4	Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible, and socially acceptable.
PEO5	Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation

PROGRAMME OUTCOMES (POs):

After going through the two years of study, our Irrigation Water Management Graduates will exhibit ability to:

PO	Attributes	Programme Outcomes
1	Research Aptitude	An ability to independently carry out research/ investigation and development work to solve practical problems
2	Technical Documentations	An ability to write and present a substantial technical report/document
3	Technical Competence	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
4	Handle Complex Problems	Use research based knowledge, resources, methods, appropriate techniques and tools to solve water resources engineering complex issues with an understanding of limitations.
5	Environmental Sustainability and Societal Ethics	Ensure development of socially relevant and eco-friendly hydrological, hydraulics and environmental projects by applying technical knowledge, ethical principles and sustainable engineering practices
6	Life-long Learning	Recognize the need for independent, life-long learning and adapt to emerging technologies in water resources and solutions to novel problems.

Attested

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PEO/PO Mapping:

PEO	PO					
	1	**2**	**3**	**4**	**5**	**6**
I.	3	2	3	3	2	2
II.	2	2	3	3	2	3
III.	3	2	3	3	2	2
IV.	2	1	2	2	3	3
V.	2	1	2	2	2	3

1-Low, 2-Medium, 3-High

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Statistical Methods for Engineers	3	3	3	3	2	2
		Research Methodology and IPR						
		Advanced Irrigation Engineering and Management	2	2	3	3	3	3
		Integrated Water Resources Management	2	2	2	2	3	3
		Surface and Groundwater Hydrology	3	2	3	3	3	3
		Irrigation Structures and Drainage Engineering	3	2	2	2	2	3
	SEMESTER II	Soil Science and Agronomy	2	2	2	2	2	2
		Micro-Irrigation Engineering	2	2	3	3	2	3
		Participatory Field Research Methodology	1	2	2	2	3	3
		Remote Sensing and GIS for Water Resources	2	2	2	3	3	3
		Professional Elective I						
		Professional Elective II						
YEAR II	SEMESTER III	Water Quality	1	2	2	2	2	3
		Professional Elective III						
		Professional Elective IV						
		Practical Training (4 Weeks)	3	2	3		1	2
		Project Work I	3	3	3	3	2	3
	SEMESTER IV	Project Work II	3	3	3	3	2	3

1-Low, 2-Medium, 3-High

MAPPING FOR PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	Watershed Conservation and Management	3	2	3	3	3	3
2.	Irrigation Economics	2	2	2	2	2	3
3.	Environmental Impact Assessment for Water Resources	2	2	2	3	3	3
4.	Rainfed Agriculture and Tank Irrigation Management	2	2	3	2	2	3
5.	Drought Risk Assessment and Management	2	2	2	3	2	3
6.	Participatory Irrigation Management	1	2	2	2	2	2
7.	Gender and Water	1	2	2	2	3	3
8.	Legal Aspects of Water Resources	2	1	2	3	3	3
9.	Water, Sanitation and Health	1	2	2	2	3	3
10.	Wastewater Treatment and Utilisation	3	2	3	3	3	3
11.	Circular Water Economy	2	3	2	3	3	3
12.	Climate Change and Water Resources	2	2	3	3	3	3
13.	Rehabilitation and Modernization of Irrigation Systems	2	2	3	2	3	3
14.	Radar Meteorology	2	2	3	3	3	3
15.	Virtual Water; Concept, Assessments and Applications	2	2	2	3	3	2

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. IRRIGATION WATER MANAGEMENT (FULL-TIME)
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3161	Statistical Methods for Engineers	FC	4	0	0	4	4
2.	IW3101	Advanced Irrigation Engineering and Management	PCC	3	0	4	7	5
3.	IW3102	Integrated Water Resources Management	PCC	3	0	0	3	3
4.	IW3103	Surface and Groundwater Hydrology	PCC	3	0	0	3	3
5.	IW3104	Irrigation Structures and Drainage Engineering	PCC	3	0	0	3	3
6.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
			TOTAL	**18**	**1**	**4**	**23**	**21**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IW3201	Soil Science and Agronomy	PCC	3	0	0	3	3
2.	IW3202	Micro-Irrigation Engineering	PCC	3	0	0	3	3
3.	IW3203	Participatory Field Research Methodology	PCC	3	0	2	5	4
4.	HW3251	Remote Sensing and GIS for Water Resources	PCC	3	0	4	7	5
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**6**	**24**	**21**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IW3301	Water Quality	PCC	3	0	4	7	5
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
PRACTICALS								
4.	IW3311	Practical Training (4 weeks)	EEC	0	0	0	0	2
5.	IW3312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**16**	**25**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	IW3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR AWARD OF THE DEGREE: 73

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecturer	Tutorial	Practical		
1	MA3161	Statistical Methods for Engineers	4	0	0	4	1
					TOTAL CREDITS	**4**	

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecturer	Tutorial	Practical		
1.	IW3101	Advanced Irrigation Engineering and Management	3	0	4	5	1
2.	IW3102	Integrated Water Resources Management	3	0	0	3	1
3.	IW3103	Surface and Groundwater Hydrology	3	0	0	3	1
4.	IW3104	Irrigation Structures and Drainage Engineering	3	0	0	3	1
5.	IW3201	Soil Science and Agronomy	3	0	0	3	2
6.	IW3202	Micro-Irrigation Engineering	3	0	0	3	2
7.	IW3203	Participatory Field Research Methodology	3	0	2	4	2
8.	HW3251	Remote Sensing and GIS for Water Resources	3	0	4	5	2
9.	IW3301	Water Quality	3	0	4	5	3
					TOTAL CREDITS	**34**	

PROFESSIONAL ELECTIVE COURSES (PEC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			Lecturer	Tutorial	Practical		
1.	IW3051	Watershed Conservation and Management	3	0	0	3	3
2.	IW3001	Irrigation Economics	3	0	0	3	3
3.	HW3051	Environmental Impact Assessment for Water Resources	3	0	0	3	3
4.	IW3002	Rainfed Agriculture and Tank Irrigation Management	3	0	0	3	3
5.	IW3056	Drought Risk Assessment and Management	3	0	0	3	3
6.	IW3003	Participatory Irrigation Management	3	0	0	3	3
7.	IW3004	Gender and Water	3	0	0	3	3
8.	HW3052	Legal Aspects of Water Resources	3	0	0	3	3
9.	IW3055	Water, Sanitation and Health	3	0	0	3	3
10.	IW3054	Wastewater Treatment and Utilisation	3	0	0	3	3
11.	IW3053	Circular Water Economy	3	0	0	3	3
12.	IW3052	Climate Change and Water Resources	3	0	0	3	3
13.	IW3005	Rehabilitation and Modernization of Irrigation Systems	3	0	0	3	3
14.	HW3053	Radar Meteorology	3	0	0	3	3
15.	IW3006	Virtual Water; Concept, Assessments and Applications	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecturer	Tutorial	Practical		
1	RM3151	Research Methodology and IPR	2	1	0	3	1
					TOTAL CREDITS	**3**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecturer	Tutorial	Practical		
1.	IW3311	Practical Training (4 Weeks)	0	0	0	2	3
2.	IW3312	Project Work I	0	0	12	6	3
3.	IW3411	Project Work II	0	0	24	12	4
					TOTAL	**20**	

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SUMMARY

S. No	NAME OF THE PROGRAMME: M.E.IRRIGATION WATER MANAGEMENT					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1	FC	4	0	0	0	4
2	PCC	14	15	5	0	34
3	PEC	0	6	6	0	12
4	RMC	3	0	0	0	3
5	EEC	0	0	8	12	20
TOTAL CREDIT		**21**	**21**	**19**	**12**	**73**

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MA3161 STATISTICAL METHODS FOR ENGINEERS L T P C
4 0 0 4

UNIT I ESTIMATION THEORY 12

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency–Maximum Likelihood Estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS 12

Tests based on Normal, *t*, χ^2 and *F* distributions for testing of means, variance and proportions – Analysis of *r x c* tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION 12

Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients.

UNIT IV DESIGN OF EXPERIMENTS 12

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT V MULTIVARIATE ANALYSIS 12

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Obtain the value of the point estimators using the method of moments and method of maximum likelihood.

CO2: Use various test statistics in hypothesis testing for mean and variances of large and small samples.

CO3: Determine the regression line using the method of least square and also to calculate the partial and multiple correlation coefficient for the given set of data points.

CO4: Test the hypothesis for several means using one way, two way or three way classifications.

CO5: Get exposure to the principal component analysis of random vectors and matrices.

REFERENCES:

1. Devore, J.L., “Probability and Statistics for Engineering and the Sciences”, Thomson and Duxbury, Singapore, 6th Edition, Boston, 2004.
2. Gupta, S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, Eleventh Edition, Reprint, New Delhi, 2019.
3. Johnson, R. A. and Gupta, C. B., “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, Eighth Edition, New Delhi, 2015.
4. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Sixth Edition, New Delhi, 2013.
5. Spiegel, M.R. and Stephens, L.J.,” Schaum’s outlines on Statistics”, Tata McGraw-Hill, 6th Edition, New York, 2018.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2
Avg	**3**	**3**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

IW3101 ADVANCED IRRIGATION ENGINEERING AND MANAGEMENT L T P C
3 0 4 5

UNIT I DEVELOPMENTOFIRRIGATION 6

Water Resources of India - Importance of Irrigation – Impacts of Excess Irrigation - Irrigation in India – Major Irrigation projects – Crop and Cropping Seasons in India and Tamil Nadu - National Water Policy - Thornthwaite's Classification of Climate.

UNIT II SOIL WATER PLANT RELATIONSHIP 10

Soil physical properties influencing - Soil-water relationship - Forms and occurrence of Soil Water- Classification of Soil Water- Soil Water Constants- Energy concept of Soil Water - Forces acting on Soil Water- Soil Water Potential concept- Soil Water retention - Soil Moisture Measurement.- soil water plant relationship – soil water availability to plants.

UNIT III CROP WATER REQUIREMENT 10

Water requirement of crops - Evapotranspiration and Consumptive use- Methods of estimating Evapotranspiration - Effective Rainfall- Irrigation Requirement – Duty of Water-Irrigation Efficiency-Irrigation Scheduling - Irrigation measurement – Introduction to Cropwat / AQUACROP.

UNIT IV IRRIGATION METHODS 10

Canal network and canal design – Irrigation silt theories - Surface irrigation methods – Types Border irrigation, Furrow irrigation, Basin Irrigation - Specifications, Hydraulics and Design – Lift Irrigation - IoT-Based Smart Irrigation Systems.

UNIT V IRRIGATION MANAGEMENT 9

Irrigation Management Systems in India - Warabhandi, Shejpali and Localisation – Diagnostic Analysis of Irrigation Systems – Performance Indicators - Main system management - Command area Development – On Farm Irrigation system – Design.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Determination of Agro-meteorological parameters.
2. Determination of Bulk density and Specific gravity of Soil
3. Determination of Textural classification of Soil
4. Determination of field capacity and permanent wilting coefficient
5. Estimation of Soil Moisture for Irrigation Scheduling by Tensiometer
6. Measurement of Infiltration rate in Soil
7. Demonstration on measurement of Transpiration in plants
8. Determination of Leaf Area Index

9. Flow measurement in open channels through flumes and notches
10. Evaluation of Surface irrigation system.
11. Evaluation of Drip irrigation system
12. Evaluation of Sprinkler irrigation system
13. Study on soil moisture wetting pattern
14. Demonstration on automation of Micro-irrigation systems

TOTAL: 45+60=105 PERIODS

COURSE OUTCOMES

On completion of the course, the student is expected to be able to

CO1 Explain the importance of irrigation in the development of the nation and national water policy and its relevance. To observe and record weather data, analyze and plot them

CO2 Apply knowledge of science and engineering to Soil - Water - Plant relationship and estimation of soil moisture. To understand the concept of infiltration, evapotranspiration and soil moisture measurement

CO3 Apply knowledge of science and engineering in estimating the water requirement of crops and designing water network. To analyze and interpret soil physical properties for irrigation

CO4 Analyse and evaluate irrigation methods and identify suitable methods. To understand the flow measurement in pipes and channels

CO5 Identify the performance of the irrigation systems for better management. To evaluate the performance of irrigation methods

REFERENCES:

1. D. P. Majumdar, "Irrigation Water Management Principles and Practices", Prentice Hall of India, New Delhi, 2004.
2. A. M. Michael, "Irrigation Theory and Practice", Vikas Publishing House, New Delhi, 2009.
3. "Irrigation and Drainage", Paper 24. "Crop Water Requirement". FAO, Rome, 1992
4. "Irrigation and Drainage" paper 56. "Crop Evapotranspiration: guidelines for computing crop water requirements", FAO, Rome 1998.
5. David Molden, R. Sakthivadivel, Christopher J. Perry, Charlotte de Fraiture and WimH. Kloezen," Indicators for Comparing Performance of Irrigated Agricultural Systems", Irrigation Management Transfer, IWMI, 2005
6. M.V.K Sivakumar, C.J. Stigter and D. Rijks (eds), 2000: Agrometeorology in the 21st Century – Needs and Perspectives. Papers from the International Workshop held in Accra, Ghana, 15–17 February 1999. Agric. For. Meteorol., 103(1–2). Special Issue.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	3	2	3
CO2	2	3	3	3	3	3
CO3	2	2	3	3	2	3
CO4	1	2	3	3	3	3
CO5	2	2	3	3	3	3
Avg	**2**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3102 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges in sustainable water management – Paradigm shift in water management - Definition of IWRM within the broader context of sustainable development – Key elements of IWRM – Principles - IWRM Framework - Complexity of the IWRM process – UN World Water Assessment – SDGs in the context of IWRM.

UNIT II WATER ECONOMICS 9

Economic view of water issues - Economic characteristics of water good and services - Non-revenue waters (NRW) - Metering water uses - Non-market monetary valuation methods Water management through economic instruments – Private sector partnership in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of governance: principles of international law in water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - -Water governance in India – National Water Policy – Alternative mechanisms of dispute resolution – Application of game theory on dispute resolution – Case studies.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V GLOBAL ISSUES IN THE CONTEXT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate –- Water foot print - Virtual water trade for achieving global water and food security - -Urban water security – Climate change: Key challenges and impacts and adaptation in the context of IWRM –International Water management Institute Models and Software for water management - Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- On completion of the course, the student is expected to be able to

CO1 Describe the concepts and principles of IWRM and its advantages over the conventional water management practices to attain the SDGs.

CO2 Analyze the various economic instruments for water management and to interpret the pros and cons of PPP.

CO3 Appraise the legal framework for water management and the application of game theory on dispute resolution.

CO4 Discuss the linkages between water and health and develop HIA framework.

CO5 Value the importance of IWRM for global issues such as urban water security, food security and climate change and understand the applications of models and software in water management.

REFERENCES:

1. H. A. Koop, Grison, J. Eisenreich, Hofman, Leeuwen, "Integrated water resources management in cities in the world: Global solutions," *Sustainable Cities and Society*, Vol 86, 104137, 2022. https://doi.org/10.1016/j.scs.2022.104137.
2. V. Thomas Cech*, Principles of water resources: history, development, management and policy*, 4th Ed. John Wiley and Sons Inc., New York, 2018.
3. M. Rohani, "Freshwater Values Framework. A Review of Water Valuation Methods Utilized within Total Economic Valuation", Auckland Council working report, WR2013/001 [Online], 2013. Available: https:// knowledgeauckland.org.nz/media/ 1953/wr2013-001-freshwater-values-framework.pdf
4. Madani Kaveh, "Game theory and water resources," *Journal of Hydrology,* Vol 381, Issues,3-4,pp.225-238,15February 2010. https://doi.org/10.1016/j.jhydrol.2009.11.045
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6. Technical Advisory Committee, "Effective Water Governance, Technical Advisory Committee Background Paper No: 7", Global water partnership, Stockholm, Sweden [Online],2003. Available: https:// www.gwp.org/ globalassets/ global/toolbox/ publications/background-papers/07-effective-water-governance-2003-english.pdf

7. Technical Advisory Committee, “Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4”, Global water partnership, Stockholm, Sweden [Online], 2002. Available: https:// www.gwp.org/ globalassets/global/ toolbox/publications/background-papers/04-integrated-water-resources-management-2000-english.pdf
8. 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 [Online], 1999. Available: https:// www.gwp.org/ globalassets/global/toolbox/ publications/background-papers/03-the-dublin-principles-for-water-as-reflected-in-a-comparatice-assessment-of-institutional-and-legal-arrangements-for-iwrm-1999.pdf
9. International Water management Institute. *Models & Software* [Online]. Available: https://www.iwmi.cgiar.org/resources/data-and-tools/models-and-software/

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	2	1	1	2	2	2
CO3	2	2	2	2	3	3
CO4	2	2	2	2	3	3
CO5	2	2	3	2	3	3
Avg	**2**	**2**	**2**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3103 SURFACE AND GROUND WATER HYDROLOGY L T P C
3 0 0 3

UNIT I HYDROLOGICAL CYCLE AND PRECIPITATION 9

Hydrological cycle, Hydrological budget – Hydro meteorological observation - Precipitation, Types and Forms - Measurement - Radar Measurement -Processing of precipitation data - Spatial analysis using GIS

UNIT II HYDROLOGICAL PROCESSES OF ABSTRACTION 9

Water losses – Initial abstraction – interception and Depression storage - Evaporation, Evapotranspiration and infiltration – Field Measurement – Estimation by empirical formulae - - Infiltration Indices

UNIT III RUNOFF PROCESS 9

Concept of catchment – Linear, Areal and Relief Aspects – Runoff process – components of runoff – Factors affecting Runoff - Hydrograph, hydrograph separation, Unit hydrograph, Instantaneous unit hydrograph, Synthetic unit hydrograph, rainfall-runoff models – SCS method – SWAT model.

UNIT IV GROUNDWATER 9

Origin of groundwater, Types of aquifer, Aquifer properties affecting groundwater, Darcy’s law and its limitations, coefficient of permeability, laboratory and field measurement of permeability, Groundwater movement, Flow through layered soils – Stream Lines and Equipotential Lines – Boundary Conditions.

UNIT V WELL HYDRAULICS 9

General flow equation, Steady and unsteady flow, well flow near aquifer boundaries, partially penetrating wells, characteristics of well losses, specific capacity – Safe yield - Image well theory - Ground Water Recharge – GEC norms for Groundwater Assessment – Managed Aquifer Recharge.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 The students describe the various processes of hydrologic cycle and hydro meteorological Measurements

CO2 The students quantify various abstractions by selecting appropriate field measurements and empirical equation.

CO3 The students apply their knowledge on runoff processes to assess the water balance and runoff potential

CO4 The students identify and describe the various features of ground water system.

CO5 The students apply their knowledge on well hydraulics to estimate the safe yield and ground water potential.

REFERENCES:

1. Warren Viessman, et al., "Introduction to Hydrology", Thomas Y.Crowell , New York , 1972.
2. Ven Te Chow, Maidment, R. David, Maidment and Lorry W. Mays, L.W. "Applied Hydrology", McGraw Hill Education, First Edition, 2017.
3. K. David, Todd and Larry W. Mays "Groundwater Hydrology", Wiley India Pvt Ltd, Third Edition, 2011
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5. K.C.Patra, "Hydrology and Water Resources Engineering", Narosa Publications, Second Edition, New Delhi, 2008.
6. P. Jaya Rami Reddy, "Hydrology", Laxmi Publications – Third Edition – 2016.
7. A.K. Rastogi, "Numerical Groundwater Hydrology", 2011.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	1	1
CO2	3	2	3	3	2	-
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3
Avg	**3**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3104 IRRIGATION STRUCTURES AND DRAINAGE ENGINEERING **L T P C**
3 0 0 3

UNIT I IRRIGATION CANAL STRUCTURES **8**

Irrigation channels- Weirs and Barrage -Components of diversion head works – selection of the suitable site for the headwork –Cross drainage structures: aqueduct, siphon, super-passage, level crossing, inlet/outlet - fall or drop structures - necessity and location- Regulation and control structures: silt ejectors, gates, division boxes - Canal outlets -Canal escapes-types of escapes.

UNIT II DESIGN OF IRRIGATION CHANNEL **10**

Types of canals - canal alignment-types of irrigation channels-design Parameters-Regime theory-Kennedy's silt theory - Lacey's silt theory - Design of canals using the above theories – comparison of kennedy's and laceys's theory - canal maintenance.

UNIT III SURFACE DRAINAGE SYSTEM AND DESIGN **8**

Waterlogging-Classification of waterlogging-surface drainage-objectives of drainage- benefits of drainage-land forming: smoothing, bedding, grading, Planning-Layout of drainage system - types of surface drainage systems– Design of surface drainage systems- procedure of rational method- CN method for drainage coefficient.

UNIT IV SUBSURFACE DRAINAGE SYSTEM AND DESIGN 10

Sub-surface drainage system-types of sub-surface drainage system recharge condition-Horizontal flow through layers of soil- Design of subsurface drainage system: The Hooghought's equation-derivation, Importance of equivalent depth: The Ernst's equations- derivation, horizontal, vertical and radial – Conditions for two layered soil Profile-Unsteady flow to drains: Glover-Dumm equation, De Zeeuw-Hellinga Equation – comparisons between steady state and unsteady state-- drainage materials.

UNIT V NON-CONVENTIONAL DRAINAGE AND SALT CONTROL 9

Special drainage systems: vertical drainage, bio-drainage, mole drains and pump drainage their adaptability-Characteristics of salt affected soils-formation of salt affected soils-problems of salt affected soils-identification and reclamation of salt affected soils- soil chemical analysis and estimation of lime and gypsum requirement (GR) - Quantity of amendments to be added.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 knowledge about various types of irrigation canal hydraulic structures.
CO2 have the knowledge for designing irrigation canals.
CO3 acquire knowledge to estimate surface runoff in the agricultural land.
CO4 understand usefulness and design consideration under steady and unsteady state subsurface drainage.
CO5 know the types of non-conventional drainage structures and understand the salt problems in agricultural soils.

REFERENCES:

1. H.P.Ritzema, "Drainage Principles and Applications", Publication No. 16, International Institute of Land Reclamation and Improvement, Netherlands, 1994.
2. R.K Sharma and T. K. Sharma, "Irrigation Engineering", S. Chand and Company, New Delhi, 2008.
3. A. K. Bhattacharya and A. M. Michael, "Land Drainage", Principles, Methods and Applications", Konark Publishers Pvt. Ltd., New Delhi, 2003.
4. J. Kessler, "Drainage Principles and Applications," Vol. II and IV, International Institute of Land Reclamation and Improvement, Netherlands, 1979.
5. Ranvir Kumar and Joginder Singh "Text book of Drainage Engineering", *Indian* Council of Agricultural Research 1st edition, 2005.
6. S.K. Gupta and Megh.R.Goyal*,"* Soil salinity Management in Agriculture*: Technological Advances and Applications,*", Apple Academic Press Inc.; 1st edition, 2017.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	2	2
CO2	3	3	2	2	2	3
CO3	3	2	2	2	3	3
CO4	3	2	2	2	3	3
CO5	3	2	2	3	3	3
Avg	3	2	2	2	2	3

• 1-low, 2-medium, 3-high

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

IW3201 SOIL SCIENCE AND AGRONOMY L T P C
3 0 0 3

UNIT I SOILS AND THEIR CLASSIFICATION 8

Importance of soil- soil genesis- weathering of rocks and minerals–soil profile- soil forming processes-Important soil physical properties and its importance; Soil texture, structure, density, porosity, colour, organic matter– Major soils of India and Tamil Nadu, U.S. system of soil taxonomic orders and characterisation –collection of soil samples, techniques and procedure.

UNIT II SOIL NUTRIENTS AND PRODUCTIVITY 8

Plant nutrients- essential plant nutrients-based on mobility in plants-their function, deficiency symptoms-methods of control and toxicity-nutrient deficiency symptoms- soil pH and scale- effects of pH on nutrient availability –life in the soil – soil fertility and productivity - fertility vs productivity.

UNIT III PRINCIPLES OF AGRONOMY AND TILLAGE 10

Agriculture in the sangam literature- Scope of agronomy-eco-friendly agriculture- agro-climatic zones of Tamil Nadu-Influence of genetic and environmental factors on crop production-Tillage–objectives-types of tillage: on season tillage and off-season tillage-modern concepts of tillage- main field preparation–tillage implements for different agricultural operations-seeds and sowing.

UNIT IV NUTRIENT AND WEED MANAGEMENT 10

Classification of manures, commercial fertilizers- Role of manures and fertilizers- Methods of fertilizers application - Integrated nutrient management (INM): concept, advantage and components of INM-weed management: physical, cultural, chemical, biological methods -Harmful effects of weeds- Integrated Pest Management (IPM): tools and components of IPM.

UNIT V CROP PRODUCTION OF FIELD CROPS 9

Classification and distribution of field crops- cropping systems- Introduction of major field crops:cereals, millets, minor millets, pulses, oil seeds crops and cash crops.

TOTAL: 45 PERIODS

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 **u**nderstand the various physical properties and classification of soils types required for an agricultural field.

CO2 Learn about plant nutrients and their functions, deficiency, and symptoms of nutrients in plants. To know the influence of soil reaction on availability of plant nutrients..

CO3 understanding the basic concepts and theory of agronomy and will know the different tillage practices in the crop field.

CO4 Knowledge of different types of manure and fertilizer and also management of crop pest through integrated Pest Management approach without side effect on plant, animal and environment health.

CO5 learn about the crop classification and cultivation practices of field crops.

REFERENCES:

1. N.C. Brady and R.R.Weil, "The Nature and Properties of Soil", 13th Ed, Prentice-Hall of India Pvt. Ltd. New Delhi, 2002.
2. "Fundamental of Soil Science", Indian Society of Soil Science, IARI, New Delhi, 1988.
3. "Hand book of Agriculture", Indian Council of Agriculture Research, New Delhi, 1999.
4. DOA, "Crop Production Guide", Directorate of Agriculture, Government of Tamil Nadu, Chepauk, Chennai, 1999.
5. T. Yellamanda Reddy and G.H. Sankara Reddy, "Principles of Agronomy, "Kalyani Publishers; 5th edition, 2018.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	3	2	3
CO3	2	1	2	2	2	3
CO4	3	2	2	2	3	3
CO5	2	2	2	2	2	2
Avg	**2**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

IW3202 MICRO-IRRIGATION ENGINEERING L T P C
3 0 0 3

UNIT I INTRODUCTION TO MICRO-IRRIGATION 7

Importance – comparison between traditional and micro irrigation methods –types of micro irrigation – present status, scope, potentials, problems, promotion, implementation and constraints of micro irrigation – constraints for the farmers for adoption of micro irrigation - economics in micro irrigation system - Basic hydraulics of pressurized irrigation system - Friction losses and pressure variation - Flow in nozzles and emitters.

UNIT II DRIP IRRIGATION SYSTEM DESIGN AND LAYOUT 10

Drip irrigation – advantages and disadvantages – types – suitable crops – planning and layout of drip system – components. Principles and hydraulics for design of drip system - Darcy Weishbach equation – Hazen Williams equation – factors to be considered for the design of drip system – design procedure –design of emitters, laterals, sub mains and main lines – head works. Installation- O & M – trouble shooting - Dripper types - Wetting pattern- Chemigation - sub-surface drip system - Subsidy calculation.

UNIT III SPRINKLER IRRIGATION SYSTEM DESIGN AND LAYOUT 10

Sprinkler irrigation - suitability, economic viability and adaptability of sprinkler system – advantages and disadvantages - Types of sprinkler system - Components – Layout – factors affecting sprinkler performance – water distribution pattern - Design of Sprinkler irrigation system – Cost estimation – O & M – trouble shooting – overlapping - Micro Sprinklers, mini sprinklers, foggers, misters, pop-up sprinklers, bubblers etc.

UNIT IV FILTRATION, CHEMIGATION, CARE & MAINTENANCE OF MICRO IRRIGATION 10

Filters – importance and applications – types and selection of filters – filtration – flushing – plugging. Plant nutrients – uptake mechanism – Chemigation and Fertigation – advantages and disadvantages – fertilizers – selection, quantity estimation - concentration, equipment for fertigation - Clogging – physical, chemical and biological clogging – control measures – maintenance of filters – trouble shooting.

UNIT V AUTOMATION IN MICRO IRRIGATION AND ITS COMPATIBILTIES 8

Automation – need, benefits and limitations – Automation systems – components cost – trouble shooting – IoT in micro irrigation. Mulching – precision farming – application of micro irrigation under protected cultivation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand the fundamental concepts of micro irrigation.
CO2 Design drip irrigation system, install, operate and maintain.
CO3 Design sprinkler irrigation system, install, operate and maintain.
CO4 Understand filtration & chemigation in micro irrigation and their care and maintenance.
CO5 Understand automation in micro irrigation and its compatibilities.

REFERENCES:

1. R.K Sivanappan., “Sprinkler Irrigation”, Oxford and IBH Publishing Co., New Delhi, 1987.
2. Jack Keller and Rond Belisher., “Sprinkler and Trickle Irrigation”, Van nastrand Reinhold, New York, 1990.
3. A.M.Michael, “Irrigation Theory and Practice”, Vikas Publishers, New Delhi, 2000.
4. Dilip Kumar Majumdar., Irrigation Water Management, Prentice Hall Inc., 2004
5. R. Suresh., “Principles of Micro-Irrigation Engineering”, Standard Publishers Distributors, New Delhi, 2010.
6. Megh R Goyal, Sustainable Micro Irrigation: Principles and practices, Apple Academic Press, 2014.
7. V. Ravikumar, “Sprinkler and Drip Irrigation”, Springer, Singapore, 2023.

Attested

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CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	2	3	3
CO2	2	3	3	3	2	3
CO3	2	3	3	3	2	3
CO4	3	2	3	3	2	3
CO5	2	1	3	3	3	3
Avg	**2**	**2**	**3**	**3**	**2**	**3**

• 1-low, 2-medium, 3-high

IW3203 PARTICIPATORY FIELD RESEARCH METHODOLOGY LT P C
3 0 2 4

UNITI RESEARCH 9

Meaning–Purpose–Types of Research–Stages of Research How to conduct a Research: Formulation of Problem, Hypothesis-Sampling-Designs-Method – Research Paradigms : Definition - Meaning - Significance of Paradigms In Research - Paradigm Shift - Stages Leading to Paradigm Shift - Paradigm Shift And Scientific Progress.

UNITII PARTICIPATORY AND FIELD RESEARCH 9

Types of Participation-Participatory meaning-Importance of Peoples Knowledge Emergence of Participatory Research-Participatory Research Approaches in Science and Technology-Participatory Research and Development.

UNITIII TECHNIQUES IN FIELD RESEARCH 9

Primary data collection- Qualitative and Quantitative Survey– Observation-Semi Structured Interview Questionnaire Schedule and Field Trials–Analysis and Evaluation.

UNITIV METHODS OF FIELD RESEARCH 9

Research Methods: Rapid Rural Appraisal (RRA),Participatory Rural Appraisal(PRA), Participatory Learning and Action(PLA)—Diagramming and Mapping – Field Observation and Field Trials Analysis and Evaluating Participatory Research and Development: Some Key Elements.

UNITV PARTICIPATORYTOOLS 9

Situation Query Problem and Response (SPQR)–Statistical Analysis-case studies.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Transect Walk	2
2. Social Mapping	2
3. Resource Mapping	2
4. Focus Group Discussion	2
5. Time Line Charting	2
6. Time Trend Analysis	2
7. Cause and Effect Mapping	2
8. Seasonal Calendar	2
9. Daily Calendar	2
10. Matrix Ranking	2
11 . Pair-wise Ranking	2
12. Key Informant Interview	2
13. Situation, Problems, Query and Response(SPQR)	6

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TOTAL: 45+30=75 PERIODS

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COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Gain comprehensive understanding of particular research area.
CO2 Capture roles and responsibilities in social context.
CO3 Verify the proposed interventions and the real time experiences.
CO4 Discover both internal and external agents and their influence.
CO5 Facilitate students to understand problem solving or solution based approach.

REFERENCES:

1. A. L. Borumet al., On the Art of Doing Field Studies: An Experience Based Research Methodology. Denmark: Copenhagen Business School Press, 1995.
2. R. Chamberset al., "Farmer first,"Farmer Innovation and Agricultural Research. London: Intermediate Technology Publications, 1989.
3. M.Lengwiler, "Participatory approaches in science and technology,"Hist.Orig. Curr.Pract. Crit.Perspect.Sci.Technol.Hum. Values, vol.33, 2008. Available at: http://sth.sagepub. com/cgi/content/abstract/33/2/186.
4. K. McAllister and R. Vernooy, Action and Reflection: A Guide for Monitoring and Evaluating Participatory Research. Ottawa, ON, Canada: International Development Research Centre, 1999.
5. P. V.Young, Scientific Social Surveys and Research Prentice-Hall of India Ltd.New Delhi, 1984.
6. Wilkinson and Bhandarkar, Methodology and Techniques of Social Research, 17th ed. Himalaya Publishing House, 2004.
7. T. S.Khun, The Structure of Scientific Revolution, 4thed.University of Chicago Press, 2012.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	3
CO2	1	1	1	2	2	2
CO3	1	2	2	2	3	3
CO4	2	1	2	2	3	3
CO5	2	3	3	3	3	3
Avg	**1**	**2**	**2**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

HW3251 REMOTE SENSING AND GIS FOR WATER RESOURCES **L T P C**
3 0 4 5

UNIT I BASICS OF REMOTE SENSING **9**

Physics of remote sensing, Types of Remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Swath, Nadir, resolutions, image referencing system; Monitoring atmosphere, land and water resources - Indian Space Programme, Sensor characteristics LANDSAT, SPOT, ERS, IKONOS, IRS and others - Principles of LiDAR Remote Sensing - LiDAR Data Processing- LiDAR applications.

UNIT II INTERPRETATION AND ANALYSIS **9**

Remote sensing data products – Visual image interpretation – interpretation keys; data formats of digital image - Digital image processing – Image preprocessing – Image enhancement – Image transformation – image classification – accuracy assessment - Data merging.

UNIT III GEOGRAPHIC INFORMATION SYSTEM **9**

Definition – Basic components of GIS – Map projections and coordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology – Geodatabase models: hierarchical, network, relational, object-oriented models – Data Encoding methods – encoding raster data, vector

data and attribute data, linking spatial and attribute data- Integrated GIS database -common sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards.

UNIT IV GEOSPATIAL ANALYSIS 9

Thematic mapping – Geospatial Measurements, query analysis, buffering, overlay operations, network analysis, DEM, DSM, DTM, Interpolation - Geovisualisation - Object oriented GIS – Modern trends of GIS – WebGIS, 3DGIS, Real-time GIS.

UNIT V WATER RESOURCES APPLICATIONS 9

Water resources models – Rainfall-runoff modelling – Groundwater modelling – Water quality modelling - Flood inundation mapping and modelling – Drought monitoring – Cropping pattern change analysis - Site selection for artificial recharge - Reservoir sedimentation - Case studies – Drones in irrigation and agriculture

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

Image processing

1. Satellite data products: commercial and open source
2. Land use land cover classification
    1. Unsupervised
    2. Supervised
    3. Accuracy assessment
3. Vegetation indices for vegetative cover analysis
4. Reservoir volume estimation using temporal satellite imageries

Geographical Information System

5. Georeferencing of toposheet and creating vector layers, attribute tables and layout preparation
6. GPS Survey, data transformation into GIS, analysis of data and creation of maps using Google earth maps.
7. Use of D8 pointer algorithm for deriving flow direction, flow accumulation and watershed delineation.
8. Interpolation of point data to create Spatial Maps.
    1. Theisson polygon method
    2. Natural Neibourhood method
    3. Triangular irregular network
    4. Kriging method
9. Derivation of integrated map using weighted overlay techniques (anyone).
    1. Identifying suitable artificial recharge areas
    2. Identification of ground water potential zones
    3. Estimation of sedimentation yield using RUSLE method
10. Join and Relate tables, File conversion from .kml to.shp
11. Open source GIS –Demo

TOTAL: (45+60) = 105 PERIODS

COURSE OUTCOMES

On completion of the course, the student is expected to

CO1 Describe the principles of remote sensing and distinguish the sensors and satellite's characteristics for different applications Demonstrate the methodology for image classification and interpretation using remote sensing

CO2 choose the appropriate data products and techniques for image analysis Illustrate the basics of map preparation, watershed delineation and geospatial data analysis techniques in GIS attribute creation

CO3 Illustrate the basics of map preparation in GIS Formulate the methodology using remote sensing and GIS tools for various applications in water resources engineering

CO4 Demonstrate the geospatial data analysis techniques

CO5 Formulate the methodology using remote sensing and GIS tools for various applications in water resources engineering

REFERENCES

1. B. Bhatta, *Remote Sensing and GIS*, 2nd ed, Oxford University Press, New Delhi, 2011
2. T.M. Lillesand and R.W. Kiefer, *Remote Sensing and Image Interpretation*, 7th ed, John Wiley and Sons, New York, February 2015
3. P.A. Burrough and R.A. McDonnell, *Principles of Geographical Information Systems*, 3rd Edition, Oxford University Press, New York, 2016
4. Ian Heywood Sarah, Cornelius and Steve Carver, *An Introduction to Geographical Information Systems*, Pearson Education, New Delhi, 2002.
5. G. Joseph and C. Jeganathan, *Fundamentals of Remote Sensing*, 3rd ed, Universities Press Pvt. Ltd., Hyderabad, India, 2018.
6. Pinliang Dong and Qi Chen, "LiDAR Remote Sensing and Applications" CRC Press Taylor & Francis Group, 2018
7. T.M. Lillesand and R.W. Kiefer, *Remote Sensing and Image Interpretation*, 3rd ed, John Wiley and Sons, New York,1993.
8. P.A. Burrough and R.A. McDonnell, *Principles of Geographical Information Systems*, Oxford University Press, New York,1998.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	3	2	3
CO2	2	2	2	3	3	3
CO3	1	1	2	3	2	3
CO4	2	2	2	3	3	3
CO5	3	3	3	3	3	3
Avg	**2**	**2**	**2**	**3**	**3**	**3**

3 – High, 2 – Medium, 1 – Low

IW3301 WATER QUALITY L T P C
3 0 4 5

UNIT I WATER QUALITY MONITORING 9

Physical, chemical and biological characteristic of water-suspended and dissolved solids–EC and pH-major ions-water quality investigation-sampling design- samplers and automatic samplers- field kits- water quality data storage, analysis and inference-Methods of illustration -outline of global hydrochemical software: AQUACHEM.

UNIT II IRRIGATION WATER QUALITY 9

Water quality for irrigation- salinity and permeability problem – Root zone salinity – Irrigation practices for poor quality water – saline water irrigation-irrigation water quality criteria.

UNIT III GROUNDWATER QUALITY 10

Chemical composition of groundwater water - origin, movement, and quality – groundwater quality for various uses - geochemical evolution of groundwater – Geogenic contamination of groundwater - salinization of groundwater in coastal regions- case studies.

UNIT IV WATER QUALITY POLLUTION 9

Sources and types of water pollution -organic and inorganic pollutants- BOD-DO-relationships-impact on water Resources-NPS pollution and its control-eutrophication control –water -packed water quality.

UNIT V WATER QUALITY MANAGEMENT 8

Principles of water quality – Water quality classification – Water quality standards - Water quality indices- TMDL concepts – Water quality models.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1 Introduction to the analytical laboratory. Good Laboratory Practices and Quality Control
2 Determination of physical parameters of the water
   - Measurement of pH, turbidity, solids and electrical conductivity
3 Determination of Chemical parameters of water
   - Major ions - Sodium, potassium, chloride, fluoride, hardness, alkalinity
   - Calculation of Sodium Absorption Ratio
4 Determination of nutrients
   - Nitrate and phosphate
5 Demonstration of multi-parameter water quality probes
6 Demonstration of BOD and COD estimations

TOTAL: 45+60=105 PERIODS

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 describe the water quality parameters, its sampling design and methodology for data analysis. Analyse the physical, chemical and nutrients parameters through the analytical procedures
CO2 Describe the water quality standards for irrigation and the methods to assess irrigation water quality. Examine the physical, chemical and nutrients parameters in respect to the standards
CO3 understand the groundwater quality and effects the groundwater quality in coastal aquifer Demonstrate the usage of multiparameter probes, field kits and sondes for measuring water quality parameters
CO4 Relate water quality and its dependence on sources of water pollution.
CO5 Understand, formulate and interpret water quality data for beneficial uses and water quality models.

REFERENCES:

1. E. Claude., Boyd, *Water Quality An Introduction*, Second Edition, Springer International Publishing Switzerland, 2015.
2. Vladimir Novonty, Water Quality: Diffuse pollution and watershed Management, 2nd edition, John Wiley & Sons, 2003.
3. P.K. Goel, Water Pollution causes, effects and control, New Age International (P) Limited Publishers, 2006.
4. R.A.Freeze, and J.A. Cherry, *Groundwater*, Prentice Hall, 1979
5. Chin, A. David, Water quality Engineering in Natural Systems, Wiley- Inter science.
6. APHA. Standard methods for the examination of water and wastewater, 24th Edition. Washington, DC, New York: American Public Health Association; 2023.
7. IS 10500 : 2012 - Indian Standard DRINKING WATER — SPECIFICATION (Second Revision), BUREAU OF INDIAN STANDARDS 2012
8. IS 11624 : 1986 (Reaffirmed 2001) - Indian Standard Guideline for the Quality of Irrigation Water, BUREAU OF INDIAN STANDARDS 2001

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	2	2	3
CO2	2	3	2	2	2	3
CO3	1	2	3	3	2	3
CO4	1	1	2	2	2	3
CO5	1	1	2	2	2	3
Avg	**1**	**2**	**2**	**2**	**2**	**3**

• 1-low, 2-medium, 3-high

Attested

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IW3311 **PRACTICALTRAINING (4 WEEKS)** **L T P C**
0 0 0 2

SYLLABUS: The students individually undertake training in reputed institutions doing Irrigation Water Management with a special focus on Irrigation Water Management during the summer vacation for a specified duration of four weeks. At the end of the training, a detailed report on the work done. The students will be evaluated through a viva-voce examination by a three-member committee.

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 Get expose to the real-world problems
CO2 Describe the challenges in the management of irrigation water.
CO3 Develop skills for solving the problem
CO4 Present the work carried out during the practical training

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	2	-	2	3	2	2
CO3	3	-	3	3	2	2
CO4	-	3	-	-	-	2
Avg	**2**	**3**	**2**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

IW3312 **PROJECT WORK I** **L T P C**
0 0 12 6

SYLLABUS:
The student individually works on a specific topic approved by faculty member who is familiar in the area of interest. The student can select any topic which is relevant to his/her specialization. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted, which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 apply the knowledge gain from the theoretical and practical courses to the real-world problems.
CO2 identify the gap in research by doing extensive literature survey.
CO3 formulate the methodology for arriving at the solution.
CO4 Interpret and present the findings of the research work carried out
CO5 Synthesize the conclusion of the research
CO5 Present the research work carried out during project work I

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	3	-	2	3	2	2
CO3	3	-	3	3	2	2
CO4	3	-	3	3	2	3
CO5	3	-	3	3	2	3
CO6	-	3	-	-	-	2
Avg	**3**	**3**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

IW3411 **PROJECT WORK II** **L T P C**
0 0 24 12

SYLLABUS:

The student should continue the Project work I on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination conducted by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 apply the knowledge gain from the theoretical and practical courses to the real-world problems.
CO2 identify the gap in research by doing extensive literature survey.
CO3 formulate the methodology for arriving at the solution.
CO4 Interpret and present the findings of the research work carried out
CO5 Synthesize the conclusion of the research
CO6 Present the research work carried out during project work II

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	2
CO2	3	-	2	3	2	2
CO3	3	-	3	3	2	2
CO4	3	-	3	3	2	3
CO5	3	-	3	3	2	3
CO6	-	3	-	-	-	2
Avg	**3**	**3**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

PROFESSIONAL ELECTIVE COURSES

IW3051 **WATERSHED CONSERVATION AND MANAGEMENT** **LT P C**
3 0 0 3

UNITI WATERSHED CONCEPTS **9**

Watershed – Definition, Need and Elements – Principles - Influencing Factors: Geology – Soil – Morphometric analysis - Toposheet - Delineation – Codification – Prioritization – Watershed Atlas.

UNITII SOIL CONSERVATION MEASURES **9**

Types of Erosion – Water and Wind Erosion: Causes, Factors, Effects and Control – Soil Conservation Measures: Agronomical and Mechanical – Design of Terraces and Bunds - Estimation of Soil Loss – USLE Modified and Revised USLE - Sedimentation.

UNITIII WATER HARVESTING AND CONSERVATION **9**

YieldfromaCatchment-TraditionalWaterHarvestingTechniques–Micro-Catchments-Design of Small Water Harvesting Structures — Farm Ponds — Percolation Tanks — Check dams —Grassed Waterways.

UNITIV GIS FOR WATERSHED MANAGEMENT **9**

Applications of Remote Sensing and Geographical Information System - Role of Decision Support System—Conceptual Models and Case Studies.

UNITV WATERSHED MANAGEMENT **9**

Project Proposal Formulation - Watershed Development Plan – Entry Point Activities – Watershed Economics - Agroforestry – Grassland Management – Wasteland Management – Watershed approach in Government Programmes – People's Participation – Evaluation of Watershed Management programme–Integrated Watershed Management–Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 Recognize and interpret the morphological features of a watershed and describe the principles of watershed management.

CO2 State, design and sketch the soil conservation structures.

CO3 Describe the micro catchment and apply the concepts to design the small water harvesting structures.

CO4 Illustratetheapplicationofmoderntoolsandtechnologyinthemanagementofwatershed.

CO5 Classify the management activities and to develop an integrated watershed development plan.

REFERENCES:

1. Glenn O. Schwab, Soil and Water Conservation Engineering, John Wiley and Sons, 1981.
2. Suresh, R. Soil and Water Conservation Engineering, Standard Publication, NewDelhi, 1982.
3. Heathcote,I.W. Integrated Watershed Management: Principles and Practice.JohnWiley and Sons, Inc., New York,1988.
4. Ghanashyam Das, Hydrology and Soil Conservation Engineering, Prentice Hall of India Private Limited, New Delhi,2000.
5. Vir Singh, Raj, Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	3
CO2	3	1	3	3	2	3
CO3	3	2	3	3	3	3
CO4	2	2	3	3	2	3
CO5	3	3	2	2	3	3
Avg	**3**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3001 IRRIGATION ECONOMICS **L T P C**
3 0 0 3

UNIT I SCOPE OF ECONOMICS **9**

Scope of irrigation economics – Role of irrigation in economic development – Performance of agriculture in Indian economy: pre independent, post independent and post liberalisation scenario.

UNIT II CONSUMPTION ECONOMICS **9**

Concept of demand and supply – Tools of economic analysis – Price determination – Demand and consumer behaviour – consumer surplus - Market analysis – Economic efficiency – Applications.

UNIT III PRODUCTION ECONOMICS **9**

Production economics – Conventional approach – Non-conventional approach – Cobb Douglas, Spillman and other types of production functions – Data analysis for production function estimation - Cost, revenue, production and profit maximization approach.

UNIT IV FARM ECONOMICS **9**

Concept of farm management – Farm records and budgeting – Whole farm and partial budgeting – Risk and uncertainty in farming – Case studies.

UNIT V FINANCIAL ANALYSIS 9

Role of financial analysis – Central and State financing – Economic instruments: water charges, cess, taxes, subsidies and compensation - Irrigation water pricing - Concept and methods of irrigation water pricing - Discounting factors and techniques – Applications of discounting techniques for irrigation project viability.

TOTAL: 45 PERIODS

COURSE OUTCOME:

- On completion of the course, the student is expected to be able to

CO1 Understand the meaning and scope of economics applied to agriculture and irrigation and economic development from past to present.

CO2 Analyse the tools of economics and its application to behavioural pattern of market dynamics.

CO3 Impart knowledge into concepts of production economics by understanding the principle and types of production functions.

CO4 Discuss the importance of farm management and expose to preparation of farm records and budgeting.

CO5 Analyse the financial aspects, water pricing and identify the justifiable irrigation project among different alternatives.

REFERENCES:

1. Allan, Deserpa C., Micro-economic theory – Issues and applications. Allyn and Bacon, Inc. Massachusetts. 1997.
2. Paul A, Samuelson and William D., Nordhaus, Economics. Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 2004.
3. Bilgrami S.A.R., An introduction to Agricultural Economics. Himalaya Publishing House, Mumbai. 2006.
4. Douglas James L. and Robert Lee, Economics of Water Resources Planning. Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 1971.
5. Ronald D. and Kay, Farm Management, Planning, Control and Implementation, McGraw-Hill Publishing Co. Ltd., New Delhi, 2007.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	2
CO2	2	2	2	2	2	3
CO3	2	2	2	2	2	3
CO4	2	2	2	2	2	3
CO5	2	2	2	3	2	3
Avg	**2**	**2**	**2**	**2**	**2**	**3**

• 1-low, 2-medium, 3-high

HW3051 ENVIRONMENTAL IMPACT ASSESSMENT FOR WATER RESOURCES

L T P C
3 0 0 3

UNIT I ENVIRONMENTAL ISSUES 9

Water resources development and environmental issues – Environment in water resources project planning – Environmental regulations and requirements – EIA notification - Role of EIA

UNIT II EIA FUNDAMENTALS 9

Environmental Impact Assessment (EIA) – EIA in Project Cycle – Legal and Regulatory aspects in India according to Ministry of Environment and Forests – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Public hearing - Merits and Demerits of EIA

UNIT III ENVIRONMENTAL BASELINE AND IMPACT STUDIES 9

Baseline Data - Methodologies of EIA - Semi-quantitative methods: Ad hoc Methods - Check lists - Network and matrix methods -Overlay - Cost benefit analysis – Analysis of alternatives – 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 - Cumulative impact assessment

UNIT IV EIA REPORT 9

EIA team formation - Environmental management plan – Mitigation and rehabilitation plans – Policy and Guidelines for planning and monitoring programmes – Post project audit – Documentation of EIA findings – Ethical and quality aspects of EIA

UNIT V EIA CASE STUDIES 9

EIA of water resources projects – Case studies – Hydropower projects – Command area problems - Role of NGOs - Digital EIA

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand the complex socio-ecological issues in developmental projects.
CO2 Analyse the tools of environmental impact in both the qualitative and quantitative terms
CO3 Apply the domain knowledge and legal principles, access to information, public participation.
CO4 Communicate research findings effectively through written, media materials and colloquial in public hearing for project based EIA.
CO5 Analyse and evaluate the evidences, arguments, claims, beliefs on the basis of empirical evidence

REFERENCES:

1. B. Chari, Richa Sharma and S.A. Abbasi, Comprehensive Environmental Impact Assessment of Water Resources Projects: With Special Reference to Sathanur Reservoir Project (Tamil Nadu)/K, Discovery Pub., New Delhi, 2005.
2. John Glasson, Introduction to Environmental Impact Assessment, 2nd Edition Taylor & Francis e-book, 2005.
3. D.P. Lawrence, Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Inter Science, New Jersey. 2003.
4. N. Arnel, Hydrology and global environmental change, Prentice Hall, Harlow, 2002.
5. R.R. Barathwal, Environmental Impact Assessment, New Age International Publishers, New Delhi. 2002.
6. UNEP's Environmental Impact Assessment Training Resource Manual, Second Edition, 2002.
7. Petts, Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London, 1999.
8. L.W. Canter, Environmental Impact Assessment, McGraw Hill International Edition, New York. 1995.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	2
CO2	2	2	2	2	3	2
CO3	2	2	2	2	3	3
CO4	2	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**2**	**2**	**2**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

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IW3002 RAINFED AGRICULTURE AND TANK IRRIGATION MANAGEMENT L T P C
3 0 0 3

UNIT I RAINFED AGRICULTURE 9

Rainfed agriculture – introduction and importance - Types of Rainfed farming systems - Past trends, problems and prospects of rainfed agriculture in India - Soil and climatic conditions prevalent in rainfed areas - Drought: introduction, classification – effects of drought – moisture stress - Impact of climate change on rainfed agriculture

UNIT II SUSTAINABLE DEVELOPMENT AND MANAGEMENT STRATEGIES IN RAINFED AREAS 10

Contingent crop planning for aberrant weather conditions - Crops and cropping practices in rainfed areas - land development for soil moisture conservation - Improvement of tillage and soil management - Soil and moisture conservation for rainfed lands - Water harvesting - micro catchments - Farm Ponds, percolation tanks - Fertility management in dryland farming – drought management strategies - Increasing crop productivity and water use efficiency - Integrated farm management practices - Case studies.

UNIT III TANK IRRIGATION 8

Concept of tank irrigation – Status of tank irrigation in Tamil Nadu - Classification - Components of tank irrigation - Terms used in tank system - Water distribution network - Cascade of tanks - Degradation of Tank Irrigation Systems - Causes and Remedy.

UNIT III TANK CONSTRUCTION & DESIGN OF TANK COMPONENTS 10

Principles of Construction of new tanks and rehabilitation of existing tanks - Site Selection- Surveying and Levelling in Tank Works - Computation of Water Yield-Runoff- Strange Table- Rational method - Design of Supply & Feeder Channels - Bund for Tank - Design of Sluice Outlets and Surplus Weir- Estimate preparation - Guidelines for preparation of Completion Report

UNIT V FARMERS' PARTICIPATION IN TANK IRRIGATION SYSTEMS 8

On Farm Development – organization, operation and maintenance- Water Users' Association- People's participation in tank irrigation system and its maintenance - community based tank irrigation system - Turn over – Traditional Governance of tank system – Water rights (Ancestral rights) – Multiple users of tank water –Methodologies for tank irrigation performance and management

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Interrelate the rainfed agriculture and tank irrigation systems
CO2 Provide sustainable management strategies
CO3 Sketch the components of tank systems and identify the need to upgrade
CO4 Compute capacity of tanks, design components of tanks
CO5 Assess the level of farmer participation in tank management

REFERENCES:

1. J. Venkateswarulu., Rainfed Agriculture in India – Research and Development Scenario. ICAR Publications, New Delhi, 2004.
2. R.P.Singh., Sustainable Development of Dryland Agriculture in India. Scientific Publishers, 2005.
3. P.Wani, Suhas, John Rockstorm and Theib Oweis, 'Rainfed agriculture: Unlocking the Potential', IWMI, CAB International, UK, 2009.
4. Philip Tow, Ian Cooper, Ian Partridge, "Rainfed farming systems" Springer, 2011.
5. P. Wani, Suhas, Johan Rockstorm and K.L.Sharawat, "Integrated Watershed in Rainfed Agriculture", Taylor and Francis Publishing Ltd., 2011.
6. C.R. Shanmugham and J. Kanagavalli, 'Technology of Tanks', Reflection Publications, Madurai, 2013.

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CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	1	3	3
CO2	2	2	3	3	3	3
CO3	2	1	3	2	1	2
CO4	3	2	3	2	2	2
CO5	2	3	3	3	2	3
Avg	**2**	**2**	**3**	**2**	**2**	**3**

• 1-low, 2-medium, 3-high

IW3056 DROUGHT RISK ASSESSMENT AND MANAGEMENT L T P C
3 0 0 3

UNITI UNDERSTANDING DROUGHT 10

Hydrological Cycle – Drought Definitions based on rainfall, stream flow, vegetation and comprehensive aspects – Causes and Types of Drought – NCA classification –Characterization of Drought/water shortage/aridity/desertification - History of droughts in Worldwide and Indian context - Climate change and Drought: Rainfall variability, frequency of drought, temporal trends, heat waves, groundwater depletion and drought severity.

UNIT II DROUGHT IMPACTS 8

Environmental, Social and Economical impacts – Impact on Rainfed and Irrigated Agriculture - Drought effects on poverty, unemployment, and food security – Drought induced Migration - Hydropower Production - Drought effects on agribusiness and industrial sector – Case studies on Climate change induced Drought.

UNIT III DROUGHT HAZARD AND RISK ASSESSMENT 9

Drought Hazard Assessment – Drought indices - Meteorological, Hydrological and Agricultural Drought Indices – Drought Exposure, Vulnerability and Risk Assessment – Global climate and Drought Monitoring - Early Warning and Forecasting of Drought - - Application of Remote sensing and GIS in Drought Monitoring - Key Drought Indicators and Drought Declaration.

UNIT IV DROUGHT RELIEF MEASURES 8

Contingency Crop Planning – Support to Farmers - Relief Employment – Water Resources Management - Food Security - Tax Waiver – crop Insurance - Public aid to compensate loss of revenue - Rehabilitation/recovery programs - Cattle Camp and Fodder supply – Institutional Response – Role of Central, State, District and Panchayat Raj Institutions – Checklist for Drought Preparedness – Drought response and recovery measures.

UNIT V DROUGHT MITIGATION AND MANAGEMENT 9

Drought Mitigation - Risk and Crisis Management – Water Demand Supply management - Water harvesting and Conservation – Drip and sprinkler Irrigation System – Long-term Irrigation Management – Adopting/reviewing water tariffs - Drought tolerance crop varieties - Afforestation – Drought Awareness, capacity building and Knowledge Management - Community Participation – Climate change and Adaptation - DPAP, DDP and IWMP Programmes - National Drought Policy and action plan – Climate change and Drought mitigation measures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to

CO1 Classify the different types and comprehend various definitions of drought and differentiate Drought with water shortage, aridity and desertification

CO2 Discuss the impacts of drought on various sectors.

CO3 Evaluate the drought severity, risk and vulnerability and the modern tools of drought monitoring

CO4 Prepare the drought plan and frame relief measures for the efficient reduction of drought risk.

CO5 Comprehend the risk and crisis management of drought mitigation and design programs for drought risk management.

REFERENCES:

1. V. Yevjevich, Drought Research Needs, Water Resources Publications, Colorado StateUniversity, USA, 1977.
2. Linda Courtenay Botterill, Geoff Cockfield., Drought, Risk Management, and Policy:Decision-Making Under Uncertainty, Drought and Water crises, CRC press, 2013.
3. National Disaster Management Authority, Government of India, National DisasterManagement Guidelines, Management of Drought, 2010.
4. Wilhite, A. Donald A, Drought Assessment, Management, and Planning: Theory and CaseStudies, Kluwer Academic Publishers, 1993.
5. UN/ISDR, Drought Risk Reduction Framework and Practices: Contributing to the Implementation of the Hyogo Framework for Action, United Nations secretariat of the International Strategy for Disaster Reduction (UN/ISDR), Geneva, Switzerland, 2007.
6. World Bank. 2019. Assessing Drought Hazard and Risk: Principles and Implementation Guidance, World Bank, Washington, DC

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	2
CO2	2	1	2	2	2	2
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	**2**	**2**	**2**	**3**	**2**	**3**

• 1-low, 2-medium, 3-high

IW3003 PARTICIPATORY IRRIGATION MANAGEMENT L T P C
3 0 0 3

UNIT I FUNDAMENTALS OF SOCIOLOGY AND PARTICIPATORY APPROACH 6

Basic Sociological concepts and Definitions - Objectives – Perspectives- Social stratification– Sociological understanding - Irrigation as a Sociotechnical Process - paradigm shift and Participatory approach

UNIT II UNDERSTANDING FARMERS PARTICIPATION 12

Need of farmers participation –Benefits of farmers participation – Comparisons of cost and benefit – Water User Association–-Membership -Kinds of participation –National and International Experiences -Activities on Water towards Organization and Structure - Context of participation factors in the environment.

UNIT III ROLE OF STAKEHOLDERS AND THE UNDERLYING ISSUES 12

Multiple use of water – Issues in sectoral Water Allocation - Domestic, Irrigation, Industrial sectors – Woman as a water user –Constraints and Opportunities. Role of Community Organisers – Constraints in Organising farmers Organisation.

UNIT IV IMPROVING AGENCY RELATIONSAND INSTITUTIONAL REFORMS 10

Supporting farmer organization and participation -Decision Making- Leadership and responsibilities – Development strategy – Channels for implementation — Equity and Equality- Agency Incentives-Technical co-operation – Special roles – Agency Roles- Institutional Reforms

UNIT V POLICY CONSIDERATIONS AND EMERGING CHALLENGES 5

Water Policy-Irrigation Governance-Building from Below-Non-political Associations-Bureaucratic Reorientation- Policy options and Alternatives and Sustainability.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to

CO1 Capture to fundamental concepts and terms which are to be applied and understood all through the study

CO2 Acquire a clear insight into the subject matter of participatory ideology with its rudiments under the light of both national and international illustrative cases.

CO3 Comprehend the roles of different players as stakeholders with the ground reality of the underlying issues in farm community.

CO4 Articulate as how reforms can help build up institutional and irrigation agencies with the support obtained from the existing farm network in irrigation Management

CO5 Gain an overarching understanding of recommendation for improved irrigation management with a vision to transform the existing governance and policies with the novel approach of sustainability.

REFERENCES:

1. A.R., Rural sociology in India, Popular Prakashan, Bombay, 1969.
2. C.M. Michael., Putting people first, Sociology variables in Rural Development, Oxford University press, London 1985.
3. N. Uphoff., Improving International Irrigation management with Farmer Participation – Getting the process Right – Studies in water Policy and management, New West - Viewpress, Boulder and London, 1986.
4. R.Chambers., Managing canal irrigation, Oxford IBM publishing Co. Pvt. Ltd., New Delhi, 1998.
5. F.F.Korten and Y. Robert,. Siy, Jr. Transforming a Bureaucracy – The experience of the Philippines National Irrigation Administration, Ateneo De Manila University Press, Manila, 1989.
6. K. Sivasubramanium., Water Management SIMRES Publication, Chennai, 2009.
7. http://irap india.org/IMTInIndia-Pa
8. http://mowr.gov.in/ writereaddata/mainlinkFile/ File421.pdf

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	2
CO2	1	2	2	2	2	2
CO3	1	2	2	2	1	2
CO4	2	2	2	2	1	2
CO5	2	2	2	2	2	2
Avg	**1**	**2**	**2**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

IW3004 **GENDER AND WATER** **L T P C**
3 0 0 3

UNITI INTRODUCTION **9**

Basic Concepts of Sociology-Definition-Gender–Social Perspectives-Historical Framework Gender and Social Stratification-Roles-Power and authority Equity and Equality Gender Empowerment

UNITII GENDER IN DEVELOPMENT SECTORS **9**

Gender Issues in Agriculture and Irrigation –Gender and Allied and Other Agricultural Activities-Gender in Coastal Region: Salt Production –Gender and Health : A third World outlook

UNITIII GENDER AND INTEGRATED WATER RESOURCES MANAGEMENT **9**

Gender Approach to Water Management-Drinking and Domestic Water Sanitation and Hygiene – Gender and Food Security Indicators for Development Gender Policies in Water Management – Country Experiences.

UNITIV GENDER COMPETENCY ISSUES AND POLICY REFORMS 8

Gender and Technology –Gender in Water Shed Management–Protection of fresh Water Resources-Water Rights-Water Privatization–Legal Frameworks

UNITV GENDERIN GLOBAL SCENARIO 10

Impacts in Water Sector: Globalisation- Liberalisation–Millennium Development Goals-Global Warming and Climate Change-Gender and Capacity Building-– Gender Analysis Tools-Main streaming gender in Water Management–A sustainability perspective

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected

CO1 Understand the necessity of gender participation in water management.
CO2 Comprehend the roles of men and women as stake holders in various domains
CO3 Apply IWRM concepts and understand the intensity of women involvement in water resource management.
CO4 Articulate gender and water in water management practices.
CO5 Gain an overarching understanding of the global, regional and local issues of women in water resources management.

REFERENCES:

1. Gender and Water Alliance, *The Gender Approach to Water Management: 3TU, UK,2002 http://www.genderandwateralliance.org*.
2. *Main streaming Gender in Water Management, Resource Guide*, version 2.1, Nov. 2006. Available at: http://www.gender and water resource guide.
3. R. V. Reddy and S. M. Dev, Eds., *Managing Water Resources, Policies, Institutions, and Technologies*, Oxford University Press, 2006.
4. E. Bolt, Ed., *Together for Water and Sanitation: Tools to Apply a Gender Approach. The Asian Experience, Edited* by.IRC International Water and Sanitation Centre,1994.
5. Vasudha Pangare, et.al, Global Perspectives on Integrated water Resources Management: A Resource Kit, Academic Foundation, 2006.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	3
CO2	1	1	1	2	2	2
CO3	1	2	2	2	3	3
CO4	2	1	2	2	3	3
CO5	2	3	3	3	3	3
Avg	**1**	**2**	**2**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

HW3052 LEGAL ASPECTS OF WATER RESOURCES L T P C
3 0 0 3

UNIT I HISTORICAL BACKGROUND AND CURRENT CHALLENGES 9

Introduction – Policy, Law, Bill, Act, Rules, Notifications – Nature of Rights: Natural Rights – Customary Rights – Positive and Negative rights – Individual and Group rights -Doctrine of Riparian Rights – Doctrine of Prior Appropriation – Doctrine of Equality – Doctrine of Equitable Apportionment – Public Trust Doctrine – Doctrine of Inter-Generational Equity – Absolute Ownership Theory - Role of Law in Water Management – Conceptions of Water: Commodity, Service, Human Right – Political Ecology.

UNIT II WATER LEGISLATION IN INDIA AND TAMILNADU 9

Pre-Constitutional Water Laws – Constitutional Provisions: Article 14, Article 21, Directive Principles of State Policy, Fundamental Rights and Constitutional Rights, State List - Entry 17 – 73rd and 74th amendments, Article 262 – Legislative Process: Legislative, Judicial, Executive – Natural Justice – Delegation of Powers – Post-Constitutional Water Laws – National-Level Enactments - The Overview of State Acts with Case Laws: Indian Easements Act – Land-Related Legislation –Tanks – Irrigation Management – Irrigation Cess – Protection of Water Sources – Groundwater – Drinking and Domestic Water Supply – Industrial Use –Water Pollution – Climate change and Law - Torts and Crimes – Provisions of IPC relating to water (Sections 277, 430, 431, 432) - Constitutional Remedies.

UNIT III WATER GOVERANCE: POLICIES AND LEGAL FRAMEWORKS 9

Water Governance: Elements and dimensions of water governance - Effective water governance schemes - Indicators of good governance – Legal Framework of Water – Changing incentives through Regulation - National Water Policy – National - Level Commissions – Irrigation Management Transfer Policies and Activities – Legal Registration of WUAs – Legal Challenges in Water Allocation – Role of Local Institutions

UNIT IV TRANSBOUNDARY WATER ISSUES 9

International Water Law – Emerging Principles - International Law Commission – International Treaties and Protocols – Transboundary Water Issues: Indus Waters Treaty – India-Nepal Treaty – Indo-Bangladesh Cooperation – Sharing of Nile and Mekong River Basins.

UNIT V WATER CONFLICTS IN INDIA 9

Water conflicts - Contending Water Uses – Equity, Access and Allocation - Conflicts in Water Pricing - Water pricing practices in India and abroad - Water Quality Conflicts - Sand Mining – Macro and Micro-level Conflicts, Dams and Displacement – Quality Issues – Head-Middle-Tail conflicts – Existing cultivators Vs New cultivators - Inter-State water sharing - Tribunals - Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Discuss the historical background of formation of laws and the types of rights.
CO2 Explain the legal provisions existing in India and Tamil Nadu.
CO3 Analyze the policy reforms that have taken place in water management.
CO4 Illustrate the trans boundary conflicts.
CO5 Assess the water conflicts based on the rights issue and reveal the gaps that need to be filled up.

REFERENCES:

1. K.J. Joy, Suhas Paranjape, Biksham Gujja, Vinod Goudand Shruti Vispute,Water Conflicts in India – A Million Revolts in the Making.New Delhi: Routledge, 2018.
2. Gunawansa, A. & Bhullar, Lovleen. Water Governance: An Evaluation of Alternative Architectures, Gunawansa, A. & Bhullar, Lovleen, Eds.Edward Elgar Publishing, 2013.
3. Iyer R. Ramaswamy, Towards Water Wisdom: Limits, Justice, Harmony. Sage Publications, New Delhi, 2007.
4. Mollinga, Peter P., and Alex Bolding, The Politics of Irrigation Reform – Contested Policy Formulation and Implementation in Asia, Africa and Latin America. England:Ashgate Publishing Limited, 2004.
5. J. Brewer, S. Kolavalli, A. H. Kalru, G. Naik, S, Ramnarayan, K.V. Rajuand R. Sakthivadivel, Irrigation Management Transfer in India – Policies and Performance. Oxford and IBH Publishing Company, New Delhi,1999.
6. Singh, Chhatrapati, Water Rights in India, Singh, Chhatrapati,Ed.New Delhi: Indian Law Institute, 1992.

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CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	2	2
CO2	2	1	2	2	2	2
CO3	2	1	2	2	3	3
CO4	2	2	2	3	3	3
CO5	3	2	3	3	3	3
Avg	**2**	**1**	**2**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3055 WATER, SANITATION AND HEALTH L T P C
3 0 0 3

UNITI FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene — Equity issues-Water security - Food Security. Sanitation and Hygiene (WASH) and Integrated Water Resources Management (IWRM)-Need and Importance of WASH.

UNITII MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario— Poor and Multidimensional Deprivation—Health Burden in Developing Scenario-Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography:PopulationandMigration-Fertility-Mortality-Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage – Water and Health Budgeting-Psychological: Non-compliance-Disease Relapse- Political: Political Will.

UNITIII CHALLENGES IN MANAGEMENTAND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation-Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues-Equity Issues-Paradigm Shift: Democratization of Reforms and Initiatives.

UNITIV GOVERNANCE 9

Public health-Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water,(WASH)-Cost Benefit Analysis— Institutional Intervention-Public Private Partnership –Policy Directives –Social Insurance -Political Will vs Participatory Governance-

UNITV INITIATIVES 9

Management vs Development-Accelerating Development –Development Indicators-Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans-Implementation- Capacity Building-Case studies on WASH.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Capture fundamental concepts and terms which are to be applied and understood allthrough out the study.
CO2 Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3 Critically analyse and articulate the underlying common challenges in health care services.
CO4 Acquire knowledge on the existing policies and its say on water sanitation and health.
CO5 Gain an overarching in sight in to the aspects of sustainability in health care.

REFERENCES

1. R .Bonitha Beaglehole, “R,Kjellstorm,” Basic Epidemiology, 2nd ed. World Health Organization, 2006.

2. N. Van Note Chism and D. J. Bickford(Improving the environment for learning: An expanded agenda, New Dir. Teach. Learn., pp. 91-98,2002. doi:10.1002/tl.83 Improving the Environment for learning: An Expanded Agenda.
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5 "Inter sectoral water allocation planning and management," 2000, World Bank Publishers Www,Amazon.com.
6. Third World Network.org. Available at: http://www.twn.org.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	3
CO2	1	1	1	2	2	3
CO3	1	2	2	2	3	3
CO4	1	1	2	2	3	3
CO5	2	3	3	3	3	3
Avg	**1**	**2**	**2**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3054 WASTEWATER TREATMENT AND UTILIZATION L T P C
3 0 0 3

UNIT I INTRODUCTION AND BIOLOGICAL TREATMENT 9

Types of wastewater- causes of pollution- analysis of pollutants in the waste effluents- Biological wastewater treatment- biological sludge treatment. Biological systems: Fundamentals of microbiology and biochemistry- bioenergetics and metabolism- kinetics of biological growth. Process analysis: Reaction rates- effect of temperature on reaction rate- enzyme reaction and kinetics- Reactor analysis, residence time distribution.

UNIT II DOMESTIC WASTEWATER GENERATION AND TREATMENT PROCESS 9

Sewerage system- Domestic wastewater characteristics- flow equalization- population equivalent- treatment flow chart- Primary, secondary and tertiary treatment of domestic wastewater- Downstream wastewater treatment for reuse and recycle- Guidelines for wastewater recycling.

UNIT III KINETICS OF WASTEWATER TREATMENT 9

Activated sludge process -Substrate utilization and biomass growth - estimation of kinetic parameters- Process description and its modification- performance evaluation, troubleshooting- Nitrogen removal- Biological nitrification and denitrification.

UNIT IV ADVANCES IN WASTEWATER TREATMENT 9

Activated sludge process design for nutrient removal-Process operation - mean cell residence time, oxygen requirement- Biological and chemical phosphorus removal- Sedimentation of activated sludge- Sequencing Batch reactor, Oxidation ditch and membrane bioreactors.

UNIT V REUSE OF WASTEWATER 9

Biofilm process: Trickling filter, bio tower, rotational biological contactor, integrated activated sludge and biofilm processes- Stabilization ponds and aerated lagoons- Types and their description, design, operation and maintenance- Anaerobic processes: Process description, process design, operation and maintenance, sludge digestion- Sludge treatment thickening, dewatering-mechanical and sludge drying beds- treatment of domestic wastewater- grey water management - Utilization of wastewater in agriculture and other sectors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand the characteristics and composition of wastewater and the biological treatment
CO2 Know the different types of domestic wastewater generation and its treatment
CO3 Gain knowledge on the kinetics of wastewater treatment
CO4 Acquire knowledge of advanced wastewater treatment technologies
CO5 Understand the different reuses of wastewater after treatment

REFERENCES

1. R.l.Droste ., Theory and Practice of Water and Wastewater Treatment. John Wiley, 1997
2. Metcalf and Eddy, Wastewater Engineering. 4th Ed., McGraw Hill, 2003
3. Gray N.F, Water Technology, Elsevier India Pvt. Ltd., New Delhi, 2006.
4. B.C.Punmia., A.k. Jain, and A.K. Jain..., Environmental Engineering, Vol.II, Laxmi Publications, 2010.
5. S.R.Qasim., Wastewater Treatment Plants – Planning, Design and Operation. CRC Press, Florida, 2010.
6. K.N.Duggal ., "Elements of Environmental Engineering" S.Chand and Co. Ltd., New Delhi, 2014.
7. S.K.Garg., Environmental Engineering Vol. II, Khanna Publishers, New Delhi, 2015.

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	3	3	2
CO2	3	2	3	3	3	3
CO3	3	2	3	2	2	-
CO4	3	1	3	3	2	3
CO5	3	2	3	3	3	3
Avg	**3**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3053 CIRCULAR WATER ECONOMY L T P C
3 0 0 3

UNIT I CIRCULAR ECONOMY CONCEPTS 12

Circular economy; Linear economy - Resource scarcity - Climatic and Non-climatic challenges to cater the linear economy - Techno-economic feasibility - Social acceptance of a circular economy Application of circular economy principles in the water sector; Resilient and inclusiveness of water systems in the circular economy; The 6 R's in the circular water economy - Circular Economy in water Conservation**:** Water efficiency; Reducing water wastage; Water utility-led water conservation

UNIT II DEVELOPING THE CIRCULAR WATER ECONOMY 9

Reuse and Recycle- Industrial water reuse and recycling; Agricultural reuse; Urban reuse; Sustainable water - management and circular economy in water-energy-food nexus

UNIT III CIRCULAR WATER ECONOMY IN THE ENERGY SECTOR 9

Recover-Renewable energy generation technologies at wastewater treatment facilities; Traditional renewable energy at water and wastewater treatment facilities; Resource recovery from wastewater

UNIT IV CIRCULAR ECONOMY IN WATER RESOURCES MANAGEMENT 9

Restore and Reclaim- Restoration of the water sources like groundwater, river water, water in lakes, artificial recharge; Managed Aquifer Recharge; Rejuvenation of water sources; Constructed Wetland (CW) technology; Repurposing the wastewater from residential buildings, industries or agriculture

UNIT V VIRTUAL WATER 6

Understanding virtual water and the water footprint - Water footprint categories based on consumption- Perspectives on blue water - Food production and food security - Environmental sustainability - Water pricing – Ownership - Policy implications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Comprehend the circular economy concepts.

CO2 Demonstrate the methodology for developing water quality models in the Environment of Rivers and streams.

CO3 Demonstrate the methodology for developing water quality models in the environment of lakes, impoundments and sediments.

CO4 Illustrate the mechanism of nutrient loading, its control and heat budget for temperature models

CO5 Comprehend the differences among the numerical modelling methods in water quality modelling and also hands-on practice for water quality analysis.

REFERENCES

1. A. Delgado., D.J.Rodriguez., C.A.Amadei., and M. Makino., "Water in Circular Economy and Resilience (WICER)." World Bank, Washington, DC
2. R.C. Brears., "Developing the circular water economy" Springer International Publishing. 2020
3. WBCSD (World Business Council for Sustainable Development)., "Business Guide to Circular Water Management: Spotlight on Reduce, Reuse and Recycle", World Business Council for Sustainable Development. 2017
4. UNIDO (United Nations Industrial Development Organization). "Circular Economy" 2017
5. IWA. "Water Utility Pathways in a Circular Economy." IWA, London. 2016
6. Veolia., "Water at the Heart of the Circular Economy. 2014
7. McKinsey Global Institute. Resource Revolution: Meeting the World's Energy, Materials, Food, and Water Needs. McKinsey Global Institute.
8. Chittaranjan Ray, David McInnes and Matthew Sanderson (2018) Virtual water: its implications on agriculture and trade, Water International, 43:6, 717-730, DOI:10.1080 /02508060. 2018.1515564
9. T. Allan., "Virtual water: Tackling the threat to our planet's most precious resource. London: I.B. Tauris & Co Ltd, 2011

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	3	2	3
CO2	1	3	3	3	3	3
CO3	2	3	3	3	2	3
CO4	2	2	2	3	3	3
CO5	3	3	2	3	3	3
Avg	**2**	**3**	**2**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3052 CLIMATE CHANGE AND WATER RESOURCES L T P C

3 0 0 3

UNITI GLOBAL CLIMATE SYSTEM 9

Climate - Drivers of Climate change - Components of Global Climate System: Atmosphere, hydrosphere, Lithosphere, cryosphere and biosphere, atmospheric circulation- redistribution of heat; Global Energy Balance: Green house effect; Hydrological cycle: Reservoirs, flows (or Fluxes), Residence Times, Water Vapor,

UNIT II CLIMATE VARIABILITY AND CHANGE 9

Climate variability and change: Factors Responsible for Natural Climate Variability and Change: large scale variability- ElNino, LaNina—ENSO, Teleconnections, Sun-Moon-Earth interaction- Factors Responsible for Anthropogenic Climate Change, Detection and Attribution of Climate Change; Global and Indian Scenarios —Observed changes and projected changes of IPCC – Impacts on water resources– IPCC Scenarios

UNIT III CLIMATE MODELS 9

Need for vulnerability assessment - Approaches for assessment — Types of climate models, History of climate modelling, Sensitivity of climate models, parameterization of climate process, simulation. Box models - Zero-dimensional models - Radiative-convective models - Higher- dimension models - EMICs (Earth-system models of intermediate complexity) - GCMs (global climate models or general circulation models) —Regional Models - Sectoral models – CMIP - Selection of Global Climate Models- Performance Indicators for Evaluating GCMs

UNIT IV ADAPTATION AND MITIGATION 9

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

UNITV IMPACTS ON WATER RESOURCES 9

General Circulation Models – downscaling – statistical downscaling – dynamic downscaling Case studies on impacts of climate change on Water resources assessment, water quality, groundwater, irrigation and agriculture

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Describe the earth's climate system and the interaction among the subsystems of the earth's components.
CO2 Illustrate the basics of climate variability and change including the observations and projections.
CO3 Demonstrate the climate models for vulnerability assessment at global and at regional scale.
CO4 Describe the options available for adaptation and mitigation for different sectors
CO5 Comprehend the methodology for using appropriate data sets for an impact assess menton Water resources assessment, water quality, groundwater, irrigation and agriculture through case studies.

REFERENCES

1. Sangam Shrestha, MukandS. Babeland Vishnu Prasad Pandey," Climate Change and Water Resources", CRC Press an imprint of the Taylor & Francis Group, 2014.
2. M.John, Wallace and Peter V. Hobbs, "Atmospheric Science: An Introductory Survey", Second Edition, Academic Press an imprint of Elsevier, 2006.
3. J.David Neelin., "Climate Change and Climate Modeling",University Press, Cambridge, United Kingdom, 2011.
4. K. McGuffie and A. Henderson-Sellers., "A Climate Modelling Primer", Third Edition, John Wiley & Sons, Ltd, 2005.
5. ThomasT.Warner, "Numerical Weather and Climate Prediction",Cambridge University Press, New York, 2011.
6. Inter governmental Panelon Climate Change:https://www.ipcc.ch/
7. Komaragiri Srinivasa Raju and Dasika Nagesh Kumar, Impact of Climate Change on Water Resources With Modeling Techniques and Case Studies, Springer Climate, 2018.

CO - PO Mapping

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CO1	1	2	2	3	2	3
CO2	2	3	3	3	3	3
CO3	2	3	3	3	2	3
CO4	2	2	3	3	3	3
CO5	3	2	3	3	3	3
Avg	**2**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

IW3005 REHABILITATION AND MODERNISATION OF IRRIGATION SYSTEMS **L T P C**
3 0 0 3

UNITI IRRIGATION SYSTEMS **9**

Historical evolution of irrigation systems in India– Canal system operation – Conventional operation – Water delivery practices: the Warabandi – Shejpoli block and Satta System – the localized system for paddy area – Irrigation system classification – Nature of system modernization and rehabilitation. Distinction between rehabilitation and modernization; Rehabilitation and modernization objectives – Theory and Practice.

UNITII SYSTEM MAINTENANCE **9**

Strategy for improving irrigation systems – Conceptual Approach - Essential, catch up, preventive and normal, deferred maintenance – causes – Activities for improving irrigation system maintenance practices –-Baseline survey – asset mapping using GIS and GPS - -Hydraulic and maintenance surveys of the system Diagnostic analysis of flow, seepage and other parameters through Participatory Rural Appraisal, Rapid Rural Appraisal and Walk-through Survey–Development and maintenance programme–-Turnover–Role of Water Use Associations.

UNITIII REHABILITATION OFIRRIGATIONSYSTEMS **9**

Concepts and Methodology – Project objectives – Development Strategies: Irrigation, Institutional and Crop improvement, Economic and Social organization – Major Problems – Planning process – Implementation – Improvement strategies – Sustainability – System performance: history of in flow,cropping pattern,System alterations distribution performance – Operational constraints – Management constraints – Resources constraints -Criteria used for taking Rehabilitation programmes –Service Delivery Concepts - Prioritization –Monitoring and Evaluation.

UNITIV MODERNIZATION OFIRRIGATIONSYSTEMS **9**

Frame work for modernization- Scope and concept of modernization – Obstacles – Model for the modern irrigation enterprise – Reengineering irrigation system operations – Flexibility in modernization – Modern water control and management practices – Effective application of information technology – the modernization efforts: Institutional development – equitable water distribution – self sustainability – water delivery modernization – Canal Automation – Piped Irrigation.

UNITV REHABILITATION AND MODERNISATION INITIATIVES **9**

Tank Modernisation Project: Periyar Vaigai Project – Parambikulam – Aliyar project - Water Resources Consolidation Project (WRCP)–DRIPproject–RRRofwaterBodiesProject–KudimaramathSchemetorestore Water Bodies – IAMWARM Project – Farm Pond Scheme – Government Subsidies –Successful Rehabilitation and Moderinisation Projects implemented in Asian Countries

TOTAL: 45 PERIODS

COURSE OUTCOMES

- On completion of the course the student is expected to be able to

CO1 Describe about Indian irrigation systems and discriminate between rehabilitation and modernization.

CO2 Analyse the different types of maintenance problems with respect to technical and social aspects using Different PRA tools

CO3 Carryout diagnostic analysis to identify the constraints in improving the performance of irrigation system

CO4 Illustrate the various types of modern irrigation technologies to attain sustainable Irrigated agriculture.

CO5 Explain the rehabilitation and modernization advancements achieved so far through the implemented projects in India and Asian Countries.

REFERENCES:

1. Technical Report no. 19-A, Hand Book for Improving Irrigation System maintenance practices, Louis Berger International, InC, India, 1989.
2. IT IS Report, Food and Agriculture Organization of the United Nations, 1998.
3. W.A. T Abey Sekera , *Rehabilitation of Irrigation Systems in Sri lanka*: A Literature Review, IWMI 1993.
4. Martin Donaldson, *Rehabilitation and Modernization of Irrigation Schemes*, proceeding of the Institutions of Civil Engineers: Water Management 2013.
5. CWR, *Baseline Survey of Irrigation Commands*, Centre for Water Resources, Anna University, Chennai, 2000.
6. SU, *Diagnostic Analysis of Irrigation Systems* Volume 2: Evaluation Techniques. Water Management Synthesis Project, Colorado State University, USA. 1984.
7. WAPCOS,TechnicalReportNo.19,Handbook for Improving Irrigation System Maintenance Projects, WAPCOS,New Delhi.1989
8. CWR, *Tank Modernization Project EEC Assistance*: Monitoring and Evaluation. Final Reports. Centre for Water Resources, Anna University, Chennai. 2000.
9. CWR, *Planning and Mobilization of Farmers Organization and Turn over*. Tamil Nadu Water Resources Consolidation Project, Centre for Water Resources, Anna University, Chennai, 1997.

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CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	2	3	3	2	3	3
Avg	**2**	**2**	**3**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

HW3053 RADAR METEOROLOGY L T P C
3 0 0 3

UNIT I RADAR PRINCIPLES 9

Electromagnetic waves (EM): Electric field (EF), Magnetic field (MF), relating EF and MF, Maxwell's equations; Interaction of EM waves: refraction, reflection, scattering, absorption, Polarization of waves; Radar components: radar beam, pulse, signal processing;

UNIT II RADAR RAY PROPAGATION, REFLECTIVITY FACTOR AND RADIAL VELOCITY 9

Ray propagation in the idealized atmosphere: factors influencing ray paths, range and height of pulse; Radar equation: solitary target and distributed target, weather radar equation, radar reflectivity factor, the validity of Rayleigh's approximation; Radial velocity: Doppler effect, measurement, Doppler spectra

UNIT III PRECIPITATION ESTIMATION WITH RADAR 9

Measurement of precipitation rate, total precipitation, drop size distribution; instruments, terminal velocities, Radar reflectivity (Z) and Rainfall rate (R), Z-R relationships; Polarimetric Radar Quantitative Precipitation Estimation: Hydrometeor Classification, Polarimetric Radar-Based QPE, Microphysical Retrievals, Precipitation Typology, Precipitation Estimation

UNIT IV ADVANCED RADAR TECHNOLOGIES FOR QUANTITATIVE PRECIPITATION ESTIMATION 9

Mobile and Gap-Filling Radars, Space borne Radars: TRMM and GPM, Phased-Array Radar; Surface water radar: Stream flow radar, SAR, Altimetry; Subsurface water: L-band, c band and Ground penetrating radar

UNIT V RADAR QPE FOR HYDROLOGIC MODELING 9

Model Classes, Model Parameters, Model State Variables and Data Assimilation, Hydrological Model Evaluation, Hydrological Evaluation of Radar QPE; Flash Flood Forecasting: Lumped flash flood guidance and gridded flash flood guidance. Flash Flood Potential Index, threshold frequency approach

TOTAL: 45 PERIODS

COURSE OUTCOMES

On completion of the course, the student is expected to be able to

CO1 Describe the principles of radar, its components and the interaction of waves with the atmosphere and objects

CO2 Comprehend the radar ray propagation and the parameters that can be measured using radar waves

CO3 Illustrate the methodology for the estimation of precipitation using radar principles

CO4 Demonstrate the advanced techniques for precipitation estimation using mobile and space-borne radars

CO5 Formulate and choose the appropriate model classes and parameters for hydrologic modelling using QP estimated through radar

REFERENCES

1. Robert M. Rauber and Stephen W. Nesbitt, “Radar Meteorology: A first course”, Wiley Blackwell, UK, 2018
2. Bringi V. N and Chandrasekar. V, “Polarimetric Doppler Weather Radar: Principles and applications”, Cambridge University Press, 2004
3. Richard J Doviak and Dusan S Zrnic, “Doppler Radar and, Weather observations”, Dover Publications Inc., New York, 2016
4. Yang Hong, Jonathan J. Gourley, “Radar Hydrology: Principles, Models, and Applications”, CRC Press, Taylor & Francis Group, USA, 2015
5. Peter Meissner, “Weather Radar: Principles and Advanced Applications”, Springer- Verlag Berlin Heidelberg Publications, 2004

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CO4	2	2	3	3	3	3
CO5	2	2	3	3	3	3
Avg	**2**	**2**	**3**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

IW3006 VIRTUAL WATER: CONCEPT, ASSESSMENTS AND APPLICATIONS **L T P C**
3 0 0 3

UNITI BACKGROUND AND INTRODUCTION TO VIRTUAL WATER CONCEPT 6

Background – Introduction to the concept of virtual water and water foot print -Introduction to water use for crop and livestock products - Water use behind consumer goods - Water for domestic services - Water use for industrial products - Goals and scope of water footprint assessment and accounting - Coherence between different sorts of water footprint accounts.

UNIT II ASSESSMENT AND ACCOUNTING OF VIRTUAL WATER 10

Virtual water of a process step – Blue, Green, Grey water footprint and assessment – Calculation of virtual water for a product– Virtual water of a consumer or group of consumers - Water footprint of a business - Analytical framework for the assessment of virtual water content, virtual-water flows, water savings, water footprints, and water dependencies

Case Analysis: The virtual water of coffee and tea consumption; The virtual water of cotton consumption

UNIT III SUSTAINABILITY ASSESSMENT – VIRTUAL WATER AND WATER BUDGETING10

Water footprint within geographically delineated area - Sustainability of the water footprint within a catchment or river basin - Environmental sustainability criteria for identifying environmental, social, economic hotspots - Sustainability of the water footprint of a process, of a product, of a business and of a consumer

Case Analysis: Water footprint accounting along the wheat-bread value chain: implications for sustainable and productive water use benchmarks; Evaluating water use for agricultural intensification in Southern Amazonia using the water footprint sustainability assessment

UNIT IV VIRTUAL WATER TRADE 10

Virtual water of nations - National water footprint accounting - Water footprint accounting for catchments and river basins – Virtual water flows between nations as a result of trade in agricultural and industrial products- The relation between trade and water scarcity - Water saving through international trade in agricultural products - National water losses – Global water savings – Virtual Water as a new indicator of water use

Case Analysis: The water footprints of Morocco and the Netherlands; Virtual versus real-water transfers within China

UNIT V WATER FOOTPRINT A GLOBAL POLICY TOOLS 9

Water as a geopolitical resource efficient, sustainable, and equitable water use in a globalizorld – Water footprint: A tool towards collective action in water governance - Water footprint response options for producers, consumers and stakeholders –Water footprint-based water policy for local bodies - Limitation and challenges of water footprint assessment

Case Analysis: Informing national food and water security policy through water footprint assessment: the case of Iran; Simplified direct water footprint model to support urban water management; Water and land footprints and economic productivity as factors in local crop choice: the case of silk in Malawi

TOTAL: 45 PERIODS

COURSE OUTCOMES

On completion of the course the student is expected to be able to

CO1 Explain the concept of Virtual water and identify the scope of water footprint assessment at individual, community, panchayat and national scales

CO2 Apply the tools and techniques in Water footprint assessment and accounting for various products, services, institutions and events for sustainable processes

CO3 Apply knowledge and reflect on the sustainable assessment on products and services and to identify hotspots for sustainable decision making based on virtual water

CO4 Appraise the virtual water trade, its implications with local and global water security and scarcity

CO5 Evolve water norms, policies and regulations based on the water footprint at grassroots to global geographies and integrating with SDGs and National indicators

REFERENCES

1. Y.Arjen, K. Hoekstra, Chapagain, M.Maite, Aldaya, M.Mesfin and Mekonnen., The Water Footprint Assessment Manual: Stting the global standard [Book]- Washington DC, USA: Eartthscan 1st edition, 2011.
2. Y. Chapagain Arjen, Hoekstra and K.Ashok., Globalization of Water Sharing the Planet's Freshwater Resources [Book] Oxford UK: Blackwell Publishing 1st edition, 2008.
3. Y.Hoekstra Arjen., TheWater Footprint of Modern Consumer Society [Book}, Washington DC, USA, 2nd edition, 2020.
4. Marta Antonelli Francesca Greco., The Wate We Eat Book: Combining Virtual Water and Water Footprints [Book} Switzerland: Springer International, 1st edition, 2015.
5. Y.Oel Arjen, K.Ashok Hoekstra, R. Chapagain Pieter and Van., Progress in Water Footprint Assessment [Book], Basal, Switzerland: MDPI, 1st edition, 2019.

Indicative topics for Practical:

- Assessment of Virtual Water for an individual of various socio-economic backgrounds
- Water footprint-based water budgeting at Panchayat or Wards
- Assessment of Blue, Green, Grey Water footprint for a single crops tank-fed, canal fed, aquifers fed and rainfed
- Comparative study on Blue, Green, Grey Water footprint for various crops at a specific agro-climatic zone
- Assessment of virtual water of a single crop across various ecosystems (Hills, plains, coastal, urban and controlled environments)
- Assessment on Virtual water trade of a village Panchayat based on the production, consumption and services
- Deriving Panchayat policies based on Water footprint assessment
- Designing industry, institution and event processes towards sustainable water security based on the Water footprint
- Estimating Virtual water for non-listed local produces using the assessment tools

Indicative Tutorial:

- Case Analysis of recent researches on Water footprint assessment, accounting methods, virtual water trade among nations, regions and counties, various products and services, Water footprint-based policies, regulations and strategies

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	3	1
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CO4	1	2	3	3	2	2
CO5	3	2	3	3	3	2
Avg	**2**	**2**	**2**	**3**	**3**	**2**

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