ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M. E. INTEGRATED WATER RESOURCES MANAGEMENT

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To provide students with a firm foundation in mathematical, scientific and engineering fundamentals required to solve complex water resources problems.

II. To develop an integrated approach to manage water resources through technically feasible, environmentally sound, economically viable, legally implementable and socially acceptable solutions.

III. To impart knowledge towards working with the latest tools, methods and technology available for sustainable development and management of water resources with the bottom-up approach.

IV. To train students collect scientific and social data, analyze and interpret them so as to promote water resources research with an impact.

V. To kindle interest among students to take up real world problems and disseminate their knowledge through effective communication for saving the elixir of life for future generations.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will exhibit knowledge of mathematics, science and engineering.
2. Graduates will reorient their attitude towards the development and management of water resources from the sectoral approach towards an integrated approach.
3. Graduates will identify the existing real world issues and choose the appropriate tools and methods for solving them in an integrated way.
4. Graduates will get an ability to collect and analyze the data with a participatory approach.
5. Graduates will develop conceptual models by using modern engineering tools, software and equipment to work with complex problems.
6. Graduates will derive meaningful inferences to solve multidisciplinary tasks.
7. Graduates will take up independent field research work.
8. Graduate will communicate effectively in both verbal and written form.
9. Graduates will show the understanding of impact of engineering solutions on the society and vice-versa.
10. Graduates will express a thirst towards acquiring more knowledge which will take them towards achieving sustainable solutions.

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	Ě	Ě	Ě	Ě	Ě	Ě				
II	Ě	Ě	Ě			Ě			Ě	
III		Ě		Ě	Ě					
IV		Ě		Ě		Ě	Ě	Ě	Ě	
V		Ě		Ě		Ě	Ě	Ě	Ě	Ě

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Surface and Ground Water Hydrology	Ě	Ě	Ě	Ě						
		Integrated Water Resources Management		Ě	Ě			Ě		Ě	Ě	Ě
		Gender and Water		Ě	Ě					Ě	Ě	Ě
		Statistical Methods for Engineers	Ě	Ě	Ě	Ě	Ě	Ě				
		Elective I										
		Elective II										
	SEM 2	Remote Sensing and GIS for Water Resources			Ě	Ě	Ě					
		Participatory Field Research Methodology		Ě	Ě				Ě	Ě		Ě
		Legal Aspects of Water Resources		Ě						Ě	Ě	Ě
		Water and Ecosystems	Ě	Ě		Ě		Ě				
		Elective III										
		Elective IV										
		GIS Laboratory		Ě	Ě		Ě	Ě			Ě	
		Field Practice on PRA Tools		Ě	Ě					Ě	Ě	Ě
YEAR 2	SEM 3	Water, Sanitation and Health		Ě				Ě	Ě	Ě	Ě	
		Elective V										
		Elective VI										
		Practical Training (2 weeks)	Ě	Ě	Ě	Ě	Ě	Ě				
		Project Work (Phase I)	Ě	Ě	Ě	Ě	Ě		Ě	Ě	Ě	Ě
	SEM 4	Project Work (Phase II)	Ě	Ě	Ě	Ě	Ě	Ě	Ě	Ě	Ě	Ě

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CURRICULA AND SYLLABI

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IM7101	Gender and Water	FC	3	3	0	0	3
2.	IM7102	Integrated Water Resources Management	FC	3	3	0	0	3
3.	IM7103	Surface and Ground Water Hydrology	PC	3	3	0	0	3
4.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
5.		Elective I	PE	3	3	0	0	3
6.		Elective II	PE	3	3	0	0	3
			TOTAL	**19**	**19**	**0**	**0**	**19**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HW7251	Remote Sensing and GIS for Water Resources	PC	3	3	0	0	3
2.	IM7201	Legal Aspects of Water Resources	PC	3	3	0	0	3
3.	IM7202	Participatory Field Research Methodology	PC	3	3	0	0	3
4.	IM7203	Water and Ecosystems	PC	3	3	0	0	3
5.		Elective III	PE	3	3	0	0	3
6.		Elective IV	PE	3	3	0	0	3
PRACTICAL								
7.	HW7261	GIS Laboratory	PC	4	0	0	4	2
8.	IM7211	Field Practice on PRA Tools	PC	2	0	0	2	1
			TOTAL	**24**	**18**	**0**	**6**	**21**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IM7301	Water, Sanitation and Health	PC	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
PRACTICAL								
4.	IM7311	Practical Training (2 weeks)	EEC	-	-	-	-	1
5.	IM7312	Project Work (Phase I)	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**16**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	IM7411	Project Work (Phase II)	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 68

FOUNDATION COURSES (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Statistical Methods for Engineers	FC	4	4	0	0	4
2.		Gender and Water	FC	3	3	0	0	3
3.		Integrated Water Resources Management	FC	3	3	0	0	3

PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Surface and Groundwater Hydrology	PC	3	3	0	0	3
2.		Remote Sensing and GIS for Water Resources	PC	3	3	0	0	3

3.		Participatory Field Research Methodology	PC	3	3	0	0	3
4.		Legal Aspects of Water Resources	PC	3	3	0	0	3
5.		Water and Ecosystems	PC	3	3	0	0	3
6.		Water, Sanitation and Health	PC	3	3	0	0	3
7.		Field Practice on PRA Tools	PC	2	0	0	2	1
8.		GIS Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HW7071	Urban Water Resources Management	PE	3	3	0	0	3
2.	IM7001	Climate Change and Water Resources	PE	3	3	0	0	3
3.	IM7002	Environmental Impact Assessment for Water Resources	PE	3	3	0	0	3
4.	IM7003	Integrated Flood Risk Assessment and Management	PE	3	3	0	0	3
5.	IM7004	Integrated River Basin Management	PE	3	3	0	0	3
6.	IM7005	Watershed Conservation and Management	PE	3	3	0	0	3
7.	HW7003	Environmental Hydraulics	PE	3	3	0	0	3
8.	HW7004	Flood Modelling and Drought Assessment	PE	3	3	0	0	3
9.	HW7007	River Engineering	PE	3	3	0	0	3
10.	HW7009	Water and Environment	PE	3	3	0	0	3
11.	HW7010	Water Power and Dam Engineering	PE	3	3	0	0	3
12.	HW7203	Systems Analysis in Water Resources	PE	3	3	0	0	3
13.	HW7101	Advanced Fluid Mechanics	PE	3	3	0	0	3
14.	HW7202	Open Channel Hydraulics	PE	3	3	0	0	3
15.	IW7201	Groundwater and Drainage Engineering	PE	3	3	0	0	3

16.	HW7072	Water Supply and Buried Pipelines	PE	3	3	0	0	3
17.	IW7071	Water Quality	PE	3	3	0	0	3
18.	HW7002	Computational Intelligence for Hydrosystems	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Practical Training (2 Weeks)	EEC	-	-	-	-	1
2.		Project Work (Phase I)	EEC	12	0	0	12	6
3.		Project Work (Phase II)	EEC	24	0	0	24	12

IM7101 **GENDER AND WATER** **L T P C**
3 0 0 3

OBJECTIVES:

- To enable the understanding which seeks to improve gender relations and roles how they affect and are affected by water.
- To improve the understanding and awareness of gender concepts through an easy reference to existing materials and tools.

UNIT I INTRODUCTION 9

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

UNIT II 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

UNIT III 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

UNIT IV GENDER COMPETENCY ISSUES 8

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

UNIT V GENDER IN GLOBAL SCENARIO 10

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

TOTAL: 45 PERIODS

OUTCOMES:

- By taking this course the students can have better insight into the interpersonal relationship in society; analyze the contemporary status of gender in all walks of their life.
- The course offers better anchorage of ideas, knowledge and practice in the respective field.

REFERENCES:

1. Gender and Water Alliance. The Gender Approach to Water Management: 3TU, UK.,2002 http://www.genderandwateralliance.org
2. Mainstreaming Gender in Water Management, Resource Guide, Version 2.1 November 2006. http://www.genderandwaterresourceguide.
3. Ratna V. Reddy and S. Mahendra Dev (Ed.), Managing Water Resources, Policies, Institutions, and Technologies, Oxford University Press., 2006
4. Eveline 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

IM7102 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- Students will be introduced to the role of disciplines of ecology and socio-economics play in management of water resources.
- They will be exposed to global food security and public-private participation issues and legal and regulatory settings, in the context of IWRM

UNIT I CONTEXT FOR IWRM 8

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

UNIT II WATER ECONOMICS 12

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

UNIT III WATER SUPPLY AND HEALTH WITHIN THE IWRM CONSIDERATION 9

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

UNIT IV AGRICULTURE IN THE CONCEPT OF IWR 10

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

UNIT V WATER LEGAL AND REGULATORY SETTINGS 6

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

TOTAL: 45 PERIODS

OUTCOMES:

- There will be a paradigm shift in attitude of the students towards interdisciplinary research.
- The students will gain knowledge about economic aspects of water.
- They will gain a broad understanding of the complexities of dealing with water resources problems.

REFERENCES:

1. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
2. Technical Advisory Committee, Poverty Reduction and IWRM, Technical Advisory Committee Background paper no: 8. Global water partnership, Stockholm, Sweden, 2003.
3. Technical Advisory Committee, Regulation and Private Participation in Water and Sanitation section, Technical Advisory Committee Background paper No:1. Global water partnership, Stockholm, Sweden, 1998.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.

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

IM7103 SURFACE AND GROUND WATER HYDROLOGY

L	T	P	C
3	0	0	3

OBJECTIVES :

- To make the students understand the various process of the hydrological cycle and its practical applications.
- To make the students get the basic concepts of groundwater and its movement, which will help them to make an assessment of this resource.

UNIT I HYDROLOGICAL CYCLE AND PRECIPITATION 9

Hydrological cycle, Hydrological budget – Hydro meteorological observation - Precipitation, Types and Forms - Measurement - Processing of precipitation data

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

UNIT III RUNOFF PROCESS 9

Runoff – components of runoff – Factors affecting Runoff - Hydrograph, hydrograph separation, Unit hydrograph, Instantaneous unit hydrograph, Synthetic unit hydrograph, rainfall-runoff models – SCS method – Yield Estimation

UNIT IV GROUNDWATER 9

Origin of groundwater, Rock properties affecting groundwater, Types of aquifer, Darcy's law, coefficient of permeability, groundwater flow rates, permeability formulae, laboratory and field measurement of permeability, Groundwater movement

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 - Ground Water Assessment.

TOTAL: 45 PERIODS

OUTCOMES :

- The students obtain the complete knowledge on hydrologic cycle and hydro meteorological measurements
- The students know the various methods of field measurements and estimation of precipitation, abstraction and runoff process which they apply to carryout the assessment of water balance and runoff potential
- The students apply their knowledge on ground water, 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 (editors), Handbook of applied hydrology, McGraw Hill Book company 1964.
3. Subramanya K., Hydrology,Tata McGraw Hill Co., New Delhi, 1994.
4. Patra.K.C, Hydrology and Water Resources Engineering, Narosa Publications, 2008, Second Edition, New Delhi.
5. Jeya Rami Reddy.P, Hydrology, Laximi Publications, New Delhi, 2004 .

MA7160 STATISTICAL METHODS FOR ENGINEERS L T P C
4 0 0 4

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical methods and apply them to various engineering problems.

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, X^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

OUTCOME:

- It helps the students to have a clear perception of the power of statistical ideas, tools and would be able to demonstrate the applications of statistical techniques to problems drawn from industry, management and other engineering fields.

REFERENCES:

1. Johnson, R. A. and Gupta, C. B., “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, Seventh Edition, 2007.
2. Devore, J.L., “Probability and statistics for Engineering and the Sciences”, Thomson and Duxbury, Singapore, Fifth Edition, 2002.
3. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Asia, Sixth Edition, 2007.
4. Gupta, S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, Eleventh Edition, 2002.

5. Spiegel, M.R. and Stephens, L.J., ”Schaum’s outlines,-Statistics”, Tata McGraw-Hill, Third Edition, 2000.
6. Freund, J.E., “Mathematical Statistics”, Prentice Hall of India, Fifth Edition, 2001.

HW7251 REMOTE SENSING AND GIS FOR WATER RESOURCES

L	T	P	C
3	0	0	3

OBJECTIVE:

- To teach the principles and applications of remote sensing, GPS and GIS in the context of water resources. At the end of the course, the student will appreciate the importance of remote sensing and GIS in solving the spatial problems in water resources.

UNIT I REMOTE SENSING 8

Physics of remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme.

UNIT II DIGITAL IMAGE PROCESSING 8

Satellite Data analysis - Visual interpretation – Digital image processing – Image preprocessing – Image enhancement – Image classification – Data Merging.

UNIT III GEOGRAPHIC INFORMATION SYSTEM 9

Definition – Basic components of GIS – Map projections and co-ordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology – Geodatabase models: hierarchical, network, relational, object oriented models – Integrated GIS database -common sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards.

UNIT IV SPATIAL ANALYSIS 9

Thematic mapping – Measurement in GIS: length, perimeter and areas – Query analysis – Reclassification – Buffering - Neighbourhood functions - Map overlay: vector and raster overlay – Interpolation – Network analysis –Digital elevation modelling. Analytical Hierarchy Process, – Object oriented GIS – AM/FM/GIS – Web Based GIS.

UNIT V WATER RESOURCES APPLICATIONS 11

Spatial data sources – 4M GIS approach water resources system – Thematic maps - Rainfall-runoff modelling – Groundwater modeling – Water quality modeling - Flood inundation mapping and Modelling – Drought monitoring – Cropping pattern change analysis –Performance evaluation of irrigation commands. Site selection for artificial recharge - Reservoir sedimentation.

TOTAL : 45 PERIODS

OUTCOMES:

- Introduce the technology and principles of Satellite Imaging
- Theoretical explanations on Image processing and information extraction from Satellite Data Products
- Functional elucidation of GIS integrating Satellite Data Products into the GIS platform for Decision making
- Potential of remote sensing and GIS is solving problems in water resources through case studies.

REFERENCES:

1. Lillesand, T.M. and Kiefer, R.W., Remote Sensing and Image Interpretation III Edition. John Wiley and Sons, New York. 1993.
2. Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems,.Oxford University Press. New York. 1998.
3. Ian Heywood Sarah, Cornelius and Steve Carver An Introduction to Geographical Information Systems. Pearson Education. New Delhi, 2002.
4. Centre for Water Resources, Change in Cropping Pattern in Drought Prone Chittar Sub-basin, Project Report, Anna University, Chennai, 2002.
5. Centre for Water Resources, Post-Project Evaluation of Irrigation Commands

IM7201 LEGAL ASPECTS OF WATER RESOURCES L T P C
3 0 0 3

OBJECTIVES :

- To learn the basics of water law, in a context of historical development and evolving recognition of issues related to human and ecological needs of water.
- To understand how the policies, laws and judicial approaches tackle the recent water issues.
- To help formulate recommendations/responses that could resolve/avoid disputes.
- To emphasize water as a finite common property resource that must be used in public interest.

UNIT I HISTORICAL BACKGROUND AND CURRENT CHALLENGES 9

Introduction – Policy, Law, Bill, Act, Rules, Notifications – Nature of Rights: Natural Rights – Customary 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 - Challenges in Water Management – Physical and Technical Challenges – Social and Economic Challenges - Role of Law in Water Management – Conceptions of Water: Commodity, Service, Human Right

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 Duties, State List-Entry 17 – 73^{rd} and 74^{th} amendments, Article 262 – Legislative Process: Legislative, Judicial, Executive – Natural Justice – Delegation of Powers - Tribunals – Post-Constitutional Water Laws – National-Level Enactments - The Overview of State Acts with Case Laws: Indian Easements Act – Land-Related Legislation –Tanks – Irrigation Management – Cess – Protection of Water Sources – Groundwater – Drinking and Domestic Water Supply – Industrial Use – Water Pollution – Torts and Crimes

UNIT III WATER GOVERANCE: POLICIES AND LEGAL FRAMEWORKS 9

Water Governance and Water Policy – Legal Framework of Water – Substance of National Water Laws – Other key issues – Changing incentives through Regulation - National Water Policy – National-Level Commissions – Irrigation Management Transfer Policies and Activities – Legal Registration of WUAs – Legal Changes in Water Allocation, – Role of Local Institutions – Community Based Organizations – Water Policy Reforms: India, the Philippines, Bangladesh, and Indonesia

UNIT IV WATER CONFLICTS IN INDIA 9

Water conflicts and Tribunals - Contending Water Uses – Equity, Access and Allocation - Water Quality Conflicts - Sand Mining - Micro-level Conflicts, Dams and Displacement – Privatization – Case Studies

UNIT V 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

TOTAL: 45 PERIODS

OUTCOMES:

- Knowledge in legal perspective of Water Resources Management would be strengthened**.**
- Critical analysis of water conflicts is made possible, which could reveal the gaps that need to be filled up.

REFERENCES:

1. Brewer, J., S. Kolavalli, A. H. Kalru, G. Naik, S, Ramnarayan, K.V. Raju and R. Sakthivadivel, Irrigation Management Transfer In India – Policies and Performance*,* Oxford and IBH Publishing Company, New Delhi,1999.
2. Bruns, Bryan Randolph and Ruth S. Meinzen-Dick. Ed. Negotiating Water Rights*,* Vistaar Publications, New Delhi, 2000.
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*,* Ashgate, England, 2004,
5. Report of the Expert Group, 'Groundwater Management and Ownership'. New Delhi: Government of India, Planning Commission, http: // planningcommission.nic.in / reports / genrep/rep_grndwat.pdf, 2007.
6. Row, Sanjiva Commentaries on The Indian Easements Act, 1882 and Licences, 5th Edition,Delhi Law House, New Delhi, 2006.
7. Singh, Chhatrapati "Water Rights in India," Ed: Chhatrapati Singh. Water Law in India*:* The Indian Law Institute, New Delhi,1992.
8. "Law for Water Management – A Guide to Concepts and Effective Approaches", Ed: Jessica Vapnek, Brace Aylward, Christie Popp and Jamie Bartram, FAO, Rawat Publications, New Delhi, 2011.
9. "Water Conflicts in India – A Million Revolts in the Making" , Ed: K. J. Joy, Biksham Gujja, Subas Paranjape, Vinod Goud, Shruti Vispute, Rourledge, New Delhi, 2008.
10. "The Politics of Water – A Survey", Ed: Kai Wegerich and Jeroen Warner, Taylor and Francis Group, London, 2010.
11. Philippe Cullet, Groundwater Regulation Need for Further Reforms International Environmental Law Research Centre, Geneva, Switzerland, 2010.
12. Heather L. Beach et. al., Transboundary Freshwater Dispute Resolution – Theory, Practice and Annotated References, UN University Press, 2000.

IM7202	PARTICIPATORY FIELD RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To teach interdisciplinary field research skills and enable the students to conduct field research within IWRM outlook.

UNIT I RESEARCH 9

Meaning – Purpose – Types of Research – Stages of Research – How to conduct a Research: Formulation of Problem, Hypothesis- Sampling - Designs - Method - Techniques of Data Collection - Analysis and Reporting - Ethical Responsibilities in Social Research

UNIT II 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.

UNIT III TECHNIQUES IN FIELD RESEARCH 9

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

UNIT IV 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.

UNIT V PARTICIPATORY TOOLS 9

Situation Query Problem and Response (SPQR) – Statistical Analysis- Exercises in the use of concepts and methods – Methodology.

TOTAL : 45 PERIODS

OUTCOMES:

- The students would be put to observe the environment, capture the local knowledge and incorporate it to the main stream research.
- This subject matter could help students to enhance their knowledge both theoretical and practical with a comprehensive outlook for research.

REFERENCES:

1. Anderson L. Borum, F., Kristensen. P.H and Karnoe, P.On the art of doing field studies: An experience based research methodology, Copenhagen Business School Press, Denmark, 1995.
2. Chambers, R., A. Pacey and L. Thrupp. Farmer First: Farmer Innovation and Agricultural Research. Intermediate Technology Publications: London, 1989.
3. Martin Lengwiler, Participatory Approaches in Science and Technology: Historical Origins and Current Practices in Critical Perspective Science Technology Human Values 2008; 33; 186 http://sth.sagepub.com/cgi/content/abstract/33/2/186
4. McAllister, K. and R. Vernooy. Action and Reflection: A Guide for Monitoring and Evaluating Participatory Research. International Development Research Centre, Ottawa, ON, Canada, 1999.
5. Pauline V Young, Scientific Social Surveys and Research Prentice-Hall of India Ltd, New Delhi, 1984.
6. Wilkinson & Bhandarkar, Methodology and Techniques of social Research, 17th edition, Himalaya Publishing House, 2004.

IM7203 **WATER AND ECOSYSTEMS**

L	T	P	C
3	0	0	3

OBJECTIVE:

- To introduce the principles of natural ecosystems, the social dimensions and approaches to water, the benefits to the society and the need for conservation of aquatic ecosystems.

UNIT I ECOLOGICAL PRINCIPLES 8

Levels of organization - Concept of Ecosystems – Ecosystem structure and function – Ecosystem development - Freshwater ecosystems – Agro ecosystems.

UNIT II AQUATIC ECOSYSTEMS 8

Ecosystem processes – Agricultural vs Ecosystem productivities – Riparian processes and interactions – Eco hydrology – Impacts of human intervention – Water-food-ecosystem linkages.

UNIT III ECOSYSTEM SERVICES 9

Water for irrigation – Livelihoods – Industrial / developmental needs – domestic and drinking water sector – Green, Blue and Grey water concepts – Economic instruments – Virtual water and trade.

UNIT IV ACCESS AND EQUITY 10

Water access and equity – Urban-Rural and Gender dimensions - Adjusting to water scarcity – Water allocation principles - Upstream-downstream perspectives – Institutions and democracy – Stakeholder involvement.

UNIT V ECOSYSTEM MANAGEMENT 10

Ecosystem assessments – Environmental flows – Future freshwater challenges - Eco tourism -– Social and political issues of water use - Sustainable Ecosystems - Environmental governance.

TOTAL: 45 PERIODS

OUTCOME:

- Students will understand development pressures on distribution, ecological relations and the emerging social and economical dimensions of water resources today.

REFERENCES:

1. Malin Falkenmark and Johan Rockstrom, Balancing water for Humans and Nature, Earthscan, VA, USA, 2005.
2. Caroline M Figueres, Cecilia Tortajada and Johan Rockstrom (ed), Rethinking Water Management, EarthScan, VA, USA, 2005.
3. Eugene P Odum, Basic Ecology, Holt-Saunders International Edition, Philadelphia, US, 1983.
4. Gooch, G. D., A. Rieu-Clarke and P. Stalnacke (eds), Integrating Water Resources Management: Interdisciplinary methodologies and strategies in Practice, IWA Publishing, London, UK, 2012.
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6. Sithamparanathan, J., Rangasamy, A. and Arunachalam, N., Ecosystem principles and sustainable agriculture, Scitech Publishers, Chennai, 1999.

HW7261 **GIS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

- The hands on experiments in the image processing, GIS platforms and GPS will make the students to appreciate their importance in hydrology and water resource.

LIST OF EXPERIMENTS

- Georeferencing of toposheet and creating vector layers(MapInfo/ArcGIS)
- Creation of attribute tables and layout preparation (MapInfo/ArcGIS)
- Creation of Digital Elevation Model using Vertical Mapper.
- GPS Survey and its data transformation into GIS environment.
- Converting *.tab file to *.shp & vice versa using Universal Translator.
- Transformation of Google files to GIS environment.
- Creation of Vorronoi / Theissan diagram for points using MapInfo/ArcGIS.
- Use of D8 pointer algorithm for deriving flow direction, flow accumulation and watershed delineation.
- Interpolation of point data to create Spatial Maps.
- Overlay Analysis using ArcGIS.

TOTAL: 60 PERIODS

OUTCOMES:

- Expertise in digital image processing
- Good exposure to the Global positioning system in real time data processing
- Potential of Geographical Information System
- Data integration between Satellite data, GPS and GIS in Decision Making

IM7211 **FIELD PRACTICE ON PRA TOOLS** **L T P C**
0 0 2 1

OBJECTIVE:

- To enable students understand and test the tools with exercises at the ground level and field practices.

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

TOTAL: 30 PERIODS

OUTCOMES:

- The students acquire knowledge as how to apply the tools in their research to assume at socio - technical results.
- The students can have a complete understanding of the application of mappings and correlate it them with other similar tools such as GIS etc.

REFERENCES:

1. Robert Chambers, ,Whose Reality Counts, Putting the First Last, Oxford Publications,1997
2. Neela Mukerjee, Participatory Rural Appraisal Methodology and Applications, Concept Publishing Company, 2003
3. Henman V and Chambers R, Participatory Rural Appraisal in the book Planning Agricultural Research a source book, 2001
4. http://www: Cabi.org/Cabebooks/ebook.

IM7301 WATER, SANITATION AND HEALTH L T P C
3 0 0 3

OBJECTIVES:

- Students will be able to indicate and relate the factors influencing water supply, sanitation and health.
- Explain water related diseases and show their relationships with water resources management.
- Suggest integrated water management initiatives that could be implemented to achieve better sanitation and health in a region.

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene - Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH - Third World Scenario - Poor and Multidimensional Deprivation.

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Health Burden in Developing Scenario -Factors Affecting Sanitation and Health-Infectious Diseases-Social: Social Stratification and Literacy Demography: Population and Migration- 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- Food Production.

UNIT III MANAGEMENT AND DEVELOPMENT 9

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

UNIT IV GOVERNANCE AND PARTICIPATORY IDEOLOGY 9

National Economy and Production - Investments on Water, (WASH) - Cost Benefit Analysis - Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance

UNIT V 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

OUTCOMES:

- This course would offer a better understanding of the perspectives; people and governance to upscale the downtrodden and to mainstream the unprivileged.
- With the knowledge of WASH, students can acquire knowledge of both national and international scenarios and explore avenues to streamline the equitable axis ownership of natural resource.

REFERENCES:

1. Bonitha R., Beaglehole R.,Kjellstorm, "Basic Epidemiology", 2nd Edition, World Health Organization, 2006
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. Global Issues in Water, Sanitation, and Health: Workshop Summary**.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

IM7311 PRACTICAL TRAINING **L T P C**
0 0 0 1

OBJECTIVES:

- To train the students in field work so as to have an understanding about the issues and problems prevailing in the field related to integrated water resources management.
- To develop skills in data handling and solving the field problems.

SYLLABUS

The students individually undertake training in reputed institutions or take up any case study during the summer vacation for a specified period of four weeks. At the end of the training, a detailed report on the work done should be submitted within ten days from the commencement of the third semester. The students will be evaluated through a viva-voce examination by a team of internal Faculty.

OUTCOME

- Students are trained in tackling a practical field orientated problems related to integrated water resources management.

IM7312 **PROJECT WORK (PHASE I)** **L T P C**
0 0 12 6

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS

The student individually works on a specific topic approved by Faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. 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

OUTCOME:

- At the end of the course the student will have a clear idea of his/her area of work and he/she is in a position to carry out the remaining Phase II work in a systematic way.

IM7411 **PROJECT WORK (PHASE II)** **L T P C**
0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS

The student should continue the Phase I work 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 the internal review committee, a detailed project report should be prepared and submitted to the Head of the department. The students will be evaluated by a panel of examiners including one external examiner based on the report and the viva-voce examination.

TOTAL: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

HW7071 URBAN WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concepts of urbanization and its impact on the natural water cycle
- The student is exposed to the use the urban storm water models for better storm water management.
- Students also exposed for the preparation of urban storm water master plan and different types of operation and maintenance.

UNIT I URBAN HYDROLOGIC CYCLE 9

Water in the urban eco-system – Urban Water Resources – Major problems – Urban hydrological cycle – Storm water management objectives and limitations – Storm water policies – Feasibility consideration.

UNIT II URBAN WATER RESOURCES MANAGEMENT MODELS 9

Types of models – Physically based – conceptual or unit hydrograph based – Urban surface runoff models – Management models for flow rate and volume control rate – Quality models.

UNIT III URBAN STORM WATER MANAGEMENT 9

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

UNIT IV MASTER PLANS 9

Planning and organizational aspects – Inter dependency of planning and implementation of goals and measures – Socio – economics financial aspects – Potential costs and benefit measures – Measures of urban drainage and flood control benefits – Effective urban water user organizations.

UNIT V OPERATION AND MAINTENANCE 9

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

TOTAL: 45 PERIODS

OUTCOME:

- At the completion of the course the student should be able to apply appropriate management techniques for planning, operating and maintaining the different components of urban and drainage system

REFERENCES:

1. Geiger, W.F., Marsalek, F., and Zuidena, F.C., (Ed), manual ondrainage in urbanized areas – Vol.1 and Vol.II, UNESCO, 1987.
2. Hengeveld, H. and C. De Voch.t (Ed)., Role of Water in Urban Ecology, 1982.
3. Martin, P. Wanelista and Yousef, A. Yousef., Storm Water Management, John Wiley and sons, 1993.
4. Neil S. Grigg., Urban Water Infrastructure Planning, Management and Operations, John Wiley and Sons, 1986.
5. Overtens D.E. and Meadows M.E., Storm Water Modelling, Academic Press, New York, 1976.

IM7001 CLIMATE CHANGE AND WATER RESOURCES L T P C
3 0 0 3

OBJECTIVES:

- Understanding the climate system, being aware of the impact of climate change on society, Understanding of adaptation in relation to water and climate change.
- At the end of the course, students must be in a position to describe the possible impacts, adaptations and remedies in relation to water resources and climate change.

UNIT I THE CLIMATE SYSTEM 9

Definitions- Climate, Climate system, climate change – Drivers of Climate change – Characteristics of climate system components - Green house effect – Carbon cycle – Wind systems - Trade Winds and the Hadley Cell – Ozone hole in the stratosphere - El Nino, La Nina – ENSO, Teleconnections

UNIT II IMPACTS OF CLIMATE CHANGE – OBSERVED AND PROJECTED 9

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

UNIT III TOOLS FOR VULNERABILITY ASSESSMENT 9

Need for vulnerability assessment – Steps for assessment –Approaches for assessment – Models – Quantitative models, Economic model, Impact matrix approach - Box models - Zero-dimensional models - Radioactive-convective models - Higher-dimension models - EMICs (Earth-system models of intermediate complexity) - GCMs (global climate models or general circulation models) – Regional Models - Sectoral models

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 - Potential water resource conflicts between adaptation and mitigation - Implications for policy and sustainable development.

UNIT V CASE STUDIES 9

Water resources assessment case studies – Ganga Damodar Project , Himalayan glacier studies, Ganga valley project - Adaptation strategies in Assessment of water resources- Hydrological design practices and dam safety- Operation policies for water resources projects - Flood management strategies - Drought management strategies - Temporal & spatial assessment of water for Irrigation - Land use & cropping pattern - Coastal zone management strategies.

TOTAL: 45 PERIODS

OUTCOMES:

- To orient towards the global climate change and its impact on water resources.
- To understand the climate change phenomenon and its related issues on water, irrigation and its social implications.

REFERENCES:

1. IPCC Report Technical Paper IV – Climate change and water , 2008.
2. UNFCC Technologies for Adaptation to climate change, 2006.
3. Shukla P R , Subobh K Sarma, NH Ravindranath, Amit Garg and Sumana Bhattacharya, Climate Change and India: Vulnerability assessment and adaptation, University Press (India) Pvt Ltd, Hyderabad.
4. Preliminary consolidated Report on Effect of climate change on Water Resources, GOI, CWC, MOWR, 2008.

IM7002	ENVIRONMENTAL IMPACT ASSESSMENT FOR WATER RESOURCES	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment in water resources development.

UNIT I ENVIRONMENTAL ISSUES 7

Water resources development and environmental issues – Environment in water resources project planning – Environmental regulations and requirements – The EIA (Environmental Impact Assessment) notification.

UNIT II EIA FUNDAMENTALS 8

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 –Participation of Public and Non-Governmental Organizations in environmental decision making

UNIT III ENVIRONMENTAL IMPACTS 10

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.

UNIT IV METHODS OF EIA 10

EIA team formation – Development of scope, mandate and study design – Base line survey – Check lists – Ad hoc procedures – Network and matrix methods – Semi-quantitative methods – Economic approaches – Environmental Impact Statement (EIS) preparation.

UNIT V EIA CASE STUDIES 10

Environmental issues of Irrigation systems – EIA of irrigation projects – Case studies – Hydropower projects – Command area problems - ICID checklist for water resources projects - Environmental monitoring programs.

TOTAL: 45 PERIODS

OUTCOMES:

- The student will appreciate the importance of environment in water resources development and understand current methods of environmental assessment.
- Students will become aware of future challenges facing water resources management.

REFERENCES:

1. Canter, L.W., Environmental Impact Assessment. McGraw Hill International Edition, New York. 1995.
2. Barathwal, R.R., Environmental Impact Assessment. New Age International Publishers, New Delhi. 2002.
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London. 1999.
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Inter Science, New Jersey. 2003.
5. Arnel, N., Hydrology and global environmental change. Prentice Hall, Harlow. 2002.

6. Chari. B., 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.
7. UNEP's Environmental Impact Assessment Training Resource Manual -Second Edition, 2002.

IM7003 INTEGRATED FLOOD RISK ASSESSMENT AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- This subject aims at making the students to understand the hydrologic event of flood estimation and risk assessment.
- Students gain knowledge in the extent of damages caused and the mitigation measures used to combat them by an integrated approach.

UNIT I INTRODUCTION TO INTEGRATED FLOOD RISK MANAGEMENT 8

Basic concepts and terminologies in disaster management – Hydro-meteorological hazards, their formation and predictability – Flood disaster situation in Asia and natural catastrophes occurrence in Asia and the globe Nature and causes of floods and secondary hazards – Concept of climate change and global warming – Adaptation to climate change – Climate change and flood vulnerability.

UNIT II FLOOD MODELLING AND RISK ASSESSMENT 12

Basic principles and aspects of flood assessment – Flood Hazard Modelling – Flood Plain mapping – Process of flood vulnerability and capacities assessment – Process of flood risk assessment – Community-based flood risk assessment.

UNIT III FLOOD RISK MITIGATION 9

Concept and importance of flood plain management – Tools for flood plain management – Structural interventions and its importance on flood risk mitigation – Flood-proofing in the Multi-hazard Environment – Integrated watershed management: a non-structural intervention for flood risk mitigation, Urban and Rural development planning – Public awareness and capacity building.

UNIT IV FLOOD DISASTER PREPAREDNESS & RESPONSE PLANNING 8

Flood disaster preparedness framework – Flood forecasting and early warning systems – Emergency response planning and management – Evacuation process, Search and rescue – Environmental health Concepts of recovery and rehabilitation – Flood damage assessment – Management of sustainable recovery and rehabilitation activities.

UNIT V CROSS-CUTTING ISSUES 9

Flood Insurance – Legal and Economics issues of flood risk management – Financial system and funding for flood risk reduction programs – Relevant issues on trans-boundary, governance and gender.

TOTAL: 45 PERIODS

OUTCOMES:

- Students know the different methods of design flood estimation and perform channel reservoir routing. They carryout flood inundation modeling and suggest suitable flood control measures.
- Student acquires the knowledge about different types of drought and their impacts. They asses the severity, duration and frequency of drought using drought using drought indices.
- Students exposed to various approaches, measures and case studies of drought indices.

REFERENCES:

1. Chow V.T., Maidment D.R., Mays L.W., "Applied Hydrology", McGraw Hill Publications, New York, 1995.
2. Andreas H. Schumann., “Flood Risk Assessment and Management”, Springer Science+Business Media B.V.2011.
3. Vijay P.Singh., "Elementary Hydrology", Prentice Hall of India, New Delhi, 1994.
4. Rangapathy V., Karmegam M., and Sakthivadivel R., Monograph in Flood Routing Methods as Applied to Indian Rivers, Anna University Publications

IM7004 INTEGRATED RIVER BASIN MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To get a holistic understanding about river basin management.
- To get an expose to the tools and methods available for handling data and its analysis.

UNIT I INTRODUCTION 9

Definition of Terminologies and Basic Concepts – Theories and Principles of IRBM - Processes/Phases in Integrated River Basin Management

UNIT II RIVER SYSTEMS AND HUMAN INTERFERENCES 9

River Basins - River Functions – Human Interventions and Impacts - Mekhong Basin – river Basins in India – River Basins of Tamil Nadu – Related Case Studies

UNIT III RIVER BASIN PLANNING AND MANAGEMENT 9

Water Resources Planning in River Basins, Operational Management, Economics and Finance – Case Studies

UNIT IV ANALYTICAL SUPPORT FOR IRBM 9

Tools and Methods: Monitoring, Acquisition and Processing of Water Resource Data, Statistical Methods, Decision Support Systems

UNIT V ORGANIZATIONAL AND INSTITUTIONAL FRAMEWORK 9

Institutions - RBOs - Challenges for RBOs - Establishing effective RBOs - Challenges for RBOs - Key Reforms – Process of reform – Organizational analysis and stakeholder Assessment – Local Water Management Organizations - Case Studies

TOTAL 45 PERIODS

OUTCOME:

- Students will understand the need and way of sustaining the river basins.

REFERENCES:

1. http://www.universitywatersectorpartnership.org/curriculum-development/01-irbm-and sustainable-watershed-management/1-1-definition-of-terminologies-and-basic-conceptsIntegrated River Basin Management
2. Biswas A., Cecilia Tortajada / Publisher: OUP India / 2013, pp: 19:24
3. Tackling poverty and promoting sustainable development: Key lessons for integrated river basin management, A WWF DISCUSSION PAPER, Richard McNally and Sylvia Tognetti, July 2002.
4. Danube River Basin Analysis 2013, http://www.icpdr.org/main/dba-2013.

5. Integrated basin management for the Ganges: challenges and opportunities, Mosharefa Shahjahan, Nick Harvey, Journal: International Journal of River Basin Management, vol. ahead-of-p, no. ahead-of-p, pp. 1-16, 2012.
6. A. Mohanakrishnan, Water Resources Development and Management, (Pub. No. 43), IMTI., 2004
7. A. Mohanakrishnan, History of the Sathanur Reservoir Project in the Penniyaru River Basin, 2012

IM7005 WATERSHED CONSERVATION AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES :

- To provide the technical, economical and sociological understanding of a watershed.
- To provide a comprehensive discourse on the engineering practices of watershed management for realizing the higher benefits of watershed management.

UNIT I WATERSHED CONCEPTS 9

Watershed - Need for an Integrated Approach - Influencing Factors: Geology – Soil – Morphological Characteristics - Toposheet - Delineation – Codification – Prioritization of Watershed – Indian Scenario

UNIT II SOIL CONSERVATION MEASURES 9

Types of Erosion – Water and Wind Erosion: Causes, Factors, Effects and Control – Soil Conservation Measures: Agronomical and Mechanical - Estimation of Soil Loss - Sedimentation

UNIT III WATER HARVESTING AND CONSERVATION 9

Water Harvesting Techniques – Micro-Catchments - Design of Small Water Harvesting Structures – Farm Ponds – Percolation Tanks – Yield from a Catchment

UNIT IV WATERSHED MANAGEMENT 9

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

UNIT V GIS FOR WATERSHED MANAGEMENT 9

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

TOTAL: 45 PERIODS

OUTCOME :

- The students will able to apply the knowledge of overall concepts of watershed which would help to comprehend and analyze for better management.

REFERENCES:

1. Ghanashyam Das, Hydrology and Soil Conservation engineering, Prentice Hall of India Private Limited, New Delhi, 2000.
2. Glenn O. Schwab, Soil and Water Conservation Engineering, John Wiley and Sons, 1981.
3. Gurmail Singh, A Manual on Soil and Water Conservation, ICAR Publication, New Delhi, 1982.
4. Suresh, R. Soil and Water Conservation Engineering, Standard Publication, New Delhi, 1982.
5. Vir Singh, Raj, Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

6. Brooks, K. N., P. F. Ffolliott, H. M. Gregersen and L. F. DeBano. 1997. Hydrology and the Management of Watersheds. Second Edition. Iowa State University Press. Ames, Iowa. 502 pp. Heathcote, I. W. Integrated Watershed Management: Principles and Practice. 1988. John Wiley and Sons, Inc., New York.
7. Lal, Ruttan. 2000. Integrated Watershed Management in the Global Ecosystem. CRC Press, New York.
8. Heathcote, I. W. Integrated Watershed Management: Principles and Practice. John Wiley and Sons, Inc., New York, 1988.
9. Dhruva Narayana, G. Sastry, V. S. Patnaik, "Watershed Management", CSWCTRI, Dehradun, ICAR Publications, 1997

HW7003 ENVIRONMENTAL HYDRAULICS L T P C
3 0 0 3

OBJECTIVES:

- To apply the knowledge of fluid mechanics to analyze and predict mixing in natural bodies of water.
- To study the hydrodynamic aspects of water quality management in natural bodies of water.

UNIT I INTRODUCTION TO ENVIRONMENTAL TRANSPORT PROCESSES 9

Concentration and units of measure – Conservation laws – Systems and Control Volume approach – Differential element approach – Sources, Sinks and box-models – Mixing. Advection-Diffusion equation. Analytical and numerical solution to Advection-Diffusion equation.

UNIT II GROUNDWATER FLOW AND QUALITY MODELING 9

Dupuit's approximation – Basic contaminant transport equation – Application of boundary layer approximations – Saltwater intrusion into aquifers – Non-aqueous phase liquid (NAPL) in groundwater – numerical modeling.

UNIT III TRANSPORT PROCESSES IN RIVERS 9

Mixing in Rivers – Continuous point discharges – Two rivers mixing – Dispersion in rivers.

UNIT IV TRANSPORT PROCESSES IN LAKES AND RESERVOIRS 9

Reservoir classification – External energy sources – Surface layer – mixing in the hypolimnion – inflows and outflows.

UNIT V TRANSPORT PROCESSES IN THE ESTUARIES 9

Classification – Forces – wind, tides, rivers – Trapping and pumping – Estuarine Circulation.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to gain a basic knowledge advection-dispersion processes in the environment.
- They will gain the skills to take up research activities solving environmental problems involving fluid motions.

REFERENCES:

1. Fischer, H.B., List, E.G., Koh, R.C.Y., Imberger, J and Brooks, N.H. Mixing in Inland and Coastal Waters Academic Press, New York, 1979.
2. Clark, M.M., Transport Modeling for Environmental Engineers and Scientists John Wiley and Sons, New York. 1996.

3. Martin J.L. and McCutcheon S.C. Hydrodynamics and Transport for Water Quality Modeling CRC Press, Inc. ISBN:0-87371-612-4, 1999.
4. Chapra, S.C. Surface Water Quality Modeling McGraw Hill Book Co. Singapore, 1997.
5. Thomann M., R.V. and Mueller, J.A. Principles of Surface Water Quality Modeling and Control Harper and Row, New York, 1987.
6. Csanady, G.T., Turbulent Diffusion in the Environment D.Reidel Publishing Co. Holland, 1973.
7. Rubin H. and Atkinson J. Environmental Fluid Mechanics Marcel Dekker, Inc. New York. 2001

HW7004 FLOOD MODELLING AND DROUGHT ASSESSMENT L T P C
3 0 0 3

OBJECTIVE:

- This subject aims at making the students to understand the hydrologic extremes of floods and droughts, estimation of severity and extent of damages and the mitigation measures to combat them.

UNIT I FLOOD ESTMATION 9

Hydrologic extremes – Flood – Types of Flood – Effects of Flood – Design Flood - SPF/MPF - Estimation of design flood – Physical Indicators - Envelope curves - Empirical methods – Rational method - Statistical methods – Frequency analysis – Unit hydrograph method.

UNIT II FLOOD MODELLING AND MANAGEMENT 9

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

UNIT III DROUGHT AND IMPACTS 9

Definition – Definitions based on rainfall, stream flow, vegetation and comprehensive aspects - Characterisation of Drought/water shortage/aridity/desertification - Types of Drought – NCA classification – Impacts of Drought – Environmental, Social and Economical aspects

UNIT IV DROUGHT ASSESSMENT 9

Drought Severity Assessment – Meteorological Hydrological and Agricultural methods – Drought Indices – GIS based Drought Information system – Drought Vulnerability Assessment and Mapping Using GIS.

UNIT V DROUGHT MONITORING AND MANAGEMENT 9

DPAP Programme - Drought Monitoring – Application of Remote sensing – Drought Mitigation – Proactive and Reactive Approach – Supply and Demand Oriented Measures – Long term and Short term Measures – Water Scarcity Management in Urban, Industrial and Agricultural sectors

TOTAL: 45 PERIODS

OUTCOMES:

- Students know the different methods of design flood estimation and perform channel reservoir routing. They carryout flood inundation modeling and suggest suitable flood control measures.
- Student acquires the knowledge about different types of drought and their impacts. They asses the severity, duration and frequency of drought using drought using drought indices.
- Students exposed to various approaches, measures and case studies of drought indices.

REFERENCES:

1. Chow V.T., Maidment D.R., Mays L.W., Applied Hydrology, McGraw Hill Publications, New York, 1995.
2. Vijay P.Singh., Elementary Hydrology, Prentice Hall of India, New Delhi, 1994.
3. Yevjevich V., Drought Research Needs, Water Resources Publications, Colorado State University, USA, 1977.
4. Rangapathy V., Karmegam M., and Sakthivadivel R., Monograph in Flood Routing Methods as Applied to Indian Rivers, Anna University Publications

HW7007 RIVER ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand theoretical concepts of water and sediment movements in rivers
- To inculcate the benefits of fluvial system to the society

UNIT I RIVER FUNCTIONS 8

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

UNIT II RIVER HYDRAULICS 10

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

UNIT III RIVER MECHANICS 9

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

UNIT IV RIVER SURVEYS AND MODEL 9

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

UNIT V RIVER MANAGEMENT 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to appreciate the complex behavior of rivers.
- They will gain the skills to take up research activities in river engineering.

REFERENCES:

1 Janson PL.Ph., Lvan BendegamJvanden Berg, Mdevries A. Zanen (Editors), Principles of River Engineering – The non tidal alluvial rivers – Pitman, 1979.
2. Pierre Y. Julien ., River Mechanics ,Cambridge University Press, 2002.
3. Rao K.L , INDIA's WATER WEALTH – Orient Longman Ltd., 1979.

HW7009 **WATER AND ENVIRONMENT** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the role of environment in conditioning water resources and study methods to assess them
- To expose basic management tools available to manage the quality of water

UNIT I ECOLOGICAL PRINCIPLES 7

Water as living medium – Aquatic ecosystems - Population and Communities – Nutrient Cycle – Energy flow – Water and Environment Interactions.

UNIT II WATER QUALITY 9

Chemical composition of water - Hydrological processes and water quality – Suspended and dissolved loads - Sediments and their composition – Eutrophication and its impacts - – Water quality standards.

UNIT III WATER POLLUTION 10

Sources and Types of water pollution – Organic and inorganic pollutants -- BOD – DO relationships – – NPS pollution – Waste water treatment - TMDL Concepts – Water quality models.

UNIT IV ENVIRONMENTAL ASSESSMENT 10

Environmental regulations and requirements – Types and role of EIA – Environment in water resources project planning – Methods of EIA – Hydrological and water quality impacts – Ecological and Biological assessments – ICID check list – EIS statement.

UNIT V ECOLOGICAL MANAGEMENT 9

In stream ecological water needs – Eco restoration strategies – Ecosystem services – Environmental monitoring programs - Public awareness and participation in decision making – Sustainable water resources management – Environmental Governance.

TOTAL: 45 PERIODS

OUTCOME:

- Students will understand the intricate relationship of water resources with the environmental interactions and appreciate the need to manage water quality.

REFERENCES:

1 Odum, E. P. and G. W. Barrett, Fundamentals of Ecology, India Edition, Thomson Brooks/cole, India, 2005
2 Canter L. W., Environmental impact assessment, 2 nd edition, Mc Graw Hill & Co., NY, USA, 1996
3 Vladimir Novonty, Water Quality: Diffuse pollution and watershed Management, 2 nd edition, John Wiley & Sons, , 2003
4 Jorgensen, S., J. G. Tundisi, J. M. Tundisi, Handbook of inland aquatic ecosystem management, CRC Prerss, FL, USA, 2013.
5 Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, McGraw-Hill 2006.

HW7010 WATER POWER AND DAM ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- The student is exposed to the design aspects of hydro-power plants, various components of hydropower plants and their layout.
- Different types of dams design taking into account the suitability of the site and the different type loads that are likely to be encountered.

UNIT I HYDROELECTRIC POWER DEVELOPMENT 9

Introduction – Types of power development – Classification. Planning – Environmental Considerations - Data requirement for assessment of hydropower. Components of hydropower.

UNIT II DESIGN OF HYDROPOWER INSTALLATION 9

Components – Intake structure – water conductor systems – tunnels – surge tanks – penstocks – valves – anchor blocks.

UNIT III TYPES OF POWER HOUSE 8

Underground – semi-underground. Turbines and their foundations – structural and geotechnical aspects of power house design.

UNIT IV EMBANKMENT DAM ENGINEERING 9

Introduction. Nature and classification of engineering soils. Principles of design. Materials and construction. Internal seepage. Stability and stress. Settlement and deformation. Rock fill and rock fill embankments.

UNIT V CONCRETE DAM ENGINEERING 10

Loading: Concepts and criteria. Gravity dam analysis. Buttress dam analysis. Arch dam analysis. Design features and construction. Concrete for dams. Roller Compacted Concrete (RCC) Dams. Dam safety and instrumentation. Foundation measurements. Analysis of strain data.

TOTAL: 45 PERIODS

OUTCOME:

- The students will be able to get a basic knowledge of planning and designing hydropower plants.

REFERENCES:

1. Novak, P., Moffat, A.I.B., Nalluri, C. and Narayanan, R. Hydraulic Structures Unwin Hyman Ltd., London 1989.
2. Dandekar, M.M. and Sharma, K.N. Water Power Engineering Vikas Publishing House, New Delhi 1994.
3. USBR Design of Small Dams Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1974.
4. Sharma, H.D. Concrete Dams Metropolitan New Delhi 1981
5. Varshney, R.S. Concrete Dams Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1982.
6. Varshney, R.S. Hydro Power Structures – Nem Chand Bros. Roorkee 1973 Guthrie, Brown J. (ed) Hydro Electric Engineering Practice Blackie and Son, Glasgow 1970.

HW7203 SYSTEMS ANALYSIS IN WATER RESOURCES L T P C
3 0 0 3

OBJECTIVE:

- Students will be introduced to application of systems concept to water resources planning and management. Optimization technique for modeling water resources systems and advanced optimization techniques to cover the socio-technical aspects will be taught.

UNIT I SYSTEM CONCEPTS 7

Definition, classification, and characteristics of systems - Scope and steps in systems engineering - Need for systems approach to water resources and irrigation.

UNIT II LINEAR PROGRAMMING 9

Introduction to operations research - Linear programming, problem formulation, graphical solution, solution by simplex method - Sensitivity analysis, application to design and operation of reservoir, single and multipurpose development plans - Case studies.

UNIT III DYNAMIC PROGRAMMING 9

Bellman's optimality criteria, problem formulation and solutions - Application to design and operation of reservoirs, Single and multipurpose reservoir development plans - Case studies.

UNIT IV SIMULATION 9

Basic principles and concepts - Random variant and random process - Monte Carlo techniques - Model development - Inputs and outputs - Single and multipurpose reservoir simulation models - Case studies.

UNIT V ADVANCED OPTIMIZATION TECHNIQUES 11

Integer and parametric linear programming - Goal programming models with applications Discrete differential dynamic programming and incremental dynamic programming - Linear decision rule models with application - Stochastic dynamic programming models.

TOTAL: 45 PERIODS

OUTCOME:

- At the completion of the course the students will be able to understand the system behaviors and know how to apply the various simulation and optimization techniques to resolves the various socio-technical aspects of water resources systems.

REFERENCES:

1. Gupta P.K and Man Mohan, Problems in Operations Research (Methods and solutions). Sultan Chand and sons, New Delhi, 1995
2. Hiller F.S and Liebermann G.J., Operations Research CBS Publications and distributions. New Delhi, 1992.
3. Chaturvedi. M.C., Water Resources Systems Planning and Management. Tata McGraw Hill, New Delhi, 1997.
4. Mays L.W., and Tung YK, Hydro systems Engineering and Management. McGraw Hill Inc., New York, 1992.
5. Goodman Alvin S., Principles of Water Resources Planning, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1995.
6. Course material, Micro Computer Application to Systems Analysis in Irrigation Water Management, CWR, Anna University, 1992.
7. Wagner H.M., Principles of Operations Research with Application to Management Decisions, Prentice Hall, India, New Delhi, 1993.

HW7101 ADVANCED FLUID MECHANICS L T P C
3 0 0 3

OBJECTIVES:

- To introduce students to concepts of fluid mechanics from both theoretical and applications perspective.
- Outcomes: The students will have sufficient mathematical and physical background to formulate real life problems in fluid mechanics.

UNIT I INTRODUCTION & BACKGROUND 9

Continuum hypothesis, fluid properties, basic thermodynamic relations, perfect gas, scalars and vectors, cartesian tensors, Gauss' theorem, Stokes theorem. Lagrangian and Eulerian description, material derivative and stream function.

UNIT II CONSERVATION LAWS AND DIMENSIONAL ANALYSIS 9

Control volume concepts, Reynolds transport theorem, conservation of mass, momentum and energy, Navier-Stokes equation, non-dimensional parameters determined from differential equations, Buckingham's Pi theorem, similitude and model testing.

UNIT III IDEAL FLUID FLOW 9

Stream function and velocity potential, laplace equation, application of complex variables, flow at a wall angle, source, sinke, doublet, flow past Rankine half-body, flow past a circular cylinder with circulation, source near a wall, method of images, conformal mapping and applications.

UNIT IV REAL FLUID FLOW 9

Laminar flow, analogy between heat and vorticity diffusion, steady flow between parallel plates, steady flow between concentric cylinders, impulsively started plate, high and low Reynold's number flows, creeping flow around a sphere, Hele-Shaw flow. Boundary layers, Blasius solution, von-Karman momentum integral equation, boundary layer seperation and control.

UNIT V INSTABILITY AND TURBULENCE 9

Method of normal modes, thermal instability, Kelvin-Helmholtz instability, Orr-Sommerfeld equation, inviscid instability of parallel flows, turbulence, averages, correlations and spectra, averaged equation of motion, kinetic energy budget of mean flow, kinetic energy budget of turbulent flow, turbulence production and cascade, wall shear flows, eddy viscosity and mixing length hypothesis, turbulence closure.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to get a basic knowledge of the applicability of physical laws is addressing problems in hydraulics and hydrology.
- They will gain the skills to take up research activities involving fluid motions.

REFERENCES:

1. Kundu P.K. and Cohen I.M. Fluid Mechanics 2/e Academic Press, Elsevier Science India 2002.
2. Schlichting H. and Gersten K. Boundary Layer Theory, 8th ed. Springer-Verlag 2004, ISBN 81-8128-121-7
3. Yuan S.W. Foundations of Fluid Mechanics (SI unit edition) Prentice Hall of India 1970
4. Vallentine H.R. Applied Hydrodynamics Butterworths London 1959
5. White F.M. Viscous Fluid Flow, 3rd edition McGraw Hill, New York, ISBN:007124493X
6. Tennekes H. and Lumley J.L. A First Course in Turbulence MIT Press 1972 ISBN 0 262 20019 8

HW7202 **OPEN CHANNEL HYDRAULICS** **L T P C**
3 0 0 3

OBJECTIVES:

- Application of principles of fluid mechanics to the solution of problems encountered in both natural and constructed water systems.
- Use of model studies and computers in solving a host of problems in hydraulic engineering.

UNIT I BASIC PRINCIPLES 9

Basic concepts of uniform flow - computations. Specific energy and specific force concepts – applications.

UNIT II STEADY VARIED FLOWS IN OPEN CHANNELS 9

Dynamic equation for spatially varied flows. Flow profile computations. Introduction to HEC-RAS. Spatially varied flows and rapidly varied flows – applications.

UNIT III UNSTEADY FLOWS IN OPEN CHANNELS 9

Equations of motion. Uniformly progressive wave. Rapidly varied unsteady flow – positive and negative surges. Dam break problem.

UNIT IV SEDIMENT TRANSPORT 9

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

UNIT V FLOW MEASUREMENTS AND HYDRAULIC MODELING 9

Sharp-Crested weirs, broad-crested weirs, critical depth flumes. Recent advancement in open channel flow measurements. Physical modeling in hydraulics. Dimensional analysis. Modeling closed flows and free surface flows. Distorted models. Design of physical models.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be apply their knowledge about fluid mechanics in addressing problems in open channels.
- They will develop skills to solve problems using HEC-RAS software.
- They will be able to make flow measurements in fields.

REFERENCES:

1. Sturm T.W., Open Channel Hydraulics – Tata-McGraw Hill 2nd edition, New Delhi 2011. ISBN:978-1-25-900225-0
2. Wurbs R.A., and James W.P. Water Resources Engineering. Prentice Hall of India, Eastern Economic Edition. ISBN: 81-203-2151-0, New Delhi, 2007.
3. Subramanya K., Flow in Open Channels (2nd ed.) Tata McGraw Hill, ISBN 00-746-2446-6, New Delhi 2003.
4. Chaudhry M. H., Open Channel Flow. Prentice Hall of India, Eastern Economic Edition, ISBN: 81-203-0863-8, New Delhi. 1994.
5. Chow Ven-te Open Channel Hydraulics McGraw Hill, New York NY 1959.
6. French, R. H., Open Channel Hydraulics McGraw Hill, New York NY 1985.
7. Srivastava R. Flow through Open Channels Oxford University Press New Delhi, 2008.

IW7201 GROUNDWATER AND DRAINAGE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- Students will be exposed to ground water, hydraulics of ground water related to drainage, drainage concepts, planning, design and management of drainage related work.
- They will learn about the latest developments in ground water applications to drainage on the basis of a clear understanding of the principles of drainage engineering.

UNIT I GROUND WATER COMPONENT AND MOVEMENT 8

Occurrence of Ground water – Utilization – Ground water component in hydrologic cycle – Geological formations – Types of aquifers and their characteristics – Ground water movement – Darcy's Law – Flow through layered soils – Stream Lines and Equipotential Lines – Boundary Conditions.

UNIT II GROUND WATER HYDRAULICS 10

Steady and unsteady flow of ground water– Ground water recharge – Dupuit-Forchheimer assumptions - Subsurface flow into drains – Steady and unsteady state drainage equations – Seepage from river into aquifers – Seepage from open channels.

UNIT III DRAINAGE PRINCIPLES AND CRITERIA 9

Factors to be considered in land drainage – Combined irrigation and drainage systems - Water balance – Equations for water balance – Drainage surveys – Agricultural drainage criteria – Effect of field drainage systems on agriculture.

UNIT IV SALINITY CONTROL 9

Salinity in relation to irrigation and drainage – Soil Salinity and Sodicity- Salt balance of the root zone – Salinisation due to capillary rise - Leaching process – Long term salinity level – Sodium Hazard of Irrigation Water – Reclamation of salt affected soils – Bio drainage – Environmental aspects of drainage.

UNIT V DESIGN AND MANAGEMENT OF DRAINAGE SYSTEMS 9

Drainage materials – Surface drainage systems, their components and applications in sloping areas – Subsurface drainage systems – Mole drainage - Tube well irrigation - Drainage application and design – Management and maintenance of drainage systems.

TOTAL : 45 PERIODS

OUTCOMES:

- This course impacts knowledge about the need for irrigation drainage system and its design.
- In addition it enabled to manage the salinity problems and leaching process.

REFERENCES:

1. Todd D.K. Ground Water Hydrology, John Wiley and sons, Inc, New York, 1976.
2. Raghunath, H.M., Ground Water, 2nd edition, Wiley Eastern Ltd., New Delhi, 1987.
3. Kessler J., Drainage Principles and Applications Vol. II and IV, International Institute of Land Reclamation and Improvement, Netherlands. 1979.
4. Ritzema H.P., Drainage Principles and Applications, Publication No. 16, International Institute of Land Reclamation and Improvement, Netherlands. 1994.

HW7072 WATER SUPPLY AND BURIED PIPELINES

L	T	P	C
3	0	0	3

OBJECTIVE:

- To educate the students in detailed design concepts related to water transmission mains, water distribution system and buried pipes with emphasis on computer application

UNIT I WATER SUPPLY SYSTEMS 9

Water requirement – sources of water – water demand – reservoir storage – nodal hydraulic gradient level values - water supply consideration, Types of water supply systems- piping system- distribution network- labeling- network components – Network models – design – optimization in practice

UNIT II HYDRAULIC PRINCIPLES AND NETWORK PARAMETERS 10

Energy and hydraulic gradient lines – head loss in links – equivalent pipes – series – parallel pipes – path head loss and loop head loss – analysis of water distribution network- static node, dynamic node – network performance – flow analysis - Layout – in situ lining - pipes material – appurtenances – minimization of water losses – leak detection.

UNIT III STORM WATER DISTRIBUTION AND BURIED PIPES 9

Planning – runoff estimation – rainfall data analysis – storm water drain design Introduction to Buried pipes – external loads – gravity flow design, pressurized flow- rigid and flexible pipes – installation – trenchless technology

UNIT IV RELIABILITY ASSESSMENT AND DESIGN 8

Uncertainty and reliability – affecting events- assessment – reliability parameters- configurations. Design methodology - strengthening and expansion

UNIT V FLUID TRANSIENTS 9

Basic equations of unsteady flows through closed conduits. Method of characteristics. Transients caused by centrifugal pumps and hydroelectric power plants.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to get a basic knowledge of the design of pipe networks.
- They will be able to analyze pipe network problems using computer software like EPANET2.0

REFERENCES:

1. Bhave P. R, Optimal design of water distribution networks, Narosa publishing House, New Delhi, 2003
2. Bajwa. G. S, Practical handbook on Public Health Engineering, Deep publishers, Shimla 2003
3. Manual on water supply and treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999
4. B.A. Hauser, practical hydraulics Hand Book, Lewis Publishers, New York, 1991
5. Moser A. P, Buried pipe Design, 3rd Edition, American Water Works Association
6. Robert van Bentum and Lan K. Smout, Buried Pipe lines for surface Irrigation, The Water, Engineering and Development Centre, Intermediate Technology Publications,UK,1994
7. Wurbs R.A., and James W.P. Water Resources Engineering. Prentice Hall of India, Eastern Economic Edition. ISBN: 81-203-2151-0, NewDelhi, 2007

IW7071 **WATER QUALITY** **L T P C**
3 0 0 3

OBJECTIVES:

- These courses introduce water quality concepts, its evaluation for irrigation purposes, besides relevant environmental problems and recycle and reuse concepts.
- At the end of the course, the students will understand the importance of water quality for irrigation and major uses of water and the role environmental issues.

UNIT I WATER QUALITY 10

Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – major ions –. Water quality investigation – Sampling design - Samplers and automatic samplers - Data collection platforms – Field kits – Water quality data storage, analysis and inference – Software packages

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 – Future strategies

UNIT III WATER POLLUTION 10

Sources and Types of pollution – Organic and inorganic pollutants - BOD – DO relationships – impacts on water resources – NPS pollution and its control – Eutrophication control - Water treatment technologies - Constructed wetland.

UNIT IV RECYCLING AND REUSE OF WATER 8

Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation.

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

OUTCOME:

- Students could relate water quality and its dependence on sources of water pollution.
- Students would understand and interpret water quality data for beneficial uses and in water quality models.

REFERENCES:

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, 2002.
2 Vladimir Novonty, Water Quality: Diffuse pollution and watershed Management, 2nd edition, John Wiley & Sons, , 2003
3. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, McGraw-Hill 2006.
4 Stum, M and Morgan, A., Aquatic Chemistry, Plenum Publishing company, USA, 1985.
5. Lloyd, J.W. and Heathcote, J.A., Natural inorganic chemistry in relation to groundwater resources, Oxford University Press, Oxford, 1988.

HW7002 COMPUTATIONAL INTELLIGENCE FOR HYDRO SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To develop skills of the students in software usage for simulation and water resources management. To enable the students to understand application of the latest information technology to water resources engineering

UNIT I ADVANCED COMPUTING TECHNIQUES 10

Computer methods in water resources - Computing techniques - Solution to ordinary and partial differential equation using Finite difference and Method of Characteristics- Numerical integration and differentiation Design of digital models - Visual programming - Graphical user interface - Interactive model concepts.

UNIT II ARTIFICIAL INTELLIGENCE 10

Heuristic search - Principle of Artificial Neural Network (ANN) - Application of ANN Model to Hydrology and Crop Water Requirement model. Fuzzy Logic concepts and Applications – Genetic Algorithms-Heuristic Optimization techniques.

UNIT III DIGITAL DATA MANAGEMENT 10

Data base structure - Data acquisition - Data warehouse - Data retrieval-Data format Attribute - RDBMS - Data analysis - Network data sharing - Statistical Analysis (SYSTAT) - Regression - factor analysis - histogram - scatter diagram - Goodness of fit.

UNIT IV SIMULATION SOFTWARE IN WATER RESOURCES 8

Surface water models (HMS) - Storm Water Management Models (SWMM) –culvert hydraulic design(HY) – River Analysis system models (HEC-RAS)-Ground Water Flow models – Groundwater transport models.

UNIT V SIMULATION MODELS IN IRRIGATION WATER MANAGEMENT 7

Soil water assessment simulation models (SWAT) - Basin simulation models (MITSIM, VASIM) Real time operation models - Water Resources Information System, Management Information System. Decision support system for Irrigation management.

TOTAL: 45 PERIODS

OUTCOMES:

- Students can able to enhance the computational knowledge in the field of water resources systems.
- Students could themselves develop the simulation models and use the latest intelligent technology and algorithms.

REFERENCES:

1. Aliev R. A, and Aliev Rashad Soft Computing and its Applications World Scientific Publications Co. Pte. Ltd. Singapore, 2001.
2. Janusz Kacprzyk Applied Decision with Soft Computing Springer, 2003
3. Carlos A. Coello Coello, David A Van Veldhuizen, Gary B Lamont, Evolutionary Algorthms for Solving Multi-objective problems, Springer, 2002.
4. Tayfur Gökmen Soft computing in water resources engineering, WIT Press, Great Britain,UK,20124.
5. John E. Gribbin, Introduction to hydraulics and hydrology with applications for Storm water Management. DELMAR, Thomson Learning, USA,2002.
6. Remson I, Hornberger G.M. and Moiz F.J., Numerical methods in Sub- Surface Hydrology. Wiley Inter Science, 1985
7. Kazda, I., Finite element Techniques in ground water flow studies (with Applications in Hydraulic and Geotechnical Engineering), Elsevier, 1990.

8. Abbott M.B, and Minns A.W. Computational hydraulics Ashgate, London,UK,2007.
9 . Loucks Daniel P., Jery R Stedinger and Douglas, A. Haith, Water Resources systems Planning and Analysis. Prentice Hall Inc., Englewood Clifts, New Jersey, 1981.