ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M. E. IRRIGATION WATER MANAGEMENT

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare students to excel in research or to succeed in Irrigation Water Management profession through global, rigorous post graduate education.

II. To provide students with a strong base in mathematical, scientific and engineering fundamentals required to solve water management problems.

III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems.

IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate irrigation water management issues in the broader socio economical context.

V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve irrigation water management problems.
3. Graduate will demonstrate an ability to acquire data, analyze and interpret.
4. Graduates will demonstrate an ability to design an irrigation system, component or process as per the needs of the society.
5. Graduates will demonstrate an ability to analyze and work on multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze water management problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions to water management problems and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.

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

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Statistical Methods for Engineers	✓		✓		✓					
		Advanced Irrigation Engineering		✓		✓	✓	✓				
		Soil Science and Agronomy	✓			✓		✓				
		Participatory Irrigation Management	✓		✓		✓		✓			
		Elective I										
		Elective II										
	SEM 2	Remote Sensing and GIS for Water Resources	✓	✓	✓			✓			✓	
		Research Methodology for Water Resources		✓	✓	✓		✓			✓	
		Groundwater and Drainage Engineering	✓	✓	✓			✓				
		Irrigation Management		✓	✓	✓	✓	✓				
		Elective III										
		Elective IV										
YEAR 2	SEM 1	Micro Irrigation Engineering		✓		✓	✓	✓				
		Elective V										
		Elective VI										
		Practical Training (2 Weeks)			✓		✓	✓	✓		✓	✓
		Project Work Phase I		✓	✓		✓	✓		✓		✓
	SEM 2	Project Work Phase II		✓	✓		✓	✓		✓		✓

ANNA UNIVERSITY, CHENNAI

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M.E. IRRIGATION WATER MANAGEMENT

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CURRICULA AND SYLLABI

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IW7101	Advanced Irrigation Engineering	PC	3	3	0	0	3
2.	IW7102	Participatory Irrigation Management	PC	3	3	0	0	3
3.	IW7103	Soil Science and Agronomy	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
PRACTICAL								
7.	IW7111	Advanced Irrigation Engineering Laboratory	PC	4	0	0	4	2
			TOTAL	**23**	**19**	**0**	**4**	**21**

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	FC	3	3	0	0	3
2.	HW7252	Research Methodology for Water Resources	FC	3	3	0	0	3
3.	IW7201	Groundwater and Drainage Engineering	PC	3	3	0	0	3
4.	IW7202	Irrigation Management	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	FC	4	0	0	4	2
			TOTAL	**22**	**18**	**0**	**4**	**20**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IW7301	Micro Irrigation Engineering	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.	IW7311	Practical Training (2 weeks)	EEC	0	0	0	0	1
5.	IW7312	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.	IW7411	Project Work (Phase II)	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 69

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.		Remote Sensing and GIS for Water Resources	FC	3	3	0	0	3
3.		Research Methodology for Water Resources	FC	3	3	0	0	3
4.		GIS Laboratory	FC	4	0	0	4	2

PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Advanced Irrigation Engineering	PC	3	3	0	0	3
2.		Soil Science and Agronomy	PC	3	3	0	0	3
3.		Participatory Irrigation Management	PC	3	3	0	0	3
4.		Groundwater and Drainage Engineering	PC	3	3	0	0	3
5.		Irrigation Management	PC	3	3	0	0	3
6.		Micro Irrigation Engineering	PC	3	3	0	0	3
7.		Advanced Irrigation Engineering Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HW7072	Water Supply and Buried Pipelines	PE	3	3	0	0	3
2.	IW7001	Drought Risk Assessment and Management	PE	3	3	0	0	
3.	IW7002	Irrigation Economics	PE	3	3	0	0	3
4.	IW7003	Rainfed Agriculture and Tank Irrigation Management	PE	3	3	0	0	3
5.	IW7004	Rehabilitation and Modernisation of Irrigation systems	PE	3	3	0	0	3
6.	IW7071	Water Quality	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.	IM7001	Climate Change and Water Resources	PE	3	3	0	0	3
13.	IM7002	Environmental Impact Assessment for Water Resources	PE	3	3	0	0	3
14.	IM7003	Integrated Flood Risk Assessment and Management	PE	3	3	0	0	3
15.	IM7004	Integrated River Basin Management	PE	3	3	0	0	3
16.	IM7005	Watershed Conservation and Management	PE	3	3	0	0	3
17.	HW7203	Systems Analysis in Water Resources	PE	3	3	0	0	3
18.	HW7101	Advanced Fluid Mechanics	PE	3	3	0	0	3
19.	HW7202	Open Channel Hydraulics	PE	3	3	0	0	3
20.	IM7102	Integrated Water Resources Management	PE	3	3	0	0	3
21.	IM7103	Surface and Ground Water Hydrology	PE	3	3	0	0	3
22.	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	-	0	0	0	1
2.		Project Work (Phase I)	EEC	12	0	0	12	6
3.		Project Work (Phase II)	EEC	24	0	0	24	12

IW7101	ADVANCED IRRIGATION ENGINEERING	L T P C 3 0 0 3

OBJECTIVES:

- To expose the students, the concept of Irrigation management.
- To introduce the concepts of Soil-water-plant relationship from the context of irrigation water management.
- To train the students to evaluate the efficiency of surface irrigation systems, Productivity of irrigation systems and their performance.
- To train the students to design different micro irrigation systems and select suitable methods.

UNIT I DEVELOPMENT OF IRRIGATION 6

Water Resources of India - Irrigation- Need, Advantages and Disadvantages- Crop and Cropping seasons in India and Tamil Nadu-National Water Policy- Inadequacy of Irrigation Management-Criteria for good Irrigation management.

UNIT II SOIL WATER PLANT RELATIONSHIP 9

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.

UNIT III CROP WATER REQUIREMENT 9

Water requirement of crops- Evapotranspiration and Consumptive use- Methods of estimating Evapotranspiration- Effective Rainfall- Irrigation Requirement-Duty of Water- Irrigation Efficiencies-Irrigation Scheduling- Irrigation measurement.

UNIT IV IRRIGATION METHODS 12

Canal network and canal design- Surface irrigation methods- Types- Border irrigation, Furrow irrigation, Basin Irrigation and Micro irrigation - Specifications, Hydraulics and Design.

UNIT V IRRIGATION DRAINAGE 9

Land-Grading and Land-Leveling Principles and Practices- Drainage- Nature and extent of Drainage Problems- Hydraulic conductivity measurement in-situ-Definition and calculation of drainage design criteria - Design, alignment, construction and maintenance of surface and subsurface drainage systems.

TOTAL:45 PERIODS

OUTCOMES:

- Students will understand the concept of soil-water-plant relationship and can apply it to schedule irrigation.
- Students can design surface, drip and sprinkler irrigation systems for various crops.

REFERENCES:

1. Majumdar D. P., "Irrigation Water Management Principles and Practices", Prentice Hall of India, New Delhi, 2004.
2. Michael A. M., "Irrigation Theory and Practice", Vikas Publishing House, New Delhi, 2009.
3. "Irrigation and Drainage", Paper 24. "Crop Water Requirement". FAO, Rome, 1992 Reprint.
4. "Irrigation and Drainage" paper 56. "Crop Evapotranspiration: guidelines for computing crop water requirements", FAO, Rome 1998.
5. Sharma R.K and Sharma T.K., "Irrigation Engineering", S.Chand, New Delhi, 2008.
6. Bhattacharya A.K. and Michael A.M., "Land Drainage Principles, Methods and Applications", Konark Publishers Pvt. Ltd., New Delhi. 2003.

IW7102 PARTICIPATORY IRRIGATION MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- At the completion of the course the students should be able to gain insight on local and global perceptions and approaches to participatory water resource management
- Learn from successes and failures in the context of both rural and urban communities of water management.

UNIT I FUNDAMENTALS OF SOCIOLOGY AND PARTICIPATORY APPROACH 6

Basic Sociological concepts and Definitions – Perspectives- Social inequality – Sociological understanding. - Irrigation as a Sociotechnical Process - Participatory approach – Necessity – Objectives of participatory approach

UNIT II UNDERSTANDING FARMERS PARTICIPATION 10

Why farmers participation –Benefits of farmers participation – Comparisons of cost and benefit - Sustained system performance - Kinds of participation –Activities on Water towards Organization and Structure - Context of participation, factors in the environment.

UNIT III ORGANIZATIONAL DESIGN AND IMPROVING AGENCY RELATIONS 9

Membership and decision making – Leadership and responsibilities – Development strategy – Channels for implementation –– Equity and Equality- Agency Incentives- Technical co-operation – Special roles – Agency Roles.

UNIT IV POLICY CONSIDERATIONS 10

Building from Below-Existing Organisation**-** Ownership-Non-political Associations-Bureaucratic Reorientation

UNIT V ROLE OF STAKEHOLDERS IN IRRIGATION 10

Multiple use of water – Issues in Intersectoral Water Allocation - Domestic, Irrigation, Industrial sectors – Participation of women –. Role of Community Organisers – Constraints in Organising farmers Organisation – Supporting farmer organization and participation.

TOTAL: 45 PERIODS

OUTCOME:

- The organizational skills to manage resources can be acquired with coordinating and integrating both resources and stakeholders through participatory ideology.

REFERENCES:

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

IW7103 SOIL SCIENCE AND AGRONOMY L T P C
3 0 0 3

OBJECTIVE:

- To introduce the students to soils from a crop production perspective, as well as to expose them to the principles and practices of crop production.

UNIT I SOILS AND THEIR CLASSIFICATION 10

Introduction– soil forming rocks and minerals- Soil forming processes, profile development – Major soil types of India and U.S. System of soil Taxonomic classification - Soil survey, Land capability classes and Remote sensing techniques.

UNIT II SOIL-WATER-RELATIONSHIPS 9

Soil physical properties – Soil water relation - Soil water potential and its components – Kinds of water in soil - Soil moisture characteristic curve – Moisture constants – Entry, retention and flow of water in the root zone – Concept of plant-available water – Methods of measurement of soil moisture and matric tension- soil irrigability

UNIT III SOIL FERTILITY AND PRODUCTIVITY 9

Plant nutrition-Essential and beneficial elements, Physiological role of nutrients, mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants- soil reaction –Life in the soil - soil fertility– Fertility vs. productivity – Problems of salinity and sodicity.

UNIT IV PRINCIPLES OF AGRONOMY AND CROP PRODUCTION 12

Meaning and scope of Agronomy, Relationship with other sciences– Role of agronomy – Influence of genetic and environmental factors on crop growth – Growth stages of crops – Biological and economic yield– Cropping systems – Tillage and tilth – Seeds and sowing – Density and plant arrangement – Manures and fertilizers – Weed management – Plant protection, including the concept of Integrated Pest Management - Harvesting.

UNIT V CROP PRODUCTION PRACTICES 5

Crops and cropping pattern and production practices for crops of importance in Tamil Nadu: rice; cereals and millets; grain legumes; oilseed crops; and cash crops such as sugarcane, cotton and banana - Agroclimatic zones of Tamil Nadu.

TOTAL : 45 PERIODS

OUTCOME:

- Students would have knowledge of soils and crops, which they can beneficially use as specialists in irrigation water management.

REFERENCES:

1. Brady N.C., The Nature and Properties of Soil. Prentice-Hall of India Pvt. Ltd. New Delhi. 1995.
2. Raymond W., Miller., Roy L. and Donahue. Soils In Our Environment. Prentice-Hall of India Pvt. Ltd. New Delhi. 1997.
3. Edward J. Plaster. Soil Science. Cengage Learning India Pvt. Ltd. New Delhi. 2009.
4. ICAR, Hand Book of Agriculture. Indian Council of Agricultural Research, New Delhi. 1999.
5. Chapman S.R. and Carter L.P., Crop Production Principles and Practices,W.H. Freeman and Co., New York. 1976.
6. Morachan Y.B., Crop Production and Management. Oxford and IBH Publishing Co., New Delhi. 1984.
7. DOA, Crop Production Guide. Directorate of Agriculture, Government of Tamil Nadu, Chepauk, Chennai. 1999.

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.

IW7111 ADVANCED IRRIGATION ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To train the concepts of Soil-water-plant relationship.
- To train the students to evaluate the efficiency of surface irrigation systems and their performance.
- To train the students to design different micro irrigation systems and evaluate the same.

LIST OF EXPERIMENTS

1. Collection of data on Agro-meteorological parameters.
2. Determination of Bulk density and Specific gravity of Soil
3. Determination of Textural classification of Soil
4. Determination of Soil Moisture for Irrigation Scheduling
5. Measurement of Infiltration in Soil
6. Demonstration on measurement of plant Transpiration
7. Flow measurement in irrigated Channels
8. Flow measurement in Close Conduits
9. Evaluation of surface and micro irrigation systems.

TOTAL : 60 PERIODS

OUTCOMES:

- Students will be able to observe and record weather data and analyse them. They could measure the flow, estimate the evapotranspiration etc.
- Students will be able to analyse and interpret soil physical and chemical properties.
- Students will be able to evaluate performance of irrigation systems.

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

HW7252 RESEARCH METHODOLOGY FOR WATER RESOURCES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce concepts of research process in hydrology and water resources and water management.
- To enable students to get basic understanding of scientific research methods.
- To develop capacity to independently analyse and define a research problem.

UNIT I SCOPE 10

Objectives and types of research – Identification of research problem – Research process – Research design – Bibliography.

UNIT II SAMPLE 8

Sampling theory and sampling design – Types of samples – Sources of data – Qualitative and quantitative data – Data collection methods.

UNIT III DATA 8

Measurement levels and scaling – Types of errors – Sampling adequacy – Data collection and editing – Coding of data – Analysis and statistical inference.

UNIT IV REPORT 4

Report preparation – Structure of report – graphs and illustration tools – Tables and charts – Draft – Finalising research report.

UNIT V DESIGN OF A RESEARCH PROJECT 15

A mini project design

TOTAL : 45 PERIODS

OUTCOME:

- Students will understand applied research methods in Science and Engineering and will able to define and formulate a research problem independently.

REFERENCES:

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

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.

IW7202	IRRIGATION MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students the various principles of irrigation methods
- To inculcate the different types of irrigation systems and their performance based on service oriented approach.

UNIT I IRRIGATION DEVELOPMENT IN INDIA 9

Importance of Irrigation in Agriculture - Historical evolution of irrigation in India – Irrigation development during pre-colonisation – Colonisation and post-colonization – Different types of Irrigation prevalent in India: Warabandi, Shejpali and South Indian systems - Focus of Irrigation in India – Command area development approach and farmers' participation.

UNIT II IRRIGATION SYSTEMS AND PERFORMANCE INDICATORS 9

Systems classification - Institutions for irrigation management–Diagnostic Analysis of Irrigation Systems -Rehabilitation and modernization – Performance indicators – Improving system performance – Conjunctive management – constraints faced.

UNIT III MAIN SYSTEM MANAGEMENT 9

Main system components – Reservoir allocation rule, Operating rule and optimization methods to improve main system performance - irrigation scheduling – Constraints.

UNIT IV COMMAND AREA DEVELOPMENT AND PARTICIPATORY IRRIGATION MANAGEMENT 9

Command area development principles – Participatory Irrigation Management and Irrigation management transfer – Case studies – Constraints.

UNIT V IRRIGATION POLICY AND INSTITUTIONS 9

Present status of irrigation policy and institutions – Irrigation related conflicts – Institutional transformation needed – Constraints in effecting institutional transformation – Irrigation financing – Water pricing – Water market – Policy changes.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to understand an irrigation system, its components, its performance, and management of irrigation complexities to tackle different issues.
- The students will acquire knowledge about the need for participatory approach and irrigation management transfer along with irrigation policy and institutional aspects.

REFERENCES:

1. "Rakesh Hooja, Management of Water for Agriculture: Irrigation, Water sheds and Drainage" Rawat Publications, New Delhi, 2006.
2. Kijne, J.W., Barker, R and Molden, D, "Water Productivity in Agriculture; Limits and Opportunities for improved" CABI Publishing, Walling ford, U.K, 2003.
3. Giodano.M and Villbolth K.G, "The Agricultural Ground Water Revolution -Opportunities and threats to development" CABI Publishing, Walling ford, U.K, 2007.

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

IW7301	MICRO IRRIGATION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To stress the importance of micro irrigation methods, design and operation of sprinklers and drip irrigation methods
- To emphasize current developments in irrigation methods and the adoption of micro irrigation in the field.

UNIT I INTRODUCTION TO MICRO-IRRIGATION 7

Importance – classification of irrigation methods – classification of micro-irrigation methods – principles and selection of micro-irrigation systems – low pressure mini spray systems – bubbler system – sprinkler and drip system – irrigation efficiencies.

UNIT II SPRINKLER IRRIGATION SYSTEM AND DESIGN 10

Development – Use – Types – Portable, Semi portable and Permanent systems – Components – pumping – Main line – Lateral line – Sprinkler heads – Moisture distribution pattern and uniformity of coverage – Testing of water distribution pattern – Design of Sprinkler irrigation systems – Types of system and layout - Selection and spacing – Capacity of sprinkler system – Hydraulic design – Design of laterals – Cost estimation – Operation and Maintenance – trouble shooting – Application of Fertilizers – Fertilizer injection methods and Devices.

UNIT III DRIP IRRIGATION SYSTEM, DESIGN AND LAYOUT 10

Drip effect on water use – description of drip irrigation system – types – various methods – manufacturing drip equipments – low and high density polythene – main pipe – submains – laterals – emitters – dripper with hole and socket – micro tube emitters – nozzles – self adjusting drippers – double wall pipe – leaky pipe. Principles for design of drip system – hydraulic formulae Darcy Weishbach equation – Hazen Williams formulae – factors to be consider to the design of the system – design procedure –design of emitters, laterals, submains and main lines – head works – drip layout for different crops – field crops – close spaced crops – orchard crops – drip irrigation design and layout – model design.

UNIT IV WATER DISTRIBUTION AND FERTILIZER APPLICATION IN DRIP IRRIGATION 10

Effects of discharge rate of drip emitter – water movement under drip system – soil moisture distribution – soil water content – drainage flux – irrigation control by soil physical methods - Clogging – water quality and preventive measures – cleaning of clogged system – filtration problems and measures – gravel filters – vortex filters – other methods of filtering and prevention – clogging of outlets. Introduction and list of fertilizers – application of fertilizer – influence on general nutritional problems – fertilizers movement – fertilizing – existing fertilizer practices – continuous fertilizers – methods of applying fertilizers – volume of fertilizer tank – dilution ratio.

UNIT V ECONOMICS AND ADOPTION OF DRIP IRRIGATION IN INDIA 8

Adoption and Up scaling – Constraints for the farmers - Irrigation investment - possible economics in drip system – engineering design – Agronomic manipulation – commercial production – factors influencing economics of drip system – cost estimates – optimum farm size – economics and financial analysis – present status and application – case studies.

TOTAL: 45 PERIODS

OUTCOME:

- Students can design the micro irrigation systems (low cost and commercial) at the field level.

REFERENCES:

1. Michael, A.M., “Irrigation Theory and Practice”, Vikas Publishers, New Delhi, 2000.
2. Dilip Kumar Majumdar., Irrigation Water Management, Prentice Hall Inc., 2004.
3. Dr. Suresh R., “Principles of Micro-Irrigation Engineering”, Standard Publishers Distributors, New Delhi, 2010.
4. Sivanappan R. K. , “Sprinkler Irrigation”, Oxford and IBH Publishing Co, New Delhi, 1987.
5. Keller J. and Karmeli D., “Trickle Irrigation Design”, Rainbird Sprinkler Irrigation Manufacturing Corporation, Glendora, California, USA.
6. Jack Keller and Rond Belisher., “Sprinkler and Trickle Irrigation”, Van nastrand Reinhold, New York, 1990.

IW7311 **PRACTICAL TRAINING** **L T P C**
0 0 0 1

OBJECTIVES:

- To train the students for field oriented works so as to have an understanding about the issues and problems prevailing in the field related to irrigation water management.
- To develop skills in data acquiring and data handling for solving any kind of field problems.

SYLLABUS

The students individually undertake training in reputed organisations or take up any case study pertaining to a practical field oriented problem during the summer vacation of second semester 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 committee of internal Faculty.

OUTCOME

- Students are trained in tackling a practical field oriented problems related to irrigation water management.

IW7312 **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 and data.
- To develop the methodology to solve the identified problem.
- To train the students in preparing a project report summarizing the entire problem and its importance in the current situation.

SYLLABUS

The student individually works on a specific topic approved by Faculty member who is familiar in the chosen area. 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 would be in a position to carry out the remaining Phase II work in a systematic way.

IW7411 **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 acquire data, analyze and discuss the results, and make conclusions and recommendations if any for improvements.

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 a solution inculcating a confidence in handling such issues related to irrigation water management.

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, New Delhi, 2007.

IW7001 DROUGHT RISK ASSESSMENT AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- This subject aims at making the students to understand the drought and to assess the Drought vulnerability and risk towards suggesting the mitigation measures to combat drought

UNIT I UNDERSTANDING DROUGHT 9

Hydro-illogical Cycle – 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.

UNITII DROUGHT IMPACTS 9

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.

UNIT III DROUGHT HAZARD AND RISK ASSESSMENT 9

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

UNIT IV DROUGHT RELIEF MEASURES 9

Contingency Crop Planning – Support to Farmers - Relief Employment – Water Resources Management - Food Security - Tax Waiver – Cattle Camp and Fodder supply – Institutional Response – Role of Central, Sate, District and Panchayat Raj Institutions – Checklist for Drought Preparedness.

UNIT V DROUGHT MITIGATION AND MANAGEMENT 9

Drought Mitigation - Risk and Crisis Management –Water harvesting and Conservation – Drip and sprinkler Irrigation System – Long-term Irrigation Management – Afforestation – Crop Insurance – Community Participation – Climate Variability and Adaptation - DPAP, DDP and IWMP Programmes.

TOTAL: 45 PERIODS

OUTCOMES:

- Students know the comprehensive strategies for drought risk management.
- Students exposed to different types of drought and their impacts. They asses the severity, duration and frequency of drought.
- Student acquires the knowledge to evaluate the extent of drought risk and vulnerability and assess the capacity to response.
- Students prepare preparedness and relief measures for efficient drought risk reduction.
- Students understands the integrated risk and crisis management of drought and programs with drought risk management strategies.

REFERENCES:

1. Yevjevich V., Drought Research Needs, Water Resources Publications, Colorado State University, 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 Disaster Management Guidelines", Management of Drought, 2010.
4. Wilhite**,** Donald A., "Drought Assessment, Management, and Planning: Theory and Case Studies", Kluwer Academic Publishers, 1993.

IW7002 IRRIGATION ECONOMICS L T P C
3 0 0 3

OBJECTIVES:

- To provide an overall exposure on the use of economic concepts in irrigation development.
- To impart knowledge on economic planning so as to enable viable allocation of resources in the irrigation sector.

UNIT I SCOPE OF ECONOMICS 8

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 behavior – consumer surplus - Market analysis – Economic efficiency – Applications.

UNIT III PRODUCTION ECONOMICS 10

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 8

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

UNIT V FINANCIAL ANALYSIS 10

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

OUTCOMES:

- The students will understand the economic concepts useful for overall irrigation development based on the current trends of production, consumption and farm economics.
- The students will acquaint themselves in the allocation of resources and financial analysis in the irrigation sector.

REFERENCES:

1. Allan C. Deserpa, 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. Kay, Farm Management, Planning, Control and Implementation, McGraw-Hill Publishing Co. Ltd., New Delhi, 2007.

IW7003 RAINFED AGRICULTURE AND TANK IRRIGATION MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To make the students understand the importance of Rainfed Agriculture, Tanks and the unique design. Students should get through the detailed design & drawing of various components of Tank Irrigation System

UNIT I RAINFED AGRICULTURE 9

Rainfed Agriculture- Introduction, Types, past trends and Future Prospects- Potentials and Risks- Water availability and use - Climate risk and its impact in Rainfed Farming- Integrated Farm Management for increased productivity.

UNIT II TANK IRRIGATION 9

Concept of tank irrigation - Classification - Components of tank irrigation- Water distribution network- Cascade of tanks- Degradation of Tank Irrigation Systems- Causes and Remedy.

UNIT III TANK CONSTRUCTION & CAPACITY ESTIMATION 9

Principles of Construction of tanks and rehabilitation of existing tanks - Site Selection- Surveying and Levelling in Tank Works- Computation of Water Yield-Runoff- Strange Table- Rational method.

UNIT IV DESIGN OF TANK COMPONENTS 9

Design of Supply & Feeder Channels - Bund for Tank- tank weirs- Design of Sluice Outlets and Surplus Weir- Guidelines for preparation of Completion Report

UNIT V FARMER'S PARTICIPATION IN TANK IRRIGATION SYSTEMS 9

On Farm Development – organization, operation and maintenance- Water User Association- People's participation in tank irrigation system and its maintenance - Turn over – Traditional Governance of tank system – Water rights (Ancestral rights)– Multiple users of tank water – Usufruct Rights- tank irrigation management dealings in collective management of tanks

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Wani P Suhas, John Rockstorm and Theib Oweis (2009), 'Rainfed agriculture: Unlocking the Potential', IWMI, CAB International, UK.
2. Shanmugham. C.R. and J. Kanagavalli (2013), 'Technology of Tanks', Kalanjium hozhilagam Limited, Madurai.

REFERENCES:

1. Venkateswarlu B., PK Mishra, G. Ravindra chary, GR Maruthi Sankar and G. Subba Reddy , 'Rainfed Farming: A Compendium of improved Technologies', Central Research Institute for Dryland Agriculture, Hyderabad.,2009
2. Tow Philip, Ian Cooper, Ian Partrich and Colin Birch , 'Rainfed Farming Systems', Springer science & Business Media, New York.,2011.

IW7004	REHABILITATION AND MODERNISATION OF IRRIGATION SYSTEMS	L T P C 3 0 0 3

OBJECTIVE:

- To expose the students to the need and importance of the rehabilitation and modernization of irrigation systems and to train them in the related concepts and methods.

UNIT I IRRIGATION SYSTEMS 9

Historical evolution of irrigation systems in India; its importance to agricultural production. Irrigation system classification – Nature of system modernization and rehabilitation. Distinction between rehabilitation and modernization; Rehabilitation and modernization objectives – Theory and Practice.

UNIT II SYSTEM MAINTENANCE 9

Maintenance: essential, catch up, preventive and normal – Diagnostic analysis of flow, seepage and other parameters through Participatory Rural Appraisal, Rapid Rural Appraisal and Walk-through Survey – Development and maintenance programme – Kudimaramath **–** Turnover – WUA.

UNIT III DIAGNOSTIC ANALYSIS OF IRRIGATION SYSTEMS 9

System performance: history of inflow, cropping pattern, system alterations, distribution performance – Operational constraints – Management constraints – Resources constraints.

UNIT IV REHABILITATION 9

Baseline survey – Deferred maintenance – Causes – Criteria used for taking rehabilitation programmes –Service Delivery Concepts- Software and hardware improvements – Prioritization – Role of water users' association – Monitoring and evaluation.

UNIT V CASE STUDIES 9

Rehabilitation and modernization programmes – Periyar Vaigai Project – Walawe Project – Tank Modernization Project – Water Resources Consolidation Project. IAM WARM Project - DRIP - Case study of Rehabilitation using Water Delivery Concept.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be familiar in understanding the different types of maintenance problems with respect to technical and social aspects, its occurrence and to overcome these problems by rehabilitation and modernisation methods.
- The students will get an overall exposure to different types of irrigation system maintenance issues and to solve them for improving their performance based on service oriented approach.

REFERENCES:

1. CWR, Baseline Survey of Irrigation Commands, Centre for Water Resources, Anna University, Chennai. 2000.

2. IIMI and WALMI, The Case of Mahi Kadana, WALMI, Gujarat, India, 1994.
3. CSU, Diagnostic Analysis of Irrigation Systems Volume 2: Evaluation Techniques. Water Management Synthesis Project, Colorado State University, USA. 1984.
4. WAPCOS, Technical Report No. 19-A, Handbook for Improving Irrigation System Maintenance Projects, WAPCOS, New Delhi. 1989
5. CWR, Tank Modernization Project EEC Assistance: Monitoring and Evaluation. Final Reports. Centre for Water Resources, Anna University, Chennai. 2000.
6. CWR, Planning and Mobilization of Farmers Organization and Turnover. Tamil Nadu Water Resources Consolidation Project. CWR and OM, Anna University, Chennai, 1997.

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.

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.

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

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.

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 .

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.

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