ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M. E. HYDROLOGY AND WATER RESOURCES ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare the students to be sensitive to the problems facing the water resources sector in the country and orient them to preserve and protect this precious natural resource both in its quality and quantity through the post graduate education.

II. To impart knowledge for the sustainable development and management of water resources.

III. To develop integrated approach to water and land resources management through technically feasible, economically viable and socially acceptable solutions.

IV. To promote innovations in water resources management and development and encourage field based 'action research' (i.e., research through doing).

V. To develop interest among the students in research, problem solving skills and ability to effectively disseminate their knowledge through effective communications.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will be able to identify problems and use the appropriate tools for formulating the problem.
2. The graduates should be able to develop a methodology for solving the identified problem using technical or field research concepts.
3. The graduates should be able to collect the necessary data or make suitable assumptions in the event of lack of data and identify the appropriate method of solution.
4. Graduates will be able to construct physical or mathematical model to the identified problem.
5. The graduates should be able to derive meaningful inferences from the results of mathematical or physical models.
6. The graduates should be able to undertake independent field research work.
7. The graduates will be adept with the use of new technologies like GIS and computer software for solving water resources problems.
8. The graduates will be able to engage the stakeholders in an integrated approach in problem formulation and solution.
9. The graduates will be able to disseminate their knowledge both in verbal and written form.
10. The graduates will demonstrate an hunger for continuing education and life-long learning.

Attested

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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 Fluid Mechanics	✓	✓	✓	✓	✓					
		Groundwater Hydrology	✓	✓				✓	✓	✓		
		Surface Water Hydrology	✓	✓				✓	✓	✓		
		Elective I										
		Elective II										
		Hydraulics Laboratory				✓	✓	✓				
	SEM 2	Remote Sensing and GIS for Water Resources	✓					✓	✓		✓	
		Hydrologic Analysis and Design	✓	✓				✓	✓		✓	
		Open Channel Hydraulics	✓					✓				
		Systems Analysis in Water Resources	✓	✓	✓	✓						
		Elective III										
		Elective IV										
		GIS Laboratory				✓	✓	✓				
YEAR 2	SEM 1	Elective V										
		Elective VI										
		Elective VII										
		Industrial Training (2 weeks)		✓	✓	✓	✓		✓		✓	✓
		Project Work Phase I		✓	✓	✓	✓		✓	✓	✓	✓
	SEM 2	Project Work Phase II		✓	✓	✓	✓	✓	✓	✓	✓	✓

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CURRICULA AND SYLLABI

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HW7101	Advanced Fluid Mechanics	PC	3	3	0	0	3
2.	HW7102	Groundwater Hydrology	PC	3	3	0	0	3
3.	HW7103	Surface Water Hydrology	PC	3	3	0	0	3
4.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
5.		Elective I	PE	3	3	0	0	3
6.		Elective II	PE	3	3	0	0	3
PRACTICAL								
7.	HW7111	Hydraulics 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.	HW7201	Hydrologic Analysis and Design	PC	3	3	0	0	3
2.	HW7202	Open Channel Hydraulics	PC	3	3	0	0	3
3.	HW7203	Systems Analysis in Water Resources	PC	3	3	0	0	3
4.	HW7251	Remote Sensing and GIS for Water Resources	FC	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.		Elective V	PE	3	3	0	0	3
2.		Elective VI	PE	3	3	0	0	3
3.		Elective VII	PE	3	3	0	0	3
PRACTICAL								
4.	HW7311	Industrial Training (2 Weeks)	EEC	-	-	-	-	1
5.	HW7312	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.	HW7411	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.		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 Fluid Mechanics	PC	3	3	0	0	3
2.		Groundwater Hydrology	PC	3	3	0	0	3
3.		Surface Water Hydrology	PC	3	3	0	0	3
4.		Hydrologic Analysis and Design	PC	3	3	0	0	3

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5.		Open Channel Hydraulics	PC	3	3	0	0	3
6.		Systems Analysis in Water Resources	PC	3	3	0	0	3
7.		Hydraulics Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HW7001	Aquifer Storage and Recovery	PE	3	3	0	0	3
2.	HW7002	Computational Intelligence for Hydrosystems	PE	3	3	0	0	3
3.	HW7003	Environmental Hydraulics	PE	3	3	0	0	3
4.	HW7004	Flood Modelling and Drought Assessment	PE	3	3	0	0	3
5.	HW7005	Groundwater Modelling and Management	PE	3	3	0	0	3
6.	HW7006	Isotope Techniques in Water Resources Management	PE	3	3	0	0	3
7.	HW7007	River Engineering	PE	3	3	0	0	3
8.	HW7008	Soil Aquifer Treatment Technology	PE	3	3	0	0	3
9.	HW7009	Water and Environment	PE	3	3	0	0	3
10.	HW7010	Water Power and Dam Engineering	PE	3	3	0	0	3
11.	HW7071	Urban Water Resources Management	PE	3	3	0	0	3
12.	HW7072	Water Supply and Buried Pipelines	PE	3	3	0	0	3
13.	HW7252	Research Methodology for Water Resources	PE	3	3	0	0	3
14.	IW7071	Water Quality	PE	3	3	0	0	3
15.	IW7201	Groundwater and Drainage Engineering	PE	3	3	0	0	3
16.	IW7101	Advanced Irrigation Engineering	PE	3	3	0	0	3

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17.	IM7001	Climate Change and Water Resources	PE	3	3	0	0	3
18.	IM7002	Environmental Impact Assessment for Water Resources	PE	3	3	0	0	3
19.	IM7003	Integrated Flood Risk Assessment and Management	PE	3	3	0	0	3
20.	IM7004	Integrated River Basin Management	PE	3	3	0	0	3
21.	IM7005	Watershed Conservation and Management	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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

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

HW7102 **GROUNDWATER HYDROLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- The objective of this course is enable to the student to understand the basic empirical knowledge of the residence and movement of groundwater, as well as a number of quantitative aspects.
- At the end of the course, the student should be able to evaluate the aquifer parameters and groundwater resources for different hydro-geological boundary conditions.

UNIT I GROUNDWATER BASICS 8

Introduction to Groundwater – Hydro meteorology – Groundwater in Hydrologic Cycle – Occurrence of groundwater – zone of Aeration and Saturation – Hydrogeology –— Types of aquifers soil sample analysis - Water bearing materials – Aquifer parameters and its determination.

UNIT II GROUNDWATER HYDRAULICS 10

Groundwater Movement - Darcy's law and its limitations - Stream lines and flow net analysis – Potential flow theory – Discharge and draw down for various condition of groundwater flow - Principles of groundwater flow and its equation – Dupuit – Forchheimer assumptions – Influent and Effluent streams - Evaluation of well loss parameters – Partial penetration of wells – Interference of wells

UNIT III PUMPING TEST ANALYSIS 10

Determining aquifer parameters for unconfined, leaky and non-leaky aquifers – steady and transient conditions - Slug test – Locating hydro geological boundaries – Image well theory – Determination of well characteristics and specific capacity of wells – Well characteristics of large diameter wells.

UNIT IV WELL DESIGN AND CONSTRUCTION 8

Well design criteria – Construction of wells – Well drilling methods – Filter design – Artificial and natural packing – Well casings and screens – Production test – Maintenance of production wells – Pumping Equipment – protection of wells and Rehabilitation – Horizontal wells - Collector wells and Infiltration galleries

UNIT V SPECIAL TOPICS 9

Methods of artificial groundwater recharge – Groundwater Basin Management and conjunctive use - Groundwater assessment and balancing – Seawater intrusion in coastal aquifers – Land Subsidence – Groundwater flow in Hard Rock System: conceptual models – structure and hydrodynamic properties of hard rock aquifers.

TOTAL: **45 PERIODS**

OUTCOME:

- Students are able to understand aquifer properties and its dynamics after the completion of the course. It's imparts exposure towards well design and practical problems of ground water aquifers.

REFERENCES:

1. Todd D.K., Groundwater Hydrology, John Wiley & Sons, Inc, New York, 1976.
2. Bear J., Hydraulics of Groundwater, McGraw-Hill, New York, 1979.
3. Bouwer H., Groundwater Hydrology, McGraw-Hill, New York, 1978.
4. Driscoll, Groundwater and Wells, Johnson Filtration Systems, Inc., 1986.
5. Hantush M.S., Hydraulics of wells in Advances in Hydro science, Academic Press, 1964.
6. Ojha, C.S.P, Berndtsson, R and Bhunya, P., Engineering Hydrology, Oxford University Press,New Delhi, 2008.
7. Rastogi A.K. , Numerical Groundwater Hydrology, 2011

HW7103 SURFACE WATER HYDROLOGY L T P C
3 0 0 3

OBJECTIVE:

- This subject aims at making the students to understand the relevance of various components of hydrologic cycle, which are responsible for spatial and temporal distribution of water availability in any region.

UNIT I HYDROMETEOROLOGY 9

Hydrologic cycle – Global water budget – Practical applications – Hydrometeorology – Constituents of atmosphere – Vertical structure of the atmosphere – general circulation – Transitory system – Air mass – Air front – cyclones – Formation of precipitation – Types and forms of precipitation – Climate and Weather – Meteorological Observations.

UNIT II PRECIPITATION 8

Measurement of rainfall – Rain gauges – Radar Measurement of rainfall - Rainfall Hyetograph – Intensity Duration and Frequency analysis – Consistency – Missing data – Rain gauge network – Average depth of rainfall analysis – Spatial analysis using GIS – Annual rainfall of India and Tamilnadu

UNIT III ABSTRACTIONS 8

Water losses - Initial losses – Interception and depression storage – Evaporation – Evaporimeters – Estimation of Evaporation - Evapotranspiration – Field Measurement – Empirical Equations - Infiltration – Infiltrometers – Infiltration Equations - Infiltration Indices.

UNIT IV STREAMFLOW MEASUREMENT 8

Stage and Velocity Measurement – Gauges – Current meter and Doppler flow velocity meter - Discharge measurement – Area Velocity method - Area Slope method – Discharge Measuring Structures - Dilution Technique – Stage Discharge relationship – Selection of a Stream Gauging Site.

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UNIT V RUNOFF AND WATER CONSERVATION 12

Concept of catchment – Linear, Areal and Relief Aspects – Detailed study of Runoff process – Factors affecting Runoff – Hydrograph – Unit Hydrograph – Synthetic Hydrograph –Runoff estimation - Strange and SCS methods – Water Conservation – Rain water and Runoff Harvesting in Rural and Urban Areas - Reservoir Sedimentation.

TOTAL: 45 PERIODS

OUTCOMES:

- The students obtain the complete knowledge on hydrologic cycle, hydrometeorology and formation of precipitation.
- The students are able to apply the various methods of field measurements and empirical formulas for estimating the various losses of precipitation, stream flow and runoff.
- The students know the various methods of rainwater and runoff harvesting. Then apply the knowledge of soil erosion and sedimentation to estimate the life of the reservoir

REFERENCES:

1. Chow V.T., Maidment D.R., Mays L.W., Applied Hydrology, McGraw Hill Publications, New York, 1995.
2. Subramanya K., Hydrology,Tata McGraw Hill Co., New Delhi, 1994.
3. Patra.K.C, Hydrology and Water Resources Engineering, Narosa Publications, 2008, Second Edition, New Delhi.
4. Jeya Rami Reddy.P, Hydrology, Laximi Publications, New Delhi, 2004

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

OBJECTIVES:

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

UNIT I ESTIMATION THEORY 12

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

UNIT II TESTING OF HYPOTHESIS 12

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

UNIT III CORRELATION AND REGRESSION 12

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

UNIT IV DESIGN OF EXPERIMENTS 12

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

UNIT V MULTIVARIATE ANALYSIS 12

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

TOTAL : 60 PERIODS

OUTCOME:

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

REFERENCES:

1. Johnson, R. A. and Gupta, C. B., “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, Seventh Edition, 2007.
2. Devore, J.L., “Probability and statistics for Engineering and the Sciences”, Thomson and Duxbury, Singapore, Fifth Edition, 2002.
3. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Asia, Sixth Edition, 2007.
4. Gupta, S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, Eleventh Edition, 2002.
5. Spiegel, M.R. and Stephens, L.J., ”Schaum’s outlines,-Statistics”, Tata McGraw-Hill, Third Edition, 2000.
6. Freund, J.E., “Mathematical Statistics”, Prentice Hall of India, Fifth Edition, 2001.

HW7111 HYDRAULICS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To expose the students to experimental learning of fluid phenomena both in air and water.

LIST OF EXPERIMENTS

- Wave length, profile and group velocity as a function of wave period, water depth and wave height.
- Wave forces on cylinders and piers.
- Drag and lift characteristics of aerofoils.
- Drag characteristics of cylinders.
- Boundary layer measurements.
- Measurement of velocities in wave flume.
- Hydraulic jump studies.
- Discharge measurements using venture-flume.
- Hele – Shaw model.
- Velocity profiles in free jets.
- Flow through porous media. Flow net plotting.

TOTAL: 60 PERIODS

OUTCOME:

- The students will be able to design and construct experimental models related to open channel hydraulics and coastal engineering.

HW7201 HYDROLOGIC ANALYSIS AND DESIGN L T P C
3 0 0 3

OBJECTIVES:

- Introduce the concepts of systems approach to hydrological modeling.
- Analysis of Hydrologic time series and stochastic hydrologic models.
- Study types and classes of hydrologic simulation models.
- Design procedures used for safe and effective passage of flood flows and discuss the design methods

UNIT I HYDROLOGIC SYSTEM AND STATISTICAL ANALYSIS 9

Hydrologic cycle – System concept – Hydrologic system Model – Classification of Hydrologic Models – Statistical, Stochastic and Deterministic Approaches – Statistical characteristics of Hydrological Data – Probability distribution of Hydrologic Variables Correlation Analysis – Developing Prediction Equation by Simple and Multiple Linear Regression – Reliability of the Model.

UNIT II HYDROLOGIC TIME SERIES ANALYSIS 10

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

UNIT III DETERMINISTIC HYDROLOGIC SIMULATION 10

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

UNIT IV DESIGN STORM AND ITS SYNTHESIS 8

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

UNIT V HYDROLOGIC DESIGN 8

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

TOTAL: 45 PERIODS

OUTCOMES:

- Students develop prediction equation between hydrologic variables using simple and multiple linear regression.
- Students apply the time series models for hydrologic data generation and forecasting.
- Student exposed to different types and procedure for calibration and validation of deterministic simulation models.
- Students apply the hydrologic design concepts and methods for estimating the design flows for minor, medium and major hydraulic structures.

REFERENCES:

1. Chow V. T., David Maidment, and Larry Mays, Applied Hydrology, McGraw Hill Publications, New York, 1995.
2. Singh, V. P. Hydrologic Systems, Prentice-Hall Englewood Cliffs, NJ 1989.
3. Jayarami Reddy P., Stochastic Hydrology, Laxmi Publications, New Delhi 1995.
4. Viessman W Jr and Lewis.G.L., Introduction to Hydrology (5ed) Pearson Education, Inc. 2008.
5. Haan C.T., Statistical Methods in Hydrology Iowa State Press 2002.

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.

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.

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

OUTCOME:

- 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

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

OUTCOME:

- 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

HW7311 **INDUSTRIAL TRAINING** **L T P C**
0 0 0 1

OBJECTIVES:

- To expose the students in the real life environment of the industry/research institute/or field work.
- To help the students understand the basics functioning of the organization.
- To prepare the ground work for choosing their masters thesis topic.

SYLLABUS

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

OUTCOME:

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

HW7312 **PROJECT WORK (PHASE I)** **L T P C**
0 0 12 6

OBJECTIVES:

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

SYLLABUS

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

TOTAL: 180 PERIODS

OUTCOME

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

HW7411 **PROJECT WORK (PHASE II)** **L T P C**
0 0 24 12

OBJECTIVES:

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

SYLLABUS

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

TOTAL: 360 PERIODS

OUTCOME

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

HW7001	AQUIFER STORAGE AND RECOVERY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Students will be introduced to the new technology of aquifer recharge and their various issues;
- They will also be exposed to geochemical processes of parent groundwater and recharge water;

UNIT I INTRODUCTION 9

Aquifer Storage and Recovery: A New Management Tool - Feasibility Assessment and Conceptual Design - Recharge Objectives - Regulatory and Water Rights Issues - Institutional Constraints Field Test Program - Site Selection - Outline of Test Program and Duration – ASR Well field Expansion - Recharge Water Quantity and Quality.

UNIT II DESIGN OF ASR SYSTEMS 9

Design and Construction of Recharge Wells - Selection of ASR Storage Intervals - Wellhead Facilities - Pipeline Flushing and Waste flow Discharge – Pump sets - Cascading Control – Air and Vacuum relief – Pressure and Water Level Measurement – Flow Measurement - Disinfection and pH Adjustment – Advective and Dispersive Mixing.

UNIT III TECHNICAL ISSUES OF ASR 9

Recovery Efficiency – Well Clogging Processes and Redevelopment – Measurement Methods - Normalization of Clogging Rate - Well head filtration – Pre and Post Treatment – Geo Chemical Processes and Models – Changes in Aquifer Characteristics

UNIT IV NON-TECHNICAL ISSUES OF ASR 9

Legal and Regulatory Issues – EPA Surface Water Treatment and Ground Water Quality Rule - Non-Degradation of Groundwater Quality – Seasonal vs Longterm Storage – Recovery Percentage – Water level Impacts – Location for Recovery of Stored Water – Environmental Impacts – Public Involvement

UNIT V ALTERNATIVE TO AQUIFER STROAGE RECOVERY 9

Agricultural Applications of Treated Waste – Ground Water Recharge through Soil Aquifer Treatment – Reclaimed Water Injection - Technical Considerations – Regulatory Considerations – Economics - Driving Forces – Constraints – Opportunities – Case Studies.

TOTAL: 45 PERIODS

OUTCOME:

- This course enabled to design the ASR system with better understanding of technical and non technical issues of aquifer recharge.

REFERNCES:

1. David Pyne. R., Aquifer Storage and Recovery in Wells, CRC press, 1995.
2. Karen J. Dawson, Jonathan D. Istok, Aquifer Testing Design and Analysis of Pumping and Slug Tests, Lewis Publishers, 2002.
3. John T. Scholz and Bruce Stiftel. Editors, Adaptive Governance Water Conflict – Anew Institutions for Collaborative Planning.
4. George F. Pinder, Groundwater Modeling using Geographical Information System, John Wiley & Sons, Inc.
5. Charles R. Fitts, Groundwater Science, Academic Press, An imprint of Elsevier, Elsevier Science Ltd, 2002.

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

OBJECTIVES:

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

UNIT I ADVANCED COMPUTING TECHNIQUES 10

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

UNIT II ARTIFICIAL INTELLIGENCE 10

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

UNIT III DIGITAL DATA MANAGEMENT 10

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

UNIT IV SIMULATION SOFTWARE IN WATER RESOURCES 8

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

UNIT V SIMULATION MODELS IN IRRIGATION WATER MANAGEMENT 7

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

TOTAL: 45 PERIODS

OUTCOMES:

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

REFERENCES:

1. Aliev R. A, and Aliev Rashad Soft Computing and its Applications World Scientific Publications Co. Pte. Ltd. Singapore, 2001.
2. Janusz Kacprzyk Applied Decision with Soft Computing Springer, 2003
3. Carlos A. Coello Coello, David A Van Veldhuizen, Gary B Lamont, Evolutionary Algorthms for Solving Multi-objective problems, Springer, 2002.
4. Tayfur Gökmen Soft computing in water resources engineering, WIT Press, Great Britain,UK,20124.
5. John E. Gribbin, Introduction to hydraulics and hydrology with applications for Storm water Management. DELMAR, Thomson Learning, USA,2002.
6. Remson I, Hornberger G.M. and Moiz F.J., Numerical methods in Sub- Surface Hydrology. Wiley Inter Science, 1985
7. Kazda, I., Finite element Techniques in ground water flow studies (with Applications in Hydraulic and Geotechnical Engineering), Elsevier, 1990.
8. Abbott M.B, and Minns A.W. Computational hydraulics Ashgate, London,UK,2007.
9. Loucks Daniel P., Jery R Stedinger and Douglas, A. Haith, Water Resources systems Planning and Analysis. Prentice Hall Inc., Englewood Clifts, New Jersey, 1981.

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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

HW7005 GROUNDWATER MODELLING AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To introduce the students to the application of management models to estimate the groundwater quantity and qualities. After the completion of the course, the student should able to understand the inputs, system parameters, policy, variables and outputs of a groundwater management models.

UNIT I GROUNDWATER PROSPECTING 9

Investigation and evaluation – Geophysical methods- Electrical Resistivity methods – Interpretation of data – Seismic method – Subsurface investigation – Test drilling – Resistivity logging – Application of remote sensing techniques.

UNIT II GROUNDWATER FLOW MODEL 9

Physical models – Analog models – Mathematical modeling – Unsaturated flow models Numerical modeling of groundwater flow – Finite difference equations and solutions – Successive over Relaxation, Alternating direction implicit procedure – Crank Nicolson equation – Iterative methods -Direct methods - Inverse problem – Finite element method

UNIT III CONTAMINANT Transport Model 9

Contaminant transport theory – Advection, dispersion equation – Longitudinal and transverse dispersivity – Hydrodynamic dispersion – Analytical models – Numerical simulation of solute transport – Solution methods - Sorption model – Density driven flow - Heat transport.

UNIT IV MODEL APPLICATIONS 9

Data requirements – Conceptual model design : Conceptualization of aquifer system – Parameters, Input-output stresses, Initial and Boundary conditions - Model design and execution: Grid design, Setting boundaries, Time discretization and Transient simulation – Model calibration : steady state and unsteady state – sensitivity analysis – Model validation and prediction – Uncertainty in the model prediction

UNIT V GROUNDWATER MANAGEMENT MODELS 9

Optimal groundwater development – Indian GEC norms – Conjunctive use models Modeling multilayer groundwater flow system -Modeling contaminant migration – Modeling fracture flow system – Artificial recharge feasibility through modeling – Simulation of movements of solutes in unsaturated zone – Stochastic modeling of groundwater flow - Groundwater contamination, restoration and management

TOTAL: 45 PERIODS

OUTCOME:

- Students are able to develop and apply numerical model for various application along with better understanding aquifer characteristics.

REFERENCES:

1. Anderson M.P., and Woessner W.W., Applied Groundwater Modelling : Simulation of flow and advective transport, Academic Press, Inc., 1992
2. Fetter C.W., Contaminant Hydrogeology, Prentice Hall, 1999
3. Rushton K.R., Groundwater Hydrology : Conceptual and Computational Models, Wiley, 2003
4. Elango L. and Jayakumar, R. Modelling in Hydrology, Allied Publishers Ltd., 2001
5. Remson I., Hornberger G.M. and Moltz F.J., Numerical Methods in Subsurface Hydrology, Wiley, New York, 1971

6. Robert Willis and William W.G.Yenth, Groundwater System Planning and Management, Prentice Hall, Englewood Cliffs, New Jersey, 1987.
7. Groundwater Hydraulics and Pollutant Transport, Randall J.Charbeneau, Prentice Hall, 2000
8. Rastogi K. , Numerical Groundwater Hydrology, 2011

HW7006 ISOTOPE TECHNIQUES IN WATER RESOURCES MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the student on the emerging tools such as isotope hydrology
- To demonstrate the application of this advance technique to solve practical problems in hydrology and water resources engineering

UNIT I BASIC PRINCIPLES 9

Introduction to elements, nuclides, isotopes- Isotopes and their characteristics - Classification of isotopes -Theory of Radioactivity - Stable and radioactive isotope in hydrology;

UNIT II MEASUREMENT TECHNIQUES 9

Sampling-sample preparation for isotope analysis-Mass spectrometric techniques – Instrumentation - Continuous Flow and Dual injection systems;

UNIT III HYDROMETEOROLOGY 9

Isotope fractionation-partitioning of isotopes in the hydrologic cycle - Meteoric Water Line (MWL) - Deuterium excess - Rayleigh fractionation model - isotope effects distillation;

UNIT IV APPLICATIONS OF ISOTOPES IN SURFACE WATER HYDROLOGY 9

Water balance - Lake dynamics- sub-surface inflow and outflow estimates sedimentation in lakes and reservoirs – seepage from dams, reservoirs, canals -stream flow measurements;

UNIT V APPLICATIONS OF ISOTOPES IN GROUND WATER HYDROLOGY 9

Soil moisture movement - Groundwater velocity in saturated zone - Identification of source of recharge and recharge mechanism - Seawater intrusion - Contaminant hydrogeology;

TOTAL: 45 PERIODS

OUTCOME:

- Students are enabled to apply isotope fingerprints for better understanding of hydrological processes and mechanism for water resources development and management

REFERENCES:

1. Rao S.M., “Practical Isotope Hydrology”, New India Publishing Agency, 2006.
2. Clark I D and Fritz P, “Environmental isotopes in hydrogeology, Lewis Publishers, Boca Raton, The Netherlands, 1997.
3. Mook W.G. (Ed), “Environmental Isotopes in Hydrological Cycle, Principles and Applications”, IHP-V, Technical Documents in Hydrology, No 39, Vol 1, UNESCO, Paris, 2000.
4. Fritz P and Fontes J.Ch(Eds.) Handbook of environmental isotope Geochemistry-Vol I and II. Elsevier scientific publishing Company, The Netherlands, 1980

5. Criss R. E, Principles of stable isotope distribution. Oxford University Press.1999.
6. “Use of Artificial Tracers in Hydrology”, Proc. Adv. Group Meeting, Vienna, IAEA, 1990.
7. Kendal C.,and McDonnell J.J., “Isotopes in Catchment Hydrology”, Elsevier, 1998.

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.

HW7008	SOIL AQUIFER TREATMENT TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Students will be introduced to the new technique of groundwater reclamation and recharge
- Students will be exposed to the concept of simulation of flow and transport in an unsaturated zone

UNIT I SOIL PHYSICS OF UNSATURATED ZONE 9

Soil Solid Phase : Soil phases, texture, mineralogy and structure – Soil Water Content and Potential: Measuring Soil Water Content and Potential – The Soil Water Retention Curve – Capillary Rise Law and Hydraulic Capacity Function for Van Genuchten Equation.

UNIT II SOIL AQUIFER TREATMENT (SAT) CONCEPTS 9

SAT definition – process description – layouts – components – Dynamics – Filtration, Adsorption, Biodegradation, Ion exchange and precipitation – operation. Hydraulic loading rate, Water depth in the basin, wetting and drying cycles, water Quality improvement: Removal of pathogens, nitrogen, organic carbon and inorganic compounds. Soil clogging: Physical, Chemical & Biological.

UNIT III BASIC PROCESS RESPONSES AND INTERACTIONS 9

Fundamental relationships – movement of pollutants – Groundwater mounding – under drainage – Biodegradable organics removal of BOD – Removal of suspended solids – organic priority pollutants – removal methods – removal performance – travel time in soils – pathogens and metals – Aquatic, wetland and land treatment system – Nutrients : nitrogen, phosphorous, potassium and other micronutrient.

UNIT IV DESIGN OF SAT SYSTEM 9

Design objectives – site selection – Treatment performance – pre application treatment – Design procedure – Design considerations – hydraulic loading rates, nitrogen loading rates – organic loading rates – land requirements – Hydraulic loading cycle – Infiltration system design – construction considerations – operation and maintenance.

UNIT V GROUNDWATER FLOW AND TRANSPORT IN UNSATURATED ZONE 9

Steady flow in saturated and unsaturated soils – Measurement of Hydraulic Properties – Poiseuille Equation – Transient flow in soils – The Richards equation – Initial and Boundary Conditions – Numerical Solutions to the Richard equation – Groundwater Recharge and Discharge – Solute Transport Advection Dispersion Equation – Numerical Approaches for Solute Transport – HYDRUS Examples flow and transport.

TOTAL: 45 PERIODS

OUTCOME:

- Students are enabled to design the SAT system through which unsaturated zone processes and their interaction will be understood. In addition this course leads to learning of vadose zone modeling

REFERENCES:

1. Natural Wastewater Treatment systems, Ronald W. Crites, Joe Middle brooks & Sherwood C. Reed, CRC Taylor & Francis, 2006;
2. Soil Physics with HYDRUS, modelling and applications by Radcliffe, David E : Simunek, 2005.

3. Soil Aquifer Treatment system concepts, operation and management, Thaer Abushbak, Lambert Academic Publishing, 2011.
4. Soil Aquifer Treatment for sustainable water use by Peter Fox, Sandra Houston and Pane Westernholf, 2001;
5. Soil Treatability pilot studies to design and model Soil Aquifer Treatment System, 1997;

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.

HW7071 URBAN WATER RESOURCES MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

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

UNIT I URBAN HYDROLOGIC CYCLE 9

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

UNIT II URBAN WATER RESOURCES MANAGEMENT MODELS 9

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

UNIT III URBAN STORM WATER MANAGEMENT 9

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

UNIT IV MASTER PLANS 9

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

UNIT V OPERATION AND MAINTENANCE 9

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

TOTAL: 45 PERIODS

OUTCOME:

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

REFERENCES:

1. Geiger, W.F., Marsalek, F., and Zuidena, F.C., (Ed), manual ondrainage in urbanized areas – Vol.1 and Vol.II, UNESCO, 1987.

2. Hengeveld, H. and C. De Voch.t (Ed)., Role of Water in Urban Ecology, 1982.
3. Martin, P. Wanelista and Yousef, A. Yousef., Storm Water Management, John Wiley and sons, 1993.
4. Neil S. Grigg., Urban Water Infrastructure Planning, Management and Operations, John Wiley and Sons, 1986.
5. Overtens D.E. and Meadows M.E., Storm Water Modelling, Academic Press, New York, 1976.

HW7072 WATER SUPPLY AND BURIED PIPELINES

L	T	P	C
3	0	0	3

OBJECTIVE:

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

UNIT I WATER SUPPLY SYSTEMS 9

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

UNIT II HYDRAULIC PRINCIPLES AND NETWORK PARAMETERS 10

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

UNIT III STORM WATER DISTRIBUTION AND BURIED PIPES 9

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

UNIT IV RELIABILITY ASSESSMENT AND DESIGN 8

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

UNIT V FLUID TRANSIENTS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

REFERENCES:

1. Bhave P. R, Optimal design of water distribution networks, Narosa publishing House, New Delhi, 2003

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

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.

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

OUTCOMES:

- 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.

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.

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.

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