SEMESTER -I

ADVANCED FLUID MECHANICS – I	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**

1. Acceleration and continuity equations for three dimensional flow, Cartesian coordinate system, cylindrical coordinate system, circulation and vortices Euler's equation and its application, Momentum equation and its application to pipe bends, transitions and Nozzles

2. Boundary layer equation: Prandtl laminar boundary layer equation, Blasius equations and its solutions, approximate solution to laminar boundary layer, Integral nominators and energy equations, laminar stability of boundary layer laminar and turbulent boundary layers

3. Drag and Lift: Definitions, Pressure drag, Friction drag, Drag coefficient, characteristics of sphere, disc cylinder compressibility effect, shockwave, Circulation, Lift, Magnus effect, Lift Characteristics of aero foils, Induced drag.

4. Turbulence: Origin, stability of flows, Reynolds equations statistical theories of turbulence, correlation of the random unsteady components.

5. Jets and Wakes: Mixing and Diffusion

REFERNCE BOOKS:

1. G.K. Bachelor: An introduction to fluid mechanics(Cambridge Univ. Press)
2. Hunder Rose: Advanced mechanics of fluids, 1959-Editor
3. J.O. HIntze: Turbulence (Mc Graw Hill – 1959)
4. J.L. Lunley: A first course in Turbulence 1972 H. Tennets

NUMERICAL METHODS(C)

Fundamental of numerical methods, error analysis, numerical differentiation and integration and extrapolation. Solution of non-linear algebraic and transcendental equations.

Elements of matrix algebra, solution of system of linear and non-linear equations.

Eigen Value Problems:

Solution of differential equation – initial and two point boundary value problems, and complex variables – elliptic integrals, introduction to finite elements method, computer oriented algorithms, numerical solution of problems drawn from various fields of engineering.

REFRANCE BOOKS:

1. Ralston Anthony- H.S.Wilfy- Mathematical methods for digital computers (Wiley 1960)
2. J.R.Mc Galla – Introduction to numerical methods and fortran programming (Wiley 1967).
3. O.V.Action- Numerical method that work (Harpur1970).
4. O.C.Zienkeivich- FEM in engineering and science.
5. E.H.Gellaghan and Oden- Finite Elements on fluids, Volume I & II.

GROUNDWATER HYDROLOGY

L	T	P	C
3	1	0	4

UNIT I INTRODUCTION TO GROUNDWATER

Groundwater in Hydrologic Cycle – Occurrence of groundwater – Hydrogeology – Hydrometeorology – soil sample analysis - Water bearing materials - Types of aquifers – parameters of Aquifers – Determination of specific yield and permeability

UNIT II GROUNDWATER HYDRAULICS

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 – Collector wells and Infiltration galleries.

UNIT III PUMPING TEST ANALYSIS

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

Well design criteria – Construction of wells – Well drilling methods – Filter design – Artificial and natural packing – Well castings and screens – Production test – Maintenance of production wells.

UNIT V SPECIAL TOPICS

Methods of artificial groundwater recharge – Groundwater assessment and balancing – Seawater intrusion in coastal aquifers – Land Subsidence - Wells in hard rock areas.

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.

ELECTIVES-I

HYDROLOGIC ANALYSIS AND DESIGN

L	T	P	C
3	1	0	4

UNIT I HYDROLOGIC AND HYDRAULIC MODELS

Hydrologic investigation - systems approach – concept of a model. Classification of hydrological models, Time-area methods –Unit Hydrograph – Instantaneous Unit Hydrograph. – Synthetic Unit Hydrographs. Clark model, Nash model, Tank model.

UNIT II HYDROLOGIC SIMULATION AND STREAM FLOW SYNTHESIS

Classification of Hydrologic Simulation Models. Single-Event Rainfall-Runoff Models. Continuous Simulation Models. Groundwater Flow Simulation Models. Streamflow Synthesis.

UNIT III HYDROLOGIC DESIGN

Hydraulic Structure Design Methods – Risk Analysis – Design Storms and its synthesis. Design Flows. Urban Storm Drainage Design, Airport Drainage Design, Detention Storage Design.

UNIT IV RANDOM PROCESSES

Classification – Stationary Random process - Components of time series – Trend Analysis – Regression – Multiple Linear Regression – Diagnostic tools.

UNIT V FORECASTING MODELS

Box Jenkins' models – Correlation – Auto correlation – Partial auto correlation – Yule Walker equations – AR(p) – MA(q) – ARMA(p,q) – ARIMA (p,d,q) models – model formulation – Validation – Application.

REFERENCES:

1. Singh, V. P. Hydrologic Systems, Prentice-Hall Englewood Cliffs, NJ 1989.
2. Jayarami Reddy P., Stochastic Hydrology Laxmi Publications, New Delhi 1995.
3. Viessman W Jr. Introduction to Hydrology (5ed) Pearson Education, Inc. 2003.
4. Haan C.T., Statistical Methods in Hydrology Iowa State Press 2002.

SOFT COMPUTING AND SIMULATION IN WATER RESOURCES

L	T	P	C
3	1	0	4

UNIT I COMPUTING TECHNIQUES

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

UNIT II ARTIFICIAL INTELLIGENCE

Heuristic search - Knowledge based Expert system concepts - Architecture and applications in Water Resources Management - Expert system shells - Principle of Artificial Neural Network (ANN) - Application of ANN Model to Hydrology and Crop Water Requirement model. Fuzzy Logic concepts and Applications – Genetic Algorithms

UNIT III DIGITAL DATA MANAGEMENT

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

Surface water models (HMS) - Storm Water Management Models (SWMM) - Water CAD, STORM CAD - Ground Water Flow models - Visual Modflow-FEFLOW

UNIT V SIMULATION MODELS IN IRRIGATION WATER MANAGEMENT

Soil moisture simulation models - Basin simulation models (MITSIM, VASIM, SIMYIELD) Real time operation models - Water Resources Information System, Management Information System.

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. Vijay P Singh, Hydrologic Systems: Rainfall Runoff Modeling, Prentice Hall, 1988.
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. ABBOT M.B., Computational hydraulics Elements of the Theory of Free surface flows. Pitman Advanced publishing Program, 1999.
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.

FLOOD AND DROUGHT MANAGEMENT

L	T	P	C
3	1	0	4

UNIT I FLOOD ESTIMATION AND ROUTING

Estimation of design flood – SPF/MPF empirical methods – Statistical methods – Frequency analysis – Unit hydrograph method – Flood estimation in small watersheds and mountainous region – Estimation by lumped, distributed model – Routing – Lumped – Distributed – Hydraulic and hydrological routing.

UNIT II FLOOD CONTROL AND MANAGEMENT

Flood control methods – Structural and non structural measures - Flood plain Zoning – Flood disaster monitoring and mitigation procedure – Methods of forecasting – Data analysis and warning – Flood fighting -Remote Sensing for flood management

UNIT III DROUGHTS

Definitions based on rainfall, stream flow, vegetation and comprehensive aspects - Characterisation of Drought/water shortage/aridity/desertification - NCA classification – Direct and indirect losses

UNIT IV DROUGHT ASSESSMENT

Drought indices - Drought severity assessment – meteorological, hydrological and agricultural aspects - IMD, Palmer, Herbst, Aridity Indices and Ramaprasad methods.

UNIT V DROUGHT MONITORING AND MANAGEMENT

Drought monitoring - Supply and demand oriented measures – Traditional water conservation - Drought Prone Areas Programme (DPAP) – Integrated drought management – Remote Sensing Applications for drought mitigation - NDVI concepts.

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, 1988.

ELECTIVES-II

WATER-POWER AND DAM ENGINEERING

L	T	P	C
3	0	2	4

UNIT I HYDROELECTRIC POWER DEVELOPMENT

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

UNIT II DESIGN OF HYDROPOWER INSTALLATION

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

UNIT III TYPES OF POWER HOUSE

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

UNIT IV EMBANKMENT DAM ENGINEERING

Introduction. Nature and classification of engineering soils. Principles of design. Materials and construction. Internal seepage. Stability and stress. Settlement and deformation. Rockfill and rockfill embankments.

UNIT V CONCRETE DAM ENGINEERING

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

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.

WATER QUALITY AND POLLUTION

L	T	P	C
3	1	0	4

UNIT I WATER QUALITY

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

UNIT II IRRIGATION WATER QUALITY

Water quality standards – Water quality for irrigation – Salinity and permeability - Irrigation practices for poor quality water – Waste water irrigation: problems and prospects – Saline water irrigation – Future strategies - Water quality indices

UNIT III SOURCES OF WATER POLLUTION

Leaching of agrochemicals – Domestic sewage – characteristics – Water pollutants from industries – Dissolved oxygen sag curve - Non Point Source (NPS) models – Agricultural Non Point Source (AGNPS) pollution model.

UNIT IV WATER POLLUTION ABATEMENT TECHNOLOGIES

Flow diagram and working principle of Activated sludge process, Trickling filter – Oxidation pond – Aerated lagoons – Advantages disadvantages and suitability – Packaged treatment units, advantages, disadvantages – Reverse osmosis

UNIT V RECYCLING AND REUSE OF WASTEWATER

Reuse of wastewater in agriculture – prevalence and issues from around the world – Pretreatment technologies – Removal of nutrients from treated water – Economic and social dimensions. – Constructed wetlands – reed beds

REFERENCES:

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, 2002.
2. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, McGraw-Hill 2006.
3. Stum, M and Morgan, A., Aquatic Chemistry, Plenum Publishing company, USA, 1985.
4. Lloyd, J.W. and Heathcote, J.A., Natural inorganic chemistry in relation to groundwater resources, Oxford University Press, Oxford, 1988.
5. Newmann, E.I., Applied ecology, Blackwell Science ltd., Oxford, 1996.
6. Sithamparanathan, J., Rangasamy, A. and Arunachalam, N., Ecosystem principles and sustainable agriculture, Scitech Publishers, Chennai, 1999.

WATER MANAGEMENT (E)

L	T	P	C
3	1	0	4

Moisture crop relationship, irrigation requirements, irrigation efficiencies, trickle, sprinkler, and furrow irrigation, irrigation of arid lands, drainage of irrigated lands.

Salinity of soil, cause, control, quality of irrigation water, contamination and their effects on various crop types, operation of reservoirs, water management policy during draughts, predictions of effects of water shortages of on crops.

Reference Books:

1. A.K.Biswas: System approach to water management, McGraw Hill.
2. **D.Whittington and G.Guariso: water management models in practice**

TECHNO ECONOMIC ANALYSIS OF WATER DEVELPOMENT

L	T	P	C
3	1	0	4

Development Objectives:

Need system, economic and social development, integrated development, multiple purpose of water resource development.

Institutional Studies:

Setup for evaluation implementation, operation water laws, regulation, organizations, and functions data requirement, primary and secondary data, data related to development sectors, environment, and water resource related land and other natural resources.

Elements of welfare economics, resources economics, environmental economics, definition of the project resources structure, elucidation of organization, managerial, social, technical, physical, institutional and economics dimensions.

Definition of primary and secondary impact, long-term and short-term impacts, identifications of casts and benefits, evaluation research, objective of post implementation, evolution, methodologies, elements of risk/benefits analysis, definition of risk, structural mists and performance risks, case studies.

Reference Books:

1. James and Lae: Economics of water resource planning, McGraw Hills.
2. Kuiper: Water resource development, planning engineering and economics.

DESIGN OF WATER AND BARRAGES

L	T	P	C
3	1	0	4

Determination of uplift pressure, Khoslas theory, graphical method. General consideration on location of head works, types of cut-offs employed in modern weirs, temporary study for weirs construction, methods of works in dewatered enclosure, dewatering the enclosure weirs constructed in flowing waters, solids weirs and over-fall dams, movable weirs, typical deigns for their metal equipments, vibrations and water pressure pulsations at weirs and dams, storage computations, weirs in canals, devices for excluding and extracting heavy silt and sediments, gates on barrages.

Reference Books:

1. Serge Leliavsty: Design text books on civil engineering, volume-1 & volume-5.
2. R.S.Varshney: Design of Hydraulics structure.
3. Bharat Singh: Irrigation Engineering.

THEORY OF SEEPAGE AND EARTH DAMS (E)

L	T	P	C
3	1	0	4

1. Factors influencing design of earth dam, type of dams.
2. Seepage analysis, pore pressure and settlement.
3. Design criteria for various components of earth dams.
4. Method of foundation treatment to control seepage.
5. Stability of earth dam-factor of safety, stability of slopes.
6. Embankment construction procedures, quality control.
7. Performances studies of earth dam, special problems, instrumentation.
8. Causes of failures of earth dams and corrective measures.

Reference Book:

1. Engineering for Dams: Creager, Justin and Hinds.
2. Earth and rock fill dams: Sherrod.
3. Earth and rock fill dams: Sowers and sally.
4. Earth and rock fill dams: Bharat Singh and Sharma.
5. Earth Manual: U.S.B.R.
6. Soil Mechanics: Alam Singh.

RESERVOIR PLANNING AND OPERATORS (E)

L	T	P	C
3	1	0	4

Objectives of water resource developments, purpose of storage, storage requirement, optimal timing, sequencing and rising of reservoirs, reservoir reciting, operating policies, rigid schedules, semi rigid schedules, gate operation, operation of single and multiple reservoirs in series and parallel, optimal creating policies, linear decision rules, optional releases by dynamics programming probility transition, matrix.

Reference Book:

1. V.T.Chow: Hand book of applied hydrology, McGraw Hill.
2. Loucks, Stedinger, Hatier- water Resource systems planning and analysis, prentice hall, 1981.