Babu Banarasi Das University, Lucknow

Department of Civil Engineering

School of Engineering

Master of Technology (Hydraulics & Water Resources Engineering) - Regular

Evaluation Scheme (w.e.f 2019-20)

SEMESTER I									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MAS3106	Applied Mathematics	4	0	0	40	60	**100**	**4**
C	MWE3101	Advanced Ground Water Hydrology	4	0	0	40	60	**100**	**4**
C	MWE3102	Advanced Hydrology	4	0	0	40	60	**100**	**4**
C	MWE3103	Free Surface Flow	4	0	0	40	60	**100**	**4**
GE	GE3(UB)11/ GE3(UB)15	Generic Elective I	4	0	0	40	60	**100**	**4**
C	MWE3151	Hydraulic Engineering Lab	0	0	2	100	0	**100**	**1**
C	MWE3152	Seminar	0	0	2	100	0	**100**	**1**
C	MWE3153	Technical Paper Writing	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**500**	**300**	**800**	**23**

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment
ESE End Semester Examination

Category of Courses:

C Core Course
GE Generic Elective

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SEMESTER II									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MWE3201	Advanced Irrigation Engineering	4	0	0	40	60	**100**	**4**
C	MWE3202	Advanced Hydraulic Structures	4	0	0	40	60	**100**	**4**
C	MWE3203	Numerical Methods in Flood Routing	4	0	0	40	60	**100**	**4**
C	MWE3204	Water Resources Management	4	0	0	40	60	**100**	**4**
GE	GE3(UB)21/ GE3(UB)25	Generic Elective II	4	0	0	40	60	**100**	**4**
C	MWE3251	Water Analysis and Hydrology Laboratory	0	0	2	100	0	**100**	**1**
C	MWE3252	Seminar	0	0	2	100	0	**100**	**1**
C	MWE3253	Technical Paper Presentation	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**500**	**300**	**800**	**23**

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

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SEMESTER III									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MWE3351	State of the art Seminar#	-	-	-	200	0	**200**	**4**
C	MWE3352	Thesis - I*	-	-	-	400	0	**400**	**16**
Total			**-**	**-**	**-**	**600**	**0**	**600**	**20**

\# Student need to perform a literature survey and will give a state of the art presentation and will submit a synopsis clearly mentioning the problem statement. The presentation and synopsis will be evaluated internally within two months of the start of the semester and the result will be intimated to the students so as to proceed for thesis.

* Student will develop the workable model for the problem they have supposed in synopsis.

SEMESTER IV									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MWE3451	Thesis - II**	-	-	-	200	800	**1000**	**28**
Total			**-**	**-**	**-**	**200**	**800**	**1000**	**28**

** (a) This is in continuation with Thesis - I.

(b) The required experimental / mathematical verification of the proposed model will be done in this semester.

Legends:

L Number of Lecture Hours per week

T Number of Tutorial Hours per week

P Number of Practical Hours per week

CIA Continuous Internal Assessment

ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

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Master of Technology (Hydraulics & Water Resources Engineering) - Regular

Evaluation Scheme (w.e.f 2019-20)

Course Code	Generic Elective-I
GE3(UB)11	River Engineering
GE3(UB)12	Irrigation and Drainage Systems Engineering
GE3(UB)13	Hydro Power Structures
GE3(UB)14	Computational Fluid Dynamics
GE3(UB)15	Socio-Economic and Environmental Evaluation of Water Resources Projects

Course Code	Generic Elective-II
GE3(UB)21	Water Supply Distribution Systems
GE3(UB)22	Environmental Aspects of Water Resources
GE3(UB)23	Computational Techniques in Water Resources Engineering
GE3(UB)24	Remote Sensing Applications in Water Resources Engineering
GE3(UB)25	Finite Element Analysis

Note – UB code will be allotted by the University as and when required.

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Evaluation Scheme (w.e.f 2019-20)

Credit Summary Chart						
Course Category	**Semester**				**Total Credits**	**%age**
	I	**II**	**III**	**IV**		
C	19	19	20	28	86	91.48
GE	4	4			8	8.52
Total	**23**	**23**	**20**	**28**	**94**	**100**

Discipline wise Credit Summary Chart						
Course Category	**Semester**				**Total Credits**	**%age**
	I	**II**	**III**	**IV**		
Engg. Sciences	4				**4**	4.26
Professional Subject Core	13	17			**30**	31.92
Professional Subject - General Elective	4	4			**8**	8.52
Thesis, Seminar	2	2	20	28	**52**	55.32
Total	**23**	**23**	**20**	**28**	**94**	**100**

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment
ESE End Semester Examination

Category of Courses:

C Core Course

GE Generic Elective

MWE3101 ADVANCED GROUND WATER HYDROLOGY

Course Objective:

1. To know about the groundwater and its related problems.
2. To know about the basics offlow equation and pollutant transport.
3. To know about the basics of Sea Water Intrusion.
4. To know about the basics of problems in ground water development and management.

Learning Outcome:

1. Illustrate about the groundwater and its related problems.
2. Exposure onflow equation and pollutant transport.
3. Exposure onSea Water Intrusion.
4. Illustrate the basics of problems in ground water development and management.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to groundwater** Groundwater as a resource, general problems of chemical contamination in groundwater; Fluid potential, heterogeneity and anisotropy,Aquifers, aquitardsand general geology, well hydraulics, parameter estimation.	30 Hours	1
II	**Governing Equation** Steady and transientflow equations, unsaturated flow equation. **Pollutant transport** Pollutant transport in groundwater,chemical and transport processes, numerical modeling and solution, break through curves.	30 Hours	1
III	**Sea Water Intrusion** Seawater intrusion in coastal aquifers, Modeling of pollutanttransport in the unsaturated zone, Optimization models for management ofgroundwater quantity and quality, Optimal monitoring network design, Multiple objective management.	30 Hours	1
IV	Special topics: Special problems in ground water	30	1

	development and management artificial recharge.	Hours	

References:

1. Todd D. K., “Ground Water Hydrology”,Wiley India Pvt Ltd.
2. Bouwer H., “Groundwater Hydrology”, Tata McGraw Hill.
3. Nagabhushaniah, “GroundwaterinHydrosphere: Groundwater Hydrology”,CBS Publisher.
4. Chahar, “Groundwater Hydrology”, McGraw Hill Education.

MWE3102ADVANCED HYDROLOGY

Course Objective:

1. To know about the basics of hydrological processes.
2. To know about the basics of Hydrologic measurements and networks analysis.
3. To know about the Time Series Analysis.
4. To know about the basics ofStatistical Methods.

Learning Outcome:

1. Exposure onhydrological processes.
2. Exposure onHydrologic measurements and networks analysis.
3. Illustrate about the Time Series Analysis.
4. Exposure on Statistical Methods.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Hydrological processes** The hydrologic processes: precipitation, evaporation, infiltration, groundwater, and stream flow.	30 Hours	1
II	**Hydrological Measurements** Hydrologic measurements and networks analysis of discrete and continuous hydrologic data: harmonic analysis, statistical analysis including frequency analysis, correlation, and regression analysis and multivariate analysis.	30 Hours	1
III	**Time Series Analysis** Time series analysis and its application: system analysis and synthesis, linear and nonlinear, lumped and distributed parameter systems, simulation analysis.	30 Hours	1
IV	**Statistical Methods** Statistical methods in hydrology, probability distribution of hydrologic variables,hypothesis testing and goodness of fit, flood frequency analysis, single andmultiple regression analysis, classification of time series, characteristics of hydrologic time series, statistical principles and techniques for hydrologic timeseries modeling, time series modeling of annual and periodic hydrologic timeseries (including AR,	30 Hours	1

	ARMA, ARIMA, and DARMA models), multivariate modeling of hydrologic time series, practical considerations in time series modeling applications.		

References :

1. Subramanya K., “Engineering Hydrology”, McGraw Hill Education.
2. Garg, S.K., “Hydrology and Water Resources Engineering”, Khanna Publication.
3. Patra, K C, “Hydrology and Water Resources Engineering”, Narosa Book Distributors Pvt Ltd-New Delhi.
4. Ven Chow, Larry Mays, David Maidment, “Applied Hydrology”, McGraw Hill Education.

MWE3103 FREE SURFACE FLOW

Course Objective:

1. To know about the basics of free surface flow.
2. To know about the gradually and rapid varied flow.
3. To know about the basics of unsteady open channel flow.
4. To know about the basics of spatially varied flow.

Learning Outcome:

1. Exposure onfree surface flow.
2. Illustrate about the gradually and rapid varied flow.
3. Illustrate about the basics of unsteady open channel flow.
4. Illustrate about the basics of spatially varied flow.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Basic Principles** Review of free surface flow concepts including velocity and pressure distribution, Continuity,Momentum and Energy equation, concept of specific energy, computation of critical flow, channel transitions, critical flow venturi-flume, standing wave flume and broad crested weir in discharge measurement.	30 Hours	1
II	**Gradually Varied Flow** Gradually varied profile and its computations using direct step method, advanced numerical methods, delivery of canal systems. Rapid Varied Flow:Hydraulic jump in horizontal and sloped open channel bed and its characteristics	30 Hours	1
III	**Unsteady open channel flow** Wave celerity, classification of water waves according to relative depth, orbital motions,superposition, wave trains and wave energy, transformation of waves, dissipation of waveenergy, positive and negative surges in rectangular channel, Momentum and Continuityequations (Saint Venant Equation), two	30 Hours	1

	dimensional unsteady flows and their solution bynumerical techniques.		
IV	**Spatially varied flow** Basic principles and assumptions, dynamic equation and analysis of flow profiles, Numericalintegration method, Isoclinal method, spatially varied steady and unsteady surface flows.	30 Hours	1

References:

1. ChaudharyHanif M., “Open Channelflow”, Prantice-Hall of India Pvt. Ltd. New Delhi.
2. Chow V T, “Open Channel Hydraulics”, McGraw-Hill Book Company, International editions, New Delhi.
3. Subrmanya K, “Flow in open channels”, Second edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Srivastava Rajesh, “Flow through open channels”, Oxford University press, NewDelhi.
5. French R H, “Open channel hydraulics”, McGraw Hill Publication, New York.
6. RangaRaju K.G., “Flow through Open Channels”, Tata McGraw-Hill Publishing Company Limited.

GE3(UB)11RIVER ENGINEERING

Course Objective:

1. To know about theclassification of river and sedimentation.
2. To know about the sediment load and geomorphic cycle.
3. To know about the basics of River Training Works.

Learning Outcome:

1. Exposure onclassification of river and sedimentation.
2. Exposure onsediment load and geomorphic cycle.
3. Illustrate about the basics of River Training Works.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** River classifications, Sediment properties, incipient motion, Significance, bed forms in alluvial streams and their prediction, Resistance to flow in alluvial streams.	30 Hours	1
II	**Sediment load** Transport of sediment load, estimation of bed load, suspended load and total load, Aggradation and degradation, Local scour, Hydraulic geometry of alluvial streams, cross section, longitudinal profile and plan forms, meandering of rivers, geomorphic cycle.	30 Hours	
III	**River Training Works** Type of river training works, guide bunds, Groynes, levees, cutoff, pitched island, temporary spurs, stabilization of rivers.	30 Hours	1
IV	**River models** Choice of scale for different entities, distorted models, distortion of scale, simulation of sediment transport and the geometry.	30 Hours	1

References:

1. Varma C.V.J. Saxena, K. R. and Rao, M. K., “River behavior management and training (Vol. I and II)”, CBI&P, New Dehli

2. Punmia B. C., and Lal B. B., “Irrigation & Water Power Engineering”, Laxmi Pub.
3. Yang, C.T., “Sediment transport theory and Practice”, McGraw-Hill, New York.
4. Graf, W.H., “Hydraulics of sediment transport”, McGraw-Hill, New York.
5. HendersonF.M., “Open Channel Flow”, MacMillan, New York.
6. Chang H.H., “Fluvial Processes in River Engineering”, John Wiley.
7. Garde, R.J. and RangaRaju, K.G., “Mechanics of Sediment Transport and Alluvial Stream Problems”, New Age International (P) Ltd. Publications, New Delhi.
8. Jansen, P. Ph, Van Bendegon L., De vries, M., “Principles of River Engineering”, Pitman, London.
9. Garde, R.J., “History of Fluvial Hydraulics”, New Age International (P) Ltd. Publishers, New Delhi.
10. Garde, R.J., “River Morphology”, New Age International (P) Ltd. Publishers, New Delhi.

GE3(UB)12IRRIGATION AND DRAINAGE SYSTEMS ENGINEERING

Course Objective:

1. To know about the basics of irrigation and national water policy.
2. To know about the Soil Water Crop Relationship.
3. To know about the basics of Modeling of Irrigation Systems.

Learning Outcome:

1. Illustrate about the basics of irrigation and national water policy.
2. Illustrateabout the soil water crop relationship.
3. Exposure onmodeling of irrigation systems.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Available water resources and its present utilization, Development through five year plans,Roles of various commissions on irrigation and agriculture, National water policy fordevelopment, Types of irrigation, Irrigation techniques and quality of irrigation water.	30 Hours	1
II	**Soil Water Crop Relationship** Determination of soil moisture, estimation of consumptive use and frequency of irrigation, irrigation efficiencies for economical use of water, design of various irrigation methods, assessment water charges, conjunctive use of surface and ground water, multi-crop irrigation scheduling.	30 Hours	1
III	**Modeling of Irrigation Systems** Governing equations and their solutions, computation of inundation front, cumulative infiltration estimation, modeling for sprinklers and other methods of irrigation.	30 Hours	1
IV	**Drainage of irrigated soils** Need and purpose of drainage, water logging of agricultural lands and its reclamation, steady state and transient designs of surface and sub-surface drainage systems, drainage by wells.	30 Hours	1

References:

1. Asawa G L, “Irrigation and Water Resources Engineering”, New Age International Publishers, New Delhi.
2. Dan Yaron, “Salinity in irrigation and water resources”, Morcel Dekker Inc. Newyork.
3. Michael A M, “Irrigation theory and practices”, Vikas Publishing House, New Delhi.
4. Richard H Cuenca, “Irrigation system design – An Engineering Approach”, Prentice Hall, Englewood Cliffs, New Jercy.
5. DilipkumarMujumdar, “Irrigation Water Management Principles and Practice”, PHI Publication New Delhi.

GE3(UB)13HYDRO POWER STRUCTURES

Course Objective:

1. To know about the energy sources for power generation.
2. To know about the basics of power potential studies.
3. To know about the classification and types of hydropower plant.
4. To know about the basics of power house planning.

Learning Outcome:

1. Exposure on energy sources for power generation.
2. Illustrate about the basics of power potential studies.
3. Exposure on classification and types of hydropower plant.
4. Exposure on power house planning.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Energy sources for power generation, Power scenarios, Demand and supply of power, need ofhydropower, General Hydrology, Environment and Hydro Power Development.	30 Hours	1
II	Power potential studies: Estimation of available water power, Power duration curve, Storage and pondage, Load studies, Technical terms related to hydropower, System integrated operational studies, Loadprediction, Installed capacity, Size and number of units.	30 Hours	1
III	**Classification and types of hydropower plant** Classifications, types, Storage power development ,components of storage powerdevelopment, economic aspects, social and rehabilitation aspects, Run-Off-River powerdevelopment, types of ROR, components of run-off-river power development, Run-of-powerdevelopment on canal falls, Underground and pumped storage power plants , advantages,types and location of underground power station, its components, types of layout, limitationsof underground power plants. Essential requirements of pumped storage power plant, economics of PSPP,	30 Hours	1

	Cost of power generated, Canal head power plant.		
IV	**Power House Planning** General layout of the power house and arrangement of hydropower units, Number and sizesof units, space allocation and dimensions, Super structure, Indoor, Semi-outdoor and Outdoorpowerhouse, Lighting and Ventilation, Variation in design of power house, Safetyrequirements, Operation and maintenance of hydro plants.	30 Hours	

References:

1. Barrows H. K., "Water Power Engineering", McGraw Hill Book Co., NewYork.
2. Dandekar and Sharma, "Water Power Engineering", Vikas Publishing House, New Delhi.
3. Deshmukh M.M., "Water Power Engineering", DhanpatRai Publications, New Delhi.
4. Nigam N C,"Handbook of hydro-power engineering", publishers NemChandand sons, Roorkee.
5. Sharma R.K. and Sharma T.K., "Water Power Engineering" S.CHAND &Company, New Delhi.
6. Varshney R.S, "Hydropower Structures", Nemchand and Bros., Roorkee.
7. Guthrie Brown, "Hydropower Electric Engineering", Blacki and Son, London.

GE3(UB)14COMPUTATIONAL FLUID DYNAMICS

Course Objective:

1. To know about the basics complex analysis
2. To know about thenumerical solution of system of equations.
3. To know about the Numerical Solution of ordinary differential equations and partial differential equations.
4. To know about the parabolic equations.

Learning Outcome:

1. Exposure on complex analysis
2. Exposure onnumerical solution of system of equations.
3. Exposure onnumerical solution of ordinary differential equations and partial differential equations.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Complex Analysis** Analysis functions, Equipotential curves and streamlines and their orthogonality, complex potential, Potential flow, Singularities of potential functions and their types. Sources and sinks. Image system to form the complexpotential. Doublets Complex integration, Laurentz Series, Residue Theorem and its applications.	30Hours	1
II	**Numerical Solution of system of equations** Nonlinear equations by Newton-Raphson and general iterative methods. Numerical solution of asystem of differential equations by Runge-Kutta methods of order two and four.	30 Hours	1
III	Numerical Solution of ordinary differential equations and partial differential equations Solution of Boundary value problems by weighted residualmethods: Collocation, Galerkin and Rayleigh-Ritz methods.	30 Hours	1
IV	**Parabolic equations** Schmidt and Crank-NicholsonSchemes, Elliptic	30 Hours	1

	equations: Five points scheme, Hyperbolic equations: Explicit and implicit schemes.		

References:

1. Anderson D. John, “Computational Fluid Dynamics”, McGraw Hill Education.
2. Versteeg H., Malasekra W., “An Introduction to Computational Fluid Dynamics : The Finite Volume Method”, Pearson India.
3. Ferziger J. H., “Computational Methods For Fluid Dynamics”, Springer.
4. BiswasGautam, “Computational Fluid Dynamics”, Narosa Book Distributors Pvt Ltd.
5. NiyogiPradip, “Introduction to Computational Fluid Dynamics”, Pearson India.
6. Wendt F. John, “Computational Fluid Dynamics: An Introduction”, Springer Publisher.

GE3(UB)15 SOCIO-ECONOMIC AND ENVIRONMENTAL EVALUATION OF WATER RESOURCES PROJECTS

Course Objective:

1. To know about the basics of water resources projects and socio-economic analysis.
2. To know about thebasics of environment.
3. To know about the project proposal and implementation.
4. To know about the project evaluation.

Learning Outcome:

1. Exposure onwater resources projects and socio-economic analysis.
2. Illustrate about the basics of environment.
3. Exposure onproject proposal and implementation.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Water Resources Projects** Need and importance of Water Resources Projects, Types of projects. **Socio-Economic Analysis** Social and Economic evaluation of population, standards of living, Community needs, Socio-Economic objectives.	30Hours	1
II	Ecosystems, Habitat assessment, Environmental objectives, study of availableresources, Environmental monitoring, Environmental evaluation techniques.	30 Hours	1
III	**Project Proposal and Implementation** Project planning, selection of project, Public awareness programme, feasibility reports, Eco-friendly projects, Project funding and expenditure, Cost and benefits, Risk assessment.	30 Hours	1
IV	**Project Evaluation** Evaluation and impact of projects like irrigation, Power Supply, Water Supply, Flood Control, Sewage, etc. Facilities generated, negative effects-inundation, migration, etc.	30 Hours	1

References:-

1. Modi P.A., “Economic development and Environmental Issues”
2. Abbasi S.A., “Water Resources Projects and their Environmental Impacts”,Discovery Publishing Pvt.Ltd.

MWE3151 HYDRAULIC ENGINEERING LAB

List of Experiments

1. Measurement of velocity distribution in open channel using Pitot tube, current meter and ADV, plotting of isovels and computation of α and β.
2. Establishment of subcritical, critical and supercritical flows in open channel, plotting of specific energy diagram.
3. To determine the characteristics of hydraulic jump in open channel.
4. Measurement and computation of Gradually Varied flow profiles in open channel.
5. Measurement of development of boundary layer thickness on flat plate.
6. Measurement of drag and lift force coefficient for cylinder and spheres
7. Measurements of bed shear stress by Preston tube.

MWE3201 ADVANCED IRRIGATION ENGINEERING

Course Objective:

1. To know about the basics of Sources of irrigation.
2. To know about the Irrigation Methods.
3. To know about the Rain Water Harvesting.

Learning Outcome:

1. Illustrate about the basics of sources of irrigation.
2. Illustrate about the Irrigation Methods.
3. Exposure onRain Water Harvesting.
4. Exposure onSocial Contribution with case studies.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Sources of irrigation, Water resources of India, Surface water and Ground Water, Irrigation practice in India, multipurpose reservoirs, large irrigation systems in India, Impact of irrigation on water resources, Conjunctive management of surface and groundwater.	30 Hours	1
II	Advanced Irrigation Methods: Sprinkler irrigation: Design, advantages and disadvantages, Drip irrigation: Design, advantages and disadvantages.	30 Hours	1
III	Rain Water Harvesting: Rain water harvesting: Different methods, Case study on nearby irrigation system.	30 Hours	1
IV	Social Contribution: Society participation in canal system management. Case Studies: IGNP and Narmada Canal system.	30 Hours	1

References:

1. Garg S. K., “Irrigation Engineering and Hydraulic structures”, Khanna Publishers.
2. Asawa G. L., “Irrigation and Water Resources Engineering”, New Age International Publishers.

MWE3202 ADVANCED HYDRAULIC STRUCTURES

Course Objective:

5. To know about theWater Resources Engineering Project and basics of Gravity Dam.
6. To know the basics of Embankment Dam.
7. To know the basics of Spillways and Energy Dissipaters.
8. To know about the basics of Diversion Headwork's.

Learning Outcome:

1. Illustrate about the Water Resources Engineering Project andGravity Dam.
2. Illustrate about theEmbankment Dam.
3. Illustrate about Spillways and Energy Dissipaters.
4. Illustrate about Diversion Headwork's.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Planning of Water Resources Engineering Project**Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments. Gravity Dam: Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam, joints, seals, keys in gravity dams, dam safety and hazard mitigation.	30Hours	1
II	**Embankment Dam** Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam,seepage analysis and its control through body and dam foundation, classification of rock fill dams and their design considerations.	30 Hours	1
III	**Spillways and Energy Dissipaters** Capacity of spillways, components and profile of different types of spillways, Non-conventional type of spillways, selection and design of energy dissipaters.	30 Hours	1

IV	Diversion Headwork'sComponents of diversion head works and their functions, design of weirs and barrages on permeable foundations Canal Structures, Canal regulation structures and design of cross drainage works, canal drops, operation and maintenance of canals.	30 Hours	1

References:

1. USBR, Design of gravity dams, A Water Resources Technical Publication, Denver, Colorado.
2. USBR, Design of small dams, A water resources technical publication, Oxford and IBH publishing co., New Delhi.
3. Creager W P, Justin J D and Hinds J., "Engineering for dams", Nemchand and Brothers, Roorkee.
4. Khatsuria R M, "Hydraulics of spillways and energy dissipaters", CRC Press.
5. Novak P, "Hydraulic Structures", Taylor and Francis Group publishers.

MWE3203 NUMERICAL METHODS IN FLOOD ROUTING

Course Objective:

1. To know the basics of Flow equations.
2. To know about the numerical methods in flood rooting.
3. To know about the flow analysis.
4. To know about the sediment routing

Learning Outcome:

1. Illustratethe basics of Flow equations.
2. Illustratethenumerical methods in flood rooting.
3. Illustratetheflow analysis.
4. Illustratethe sediment routing.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Basic Equations: Review of basic equations; 2D Shallow water flow equations: Boussinesq equations, Saint Venant equation.	30 Hours	1
II	Method of Solution: Method of Characteristics, Finite-difference solutions: explicit and implicit methods, Stability Criteria.	30 Hours	1
III	Problems: Dambreak flow analysis, Flood routing, super critical flow.	30 Hours	1
IV	Sediment Routing: Sediment routing models coupled and decoupled models, Stability criteria.	30 Hours	1

References:

1. ChoudharyHanif M., “Open Channel flow”, Springer.
2. Das Madan Mohan, “Open Channel Flow”, PHI Learning Private Limited.
3. Reddy Rami Jaya P., “A textbook of Hydrology”, Laxmi Publication.

MWE3204 Water Resources Engineering

Course Objective:

1. To know about the basics of Water resources system.
2. To know about the basics of Economics of Water Resources system.
3. To know about the basics of Multipurpose Water Resources and its Optimization.
4. To know about the basics Water Resources Planning and its application.

Learning Outcome:

1. Exposure onbasics of Water resources system.
2. Exposure onbasics of Economics of Water Resources system.
3. Exposure on basics of Multipurpose Water Resources and its Optimization.
4. Exposure on basics Water Resources Planning and its application.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Water resources system, components of the system, objectives of water resources development, development, planning, and construction and operation of water resources systems, System demands, geographic and geological aspects, economic, social and political consideration in system development.	30 Hours	1
II	Economics of Water Resources system: Economics of water resources systems, principles of engineering economics, Economic objectives, mathematical and econometric principles in optimal system design, Microeconomics and efficient resource allocation, conditions of project optimality.	30 Hours	1
III	Multipurpose Water Resources: Planning for multipurpose water resource projects,Benefits and costs. Optimization: Introduction to mathematical optimization techniques; Multi-objective optimization; Application of optimizationtechniques.	30 Hours	1
IV	Water Resources Planning: Water resources planning under uncertainty; Stochastic planningmodels; Application of simulation models.	30 Hours	1

References:

1. Asawa G. L., “Irrigation and Water Resources Engineering”, New Age International Publishers.
2. PunmiaB. C., “Irrigation and Water Power Engineering”, Laxmi Publication.
3. Garg S.K., “Irrigation Engineering and Hydraulic Structures”, Khanna Publisher.
4. Basak N. N., “Irrigation Engineering”, McGraw Hill Education.
5. Arora K R, “Irrigation Water Power and Water Resource Engineering”, Standard Publishers Distributors.
6. Modi P. N., “Irrigation Water Resources and Water Power Engineering”, Standard Publishers Distributors.
7. Raghunath H. M., “Irrigation Engineering”, Wiley India Pvt Ltd.

GE3(UB)21 WATER SUPPLY DISTRIBUTION SYSTEMS

Course Objective:

4. To know about the basics of intake structure.
5. To know about the basics of types of distribution systems.
6. To know about the basics of analysis of water distribution system.
7. To know about the basics of design of water distribution system.

Learning Outcome:

1. Exposure on intake structure.
2. Exposure on types of distribution systems.
3. Explain the analysis of water distribution system and methods.
4. Exposure on design and optimization of water distribution system.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Introduction to Intake structure, Hydraulics of water treatment processes.	30 Hours	1
II	Types of distribution systems: Equivalent pipe, parameters in distribution system analysis, parameters interrelationship,formulation of equation. Gravity and Rising main, location and design principles.	30 Hours	1
III	Analysis of water distribution system: Methods of analysis, Hardy – Cross method, Newton Raphson method and Linear theory method.	30 Hours	
IV	Design and optimization of water distribution system:Trial and error method of design, cost- head loss ratio method. Optimization usinglinear programming techniques. Surge analysis in water distribution systems, Pump dutystations and detailing valves, Pressure transients in pipe flow.	30 Hours	1

References:-

1. Bhave P R, “Analysis of Flow in Water Distribution Network”, TechnomicPublishingCo., Lancaster, USA.
2. Bhave P R, “Optimal Design of Water Distribution Networks”, Narosapublishinghouse, New Delhi.

3. Streter V L and Wylie E D, “Fluid Transients”, McGraw Hill Book Co.
4. Pramod R. Bhave and Rajesh Gupta, “Analysis of Water Distribution Networks”, Published by Narosa Publishing House, New Delhi and Alpha-Science Publication, UK.

GE3(UB)22 ENVIRONMENTAL ASPECTS OF WATER RESOURCES

Course Objective:

1. To know about the basics of Ecology and its development.
2. To know about the basics of hydrological cycle.
3. To know about the basics of Ecological impacts and methods of EIA.
4. To know about the basics of Human Ecology.

Learning Outcome:

1. Exposure onEcology and its development.
2. Illustrate about the basics of hydrological cycle.
3. Illustrate about the basics of Ecological impacts and methods of EIA.
4. Exposure onHuman Ecology.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Ecological principles, Levels of organization, Aquatic Ecology, Hydrobiology, Concept of ecosystems, Energy flow in aquatic ecosystems, Biogeochemical cycles, Population and community organization, Concepts of carrying capacity, Biological diversity, Ecosystem development.	30 Hours	1
II	Suspended and dissolved solids in water, Sources of pollution, Water quality classification, Impacts on hydrological cycle, Eutrophication, Bio-magnifications, Water quality indices, Transformation and fate of pollutants, Role of sediments in water quality.	30 Hours	1
III	Environment in water resources projects, Environmental requirements and laws, Environmental impacts: hydrological, social, biological and water quality, Methods of EIA, Base line survey, EIA statements, Ecological impacts, Habitat evaluation.	30 Hours	1
IV	Human Ecology, Large vs small dams,Instream ecological needs, Deforestation, watershed and water quality changes, Ecosystem services, Environmental data bases and networks, Ecological monitoring programs, Environmental quality indices, Sustainable	30 Hours	1

	water resources development.		

References:-

1. Canter L. W, “Environmental Impact Assessment”, McGraw Hill International Editions, 2nd edition, New York.
2. Mc Cully P, “Silenced Rivers, The ecology and politics of large dams”, Orient Longman India.
3. Odum E. P., “Basic Ecology, 13th Edition”, Saunders and Co., Philadelphia.
4. Odum H. T., “Systems Ecology, 3rd edition”, Saunders and Co., Philadephia.
5. Schmitz R. J., “Introduction to water pollution biology”, Gulf Publishing Co., Texas.

GE3(UB)23 COMPUTATIONAL TECHNIQUES IN WATER RESOURCES ENGINEERING

Course Objective:

1. To know about the basics computational Techniques in Water Resources Engineering.
2. To know about the basics of Statistical Techniques.
3. To know about the basics of Numerical Methods.
4. To know about the basics of Hydro informatics and its applications.

Learning Outcome:

1. Exposure oncomputational Techniques in Water Resources Engineering.
2. Illustrate about the basics of Statistical Techniques in WRE.
3. Illustrate about the basics of Numerical Methods in WRE.
4. Exposure onHydro informatics and its applications.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction:Introduction to computational Techniques, Database design, Spreadsheet, Usefulness in Water Resources Engineering.	30 Hours	1
II	Statistical Techniques: Presentation of data, Measures of location and dispersion, Probability concepts and distribution, Tests of significance, Correlation and Regression, Selection of Suitable technique, error analysis.	30 Hours	1
III	Numerical Methods: Finite difference schemes, Method of characteristics, Finite element method Advanced Techniques Genetic algorithm, Artificial Neural Network, Fuzzy logic, Other data driven methods.	30 Hours	1
IV	Hydro informatics: Introduction, Virtual institute, Web based hydro informatics system. Applications: Application with case studies, Selection of suitable technique, Different types of hydraulic engineering software, Salient features, Capabilities	30 Hours	1

	and Limitations.		

References:-

1. Abbott M.B., “Hydroinformatics – Information Technology and the Aquatic Environment”, Avebury Technical, Aldershot.
2. Adeli H. and Hung S., “Machine Learning – Neural Networks, Genetic Algorithms and Fuzzy Systems”, John Wiley, New York.
3. Chaudhry M.H., “Open Channel Flow”, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi.
5. Govindaraju, R. S. and Rao, A. R. (eds.). “Artificial Neural Networks in Hydrology”, Kluwer Academic Publishers, Dordrecht.
6. Rajsekaron S. and VijayalakshmiPai G.A., “Neural Networks, Fuzzy Logic and Genetic Algorithams-Synthesis and Applications”, PHI Learning Pvt. Ltd., New Delhi.

GE3(UB)24 REMOTE SENSING APPLICATIONS IN WATER RESOURCES ENGINEERING

Course Objective:

1. To know the basics of Principles of GIS, GPS and Remote Sensing.
2. To know about the data products, Interpretation and Analysis Techniques.
3. To know about the data processing.
4. To know about the disaster management.

Learning Outcome:

1. Exposure onPrinciples of GIS, GPS and Remote Sensing.
2. Illustrate about the data products, Interpretation and Analysis Techniques.
3. Exposure on data processing.
4. Exposure ondisaster management.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Principles of GIS, GPS and Remote Sensing:Basic concepts of GIS & GPS, introduction to remote sensing, remote sensing system, electromagnetic spectrum, black body, atmospheric windows, spectral characteristics of earth's surface, range of sensing system, Components of GPS, factors affecting, GPS setup,accessories, segments,satellites& receivers, GPS applications.	30 Hours	1
II	Platforms, Sensors and Data Products:Ground aircraft, Spacecraft platforms, photographic sensors, scanners, radiometers, radar and mission planning, data types and format, scale and legend. Interpretation and Analysis Techniques: Multispectral, multitemporal, multisensoral, multistage concepts, photo interpretation techniques for aerial photo and satellite imagery, interpretation elements, false colour composition.	30 Hours	1
III	Structure of GIS:Cartography, Geographic mapping process, transformations, map projections, Geographic Data Representation, Storage, Quality and Standards, database management systems, Raster data	30 Hours	1

	representation, Vector data representation, Assessment of data quality, Managing data errors, Geographic data standards. GIS Data Processing, Analysis and Modeling: Raster based GIS data processing, Vectorbased GIS data processing, Queries, Spatial analysis, Descriptive statistics, Spatial autocorrelation,Quadrant counts, and nearest neighbour analysis, Network analysis, Surface modeling, DTM.		
IV	Application in Civil Engineering: River drainage and flood flow, watershed delineation and characteristic studies, command area mapping, drought assessment, groundwater inventory, soil moisture study, water quality assessment and monitoring, Land use data acquisition, disaster management.	30 Hours	1

References:

1. Thomas, M. LillisandandKieferR.W., “Remote Sensing and Image Interpretation”, JohnWiley.
2. Sabins and Floyd, F.J.R, “Remote Sensing Principles and Interpretation”, W.H. Freeman, Sanfrancisco.
3. Elachi C., “Introduction to Physics and Techniques of Remote Sensing”, New YorkWiley.
4. Phillip, H. Swain and Shirley, M. Davis,“Remote Sensing-The Quantitative Approach”,McGraw Hill Publications.
5. Johnson, R. Jenson,“Introductory Digital Image Processing”, Prentice hall.
6. Agarwal, N. K., “Essentials of GPS, Spatial Networks Pvt. Ltd., Hyderabad.

GE3(UB)25 FINITE ELEMENT ANALYSIS

Course Objective:

1. To know the basics concept of FEM.
2. To know about the basics of one dimensional Finite Elements.
3. To know about the basics of two and three dimensional Finite Elements.
4. To know about the natural coordinate system.

Learning Outcome:

1. Exposure on concept of FEM.
2. Exposure onone dimensional Finite Elements.
3. Exposure ontwo and three dimensional Finite Elements.
4. Exposure on natural coordinate system.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction to Finite Element Method, Brief History of the Development, Advantages & Disadvantages of Finite Element Method, The Displacement Approach. Foundations of the FEM-Energy Principles.	30 Hours	1
II	One Dimensional Finite Elements, Stiffness Matrix for the basic Bar & Beam Element Representation of Distributed Loading, The Assembly Process within the PMPE Approach, Element Stresses. Shape Functions & Interpolation Polynomials.	30 Hours	1
III	Finite Elements for Two Dimensional Planar Bodies. Triangular Elements for Plane Stress or Strain Conditions. Higher Order Triangular Elements. Rectangular Elements for Plane Stress or Strain Conditions. Finite Elements for Three Dimensional Analysis, Tetrahedral Elements. Higher-Order Tetrahedra. Rectangular Hexahedral Elements. Higher-Order Rectangular Hexehedra.	30 Hours	1
IV	Advanced Concepts In The Formulation of Two & Three Dimensional Elasticity Elements. Natural Co-ordinates. Area or Triangular Co-ordinates.	30 Hours	1

	Serendipity Rectangles & Hexahedra. The Isoparametric Concept. Properties of Isoparametric Elements. Numerical Integration.		

References:-

1. Cook, R.D., Malkus, D.S. and Plesh, M.E."Concepts and Applications of Finite Element Analysis", John Wiley & Sons Inc. New York.
2. Bathe, K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall.
3. Reddy, J.N., "An Introduction to Finite Element Method", McGraw Hill.
4. Dawe, D.J., "Matrix and Finite Element Displacement Analysis of Structures", Clarinton Press, Oxford.
5. Krishnamoorty C. S., "Finite Element Analysis", Tata McGraw-Hill
6. David V. Hutton, "Fundamentals of Finite Element Analysis", McGraw Hill
7. Irving H. Shames, Clive L. Dym, "Energy and Finite Element Methods in Structural Mechanics", New Age International
8. Mukhopadhyay M., "Matrix, Finite Element, Computer and Structural Analysis", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
9. Rao S. S., "Finite Element Analysis", Elsevier Butterworth-Heinemann.

MWE3251 WATER ANALYSIS AND HYDROLOGY LABORATORY

List of Experiments

1. Rainfall Data collection by Natural Syphon Recording type Raingauge and determination of mass curve and hyetograph from the obtained chart.
2. Determination of infiltration rate by Double Ring type Infiltrometer.
3. Measurement of permeability.
4. Determination of rate of evaporation through Pan Evaporimeter.
5. To find Rainfall and Runoff characteristics using Rainfall Simulator.
6. To study infiltration capacity of different type of soil by Infiltrometer.