VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2020-21
M.Tech. - Water Resource Management

Semester I

Sl No	Course	Subject	Course name	Numbers of hours/week		Duration of Exam	Marks for		Total Marks	CREDITS
				Lecture	Practical/Field work/Assignment		Internal Assessment	Exam		
1	PCC	20WRM11	Advanced Fluid Mechanics	4		3	40	60	100	4
2	PCC	20WRM12	**Engineering Hydrology**	4	-	3	40	60	100	4
3	PCC	20WRM13	**Water resources System Planning & Management**	4	-	3	40	60	100	4
4	PCC	20WRM14	Open Channel Hydraulics	4	-	3	40	60	100	4
5	PCC	20WRM15	**Optimization Techniques in Water Resources**	4	-	3	40	60	100	4
6	PCC	**20WRML16**	Advanced Water resources Engineering Lab	-	4	3	40	60	100	2
7	PCC	**20RMI17**	**Research Methodology and IPR**	4	-	3	40	60	100	2
Total				22	4	21	280	420	700	24
Note: PCC Professional Core, PEC Professional Elective										

Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up /complete the internship shall be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

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SCHEME OF TEACHING AND EXAMINATION 2020-21
M.Tech. - Water Resource Management

Semester II

Sl No	Course	Subject	Course name	Numbers of hours/week		Duration of Exam	Marks for		Total Marks	CREDITS
				Lecture	Practical/Field work/Assignment		Internal Assessment	Exam		
1	PCC	20WRM21	Project Planning & Evaluation	4		3	40	60	100	4
2	PCC	20WRM22	Ground Water Hydrology	4	-	3	40	60	100	4
3	PCC	20WRM23	Watershed Conservation Management	4	-	3	40	60	100	4
4	PCC	20WRM24X	Professional Elective-I	4	-	3	40	60	100	4
5	PCC	20WRM25	Professional Elective-II	4	-	3	40	60	100	4
6	PCC	20WRM26	Advanced Water resources Engineering Lab-II	-	4	3	40	60	100	2
7	PCC	20WRM27	Technical Seminar		2	2	100		100	2
Total				22	6	20	340	360	700	24
Note: PCC Professional Core, PEC Professional Elective										

List of Professional Electives I

Second Semester Elective	
20WRM241	Hydraulic Structures
20WRM242	Environmental impact assessment of water resources development
20WRM243	Urban hydrology

List of Professional Electives II

Second Semester Elective	
20WRM251	River engineering
20WRM252	Climate change and adaptation
20WRM253	Techno economic analysis of water development

Note:
1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.
The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill, Question and Answer session in the ratio 50:25:25.
2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/ complete the internship shall be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

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SCHEME OF TEACHING AND EXAMINATION 2020-21
M.Tech. - Water Resource Management

Semester II

Sl. No	Course	Subject	Course name	Numbers of hours/week		Duration of Exam	Marks for		Total Marks	CREDITS
				Lecture	Practical/Field work/Assignment		Internal Assessment	Exam		
1	PCC	20WRM31	Sediment Transport	4		3	40	60	100	4
2	PEC	20WRM32X	Professional elective-3	4	-	3	40	60	100	4
3	PEC	20WRM33X	Professional elective-4	4	-	3	40	60	100	4
4	Project	20WRM34	Evaluation of Project Phase -I		2		100		100	2
5	Internship	20WRM35	Internship		-	3	40	60	100	6
Total				12	2	12	260	240	500	20
Note: PCC Professional Core, PEC Professional Elective										

List of Professional Electives III

Second Semester Elective	
20WRM321	Theory of seepage & earthen dams
20WRM322	Water power and dam engineering

List of Professional Electives IV

Second Semester Elective	
20WRM323	watershed conservation and management
20WRM324	Integrated watershed management

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
2. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25. SEE (University examination) shall be as per the University norms.
3. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfy the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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M.Tech. - Water Resource Management

IV-Semester

Sl. No	Course	Subject	Course name	Numbers of hours/week		Duration of Exam	Marks for		Total Marks	CREDITS
				Lecture	Practical/Field work/Assignment		Internal Assessment	Exam		
1	PCC	20WRM41	Project Phase-II	-	4	3	40	60	100	20
Total					4	3	40	60	100	20
Grand Total (from I to IV Semester) :2000 Total Credits: 88										

Note:
1. Project Phase-2:
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.
SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

20WRM-11 ADVANCED FLUID MECHANICS

Sub Code: 20WRM11X	IA Marks : 40
Hrs / Week: 04	Exam Hours : 03
Total Hrs: 52	Exam Marks : 60

Module 1

Introduction: Survey of Fluid Mechanics, Structure of Fluid Mechanics Based on Rheological, Temporal Variation, Fluid Type, Motion Characteristic and spatial Dimensionality Consideration, Approaches in Solving Fluid Flow Problems, Fundamental idealizations and Descriptions of Fluids.

Module 2

Motion, Quantitative Definition of Fluid and Flow, Reynolds Transport Theorem, Mass, Momentum and Energy Conservation Principles for Fluid Flow.

Potential Flow: Frictionless Irrotational Motions, 2 - Dimensional Stream Function and Velocity Potential Function in Cartesian and Cylindrical Polar Coordinate Systems, Standard Patterns of Flow, Source, Sink, Uniform Flow and irrotational vortex, Combinations of Flow Patterns, method of Images in Solving Groundwater Flow problems, Method of Conformal transformations.

Module 3

Viscous Flow and Boundary Layer Theory: Study of Local Behavior, Differential Approaches in Analysis of Viscous Flows, Equations of Motion of a Viscous Flow, Navier – Stokes Equations, Exact and Approximate Solution of N – S Equations, Hele – Shaw Flow, Creeping Flow past a Sphere, Boundary Layer Concept, Prandtl's Boundary Layer Equations, Laminar Boundary Layer Along a Flat Plate, Integral Momentum Equation, Blassius Solution.

Module 4

Turbulence in Fluid Flow: Origin of turbulence, Statistical Analysis of Turbulence, Reynolds Equations for Turbulent Flow obtained from N – S Equations, Models for Turbulence, Theories of Turbulent Shear Stresses, Velocity Distribution in Smooth and Rough Pipes, Resistance Coefficients for Pipes, Turbulent Boundary Layer and Boundary Layer Separation.

Module 5

Design and Testing of Models: Design of and Experiment, Dimensional Analysis, Complete Set of Dimensionless Parameters, Dimensional Analysis, Scale effect, Distorted Models, Practical Significance of Key Modeling Parameters, Design of Models and Model Tests. Diffusion: Equations of Fluid Dynamics for a Mixture of Fluids, Dispersion of Pollutant in a Fluid Medium, Coefficient of Mass Transfer.

References:

1. Wand D.J., and Harleman D.R. (91964) "Fluid Dynamics", Addison Wesley.
2. Schlichting: (1976) "Boundary Layer theory", International Text – Butterworth
3. Lamb, H. (1945) "Hydrodynamics", International Text – Butterworth
4. Lamb, H.R. (1945) "Hydrodynamics", Rover Publications
5. Rouse, H. (1957), "Advanced Fluid Mechanics", John Wiley & Sons, N York
6. White, F.M. (1980) "Viscous Fluid Flow", McGraw Hill Pub. Co, N York
7. Yalin, M.S.(1971), "Theory of Hydraulic Models", McMillan Co., 1971.
8. Mohanty A.K. (1994), "Fluid Mechanics", Prentice Hall of India, N

20WRM-12 ENGINEERING HYDROLOGY

Sub Code: 20WRM12	IA Marks: 40
Hrs / Week: 04	Exam Hours: 03
Total Hrs: 52	Exam Marks: 60

Module I

Introduction: Hydrologic Cycle, Systems Concept, Hydrologic model classification. Hydrologic Processes: Reynolds Transport Theorem. Atmospheric circulation: Water Vapour, Precipitable water, Thunderstorm cell model. Evaporation: Energy balance method and Aerodynamic method. Evapotranspiration. Subsurface water: unsaturated flow, Richard's equation. Infiltration: Horton's and Phillip's equations. Green-Ampt Method, Ponding time. Surface Water: Hydrograph Analysis, SCS method, Effective Rainfall, Runoff, Runoff Components, Direct Runoff Hydrograph.

Module II

Unit Hydrograph Theory: Linear Time Invariant System, Response Functions of Linear Systems, Derivation of Non Parametric Unit Hydrograph From Single Storm and Multi Storm Events, S – Curve Hydrograph, Instantaneous Unit Hydrotherapy.

Model III

Rainfall – Runoff Analysis: Review of Rational Methods, Conceptual Models, Parametric Unit Hydrograph, Clarke, Nash and Dooge Models, Hydrologic Simulation Models, Stanford Watershed Model, Derivation of Unit Hydrograph for Ungagged Catchments, Synthetic Unit Hydrograph.

Module IV

Hydrologic Time Series Analysis: Independent and Autocorrelated Data, Structure of a Hydrologic Time Series, Trend, Jump and Seasonality, Stationarity and Ergodicity, Autocovariance and Auto Correlation Function, Correlogaram Analysis, Spectral Analysis, Analysis of Multivariate Hydrologic Series. Modelling of Hydrologic Time Series: Data Generation Techniques, Linear Stochastic Models, Autoregressive, Moving Average, ARMA Models, Modelling of Nonstationary and seasonal Series, Thomas – Feiring Model, ARIMA Models.

Module V

Hydrologic Flood Routing: Reservoir Routing, Channel Routing, Estimation of Parameters of Flood Routing Models, Flood estimation and flood frequency studies, Real Time Flood Forecasting.

References:

1. Chow, V.T., Maidment, D.R. and Mays, L.W. (1988), "applied Hydrology", McGraw Hill Inc. N York
2. Singh, V.P. (1986), "Hydrologic Systems,", Prentice Hall Inc., N York.
3. Haan C.T., (1995), "Statistical Methods in Hydrology", East West Press, New Delhi
4. Viessman, W., Lewis, G.L. and Knapp, J.W. (1989), "Introduction to Hydrology", Harper & Row Publications Inc., Singapore.
5. McCueen R.H. and Snyder, W.M. (1985), Hydrologic Modelling – Statistical Methods and Applications", Prentice Hall Inc. N York.
6. Ponce, W.F. (1987), "Engineering Hydrology", Prentice Hll Inc. N York.
7. Meijerink A.M.J., H.A.M. de Brouwer, C.M. Mannaerts and C.R. Valenzuela, (1994)," Introduction to the use of Geographic Information Systems for Practical Hydrology, ITC Publication No. 23, UNESCO, Paris.
8. Kottegoda (1982), "Stochastic Processes in Hydrology", Prentice Hall, Inc., N Jersey
9. Hydrology and Water resources Engineering, by K.C. Patra, Narosa publishing house, New Delhi.

20WRM-13 WATER RESOURCES SYSTEMS PLANNING & MANAGEMENT

Sub Code: 20WRM13X	IA Marks: 40
Hrs / Week: 04	Exam Hours: 03
Total Hrs: 52	Exam Marks: 60

Module I

Introduction: General Principles of Systems Analysis to Problems in Water Resources Engineering, Objectives of Water Resources Planning and Development, Nature of Water Resources Systems, Socio Economic Characteristics.

Model II

Economic Analysis of Water Resources System: Principles of Engineering Economy, Capital, Interest and Interest Rates. Time Value of Money, Depreciation, Benefit Cost Evaluation, Discounting Techniques, Economic and Financial Evaluation, Socio-Economic Analysis.

Module III

Methods of Systems Analysis: Linear Programming Models, Simplex Method, Sensitivity Analysis, Dual Programming, Dynamic Programming Models, Classical Optimization Techniques, Non-linear Programming, Gradient Techniques, Genetic Algorithm, Stochastic Programming, Simulation, Search Techniques, Multi Objective Optimization.

Module IV

Water Quantity Management: Surface Water Storage Requirements, Storage Capacity and Yield, Reservoir Design, Water Allocations for Water Supply, Irrigation, Hydropower and Flood Control, Reservoir Operations, Planning of an Irrigation System, Irrigation Scheduling, Groundwater management, Conjunctive Use of Surface and Subsurface Water Resources, Design of Water Conveyance and Distribution Systems.

Module V

Water Quality Management: Water Quality Objectives and Standards, Water Quality Control Models, Flow Augmentation, Wastewater Transport Systems, River Water Quality Models and Lake Quality models. Legal Aspects of Water & Environment Systems: Principles of Law applied to Water Rights and Water Allocation, Water Laws, Environmental Protection Law, Environmental Constraints on water Resources Development.

References:

1. Loucks, D.P., Stedinger, J.R. and Haith, D.A. (1982) “Water Resources Systems Planning and Analysis”, Prentice Hall Inc. N York
2. Chaturvedi, M.C. (1987), “Water Resources Systems Planning and Management”, Tata McGraw Hill Pub. Co., N Delhi.

3. Hall. W.A. and Dracup, J.A. (1975), “Water Resources Systems”, Tata McGraw Hill Pub. N Delhi
4. James, L.D. and Lee (1975), “Economics of Water Resources Planning”, McGraw Hill Inc. N York
5. Kuiper, E. (1973) “Water Resources Development, Planning, Engineering and Economics”, Buttersworth, London
6. Biswas, A.K. (1976) “Systems Approach to Water Management”, McGraw Hill Inc. N York
7. Major, D.C. and Lenton, R.L., (1979), “Applied Water Resources System Planning”, Prentice- Hall Inc, N.Jersey
8. Taha h A, (1996), “Operations Research”, Prentice Hall of India, N Delhi.

20WRM-14 OPEN CHANNEL HYDROULICS

Sub Code: 20WRM14X	IA Marks: 40
Hrs / Week: 04	Exam Hours: 03
Total Hrs: 52	Exam Marks: 60

Module I

Basic Concepts of Free Surface Flow, classification of flow, velocity & pressure distribution. Conservation laws, continuity equation, momentum equation, Specific energy, Application of momentum & energy equation, Channel transition, Hydraulic jump. Critical flow.

Module II

Uniform flow: flow resistance, equation of flow resistance, compound channel, Computation of normal flow depth.

Module III

Gradually varied flow, Governing equation, classification of water surface profiles, and computation of GVF. Unsteady Rapidly Varied Flow. Application of conservation laws. Positive and Negative Surges. Moving hydraulic Jump, Spillways, Energy dissipaters. Critical slope and limit slope.

Module IV

Hydraulics of Mobile bed channel, Initiation of Motion of sediment, Critical analysis of Shield's diagram, Bed forms, and Predication of bed form. Sediment load: Suspended load, Bed load, total bed material load, measurement and estimation of sediment load. Design of Stable Channels: Regime and Tractive force Methods.

Module V

Introduction to Bridge Hydraulics: Water ways, Afflux, Scour: Local scour, abutment scour, Indian practice of design for scour.

References:

1. Chow, V.T. (1979) "Open Channel Hydraulics", McGraw Hill. N York.
2. Henderson. (1966): "Open Channel Flow", McMillan Pub. London.
3. Subramanya, K (1996) "Flow in Open Channels", Tata McGraw Hill Pub., 1995.
4. Grade and Ranga Raju, K.G. (1980): "Mechanics of Sediment Transportation and Alluvial Stream Problems", Wiley Eastern, N Delhi.
5. Chaudhry M.H. (1994), "Open – Channel Flow", Prentice Hall of India, N Delhi.
6. French, R.H. (1986), "Open Channel Hydraulics", McGraw Hill Pub Co., N York.
7. Hamill L. (1999), Bridge Hydraulics, E & FN Spon, London.

20WRM-15 OPTIMIZATION TECHNIQUES IN WATER RESOURCES

Sub Code: 20WRM 15	Hrs / Week : 04
Total Hrs : 50	IA Marks : 40
Exam Hours : 03	Exam Marks : 60

Module: 1

Introduction: Development of optimization techniques, nature and characteristics of operation research, methodology of optimization, applications of optimization techniques, classification of operation research model, uses and limitation of optimization techniques.

Linear programming, I: Mathematical model of LPP, canonical and standard form of Problem, LPP formulations, graphical solutions of LPP. Linear programming II: Simplex method, Simplex algorithm, method of penalty and two
phase method.

Module: 2

Linear programming III: Concept of duality, formulation of dual linear problems, primal – dual relationship, duality theorem, shadow prices in linear programming, dual simplex method, advantages of duality, revised simplex method.

Module: 3

Transportation problem: Transportation problem, mathematical formulation of problem, steps in transportation method, methods for finding initial basic feasible solution, generacy in transportation problem.

Module: 4

Assignment problems: mathematical formulation, assignment algorithm methods for solving assignment problems. Integer Programming: Nature of the problem, graphical method Gomory's all integer cutting plane method, mixed integer programming problem.

Module: 5

Goal Programming: Application and solution of the problem. Dynamic Programming: Dynamic programming, characteristics of DP problems, D.P. algorithm, Bellman's optimality principle, recursive relations, backward & forward recursions, solutions to various problems, dimensionality in D.P.

References:

1. H.A. Taha: "Operations Research" Macmilan publishing Co.
2. S.D. Sharma: "Operations Research" KedaranathRamnath& Co. Meerut.
3. S.Ravidran,D.T.Phillips& J.J Solberg "Operation Research".

4. KantiSwarup, P.K. Gupta &Manmohan “Operations Research” Sultan chand& sons.

20WRML-16 Advanced Water Resources Engineering-Laboratory-I

I-Semester M-Tech courses

1. Measurement of velocity profile in straight and meandering open channel;
2. Experiments on velocity distribution and Boundary shear in rough and smooth channels,
3. Discharge measurement by weir;
4. Measurement of Shear stress from velocity distribution obtained from Acoustics Doppler Velocity-meter (ADV).
5. Measurement of rainfall, evaporation, infiltration, laboratory and field tests.
6. Characteristics of Hydraulic Jump in horizontal and Sloping Channels
7. Determination of Manning’s N for Composite Sections
8. Velocity Distribution in Open Channels
9. Performance Characteristics of Centrifugal pumps
10. Measurement of Soil Water Tension and Determination of Soil moisture Potential
11. Rainfall – Runoff Studies
12. Determination of Infiltration Characteristics

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SEMESTER – I

Subject	**RESEARCH METHODOLOGY AND IPR**		
Subject Code	**20RMI17**	CIE Marks	**40**
Teaching Hours/Week (L:P:SDA)	**2:0:0**	SEE Marks	**60**
Total Number of Lecture Hours	**25**	Exam Hours	**03**

CREDITS – 02

Course Objectives:

At the end of this course, students will be able to:

- Interpret research problem formulation
- Analyse research related information
- Follow research ethics and IPR provisions.
- Emphasise on ideas, concept, and creativity rather than on Computer, Information Technology.

Modules	**Teaching Hours**	**RBT Levels**
Module -1		
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	**5 Hours**	**L1, L2**
Module -2		
Effective literature studies approaches, analysis, Reviews, Plagiarism, Research ethics.	**5 Hours**	**L1, L2**
Module -3		
Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	**5 Hours**	**L1, L2**
Module -4		
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**5 Hours**	**L1, L2**
Module -5		
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**5 Hours**	**L1, L2**

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Course outcomes (CO):

At the end of the course the student will be able to:

1. Discuss research methodology and the technique of defining a research problem
2. Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
3. Explain various aspects of technical writing.
4. Emphasise on the importance of IPR.

Reference Books:

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction, Juta and Co. 2004.
2. Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners, Pearson Education, 2nd Edition, 2018
3. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, 2007
4. Mayall , Industrial Design, McGraw Hill, 1992
5. Niebel , Product Design, McGraw Hill, 1974
6. Asimov, Introduction to Design, Prentice Hall, 1962
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, 2016.
8. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand, 2008

20WRM-21 PROJECT PLANNING EVALUUATION & RESOURCE ENGINEERRING

Sub Code: 20WRM 21 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Module:1

Introduction: Water Resource Projects- Over all planning- Water resources planning – water resource of India – development policy – and programs and planning approach – Data requirement- string and rational method.

Module:2

Project planning: Bar chart method, critical path method, PERT method, Float time. Compression and decompression of network scheduling. Resource leveling. Operating cost and fixed costs. Optimum costs. Objective and policies. Project control – Human aspects of project management.

Module:3

Inventories: Management and operating cost of stores, Economic levels of ordering stocks. Machinery requirements for concrete dams, earth dams, etc. estimation of costs and benefits from machinery. Irrigation projects, power projects and multipurpose projects – Lift irrigation projects.

Module:4

Spatial Planning and Regional analysis: Introduction, problems, potentials, trends, physical characteristics, basic and non basic concepts, analysis of spatial linkages. Social aspects of economic development.

Module:5

International Project Planning and Management**:** Introduction, institutes of technical, financial and scientific cooperation.

REFERENCES: -

1. Design of water resource systems- Mass et al.
2. Water resources systems planning – M.C Chaturvedi and Peter Rogards.
3. Benefit cost analysis for water resource system planning- Charles W. Howe.
4. Construction planning and Management- P.S Gahlot, B.M. Ahir
5. Irrigation commission reports 1972 Ministry of Irrigation and Power- Volume I,II,&III.
6. Water resource of India and their utilization in agriculture – Dhakshina Murthy et al.
7. Current literatures and Publications.

20WRM-22 GROUNDWATER HYDROLOGY

Sub Code: 20WRM 22	Hrs / Week : 04
Total Hrs : 50	IA Marks : 40
Exam Hours : 03	Exam Marks : 60

Model I

Introduction: Scope, historical background, utilization of groundwater, groundwater in the hydrologic cycle, origin and age of groundwater. Rock properties affecting groundwater: Geologic formations as aquifers, types of aquifers, porosity, soil classification, specific surface, vertical distribution of groundwater, zone of aeration, zone of saturation, specific retention, specific yield, storage coefficient, springs.

Model II

Groundwater movement**:** Darcy's law and its validity, intrinsic permeability, hydraulic conductivity, transmissivity, techniques for determination of hydraulic conductivity, groundwater flow rates, flow nets, flow in relations to ground water contours, flow across a water table, flow across a hydraulic conductivity boundary, dispersion, general flow equations in rectangular and radial co-ordinations.

Model III

Groundwater well hydraulics: Steady unidirectional flow steady radial flow to a well, unsteady radial flow in a confined aquifer, unsteady radial flow in an unconfined aquifer, unsteady radial flow in a leaky aquifer, well flow near aquifer boundaries, multiple

well systems, partially penetrating wells, characteristic well losses, specific capacity and well efficiency.

Model IV

Water wells: surface geophysical methods - electrical resistivity method - seismic method - subsurface investigation - test drilling - resistivity logging - application of remote sensing method. Test holes and well log; methods for constructing shallow wells and deep wells, well completion, pumping equipment for wells, protection of wells, well rehabilitation, infiltration galleries, horizontal pipes, collector wells.

Model V

Groundwater Levels and Environmental Influences: Time variations of levels, stream flow and groundwater levels, fluctuations due to evapotranspiration, meteorological phenomena urbanization, earthquakes, external loads and land subsidence.

REFERENCES

1. "Groundwater Manual", "A water resources Technical Publication", U.S. Department of the interior - Edition. 1985.
2. Karanth, K. R., A text book "Ground Water Assessment: Development and Management" Tata McGraw-Hill Education, 1987
3. Raghunath H.M , "A text book on Groundwater", IIIrd Edition, New age
4. Publications,2007.
5. Todd, D.K., "Groundwater Hydrology", John Wiley & Sons edition, 1980.

20WRM23- WATERSHED CONSERVATION AND MANAGEMENT

Sub Code: 20WRM 23	Hrs / Week : 04
Total Hrs : 50	IA Marks : 40
Exam Hours : 03	Exam Marks : 60

Model I

Introduction: Watershed – Definition and Classification – Components- Basic factors influencing watershed development – Codification - Watershed delineation - Characteristics

of watershed: size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology – Socio - economic characteristics.

Model II

Soil conservation measures: Types of Erosion – Water and Wind Erosion: Causes, Factors, Effects and Control – Estimation of Soil Erosion- Soil Loss Models- Sedimentation - Soil Conservation Practices: Vegetative and Mechanical.

Model III

Water harvesting and conservation: Types of storage Structures-Water yield from Catchments-Losses of stored water- Water Conservations Methods-Water harvesting methods and Techniques-Rainwater Harvesting-Catchment, Harvesting structures, Roof water harvesting- Soil Moisture Conservation-Check Dams-Artificial Recharge-Farm Ponds- Percolation tanks.

Model IV

Watershed management: 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

Model V

Watershed management plan: Methodology of planning a watershed management, identification of watershed problems, socio-economic issues - application of Remote Sensing and GIS in watershed management.

References:

1. Dhuruvanarayana.V.V, Sastry.G and Patnaik.U.S, "Watershed Management",
1. Publications and information division, Indian Council of Agriculture Research,
2. New Delhi, 1990.
3. Gelnn O. Schwab, "Soil and Water Conservation Engineering", john Wiley and

4. sons, New York, 1981.
2. Ghanashyam Das, “Hydrology and Soil Conservation engineering”, Prentice Hall
5. of India Private Limited, New Delhi, 2000.
3. Murthy J.V.S, “Watershed Management in India”, Wiley Eastern Limited, New
6. Delhi, 1995.
4. Suresh, R., “Soil and Water Conservation Engineering”, Standard Publishers.
5. Tideman E.M., “Watershed Management”, Omega Scientific Publishers, New
7. Delhi, 1996.

20WRM241- HYDRAULIC STRUCTURES

Sub Code: 20WRM 241 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

Reservoir Planning: Classification of reservoirs, storage zones of a reservoir, fixing capacity of reservoirs, life of a reservoir.

Dams: Investigation surveys, selection of dam site, selection of types of dam, classification of dams. Gravity Dams Forces acting on dam, combination of forces for design, design parameters, design of gravity dam, profiles of a dam, stability analysis, foundation treatment, galleries in gravity dams.

Model II

Earth and Rock fill Dams: Types, design criteria for earth dams, design consideration in seismic region, phreatic line, flow net, stability analysis, methods of analysis, slope protection, seepage, dam section to suit available materials and foundation, causes of failure of earth dams, safety measures.

Model III

Spillways: Components factors affecting type and design of spillway, types, energy dissipation below spillways, hydraulic jump type stilling basins spillway gates, types.

Model IV

Weirs and Barrages: Design of impervious floor on pervious foundation. Blighis Lane's creep theories, potential theory cut offs, weir design, Khosla's method.

Model V

Unlined irrigation channels: Design parameters, transmission losses, determination of water losses, design formulae, Kennedy's and Lacey's theories, channels on non-alluvial soils.

References:

1. Creager, W.P, Justin, J and Daud Hinds, “Engineering for Dams”, Vol. I-III, Wiley,N.Y, USA.
2. Satyanarayana Murthy, C, "Design of Minor Irrigation and Canal Structure",Wiley Eastern, 1990.
3. Sharma, R.K, "Text Book of Irrigation Engineering and Hydraulic Structures ", Oxford & IBH, 1984
4. Sharma, S.K, "Design of Irrigation Structures", S. Chand & Co, 1988.
5. Varshney, R, S, “Theory and Design of Irrigation Structures”, Nem Chand & Bros, 2009.

20WRM242 ENVIRONMENTAL IMPACT ASSESSMENT OF WATER RESOURCES DEVELOPMENT

Sub Code: 20WRM 242	Hrs / Week : 04
Total Hrs : 50	IA Marks : 40
Exam Hours : 03	Exam Marks : 60

Model I

Environmental Issues: Water resources development issues – Environment in water resources project planning – Environmental regulations and requirements – EIA (Environmental Impact Assessment) Notification, 2006 – MoEF & CC Guidance document an major Hydroelectric and Irrigation Projects – ESA (Ecologically Sensitive Area) Notification.

Model II

EIA Fundamentals: Environmental impact Assessment (EIA) - Environmental impact statement – 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 – Due Diligence Survey – Value Environmental components – Flora & Fauna; Endangered Species

Model III

Environmental Impacts: 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.

Model IV

Methods of EIA: EIA team formation – Development of scope, mandate and study design – Base line theory – Check lists – Network and matrix methods – Semi-quantitative methods – ICID check list – Economic approaches – Environmental Impact Statement (EIS) preparation.

Model V

Environmental Management: In-stream ecological water requirements – Public participation in environmental decision making – Sustainable water resources development – Eco restoration – Hydrology and global climate change – Afforestation – R & R (Resettlement & Rehabilitation) Programmes - Environmental monitoring programs.

REFERENCES

1. Biswas, A.K and Aggarwal, S.B.C, "Environmental Impact Assessment for developing Countries", Oxford Butterworth – Heinemann, 1992.
2. Canter, L.W, "Environmental Impact Assessment", McGraw Hill International Edition, New York,2008.
3. Lawrence, D.P, "Environmental Impact", Wiley-Interscience, New delhi, 2003.
4. Petts, J, "Handbook of Environmental Impact Assessment", Blackwell Science London, 1999.

20WRM243 URBAN HYDROLOGY

Sub Code: 20WRM 243 — Hrs / Week : 04
Total Hrs : 50 — IA Marks : 40
Exam Hours : 03 — Exam Marks : 60

Model I

Urban hydrologic cycle: 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.

Model I

Urban Water Resources Management Models: 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.

Model I

Urban Storm Water Management: 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.

Model I

Master plans: 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.

Model I

Operation and Maintenance: 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.

REFERENCES

1. Geiger.W.F., Marsalek.F., Rawls.W.J., and Zuidena.F.C., (Ed), manual on drainage in urbanized areas - Vol.I and Vol.II, UNESCO, 1987.
2. Hengeveld H. and C.DeVoch.t (Ed)., “Role of Water in Urban Ecology”, 1982.
3. Martin P.Wanelista and Yousef A.Yousef., “Storm Water Management”, John Wileyand 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.
6. Warren Viessman, “Introduction to Groundwater Hydrology”, Pearson, Fifth edition, 2002.

20WRM 251 RIVER ENGINEERING

Sub Code: 20WRM 251 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

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

Model II

River hydraulics**:** 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.

Model III

River mecha**n**ics: 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.

Model IV

River surveys and Model**:** 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.

Model V

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

REFERENCES

1. Janson PL.Ph., Lvan BendegamJvanden Berg, Mdevries A. Zanen (Editors),
2. Principles of River Engineering – The non tidal alluvial rivers – Pitman, 1979.
3. Pierre Y. Julien ., River Mechanics ,Cambridge University Press, 2002.
4. K.L Rao , INDIA's WATER WEALTH – Orient Longman Ltd., 1979.
5. R. J. Garde River Morphology New Age International (P) Limited, Publishers New Delhi 2011.
6. R.J.Garde and K.G.Ranga Raju Mechanics of Sediment Transportation and Alluvial
7. Stream Problems New Age International (P) Limited Publishers New Delhi 2000

20WRM 252 CLIMATE CHANGE AND ADAPTATION

Sub Code: 20WRM 252 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

Earth's Climate System**:** Introduction – Climate in the spotlight - The Earth's Climate Machine – Climate Classification – Global wind systems – Trade Wind Systems– Trade Winds and the Hadley Cell – The Weserlies – Cloud formation and Monsoon Rains – Storms and Hurricanes – The Hydrological Cycle – Global Ocean Circulation – EI Nino and its Effect – Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.

Model II

Observed Changes and Its Causes: Observation of Climate Change – Changes in pattern of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – Climate Change modeling.

Model III

Impacts Of Climate Change: Impacts of Climate Change on various sectors – Agriculture, Forestry and ECOsystem – Water resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for different regions Uncertainties in the Projected Impacts of Climate Change – Risk of irreversible changes.

Model IV

Climate Change Adaptation and Mitigation Measures: Adaptation Strategy/options in various sectors – Water – Agriculture – Infrastructure and Settlement including coastal zones. Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and practices – Energy supply – Transport – Buildings – Industry – Agriculture – Forestry – Carbon sequestration – Carbon Capture and Storage (CCS) – Waste (MSW & Biowaste, Biomedical, Industrial waste – International and Regional co-operation.

Model V

Clean Technology and Energy: Clean Development Mechanism – Carbon Trading – Examples of future Clean Technology – Biodiesel – Natural Compost – Eco-friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind –Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.

REFERENCES:

1. Al core 'Inconvenient Truth" – video form
2. Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge
3. University Press India Pvt. Ltd, 2007
4. IPCC Fifth Assessment Report – www.ipcc.ch
5. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on
6. Hydrological Regimes", Cambridge University Press, 2003

20WRM 253 TECHNO ECONOMIC ANALYSIS OF WATER DEVELOPMENT

Sub Code: 20WRM 253 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

Development Course Objectives: Need system, economic and social development, integrated development, multiple purpose of water resource development.

Model II

Institutional Studies:Setup for evaluation implementation, operation water laws, regulation, organizations, and functions data requirement.

Model III

Primary and secondary data, data related to development sectors, environment, and water resource related land and other natural resources.

Model IV

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.

Model V

Definition of primary and secondary impact, long-term and short-term impacts, dentifications of casts and benefits, evaluation research, Course Objective of post implementation, evolution, methodologies, elements of risk

References:

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

20WRM 26-Advanced Water Resources Engineering-Laboratory II

II- Semester M. Tech courses

List of Experiments

1. Estimation of Crop Water Requirements and design of an Irrigation System
2. Irrigation Scheduling
3. Watershed Modelling:
    a. Unit Hydrograph Models
    b. Synthetic Unit Hydrograph Models
4. Determination of Design Flood
5. Analysis and Design of Hydraulic Structures.
6. Design and Analysis of water Distribution Network
7. Digital Simulation of Regional Aquifers
8. Parameter Estimation Through Regression
9. Design and Operation of a Reservoir
10. Design of Sewer Network
11. Diagnostic Analysis of Irrigation Systems
12. Stream Flow Analysis and Simulation
13. Design of Urban Storm water System

20WRM 31 SEDIMENT TRANSPORT

Sub Code: 20WRM 31 — Hrs / Week : 04
Total Hrs : 50 — IA Marks : 40
Exam Hours : 03 — Exam Marks : 60

Module-I

Properties of sediment.Initiation of motion of sediment.Analysis of non-cohesive sediment movement.Shield's diagram. Critical shear stress, critical velocity, lift on particles, Hydraulic relations for alluvial streams.

Module-II

Sediment Sources & sediment yield: Gross erosion, sediment yield, delivery ratio, estimation of sheet erosion, Universal soil loss equation (USLE), different factors affecting erosion process .

Module-III

Sediment delivery ratio from watershed, flow duration curve and sediment rating curve, reservoir sedimentation: empirical equations, trap efficiency, sediment control method.

Module-IV

Fundamentals of sediment transport: general relationships. Bed forms. Wash load, suspended load and Bed load, Rouse equation for suspended sediment load. Sediment discharge formulas by DuBoys, Mayer-Peter & Muller, Schoklitsch, Einstein-Brown and Engelund-Hansen. Sediment sampling.

Module-V

Introduction to Meandering of rivers and river engineering. Scour: local scour at a bridge & abutment, Indian Codal provision for design scour depth.

References:

1. Manuals and Reports on Engineering Practice No. 54, Sedimentation Engineering : Vito A. Vanoni
2. Sediment Transport (Theory and Practice): C.T. Yang
3. Sediment and Ecohydaulics (INTERCOH 2005): T. Kusuda, H. Yamanishi, J. Spearman, and J.Z. Gailani
4. Mechanics of Sediment Transportation and Alluvial Stream Problems: R.J. Garde, K.G. RangaRaju
5. Sediment Transport (in 3 parts), ASCE: L. van Rijn
6. Hydraulics of Sediment Transport : W.H. Graf
7. Fundamentals of Fluvial Geomorphology: Ro Charlton

20WRM321 THEORY OF SEEPAGAE & EARTHEN DAMS

Sub Code: 20WRM 321 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

Seepage analysis and treatment: Seepage analysis, pore pressure, hydraulic heads, flow net in confined and unconfined condition.

Model I

Flow net of earthen dam in different condition – steady seepage and drawdown, graphical method, determination of quantity of seepage, piping phenomenon.

Model III

Application of finite difference and finite element method, conformal mapping, method of foundation treatment to control seepage.

Model IV

Earth dam**:** Factors influencing design of earth dam, type of dams, design criteria for various components of earth dams, filters for earth dam, filter design, requirement for the safety of earth dams, stability of earth dam slope -factor of safety, safety against overtopping.

Model V

Quality control and failure measures in earthen dam**:** Embankment construction procedures, quality control, Performances studies of earth dam, instrumentation, causes of failures of earth dams and corrective measures.

References:

1. Justin J. D., Hinds J. and Creager, P. W. “Engineering for Dams” Volume III, John Wiley & Sons Inc, Chapman & Hall,Ltd, London, 5th Reprint, 1955.
2. George F. Sowers, Hari Lal Sally, “Earth and Rockfill dam engineering”, Asia Pub. House, 1962.
3. Harr, M.E. “Ground water and seepage” McGraw Hill Book Co., New York, 1962.

4. Alam Singh “Soil engineering in theory and practice”, Volume 2, Asia Publishing House, 1981

20WRM322 WATER POWER AND DAM ENGINEERING

Sub Code: 20WRM 322 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

Introduction, sources of energy, role of hydropower in a power system, development of water power potential in India and the world, Features and characteristics of water power generation. Data requirement for assessment of water power potential-flow duration and mass curves, energy flow diagram, demand and prediction, Types of Hydropower generation plants- site selection and Planning – Environmental Considerations and its layouts,

Model II

Components of a hydropower structure- regulatory structures-intake structures –types, location, losses, air entrainment, anti-vortex device, air vent, fore bay, trash racks, power canals, tunnels, surge tanks, settling basins, anchor blanks, penstocks- classification, resonance in penstocks, design criteria, losses, anchor blocks, valves, bends and manifolds,

Model III

Tunnels- geometric and hydraulic design, water hammer and surges, surge tank-functions, type, design of surge tank, methods of surge analysis, channel surges Types of water power house- structural and geotechnical aspects of power house design, location, site and general arrangements, draft tubes, tail trace and their hydraulic design, draught and cooling towers, turbines - characteristics, hydraulics of turbines,

Model IV

cavitations, transients caused by turbine and foundations, pumps-efficiency and characteristics, generators, exciters, switchboard, transformers and other accessories Water retaining structures-Dams-Classifications, types, planning and investigation of reservoir and dam sites, reservoir capacity and regulation, reservoir silting, dam optimization, analysis and design of earthen and rockfill dams, internal seepage, stability and stress, settlement and deformation, foundation treatment, analysis for failure and safety criteria.

Model V

Gravity dam - forces acting and criteria, elementary and practical profile, stability analysis, modes of failures, joints, seals, keys and galleries in gravity dams, spillways-types, location and design, energy dissipaters, dam break analysis, dam safety and hazard mitigation

REFERENCES

1. Barrows, H. K, "Water Power Engineering", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2000.
2. Creager, W.P, Justin, J. D and Hinds J, "Engineering for dams", Nem Chand and Brothers, Roorkee ,1995.
3. Dandekar, M.M., and Sharma, K.N, "Water Power Engineering", Vikas Publishing House, New Delhi ,1994.
4. Garg S. K, "Irrigation Engineering and Hydraulic Structures" Khanna Publishers, New Delhi, 1998.
5. Khatsuria, R. M, "Hydraulics of spillways and energy dissipaters", CRC Press, New Delhi, 2005.
6. Sharma, R.K and Sharma,T.K, "Water Power Engineering", S. Chand and company Ltd, New Delhi,2003.
7. Streeter, V.L and Wylie B, "Fluid Transients", McGraw-Hill Book Company. New Delhi, 1967.
8. Varshney, R .S, "Hydro Power Structures", Nem Chand & Bros, Roorkee, 2001.
9. Novak, P, Moffat, A.I.B, Nalluri, C and Narayanan, R, "Hydraulic Structures", CRC press, Fourth Edition, 2006.

20WRM 323 WATERSHED CONSERVATION AND MANAGEMENT

Sub Code: 20WRM 323 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Model I

Watershed Concepts:Introduction – Significance – Geology – Soil – Morphological Characteristics – Elements – Land Capability Classification – Delineation – Codification – Factors Influencing Watershed Development.

Model II

Soil Conservation Practice: Types of Erosion – Wind Erosion: Causes, Factors, Effects and Control – Water Erosion: Types, Factors, Effects –Engineering Measures for Erosion Control in Agricultural and Non-Agricultural Lands – Estimation of Soil Loss.

Model III

Water Harvesting and Conservation:Water Harvesting Techniques – Design of Small Water Harvesting Structures – Types of Storage Structures – Yield from a Catchment – Losses of Stored Water.

Model IV

Watershed Management: Strategies – Identification of Problems – Watershed Development Plan – Entry Point Activities — Concept of Priority Watersheds – Agroforestry – Grassland Management – Wasteland Management – Watershed Approach in Government Programmes –Developing Collaborative know how – People's Participation – Evaluation of Watershed Management.

Model V

Watershed Assessment Models: Regulation and Restoration – A Brief Description and Significance of Watershed Models: SWAT, TMDL, AGNPS, BASINS, CREAMS –Case Studies.

References:

1. Debarry A. Paul, Watersheds, Wiley and Sons, 2004.Devanport E. Thomas, Watershed Project Management Guide, Lewis Publishers, London, 2003.
2. Ghanashyam Das, Hydrology and Soil Conservation engineering, Prentice Hall of India Private Limited, New Delhi, 2000.
3. Glenn O. Schwab, Soil and Water Conservation Engineering, John Wiley and Sons, 1981.

20WRM 324 INTEGRATED WATERSHED MANAGEMENT

Sub Code: 20WRM 324 Hrs / Week : 04
Total Hrs : 50 IA Marks : 40
Exam Hours : 03 Exam Marks : 60

Module: 1

Introduction: Definition & importance, delineation of watershed, watershed characteristics, causes consequences of watershed deterioration, objectives, principle of watershed operations & management, different approaches in watershed management, watershed management plan identification of problems, objectives & priorities. Steps in developing watershed. Issued in watershed management- Land degradation. Socio economic survey- collection of data, analysis of problems, watershed maps.

Module: 2

Map preparation**:** Introduction, different approaches, thematic maps- base map, drainage, land use/land cover, hydro geomorphology, soil, slope, lineament etc. Map updation, change detection & analysis.

Drainage analysis: Definition, drainage pattern- different types, Horton's &Strahler's Method of stream ordering. Analysis – linear aspects, relief aspects and the influences.

Module: 3

Runoff and Soil loss estimation: Introduction, necessity, runoff- different methods, factors affecting runoff, SCS curve number, Soil loss- introduction, importance, types of erosion,

resources mapping, urbanization effect on hydrological cycle. Runoff estimation, soil loss estimation (USLE), erosion control measures and land reclamation. Management control, sediment control & flood control.

Module: 4

Water conservation and harvesting: Introduction, conservation, methods for crop land, treatment for catchments, small storage structures, design data. Small earthen dams-planning, construction sequence, computation of storage capacity, small weirs, drought from pond, nala bonding. Ground water recharge- ground water recharge, extraction, water harvesting methods and techniques.

Module: 5

Water resources management for sustainability: principles, integrated urban water management, water law surface and ground water management aspects, sustainable water supply methodologies for arid and semi-arid regions, life cycle assessment (LCA)

References:

1. Tideman, EM "watershed management"- guidelines for Indian conditions, omega pub. New Delhi.
2. Thomas M Lillisand& RW kiefer. "remote sensing & interpretation ", WH Freeman, San Francisco.
3. Water resources engineering by larry W Mays wiley students edition.