M. TECH CIVIL ENGINEERING
(WATER RESOURCES AND ENGINEERING)

HIMACHAL PRADESH TECHNICAL UNIVERSITY, HAMIRPUR
2013-14

HIMACHAL PRADESH TECHNICAL UNIVERSITY, HAMIRPUR (H.P.)

Curriculum For M. Tech Programme in Water Resources Engineering

SEMESTER-I

Sr. No	Course No.	Subject	L/T/P	Scheme of Examination			
				Theory	**Sessional**	**Viva**	**Total**
1	WRE 101	Advanced Fluid Mechanics	3/1/0	100	50	-	150
2	WRE 102	Advanced Hydrology	3/1/0	100	50	-	150
3	WRE 103	Computational Methods in Water Resources	3/1/0	100	50	-	150
4	WRE 111/112	Elective -I	3/1/0	100	50	-	150
5	WRE 151	Seminar	0/3/0	-	50	50	100
6	WRE 121	Laboratory - I	2	-	25	25	50
		Total		400	**275**	**75**	**750**

SEMESTER-II

Sr. No	Course No.	Subject	L/T/P	Scheme of Examination			
				Theory	**Sessional**	**Viva**	**Total**
1	WRE 201	Free Surface Flow	3/1/0	100	50	-	150
2	WRE 202	Planning and Management of Water Resources	3/1/0	100	50	-	150
3	WRE 203	Groundwater and Groundwater Modelling	3/1/0	100	50	-	150
4	WRE 113/114	Elective - II	3/1/0	100	50	-	150
5	WRE 152	Term Paper - Leading to Thesis	0/3/0	-	50	50	100
6	WRE 122	Laboratory - II	2	-	25	25	50
		Total		400	**275**	**75**	**750**

SEMESTER-III

Sr. No	Course No.	Subject	L/T/P	Scheme of Examination			
				Theory	**Sessional**	**Viva**	**Total**
1	WRE 115/116	Elective -III	3/1/0	100	50	-	150
2	WRE 117/118	Elective -IV	3/1/0	100	50	-	150
3	WRE 150	Dissertation	3	-	50	50	100
		Total		200	150	50	400

SEMESTER-IV

Sr. No	Course No.	Subject	L/T/P	Scheme of Examination
1	WRE 150	Dissertation	3	Satisfactory/unsatisfactory

List of Electives

	ELECTIVE - I		ELECTIVE - II	
Sr. No.	**Course No.**	**Subject**	**Course No.**	**Subject**
1	**WRE 111**	Advanced Waste Water Treatment	WRE 113	Dam Engineering
2	**WRE 112**	Optimization Techniques	WRE 114	Environmental Impact Assessment and Management

	ELECTIVE - III		ELECTIVE - IV	
Sr. No.	**Course No.**	**Subject**	**Course No.**	**Subject**
1	**WRE 115**	Sediment Transport and River Training	WRE 117	Research Methodology and Intellectual Property Rights
2	**WRE 116**	Watershed Management	WRE 118	Hydro-Power Engineering

Laboratory - I : Water and Waste water analysis and Hydrology Laboratory

Laboratory - II : Computational and Software application Laboratory

Himachal Pradesh Technical University Hamirpur (H.P.)
General Instructions to Paper Setters

1. The question paper should be fairly distributed over the whole syllabus of study and not concentrated on any one or a few portions only.
2. The question paper shall will consist of five sections A, B, C, D & E. Section E will be compulsory and will consist of single question (20 marks) comprising of 10-20 parts of short answer type covering the whole syllabus.
3. The candidates shall be instructed to attempt five questions in all selecting one question from each of the sections.
4. Every part of each question should be clear and definite in language. Paper setters are requested to be careful in setting the questions in accordance with the syllabus and scheme and not according to the previous year's question paper which is sent as a sample.
5. The question paper is set in English language only.
6. The questions should be type written in Word format.
7. In setting question paper, abbreviations of all kinds should be avoided.
8. Serial number of questions should be given on the left hand margin and the marks allotted to each question should be mentioned on the right hand side of the paper.
9. The Question paper set by a paper setter (Press Copy) will be sent for the examination without alteration/modification. Therefore, the paper setter is expected to take full responsibility for his/her paper. The Press copy should not be signed or initialled in any case.
8. Before sending the paper, the paper setter must satisfy himself through careful scrutiny that no mistakes have crept in.
10. Any instructions to the candidates regarding the answering of different sections in different answer-books, use of non- programmable calculators, IS codes and other permissible aids should be clearly given on the top of the question paper. It should be free from ambiguity.
11. The duration of the examination in each subject will be 3 hours and the Maximum marks for question paper shall be 100 unless otherwise specified.
12. The question paper must be sent in a sealed envelope addressed to the Controller of Examination, H.P. Technical University, Hamirpur (H.P.)

Himachal Pradesh Technical University Hamirpur (H.P.)

Acceptance Form

(To be signed by the Paper setter and returned along with the question paper)

I certify that:-

i. I have destroyed all drafts, notes etc., of the questions set, and have retained no copy of the paper with me.

ii. The question paper has been typed by me personally.

iii. I have very carefully gone through the syllabus prescribed for the examination for which the paper has been set by me. The paper set does not include any question, which is outside the scope of the syllabus.

iv. The questions are distributed evenly over the whole syllabus.

v. Detailed distribution of marks for different parts of each question has been given in the question paper.

vi. I have read the instructions carefully and agree to this.

Signature of the Paper setter

Name of the Paper Setter……..

Subject…….....Paper…….

Examination…….

Semester I

WRE 101 - ADVANCED FLUID MECHANICS

UNIT -I

1. **Basic Concepts and Fundamentals:** Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics.
2. **Governing Equations of Fluid Motion:** Reynolds transport theorem, Integral and differential forms of governing equations: Mass, Momentum and Energy conservation equations, Euler's equation, Navier-Stokes equations.

UNIT - II

3. **Exact Solutions of Navier-Stokes Equations:** Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections.
4. **Potential Flows:** Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag.

UNIT - III

5. **Laminar Boundary Layers:** Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation. Introduction, Fluctuations and time-averaging, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis.

UNIT - IV

7. **Introduction to Computational Fluid Dynamics (CFD):** Basic introduction to Finite difference method, Finite volume method and Finite element method.
8. **Compressible Flows:** Propagation of pressure change, velocity of sound, elastic waves, Mach number, Mach cone, Isentropic relations, Normal-shock wave, Rankine-Hugoniot relations, Fanno and Rayleigh curve, Mach waves, Oblique shock wave, Prandtl-Meyer expansion waves, Quasi-one dimensional flows.

Books/ References:

1. Fluid Mechanics by F. M. White.
2. Fluid Mechanics by Streeter
3. Fluid Mechanics by K.L. Kumar
4. Fluid Mechanics by A.K. Jain
5. Viscous fluid flow by White
6. Computational Fluid Dynamics by Anderson

WRE 102- Advanced Hydrology

UNIT -I

1. INTRODUCTION:

Hydrologic cycle, water budget equation, world water quantities, systems concept, transfer function operators, hydrologic model classification.

2. HYDROLOGIC PROCESSES

Reynold's transport theorem, continuity, momentum and energy equations, discrete time continuity.

UNIT - II

3. ATMOSPHERIC HYDROLOGY:

Atmospheric circulation, water vapour, formation of rainfall, types and forms of precipitation, monsoon characteristics in India, rainfall measurement, density and adequacy of rain gauges, Thunderstorm Cell model, IDF relationships, Spatial averaging methods of rainfall. Factors affecting evaporation, estimation and measurement of evaporation, energy balance method, aerodynamic method, Priestly-Taylor method, and pan evaporation.

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4. SUB-SURFACE WATER

Soil moisture, porosity, saturated and unsaturated flow; Richard's equation, infiltration, Horton's Phillip's and Green Ampt methods, parameter estimation.

UNIT - III

5. SURFACE WATER

Catchment storage concept, Hortonian and saturation overland flow, stream flow hydrographs, base-flow separation. Phi-index, ERH & DRH, algorithm for abstraction using Green-Ampt equation, SCS method, overland and channel flow modelling, time area concepts and stream networks**.**

6. **UNIT HYDROGRAPH**

General hydrologic system model, response functions of a linear hydrologic systems and their inter-relationships, convolution equation; definition and limitations of a UH. Derivation of UH from single and complex storms; UH optimization using regression. matrix & LP methods. Synthetic unit hydrograph, S-Curve, IUH**.**

UNIT - IV

7. HYDROLOGIC STATISTICS

Probability concepts, random variables, laws of probability, PDFs & CDFs. Normal and Binomial distributions; Statistical parameters.

Fitting of a probability distribution, methods of moments and maximum likelihood: Testing the goodness of fit, Chi-square test.

Frequency analysis: Return period, probability plotting, Extreme value distributions, frequency factors, Log-Pearson distribution, confidence limits**.**

8. FLOOD ANALYSIS

Flood estimation by various methods, forecasting of floods, flood frequency analysis, Gumbel's, Pearson type I, II, and III distribution, Log-normal method, design flood for various hydraulic structures.

Books/ References:

1. Fluid Mechanics by F. M. White.
2. Fluid Mechanics by Streeter
3. Fluid Mechanics by K.L. Kumar
4. Fluid Mechanics by A.K. Jain
5. Viscous fluid flow by White
6. Computational Fluid Dynamics by Anderson

WRE 103: COMPUTATIONAL METHODS IN WATER RESOURCES

UNIT 1

1. Linear System

Solution for Banded and Sparse systems using Gaussian elimination and Gauss, Jordan methods, Gauss - Seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods, Interpolation – Newton's and Lagrange's interpolation

2. Finite Differences

Introduction to Finite Differences. Solution of System of Non-linear Algebraic equations using Newton and Picard Method.

UNIT 2

3. Numerical solution of Ordinary differential equations

Initial and Boundary value problems, Solutions using Euler Method, Modified Euler Method, Fourth–order Runge-Kutta method, predictor –corrector, and shooting methods.

UNIT 3

4. Numerical solution of Partial Differential Equations

Introduction to Partial Differential Equations-Elliptic, Parabolic and Hyperbolic equations. Numerical solution for partial differential equation - Finite difference Method. Relaxation methods and introduction to Method of Characteristics.

UNIT 4

5. Explicit and Implicit Finite Difference schemes for Advection, Diffusion and Advection-Diffusion equations. Convergence and Stability of difference schemes.

6. Introduction to Artificial Neural Networks: Networks and its training-Back propagation algorithm, Conjugate gradient algorithm, Cascade correlation algorithm, Applications of ANN in WRE.

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Reference Books:

1. Numerical Methods by Chapra and Canale.
2. Neural Network Fundamentals with Graphs, Algorithms, Applications-Bose N.K.
& Liang P. McGraw Hill N.Y.
3. Computational Fluid Dynamics by Anderson.

Elective-I

WRE 111 - ADVANCE WASTE WATER TREATMENT

.**Unit 1**

1. **Introduction:** Objectives of waste water treatment, Purpose of advanced wastewater treatment, Wastewater quantity and transport and waste water characteristics, Alternative flowcharts, function and basic principles involved in different units of conventional wastewater treatment plant.

2. **Process Analysis:** Reaction and reaction kinetics, Mass balance Reactors and their hydraulic Characteristics, Practical aspects of reactor design.

Unit 2

3. **Physical and Chemical Treatment:** Screening, Grit removal, flow equalizations and mixing, Flocculation, sedimentation, flotation. Detailed principles and design aspects of Screening, Grit chamber and Sedimentation tank.

4. **Principles of Biological Treatment:** Kinetics of biological growth, introduction to suspended and fixed film reactors, Concepts of gas transfer and solids separation, Nitrogen and Phosphorus removal from waste water, Concepts of aerobic and anaerobic treatment of waste water, Design of Activated Sludge system using biological process dynamics. Process concepts and design aspects of Trickling Filters, Rotating Biological Contactors (RBC) Fluidized bed reactor/treatment.

Unit 3

5. **Sludge Treatment And Disposal:** Aerobic and Anaerobic digestion of sludge, sludge stabilization, dewatering and conditioning.

6. **Sludge Disposal:** Miscellaneous methods of dissolved solids removal, sludge disposal methods

Unit 6

7. **Tertiary Treatment:** Principles of tertiary treatment, theory of adsorption and factors affecting adsorption, concepts and different methods of dissolved solids removal, basic principles of Reverse Osmosis, ultra-filtration, electro dialysis, desalination

Reference Books

1. Wastewater Engineering: Treatment, Disposal & Reuse, By Metcalf & Eddy Inc. Sixth Ed. 2002, McGraw Hill.
2. Introduction to Environmental Engg., By. P.A. Veslind, PWS, Publishing Company, Boston, 1997.
3. Wastewater Treatment and disposal, By S.J. Arceivalla, Marcel Dekker, 1981.
4. Wastewater Treatment Plant Planning, Design and Operation, By S.R. Quasim, Holt, Rinehart & Winston N.Y.
5. Activated Sludge Process: Theory and Practices, By N.F Grey, Oxford

Elective-I

WRE 112: OPTIMIZATION TECHNIQUES

Unit 1

1. **System Concepts:** System concepts, definitions, needs for system approach, different types of system parameters and variables.

Unit 2

2. **Linear Programming:** Revision, Big M Method, duality, sensitivity analysis. Application of Linear Programming for Hydraulics & Water Resource.

Unit 3

3. **Non Linear Programming:** Unconstrained one Dimensional search methods, Dichotomous search method, Fibonacci, Golden section, multivariable unconstrained, gradient techniques, steepest ascent and descent methods, Newton's methods, Application of Dichotomous search method, Fibonacci & Golden section to the various sectors of Water Resource Engineering, constrained Lagrangian multiplier techniques.

Unit 4

4. **Dynamic Programming:** Principle of optimality, recursive equations. Application of Dynamic programming to Water Resource Engineering.

5. **Stochastic Methods:** Queuing theory, simulation technique, sequencing model, Morkov's process.

Reference Books

1. Engineering Optimization Theory & Practice – S.S. Rao.
2. Operation Research – Taha Hamdey A.
3. Operation Research – Wagner.

WRE 121 - HYDRAULICS AND ENVIRONMENTAL LABORATORY – I

List of Experiments to be performed

1. Flow past a cylinder
2. Flow over Weirs
3. Growth of a boundary layer along a flat plate
4. Assignment based on drawing of flow-net
5. Flow past a circular disc.
6. Lift and drag

Semester-II

WRE 201- FREE SURFACE FLOW

UNIT -I

1. Basic Equations

Introduction: Basic concepts of free surface flows, classifications of channels, classification of flow, Equations of motion - Continuity equation, Energy equation and Momentum equation. Velocity, pressure and shear distribution, Pressure distribution in curvilinear flow.

2. Critical Flow

Energy-depth relations: Concept of specific energy, specific force, critical flow, critical depth, critical depth computation, section factor for critical depth computation, control sections, applications of specific and critical depth concepts.

UNIT - II

3. Uniform Flow

Flow through prismatic channels, Resistance equations- Chezy's and Manning's formulae, boundary roughness, Normal depth and its computations for trapezoidal, circular and composite channels.

4. Design of Canals

Concept of efficient sections, most efficient triangular, rectangular and trapezoidal sections. Lined canals and their design.

UNIT - III

5. Gradually Varied Flow

Introduction, Dynamic equation of steady gradually varied flow, Classification of gradually varies flow profiles. Sketching of composite water surface profiles, Control section. Computation of gradually varied flow - Standard step method.

6. Rapidly Varied Flow

Characteristics of rapidly varied flow, classical hydraulic jump, evaluation of the jump elements in rectangular and non-rectangular channels on horizontal and sloping beds, Hydraulic jump in gradually and suddenly expanding channels, submerged hydraulic jump, use of jump as an energy dissipater.

UNIT – IV

7. Spatially Varied Flow (SVF)

Basic principles, Differential SVF equations for increasing and decreasing discharge - continuity, momentum and energy equations. Flow over side-weir and Bottom-rack. Classifications and solutions.

8. Unsteady Flow

Introduction, Classification of waves, open channel positive and negative surge, celerity of the gravity wave, Equation of motion for unsteady flow - Saint-Venant's equations, kinematic and monoclinal waves, Method of characteristics, Dam break problem.

Books/ References:

1. Chow, V.T., Open channel Hydraulics, McGraw Hill International
2. Henderson, F.M., Open Channel Flow, McGraw Hill International
3. Subramanya, K (2002) Flow in Open Channels, Second edition, Tata McGraw Hill
4. Ranga Raju, K G (2003) Flow through Open Channels, Second edition, Tata McGraw Hill
5. M. Hanif Chaudhry, Open Channel Flow, PHI
6. French, R.H., Open channel Hydraulics, McGraw Hill International

WRE - 202: WATER RESOURCES SYSTEMS PLANNING AND MANAGEMENT

Unit 1

1. Introduction

Objectives: of water resource planning and management, its Necessity, Aspects of water resources planning, of water resource development; needs and opportunities; societal goals.

Spatial and temporal characteristics of water resources; constraints for its development like non-reversibility; planning region and horizon.

Unit 2

2. Economic Planning

Demand for drinking water; irrigation, hydropower; navigational; planning for flood control. Cost benefit studies of single and multipurpose projects– multi objective planning models, financial analysis of water resources projects, allocation of cost of multipurpose projects; repayment of cost.

Unit 3

3. Management of Water Resources

Characteristics and functions of reservoir; reservoir sedimentation; conservation storage; conflict among uses, Reservoir operation studies - effect on river regime; long term simulation; reliability; resiliency and vulnerability assessment.

4. Management of Ground-Water Resources

Ground water evaluation; conjunctive use of surface and ground water.

Unit 4 :

5. Cost - Benefit Analysis

Discounting techniques; benefit cost parameters; estimation of benefits and costs; appraisal criteria; social benefit - cost analysis. Basin planning; inter-basin transfer of water.

Recommended books

1. James, L .D., and Lee, R. R., "Economics of Water Resources Planning", Mc Graw Hill.
2. Modi, P.N., Irrigation, Water Resources and Water Power Engineering", Standard Book Pub., Delhi.
3. Garg, S.K., "Irrigation Engineering and Hydraulic Structure", Khanna Publishers.
4. Principles of Water Resources planning-by Goodman.
5. Water Resources System Planning – by M.C. Chaturvedi.
6. Water Resources Planning and Management by- O. J. Helwege.
7. Water Management System Application-A.K. Biswas

WRE 203: GROUND WATER ENGINEERING

Unit 1

1. Occurrence and Movement of Ground Water

Definition of Ground Water, Occurrence and movement of groundwater, vertical distribution of subsurface water, Aquifers & their properties, Darcy's law, Permeability, Transmissibility, Stratification, Confined and unconfined groundwater flow under Dupit's assumptions. Application of Darcy's law to simple flow systems.

Unit 2

2. Well Hydraulics

Well hydraulics, Governing differential equation for confined and unconfined aquifers, Fully & partially penetrating wells, Interference of wells, Well losses, Pumping test with steady & unsteady flow, Method of images.

3. Design and Construction of Wells

Well types, Methods of well construction, Design of wells, Screens, Perforations & gravel packs, Pumping equipment.

Unit 3

4. Planning of groundwater development

water balance, Assessment of recharge, utilizable recharge, Groundwater estimation norms in India, Constraints on groundwater development.

5. Ground Water Conservation

Ground water budget, seepage from surface water artificial recharge.

Unit 4

6. Ground Water Modelling

Numerical modelling of groundwater flow - Review of differential equations, finite difference solution, direct problem, inverse problem, Groundwater modelling using finite element method.

Recommended books

1. Chow V. T., "Hand Book of Applied Hydrology", Mc Graw- Hill, N.Y., USA.

2.M.C. Graq, "Ground water Resoucess Evaluation" McGraw-Hill, N.Y., USA 1970

3. Todd, D.K., Ground water Hydrology, John Wiley, 1980.

4. Groundwater modeling by Anderson.

Elective-I I

WRE - 113 DAM ENGINEERING

Unit 1

1. **Arch and Gravity Dams:** Gravity Dams - Forces acting on dam, design criteria, theoretical and practical profile, high and low dam, stability calculations, materials and methods of construction , Galleries, joints. Arch Dams – types, layout of Constant angle and Constant radius arch dam, forces acting, general concepts of trail load theory, elastic shell methods, thick cylinder theory.

Unit 2

2. **Earthen Dams:** Earth Dam their component and functions, causes of failure. Seepage through dam and its foundations, stability analysis for sudden drawdown condition, steady seepage condition, end of constructions, seismic effects, pore pressures, protection of upstream and downstream slopes. Factors influencing the design of an earth dam. Design criteria for Earth Dam. Elementary idea of design for spillway and energy dissipaters.

Unit 3

3. **Rockfill and Buttress Dams:** Rockfill dams - Relevant rockfill characteristics, general design principal method of construction and compaction. Buttress dams - Buttress dams, Types, selection, merits and demerits, Elementary design Principles of buttress dams.

Unit 4

4. **Spillways:** Determination of capacity, types of spillways e.g. ogee, siphon, chute and. side channel spillway.
5. **Spillway Gates:** Types of gates - trainer, drum, vertical lift and automatic gates.

Reference Books

1. Concrete Dams – R.S. Varsheny
2. Irrigation Water Resources & Water Power Engineering P.N. Modi
3. Earth Dams – J.L. Sherard.

Elective-I I

WRE 114 - ENVIRONMENTAL IMPACT ASSESSEMENT AND MANAGEMENT

UNIT 1

Introduction

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. Participation of public and non-governmental organizations in environmental decision making.

UNIT 2

Environment Impact Prediction

Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – Air – Water – Soil – Noise – Biological – Socio-cultural environments – Cumulative impact assessment – Documentation of EIA findings – Planning – Organization of information and visual display materials – Report preparation.

UNIT 3

Environmental Management Plan

Preparation, implementation and review – Mitigation and rehabilitation plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and quality aspects of environmental impact assessment.

UNIT 4

Case Studies

Case studies related to the following sectors – Infrastructure – Mining – Industrial – Thermal Power – River valley and Hydroelectric – Nuclear Power.

Reference/ Textbook

1. Biswas, A.K. and Agarwala, S.B.C., "Environmental Impact Assessment for Developing Countries", Butterworth Heinemann, 1994.
2. Asante-Duah, K., Risk assessment in environmental management: a guide for managing chemical contamination problems. John Wiley and Sons, 1998.
3. Ricci, P.F., Environmental and Health Risk Assessment and Management: Principles and Practices, Springer, 2006.
4. Theobald, R. H., Environmental management, Nova Science Publishers, 2008.
5. Madu, C. N., Environmental planning and management, Imperial College Press, 2007.

WRE - 122: COMPUTATIONAL AND SOFTWARE APPLICATION LABORATORY

Performing Lab Work Related to the subjects of Semester II (as proposed in this syllabus)

1. Characteristics of Hydraulic Jump in horizontal and sloping channel
2. Velocity distribution in open channel flow
3. Use of open channel flow simulation software like HEC
4. Measurement of discharge in rivers
5. Numerical simulation of 1-D open channel flow using MATLAB

Semester-III

Elective-III

WRE 115 - SEDIMENT TRANSPORT IN RIVERS AND RIVER TRAINING

UNIT 1

Introduction

Properties of sediment, Settling Velocity of particles, Effect of particles on the viscosity. Sediment properties and Grain-size distributions.

UNIT 2

Transport of non-cohesive sediment (sands and gravels)

Settling velocity, Incipient motion, bed-load, suspended-load and total load; Bed forms and bed load transport, Sediment measuring devices, Sediment transport in canals. Design of rigid boundary canals, Lacey's and Tractive force concepts in canal design, lining of canals.

UNIT 3

River Behaviour

Types of rivers, Classification, Meandering phenomenon, cut off. River bank erosion mechanisms; direct bank erosion protection methods (use of fascine mattresses; geosynthetics; other options); indirect bank erosion protection methods (flow deflection using spurs, groynes, etc. and their possible ill effects); river training works (guide bunds) for bridges and barrages.

UNIT 4

Design of River Training Works

Types of river training works. Embankments - design parameters and stability analysis. Bank revetment - Planning and design, pitching using geo-textiles. Design of Spurs and groynes - general features, design of boulder spurs.

Text / Reference Book:

1. W.H Graf, “Hydaulics of Sediment Transport”, Mc Graw- Hill, N.Y.,USA.

2. R.G. Grarde and Ranga Raju, “Mechanies of Sediment Transport”, Wiley, New.Delhi, India.

Elective-III

WRE 116 - WATERSHED MANAGEMENT

Unit 1

Introduction

Types of watershed and their characteristics. Purpose of planning of watershed projects, Guidelines for project formulation, Management strategies, system concept, systems components and constraints.

Unit 2

Hydrologic cycle and its effect on man's activity, erosion process and sediment yield, conservation practices, water resources and environmental problems, water quality management planning, Design of water resources systems.

Unit 3

Environmental impact assessment, adverse effects of dams and reservoir on environment, watershed management with multiple use concepts.

Unit 4

Project economics: pattern of financing and credit, cost benefit analysis, Economic evaluation, project implementation and management, problems of execution and management.

Text / Reference Books:

1. K.C. Patra, "Hydrology and water Resources Engineering"
2. S. K. Garg, " Irrigation Engineering"

Elective-IV

WRE 117-RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

UNIT 1

Introduction
Nature and objectives of research. Methods of Research: historical, descriptive and experimental, research process, research approaches, criteria for good research. Meaning of research design, need of research design, features of good design, different research designs, and basic principles of experimental designs, design of experiments.

UNIT 2
Data collection, Analysis and Processing: Types of data, methods and techniques of data collection, primary and secondary data. Use of statistics for data analysis, measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, determination of sample size, chi-square test, analysis of variance, multiple regression analysis,

UNIT 3
Decision making techniques: Application of various decision making techniques such as Analytical Hierarchy Process (AHP), TOPSIS, neural networks, graph theory, simulated annealing, genetic algorithms, data envelope analysis (DEA).

Interpretation and report writing: Techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of research report, mechanics of writing research report.

UNIT 4
Introduction to Intellectual Property Rights
Patents, Designs, Trademarks and Copyright. Process of Patenting and Development.

International Scenario
International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Recent Developments in IPR. Case Studies.

Reference Books
1. C.R Kothari, Research Methodology, Wishwa Prakashan
2. P.G Triphati, Research Methodology, Sultan Chand & Sons, N.Delhi
3. Fisher, Design of Experiments, Hafner
4. Stoufferetal, Measurement and Prediction, Wiley, N.York
5. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York

Elective-IV

WRE 118 - WATER POWER ENGINEERING

Unit 1

1. INTRODUCTION

Introduction, sources of energy, water power development, power requirements, load studies, power available, power potential of stream, storage and pondage studies.

Unit 2

HYDRO POWER PLANTS

Hydro-power plants, classification, elements, Firm and secondary powers, load factor, utilization factor, plant factor.

Unit 3

PLANT INTAKES, PENSTOCK AND SURGE TANKS

Intakes, tunnel, penstocks and draft tubes, Water hammer analysis, surge tanks, classification, working principle.

Unit 4

TURBINES FOR HYDRO POWER PLANTS

Turbines, main features, performance, selection, capacity, salient features.

Text / Reference Books:

1. Dandekar and Sharma, “Hydro Power Engineering”

2. Varshney, “Hydro Power Structures” NCB, Roorkee, India.