

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: M.E. (Civil) in Water Resources Engineering

Programme Specific Outcome (PSO)

PSO1 To demonstrate knowledge and understanding of principles of water resources engineer by using various tools and methodologies to provide application oriented solutions.

PSO2 Overall understanding, evaluation, analysis and application of sources, storage distribution, development and management of water resources and corresponding projects.

PSO3 To develop expertise on training demonstration and exposure to advances computer aided solutions and decision support systems.

PSO4 To develop and analyse the numerical techniques and soft computing models for water resources engineering corresponding projects.

Syllabus of Courses

 THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2126 : WATER RESOURCES PLANNING				Credits / Hours per week		3L + 1T				
Semester	I	Year of Introduction : 2000 Year of Syllabus Revision :				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2126 CO1 To understand economic analysis & discounting factors CO2 To get familiar with various cost characteristic CO3 To identify various types of cost and benefits in water resources planning CO4 Measurement of benefits and costs along with its measurement CO5 To emphasize on the risk & undertainties in benefit cost analysis CO6 To undertand various flood control measures in urban area CO7 To get knowledge on water supply system and understand supply demand curve for water supply system CO8 To understand various terminologies related hydro-electric power plant and project feasibilities												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	Mathematics of Economic Analysis, Formulating the analysis, Discounting factors, Discounting techniques, Other approaches	7	13	1,2,4,5	CO1	PSO1 PSO2	Emp / Ent	L/N/R/G	ES, PE
2.	Cost Composition and Comparison, Capital cost, Annual cost, Contractor's cost, Constant annual cost, Varying annual cost, Related variables, System optimization	5	11	1,2,5	CO2	PSO1 PSO2			
3.	Tangibles and Intangibles, Tangible costs and benefits, Intangible costs and benefits, Decision making process, Concept of well being, Equivalence of tangibles and intangibles	6	12	1,2,5	CO3	PSO1 PSO2			
4.	Benefit Cost Analysis, Project evaluation, Benefit cost measurement, Benefit cost variation, Value of benefit cost variation	6	12	1,2,5	CO4	PSO1 PSO2			
5.	Risk and Uncertainties Consideration, Measuring risk and uncertainties, Cost of reducing risk, Strategies for reducing risk	7	13	1,2,5	CO5	PSO1 PSO2			
6.	Planning For Flood Control, Planning context, Developing supply, Estimating demand, Project feasibilities	7	13	1,2,4	CO6	PSO1 PSO2			
7.	Planning For Water Supply, Planning context, Developing supply, Estimating irrigation demand, Estimating urban demand, Project feasibilities	7	13	1,2,4	CO7	PSO1 PSO2			
8.	Planning For Hydroelectric Power, Planning context, Developing supply, Estimating demand, Project feasibilities	7	13	1,2,4	CO8	PSO1 PSO2			

Reference Books

1.	L. Douglas James, Robert R. Lee, "Economics of Water Re-sources Planning", McGraw Hill Book Company
2.	Edward Kniper, "Water Resources Project Economics", Bneter-worths
3.	OCDE, "Management of Water Projects", Oxford & IBH Publishing Co.
4.	Warren Viessman, W. Claire Weltis, "Water Management Technologies and Institution", Harper and Rav Publishers
5.	Ray K. Linsley, Joseph B. Frazini, "Water Resources Engineering", McGraw Hill International Book Company
6.	Neil S. Grigg, "Water Resources Planning", McGraw Hill Book Co.
7.	Basawan Sinha, Ramesh Bhatia, "Economic appraisal of Irrigation Projects in India", Agricol Publishing Academy
8.	V. K. Sharma, "Water Resource Planning and Management", Himalaya Publishing House
9.	E. J. Mishan, "Cost-Benefit Analysis", George Allen & Unwin, London
10.	Aaron Wiener, "The Role of Water in Development-an Analysis of Principles of Comprehensive Planning", McGraw Hill Book Co.

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / ~~Foundation~~ WRE2126L : Laboratory Practical				Credits / Hours per week		2P	
Semester		I	Year of Introduction : 2000 Year of Syllabus Revision :				Maximum Marks / Grade		50	
Mode of Transaction			Data Collection, Analysis, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Selection procedure for determining mutually exclusive alternatives using present worth method					4	2126L	1,2,4,5	CO1	PSO1, PSO2
2	Selection procedure for determining mutually exclusive alternatives using rate of return method					4	2126L	1,2,4,5	CO1	PSO1, PSO2
3	Selection procedure for determining mutually exclusive alternatives using benefit cost ratio					4	2126L	1,2,4,5	CO1	PSO1, PSO2
4	Selection procedure for determining mutually exclusive alternatives using annual cost method					4	2126L	1,2,4,5	CO1	PSO1, PSO2
5	Determination of annual cost of hydroelectric project					4	2126L	1,2,4,5	CO8	PSO1, PSO2
6	Determination of peak flow for various return periods					3	2126L	1,2,4,5	CO6	PSO1, PSO2
7	Determination of marginal cost of water supply scheme					3	2126L	1,2,4,5	CO7	PSO1, PSO2

Syllabus of Courses

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2137 : COMPUTER AIDED RESERVOIR OPERATION				Credits / Hours per week		3L + 1T				
Semester	I	Year of Introduction : 2006 Year of Syllabus Revision : 2020				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2137 CO1 To be able to study reservoir planning for various purposes & various zones of reservoir CO2 Understanding the concept of various types of reservoirs CO3 To understand the principles of various types of reservoirs and preparation of rule curves. CO4 To understand flood routing methods using hydrologic reservoir routing & river routing. CO5 To understand the application on various optimization and simulation models. CO6 Understanding of real time operation, softwares and tools for the same CO7 To understand and prepare the schedule and operation of spillway gates. CO8 To get knowledge about the real time operation of reservoirs in India through case study.												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	Reservoir planning. Types of reservoirs. Available storage capacity of a reservoir. Investigations for reservoir planning. Selection of site for a reservoir. Capacity-elevation and area elevation curves of a reservoir site. Storage zones of a reservoir. Mass inflow curve and demand curve. Determination of the required capacity. Fixing the reservoir capacity for the computed value of the dependable yield of the reservoir catchment. Relation between the inflow outflow and storage data for a reservoir. Fixing the reservoir capacity from the annual inflow and outflow data. Determination of yield of reservoir. Analytical method for determination of storage capacity of a reservoir. Demand patterns and optimal operation. Operation plan of a multipurpose reservoir. Apportionment of the total cost of a multipurpose reservoir. Reservoir sedimentation. Reservoir losses. Reservoir clearance.	8	14	1,2,3,4	CO1	PSO1	Emp	L/N/R/G	ES, PE
2.	Reservoir Planning, Objective of water resources development, Classification of reservoir : Single purpose, Multi-purpose, systems of reservoir, Water uses, Conflicts on reservoir operation, Hydrologic forecast, Rule curve	6	12	1,2,3,4	CO2	PSO1			
3.	Principles of reservoir operation : Single purpose reservoir, Multi-purpose reservoir system of reservoirs Preparation of rules curves : Single purpose reservoir, Multi-purpose reservoir system of reservoirs	6	12	1,2,3,4	CO3	PSO1			
4.	Hydrologic routing, Inflow & outflow hydrographs, Maximum flood & design flood, Flood attenuation, Reservoir operation policy (A) Hydrological reservoir routing, Non-linear storage functions, Outflow functions graphical and semigraphical methods (B) Hydrologic river routing Muskingum & other methods, Numerical methods for non-linear hyperbolic partial differential equations	8	14	1,2,3,4	CO4	PSO1			
5.	System engineering techniques : System engineering approach, System engineering concepts, Tools available viz; Simulation, Optimization, Simulation vs Optimization, Case studies using simulation/optimization techniques	6	12	1,2,3,4	CO5	PSO1			
6.	Real time operation of reservoirs : Definition, Available software, HEC program Acres Reservoir Simulation Program (ARSP), RIBASIM program	6	12	1,2,3,4	CO6	PSO1			
7.	Development of spillway gate regulation schedules, Procedure, Computation for spillway gate, Regulation schedule	6	12	1,2,3,4	CO7	PSO1			
8.	Case studies based on reservoir operation 1. Bhakra – Beas system 2. Ukai – Kakrapar system 3. Tehri reservoir operation manual	6	12	1,2,3,4,5	CO8	PSO1			

Reference Books	
1.	Cunringham A. B. and J. R. Amend (1984), "Water Management Using Interactive Simulation", J1-Water Resources-Planning and Mgt ASCE
2.	Chaturvedi M. C., "Water Resources System Planning and Management", Tata McGraw Hill Pub. Co. 1987
3.	Indian Standard : Operation of Reservoir – Guidelines, published by Bureau of Indian Standards, 1994
4.	Real Time Intergrated Operation of Reservoirs, Govt. of India, Central Water Commission, Reservoir Operation Directorate, April-2005

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / ~~Foundation~~ WRE2137L : Laboratory Practical				Credits / Hours per week		2P	
Semester		I	Year of Introduction : 2006 Year of Syllabus Revision :2020				Maximum Marks / Grade		50	
Mode of Transaction			Data Collection, Analysis, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Determination of Required Capacity of Reservoir by graphical Method					4	2137L	1,2,3,4	CO1	PSO1
2	Determination of Required Capacity of Reservoir by Analytical Method					5	2137L	1,2,3,4	CO1	PSO1
3	reservoir Flood routing by Modified Puls method					4	2137L	1,2,3,4	CO3	PSO1
4	reservoir Flood routing by Good rich method					4	2137L	1,2,3,4	CO3	PSO1
5	Hydrological Channel Routing by Muskingum Method					4	2137L	1,2,3,4	CO3	PSO1
6	To prepare report on case studies based on reservoir operation					4	2137L	1,2,3,4,5	CO8	PSO1

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	The Maharaja Sayajirao University of Baroda Faculty of Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING												
Year	I	Core / Elective / Foundation WRE2140 : IRRIGATION NETWORK PLANNING				Credits / Hours per week		3L + 1T				
Semester	I	Year of Introduction : 2000 Year of Syllabus Revision : 2021				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2140												
CO1 Basic concept, need and importance of irrigation network planning												
CO2 Significant and procedure for survey and investigation of network planning												
CO3 Understanding components of macro and micro network planning												
CO4 To design lined & unlined canals using Kennedy's &Lacey's theory												
CO5 To familiar with canal redulation works along with their design												
CO6 Understanding stepwise procedure and actual micro network planning as per guidelines												
CO7 To prepare RWS schedule, to study various distribution systems and To study various types on drainage & its importance and design criteria for drainage												
CO8 To prepare micro network planning of a command area and to get hands on practice for the same.												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	Objective of Network Planning, Objective of structured irrigation network, Definition of terms, Regulated system and proportional system, On and off system, Basic principles of network planning, Planning of irrigation projects	6	12	1,2	CO1	PSO2	Emp/ Ent/SD	L/N/R/G	ES, PE
2.	Macro Network Planning, Survey and Investigation, Preliminary surveys, Detailed survey, Use and importance of topographic maps, Bench mark	6	12	1,2	CO2	PSO2			
3.	Planning of Command Area, C.C.A. of project, Peak demand, Concept of block, Minor service area, Computing chaksize	6	12	1,2	CO3	PSO2			
4.	Planning and Design of Irrigation Network, Water allowance, Fixing main canal capacity, Alignment of irrigation canals, Curves in canal, Duty of water, Canal losses, Design statements for distributory and minors	6	12	1,2,3,4	CO4	PSO2			
5.	Planning of Structures, Different type of structures, Selection criteria, Location and their design considerations, Micro level canal structures	6	12	1,2,3,4	CO5	PSO2			
6.	Micro Level Canal Network Planning, , Plot corner survey, Stepwise procedure for planning and designing of micro network system ,Management and Operation of micro network system,	7	13	1,2,3,4	CO6	PSO2			
7.	Rotational Water Supply (RWS), Principles of RWS system, Preparation of R.W.S. computation of National area, Drainage Planning for Command Area, Importance, , Assessment of the field drainage system, Link drain and collector drain, Design considerations for drains	7	13	1,2,3,4	CO7	PSO2			
8.	Project on Micro Network planning, Preparation of Chak map , division of chak to subchaks, alignment of subminor and field channels, To prepare FSL statement of subminor and to decide type and location of micro level canal structures	8	14	1,2,3	CO8	PSO2			
Reference Books									
1.	“Irrigation Engineering” by G. L.Asawa,Wiley Eastern Limited								
2.	“Guidelines forPlanningandDesignofMicroCanalNetworkSystem”,C.D.O.,Gandhinagar								

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING										
Year		I	Core / Elective / Foundation WRE2140L : IRRIGATION NETWORK PLANNING			Credits / Hours per week		2P		
Semester		I	Year of Introduction : 2000 Year of Syllabus Revision : 2021			Maximum Marks / Grade		50		
Mode of Transaction			Data Collection, Analysis, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Design of unlined Canal by Lacey’s Theory					4	2140L	1,2,3,4	CO4	PSO2
2	Design of unlined Canal by Kennedy’s Theory					4	2140L	1,2,3,4	CO4	PSO2
3	Design of Lined Canal by Manning’s Equation					4	2140L	1,2,3,4	CO4	PSO2
4	Micro network planning of chak using actual field data and preparation of chak map, alignment of subminor and field channel, FSL statements for subminor and decide micro level canal structures					6	2140L	1,2,3,4	CO8	PSO2
5	Preparation of RWS based on actual field data					4	2140L	1,2,3,4	CO7	PSO2
6	To prepare layout of drainage system on chak map					4	2140L	1,2,3,4	CO7	PSO2

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2127 : OPERATION RESEARCH IN WATER RESOURCES ENGINEERING				Credits / Hours per week		3L + 1T				
Semester	I	Year of Introduction : 2006 Year of Syllabus Revision :				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2127 CO1 To get familiar with operation research and various optimization models CO2 to get familiar with linear programming, construction and analysis CO3 To solve the linear programming, problems using simplex method CO4 To carry out sensitivity analysis for the solutions obtained, solving linear programming problems CO5 To carry out optimal resource allocation & optimal transportation CO6 To get familiar with the concept of game theory used for determining strategies in different situation CO7 To get familier with network diagrams and to be able to solve optimum path and minimum cost flow problems CO8 To solve complex problems by breaking it down into simpler sub problems using dynamic programming												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1.	Origin, nature and impact of operation research. Optimization and operation research process. System boundaries, sensitivity analysis, tractability and validity. Descriptive models and simulation. Numerical search and exact versus heuristic solutions. Deterministic versus stochastic models. Perspectives.	6	12	1,2	CO1	PSO1 PSO2 PSO4	Emp/ Ent/SD	L/N/R/G	ES, HV, PE
2.	Introduction to linear programming., Construction of the LP model. Graphical LP solution, Graphical sensitivity analysis. Computer solution of LP problems. Analysis of selected LP models.	6	12	1,2,3,4	CO2	PSO1 PSO2 PSO4			
3.	The Simplex method. Standard LP form and it's basic solution. The simplex algorithm. Artificial starting solution. Special cases in simplex method application.	6	12	1,2,3,4	CO3	PSO1 PSO2 PSO4			
4.	Duality and sensitivity analysis. Definition of the dual problem. Relationship between optimal primal and dual solutions. Economic interpretation of duality. Dual simplex method. Primal-dual computations. Post-optimal or sensitivity analysis.	6	12	1,2,3,4	CO4	PSO1 PSO2 PSO4			
5.	Transportation problem. Streamlined simplex method for transportation problem. Assignment problem.	6	12	1,2,3,4	CO5	PSO1 PSO2 PSO4			
6.	Game theory. Introduction. Definition of Game theory. Characteristics of Game theory. Basic definitions and terminology. Pure strategies. Mix strategies. Rules of dominance.	7	13	1,2,3,4	CO6	PSO1 PSO2 PSO4			
7.	Terminology of networks. Shortest path problem. Minimum spanning tree problem. Maximum flow problem. Minimum cost flow problem. Network simplex method.	7	13	1,2,3,4	CO7	PSO1 PSO2 PSO4			
8.	Characteristics of dynamic programming problems. Deterministic dynamic programming. Probabilistic dynamic programming.	8	14	1,2,3,4	CO8	PSO1 PSO2 PSO4			
Reference Books									
1.	Hiller, F. S. and Lieberman, G. J. "Introduction to Operations Research". Seventh Edition, Tata McGraw-Hill Publishing Company Ltd.								
2.	Taha, H. A. "Operations Research–An Introduction". Sixth Edition, Prentice Hall of India								

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / Foundation WRE2127L : Laboratory Practical			Credits / Hours per week		2P		
Semester		I	Year of Introduction : 2006 Year of Syllabus Revision :			Maximum Marks / Grade		50		
Mode of Transaction			Data Collection, Analysis, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Formulation of LP Problems based on field data					3	2127L	1,2,3,4	CO2	PSO1 PSO2 PSO4
2	Determination of optimal solution of a LP problem by using graphical method					3	2127L	1,2,3,4	CO2	PSO1 PSO2 PSO4
3	Determination of optimal solution of a LP problem by using simplex method					3	2127L	1,2,3,4	CO3	PSO1 PSO2 PSO4
4	Determination of optimal solution of a LP problem by using Big-M method					3	2127L	1,2,3,4	CO4	PSO1 PSO2 PSO4
5	Determination of optimal solution of a LP problem by using two phase method					3	2127L	1,2,3,4	CO4	PSO1 PSO2 PSO4
6	Assignments of various jobs by Hungarian method					3	2127L	1,2,3,4	CO5	PSO1 PSO2 PSO4
7	Determination of optimum solution using game theory					4	2127L	1,2,3,4	CO6	PSO1 PSO2 PSO4
8	Determination of optimal allocation using dynamic programming					4	2127L	1,2,3,4	CO8	PSO1 PSO2 PSO4

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	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2139 : COMPUTER AIDED DESIGN IN WATER RESOURCES ENGINEERING				Credits / Hours per week		3L + 1 T				
Semester	I	Year of Introduction : 2000 Year of Syllabus Revision : 2020				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2139												
CO1 To get familiar with basic computer fundamentals knowledge, also various components like hardware, software programming												
CO2 To study visual basic 6.0 for programming												
CO3 To study the application on computer programming in water resources engineering												
CO4 To study various graphics devices & their application in water resources engineering												
CO5 To understand DBMS & RDBMS along with its application in WRE												
CO6 To study the application on simulation in WRE												
CO7 To impart knowledge about various computer based WR Models.												
CO8 To understand the working of RS and its application in GIS												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)

1.	Computer Fundamentals. Introduction, Computer Types, Terminologies Related to Computers, System Software, PC Oriented General Purpose Software Programming – Word Processor, Spreadsheets, Access, Graphics and Communication Software.	6	12	1,2	CO1	PSO3 PSO4	Emp/ Ent/SD	L/N/R/G	ES, PE
2.	Computer Programming: Introduction, Variables and Data types, Operators, Introduction to Visual Basic 6.0, Input, Output, Function Arrays, Sub Programs, Programming in V.B. 6.0.	6	12	1,2,3,4	CO2	PSO3 PSO4			
3.	Typical Computer Applications: Introduction, Design flood for CD works and spillway, computation of water surface profile, Back water and drawdown curves, Programming for Lacey's theory, Kennedy's theory, Manning's theory, Tractive force theory, Determination of RMSE, Design of Gravity dam, Design of spillway, Balancing depth.	8	14	1,2,3,4,6	CO3	PSO3 PSO4			
4.	Computer Graphics for Applications in Water Resources Engineering: Introduction to Computer Graphics, Interactive Computer Graphics, Creation of Symbols, Use of Graphics for River Basin, Ground Water Levels, Rainuages, Canal networks..	6	12	1,2,3,4,6	CO4	PSO3 PSO4			
5.	Database Management in Water Resources Engineering : Introduction to DBMS, RDBMS and ORDBMS, Database Design, Database Management for Hydrological and Hydrometeorological data, Relational Model, Structured Query Language, DBMS in power production and flood management, Drought management.	6	12	1,2,3,4,5	CO5	PSO3 PSO4			
6.	Computer Simulation, Introduction, Model calibration, Digital simulation model for reservoir, Real time system operation.	6	12	1,2,3,4,5	CO6	PSO3 PSO4			
7.	Organizations in model development, Ground water models, Watershed runoff models, Stream hydraulics models, River and reservoir water quality models, Reservoir / river system operation models	7	13	1,2,3,4,5,6	CO7	PSO3 PSO4			
8.	Remote Sensing and GIS: Introduction, Types of Remote Sensing, Components of Remote Sensing and GIS, Principles of Object Identification, Digital Image Processing, Digital Elevation Models, Data Acquisition and Registration, Analysis Technique, Applications in Water Resources Engineering.	7	13	1,2,3,4,5,6	CO8	PSO3 PSO4			

Reference Books

1.	Harry C. Torno, "Computer Application in Water Resources", ASCE Publication
2.	C. S. Krishnamorthy and S. Rajeev, "Computer Aided Design Software and Analytical tools", Narosa Publishing House, 1991
3.	IASH, "The Use of Analog and Digital Computers in Hydrology", Vol-I, IASH/AISH – UNESCO
4.	Wurbs, R. A. (1994). Computer models for water resources planning and management (No. IWR-94-NDS-7). Army Engineer Institute for Water Resources Fort Belvoir VA.

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M.E. (CIVIL) Part-I in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / Foundation WRE2119L : Laboratory Practical				Credits / Hours per week		2P	
Semester		I	Year of Introduction : 2000 Year of Syllabus Revision : 2020				Maximum Marks / Grade		50	
Mode of Transaction			Hands on Practice, Programming, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
	Minor technical programs									
1	Calculation of four basic operations: Addition, Subtraction, Multiplication & Division.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
2	Determine manning's velocity.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
3	Determine the area of circle, square, rectangle and triangle.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
4	Determination of froude's number.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
5	Determine the Duty of water.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
6	To Determine the Leap Year (If else condition).					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
7	Determine the Leap Year (Using Select case).					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
8	To Determine the Greatest number out of three numbers entered by user.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
9	To check whether the entered number is odd or even.					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
10	To check if entered alphabet is a vowel or not (If else condition).					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
11	To check if entered alphabet is a vowel or not (using Select Case)					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
12	To check the result of a student (If else condition)					0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4

13	To check the result of a student (Select Case)	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
14	Sign in window by entering username and password From loading/unloading	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
15	Make a list which are perfectly divisible by 3, 5 and 6.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
16	Make a list of numbers between 5 and 555 which are perfectly divisible by 3 and 5	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
17	Add your current semester subjects in a list box.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
18	Make a separate list of even and odd number between 1 to 1000.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
19	Make a list of leap year between entered range of years given by user.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
20	Repeat 1 to 55 numbers 5 times (using for loop).	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
21	Write a program to repeat 5 to 55 numbers each 20 time (For Loop).	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
22	Write program to repeat 5 to 55 numbers each 20 time (do while loop)	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
23	Write a program to Repeat 5 to 55 number in order, 5 time (do.. while)	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
24	Write a program to find out factorial of a given number.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
25	Write a program to whether the number is prime or not.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
26	Write a program to allow the user to select their favorite fruit and vegetable.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
27	Write a program for swapping the number.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
28	Write a program for changing the color.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
29	Write program to find simple and compound interest.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
30	Write a program to arrange number in ascending and descending order.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
31	Write a program to find L.C.M of Given number.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
32	Write a program to find out G.C.F of given number.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4

33	Write a program to find trigonometric function.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
34	Write a program to find volume of cylinder, cone, and sphere.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
35	Write a program to answer of question using combo box.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
36	Write program to find out determinant and rank of the matrix 2X2, 3X3 and 4X4.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
37	Write a program to display the different shapes with different option.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
38	Write a program to make unit convertor.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
39	Write a program to conduct an objective exam and display the result within limited time of period 10 questions)	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
40	Write a program using message box.	0.25	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
	Major technical programs					
1	Canal design using Kennedy's theory.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
2	Canal design using Lacey's theory.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
3	Canal design using manning's theory.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
4	Write a program to find the balancing depth of canal..	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
5	Write a program to design pipe outlet.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
6	Calculate RMSE.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
7	Design of gravity dam.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
8	Ogee spillway design for a gravity dam with vertical u/s face.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
9	Derive hydrograph ordinates by using superposition method.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
10	Write a program for discounting techniques. A) PRESENT WORTH METHOD B) BENEFIT-COST METHOD C) ANNUAL COST METHOD	1.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4

11	Design of Sarda fall.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
12	Determine optimum raingauge station.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
13	Write a program to find w- index and phi-index.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
14	Write a program to select a type of outlet.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
15	Write a program to select type of C.D works.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
16	Write a program to show the grade of the concrete.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
17	Write a program to find types of micro network area.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
18	Determine the transmissibility and drawdown of given well for confined or unconfined aquifer.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
19	Factor of safety for earthen dam.	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4
20	Write a program to find type of flow by Reynolds's number and Froude's number using loading/unloading	0.75	2139L	1,2,3,4,5,6	CO2, CO3, CO4	PSO3, PSO4

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute				Academic Year		2025-26				
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2226 : COMPUTER AIDED CANAL OPERATION				Credits / Hours per week		3L + 1T				
Semester	II	Year of Introduction : 2000 Year of Syllabus Revision :				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2226												
CO1 To understand laws of conservation and various equation for open and closed flow system												
CO2 Able to understand open channel hydraulics and various flow condition												
CO3 To understand various numerical techniques for unsteady flow analysis												
CO4 To understand method of characteristic and its application for canal automation												
CO5 To be familiar with hydraulic simulation of various flow conditions												
CO6 To understand concept, need, application and types of automation												
CO7 To be aquatinted with various software and models in canal automation												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	Nearly Horizontal Flows, Laws of conservation, Momentum and Energy, Galilean Frames, Galilean transformations open and closed flow system, Conditions of instability	7	14	1,2	CO1	PSO1 PSO2	Emp/ Ent	L/N/R/G	PE
2.	Unsteady Flow in Open Channel, Introduction, Basic Derivations - Saint Venant equations, Dimensionless equations, The compressible flow analogy, Linearization, Integral equations	8	15	1,2	CO2	PSO1 PSO2			
3.	Numerical Method for Unsteady Flow Analysis, Introduction, Method of characteristics, Finite difference method, Explicit scheme, Implicit scheme, Stability, Convergence	8	15	1,2	CO3	PSO1 PSO2			
4.	Method of Characteristic (i) Characteristic lines, Matrix formulation of the interminancy condition, Characteristics directions and Algorithmic structures, Domain of Dependence and Region of Influence, Riemann's invariants, Use of hodograph plane (ii) Application of this method for field problems e.g. gate operation, Surge in power canal	7	14	1,2,3	CO4	PSO1 PSO2			
5.	Hydraulic Simulation, Steady state simulation model, Gradually varied flow, Control structures, Transitions on canal structures	6	12	1,2,3	CO5	PSO1 PSO2			
6.	Canal Automation, Need for Canal Automation, Controlled Volume concept, Control and Monitoring, Communication, Constraints, Demand and supply, Seasonal requirements Semi automated systems, Policy decisions	8	15	1,2,3	CO6	PSO1 PSO2			
7.	Unsteady Flow Models, Review of different models-UCLA, USBR model, SNUSM, DWOPER, Narmada project unsteady model (NPUSM), Normal operation, Emergency operation, Single pool, Multiple pool models	8	15	1,2,3	CO7	PSO1 PSO2			
Reference Books									
1.	Cunrningham A. B. and J. R. Amend (1984), "Water Management Using Interactive Simulation", J1-Water Res-Planning and Mgt ASCE								
2.	Chaturvedi M. C., "Water Resources System Planning and Management", Tata McGraw Hill Pub. Co. 1987								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute				Academic Year		2025-26		
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / Foundation WRE2226L : Laboratory Practical				Credits / Hours per week		2P	
Semester		II	Year of Introduction : 2000 Year of Syllabus Revision :				Maximum Marks / Grade		50	
Mode of Transaction			Data Collection, Analysis, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Canal Operation Methods					2	2226L	1,2,3	CO6	PSO1, PSO2
2	Compatibility between Upstream Operational concept and the Constant Downstream Depth Operational Method					2	2226L	1,2,3	CO6	PSO1, PSO2
3	Control Alternatives for the Constant Downstream Depth Operational Method					2	2226L	1,2,3	CO6	PSO1, PSO2
4	Constant Upstream Depth or Level Bank Operational Method					3	2226L	1,2,3	CO6	PSO1, PSO2
5	Downstream Flow Change with Constant Upstream depth Operational Method					3	2226L	1,2,3	CO6	PSO1, PSO2
6	Local Downstream Control for the Constant Upstream depth Operational Method					3	2226L	1,2,3	CO6	PSO1, PSO2
7	Controlled Volume Operation					3	2226L	1,2,3	CO6	PSO1, PSO2
8	Sequential Gate Operating Technique progressing from Upstream to Downstream					2	2226L	1,2,3	CO6	PSO1, PSO2
9	Sequential Gate Operating Technique progressing from Downstream to Upstream					2	2226L	1,2,3	CO6	PSO1, PSO2
10	Simultaneous Gate Operation for Constant Volume Operational Method					2	2226L	1,2,3	CO6	PSO1, PSO2
11	Multi Step Simultaneous Gate Operation					2	2226L	1,2,3	CO6	PSO1, PSO2

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2238: ADVANCED COMPUTATIONAL TECHNIQUES IN WATER RESOURCES ENGINEERING				Credits / Hours per week		3L + 1T				
Semester	II	Year of Introduction: 1991 Year of Syllabus Revision: 2020				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2238 CO1 To have better understanding about applications of matrices. CO2 To analyze and evaluate various finite element approximation methods. CO3 To analyze finite element techniques including interpolation functions, variational functions and shape functions and formulation of local and global matrix. CO4 To analyze and evaluate ground water flow problems using finite element techniques. CO5 To gain knowledge and better understanding about artificial intelligence based expert system models and its applications in WRE. CO6 To gain knowledge and better understanding about artificial neural network-based models and its applications in WRE. CO7 To gain knowledge and better understanding about fuzzy logic-based models and its applications in WRE. CO8 To gain knowledge and better understanding about genetic algorithm-based models and its applications in WRE.												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)

1	Elementary concepts of matrices Elementary concepts of matrices : Introduction, Introduction to matrices, special matrices, matrix equality, addition and multiplication by a scalar, Multiplication of matrices, The inverse matrix, Methods to solve matrices Eigen values & Eigen vectors	8	14	1,2,4	CO1	PSO2	Emp/ Ent/SD	L, N, R, G	ES, PE
2	History and development of finite element method Introduction, History and development of finite element method, General applicability, Weak formulation of boundary value problems in fluid mechanics, Approximate methods – Point collocation, Least square, Galerkin' s, Raleigh-Ritz method	8	14	1,2	CO2	PSO1			
3	Finite Element Analysis Finite Element Analysis, Weighted residual technique, Discretization of domain, Shape and size of element, Interpolating polynomials, Isoparametric elements, Triangular elements, Integration of shape function over element, Formulation of global matrix, Solution procedures and sparse matrix storage techniques	6	12	1,2,4	CO3	PSO1			
4	Ground Water Flow Problems Ground Water Flow Problems, Finite element formulation of two-dimensional steady state flow, Pump and streams, Impervious boundaries and constant head boundaries	6	12	1,2,4	CO4	PSO2			
5	Artificial Intelligence and Expert System Artificial Intelligence and Expert System for Water Resources, Introduction, Components of an expert system, Developing a knowledge base, Interface engine, Backward chaining, Forward chaining, Reservoir operation expert system, Rainfall-runoff modeling expert system.	6	12	1,2,4	CO5	PSO3			
6	Artificial Neural Network Artificial Neural Network: Introduction, History, Overview or biological neuro-system, Mathematical models of neurons, ANN architecture, learning rules, learning paradigms supervised, Unsupervised & reinforcement, Learning, Learning task, ANN training algorithms, Application of ANN in WRE	6	12	1,2,3,4,5,6	CO6	PSO4			
7	Fuzzy logic Introduction, Importance of fuzzy logic, Applications of fuzzy logic, Crisp and linguistic variables, Membership functions, Fuzzy logic rules, Fuzzy inference system, Application of fuzzy logic in WRE	6	12	1,2,3,4,5,6	CO7	PSO4			
8	Genetic Algorithm Genetic Algorithm: Introduction, Advantages & limitations of GA,	6	12	1,2,3,4,5,6	CO8	PSO4			

	Background, Natural selection, Evolution in biology, Concept of genetic algorithm, Steps involved in GA method, Encoding, Creating fitness function, Operators, Cross over, Permutations, Mutations, Parameters in GA, Initialization method & stopping criteria, Application of GAs in WRE								
Reference Books									
1.	O. C. Zienkiewicz, The Finite Element Method, Tata-McGraw Hill								
2.	Brebbia C. A., Computer Methods in Water Resources, Vol-I, II and III Computational Mechanics Publications								
3.	Neural Network: A Comprehensive Foundation, Simon Haykin, PHI								
4.	Elements of Artificial Neural Networks; Kishan Mehtrotra, S. Ranka, Penram International Publishing (India)								
5.	Neural Networks and Fuzzy Systems, Bart Kosko, PHI								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute				Academic Year		2025-26		
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / Foundation WRE2238L: Laboratory Practical				Credits / Hours per week		2P	
Semester		II	Year of Introduction: 1991 Year of Syllabus Revision:2020				Maximum Marks / Grade		50	
Mode of Transaction			Laboratory Experiments, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Tutorials on Elementary concept of matrices					3	WRE2238L	1,2,4	CO1	PSO3
2	Tutorials on Finite element approximation methods					3	WRE2238L	1,2	CO2	PSO3
3	Tutorials on interpolation functions, variational functions and shape functions					3	WRE2238L	1,2,4	CO3	PSO3
4	Tutorials on Ground Water Flow Problems					4	WRE2238L	1,2,4	CO4	PSO3
5	Tutorials on Artificial Intelligence and Expert System for Water Resources					3	WRE2238L	1,2,4	CO5	PSO3
6	Hands on practice of Fuzzy based models related to water resources problems					3	WRE2238L	1,2,3,4 ,5,6	CO6	PSO3
7	Hands on practice of ANN based models related to water resources problems					4	WRE2238L	1,2,3,4 ,5,6	CO7	PSO3
8	Hands on practice of GA based models related to water resources problems					3	WRE2238L	1,2,3,4 ,5,6	CO8	PSO3

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2236 : WATER RESOURCES SYSTEMS ENGINEERING				Credits / Hours per week		3L + 1T				
Semester	II	Year of Introduction : 2000 Year of Syllabus Revision :				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2236												
CO1 To understand the socio-political-legal-economic nature at WRS including their hydrologic characteristics												
CO2 To develop objective function of water resources development to understand political & economic statement of objectives & their economic indicators												
CO3 To understand the concepts of layout and methods of water distribution system.												
CO4 To understand about water supply reservoir systems & their optimal design												
CO5 To emphasize analysis on ground water system & also to understand legal aspects												
CO6 To understand the nature of water quality subsystem & estimate the assimilation capacity on the stream												
CO7 To determine feasibility of interim alternatives and to understand the conjunctive operations of surface & ground water storage												
CO8 To understand large-scale, complex, multiple-purpose water resources systems & to emphasize on the distribution-subsystem optimization												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	The Nature of Water Resources Systems, The socio-political-legal nature of water resources systems, The economic nature of water resources systems, The hydrologic characteristics of water resources systems, Groundwater resources, Surface and groundwater quality conservation, Flood control, Systems Analysis, Systems engineering, The concept of a system, Objective functions, Optimal policy analysis	6	12	1,2,3,4	CO1	PSO1 PSO2	Emp/ Ent	L/N/R/G	ES, PE
2.	The Objective Functions of Water Resources Development, A political statement of the objective, An economic statement of the objective, Economic indicators of objectives, The alternatives for water resources development	6	12	1,2,3,4	CO2	PSO1 PSO2			
3.	Introduction, Requirements of a good distribution system, Arrangement of distribution pipes & other accessories, Layouts of distribution network, Methods of distribution, Pressures in the distribution system, Systems of supply, Design for fixing the sizes of pipes of a simple distribution system, Analysis of complex pipe networks	6	12	1,2,3,4,5	CO3	PSO1 PSO2			
4.	Distribution reservoirs, Functions of distribution reservoirs, Types of distribution reservoir stand pipes, Storage capacity of distribution reservoirs, Location and height of the distribution reservoirs, Appurtenances in the distribution system	6	12	1,2,3	CO4	PSO1 PSO2			
5.	Analysis Of Groundwater Systems, System configuration, Computer solution, Optimal parameter identification, Conjunctive use of groundwater and surface water systems	8	14	1,2,3,4	CO5	PSO1 PSO2			
6.	Water Quality Subsystems, The nature of the water quality problem, Optimization of stream assimilation capacity, Minimization of pollution costs involving downstream damages, Maintenance of equity in economic allocation, Quality improvement by low-flow augmentation	7	13	1,2,3,4	CO6	PSO1 PSO2			
7.	Water Resources Investment Timing, The basic investment-timing problem, Feasibility of interim alternatives, Conjunctive operations of surface and ground water storage, stage development of water systems under multiple capital constraints, Determination of future requirements	6	12	1,2,3,4	CO7	PSO1 PSO2			
8.	Large-Scale, Complex, Multiple-Purpose Water Resources Systems, Summary of an analysis and design procedure for a complex system, The distribution- subsystem optimization, The supply-subsystem optimization, Phase 1 : Allocation of storage to reservoir sites and river subsystems, The supply-subsystem optimization, Phase 2 : Optimal operations for planning, The supply-subsystem optimization, Phase 3 : Optimal combined operations, Post-regulation reservoirs, Modification of the trial design, Integration of new systems and existing systems, Consideration of total alternatives	7	13	1,2,3,4	CO8	PSO1 PSO2			

Reference Books	
1.	Hall W. A. and Dracup J. A., Water resources Systems Engineering, McGraw Hill, 1970
2.	Arthur Mass, Design of Water Resources Systems, McMillan
3.	James L. D. and Lee R. R., Economics of Water Resources Planning, McGraw Hill
4.	S. K. Garg, “Water Supply Engineering”, Khanna Publishers

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute				Academic Year		2025-26		
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING										
Year		I	Core / ~~Elective~~ / Foundation WRE2236L : Laboratory Practical				Credits / Hours per week		2P	
Semester		II	Year of Introduction : 2000 Year of Syllabus Revision : 2020				Maximum Marks / Grade		50	
Mode of Transaction			Data Collection, Analysis, discussion and viva							
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO
1	Analysis of water distribution network systems					5	2236L	1,2,3,4	CO3	PSO1, PSO2
2	Determination of unit cost of surface water					4	2236L	1,2,3,4	CO7	PSO1, PSO2
3	Determining of unit cost of ground water					5	2236L	1,2,3,4	CO7	PSO1, PSO2
4	Development of conjunctive use planning by space integration strategy					4	2236L	1,2,3,4	CO7	PSO1, PSO2
5	Development of conjunctive use planning by time integration strategy					4	2236L	1,2,3,4	CO7	PSO1, PSO2
6	Development of conjunctive use planning by space and time integration strategy					4	2236L	1,2,3,4	CO7	PSO1, PSO2

Syllabus of Courses

 THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2227 : HYDRAULICS OF SEDIMENT TRANSPORT				Credits / Hours per week		3L + 1T				
Semester	II	Year of Introduction : 2006 Year of Syllabus Revision :				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2227 CO1 To determine the setting velocity of particle and understand its effects CO2 To study the effect of particles on the fluid viscosity CO3 Study various phenomena of scour, its related problem and design stable channel CO4 To determine the bedload using various equations CO5 To study the distribution of suspended load CO6 To determine the total load using different approaches CO7 To study regime concept on canal & river given by various empirical equations CO8 To study various sediment measuring devices.												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	Settling Velocity of Particles, Uniform motion in an ideal fluid, Uniform motion in a real fluid, Theoretical considerations for a sphere, Empirical equations for the drag coefficient of a sphere, Terminal settling velocity, complicating effects on the uniform motion of a sphere	6	12	1,2,3	CO1	PSO1 PSO2			
2.	Effect of Particles on the Fluid Viscosity, Theoretical considerations, Suspensions of spherical particles, Suspensions of Nonspherical particles, Experimental considerations, Suspensions of spherical particles, Suspensions of Nonspherical particles	6	12	1,2,3	CO2	PSO1 PSO2			
3.	Scour Criteria and Related Problems, Critical velocity equations, Critical shear stress equations, Lift force mechanism, Shear stress distribution, Design of stable channels.	6	12	1,2,3	CO3	PSO1 PSO2			
4.	The Bedload, DUBOYS-type equations, Schoklitsch-type equations, Einstein's Bedload equations, Equations considering Bedform equation, Bedform motion	6	12	1,2,3	CO4	PSO1 PSO2			
5.	The Suspended Load, Diffusion, Dispersion model, Theoretical considerations, Vertical distribution of suspended matter, Longitudinal distribution of suspended matter	8	14	1,2,3	CO5	PSO1 PSO2			
6.	The Total Load, Introductory remarks, Indirect determinations, Direct determinations, Comparison and application of Bed Material load equations, Hydrologic effects on sediment transport	7	13	1,2,3	CO6	PSO1 PSO2			
7.	The Regime Concept, Canals in Regime, Rivers in Regime	6	12	1,2,3	CO7	PSO1 PSO2			
8.	Sediment Measuring Devices, Bedload measuring devices, Suspended-load measuring devices, Total-load measuring devices	7	13	1,2,3,4	CO8	PSO1 PSO2			
Reference Books									
1.	Walter Hans Graf, "Hydraulics of Sediment Transport", McGraw Hill Co.								
2.	Grade R. J., Ranga Raju K. G., "Mechanics of Sediment Transportation and Alluvial Stream Problem, Wiley Eastern Limited								
3.	Raudkivi A. J., Loose Boundar, "Hydraulics", Pergamon Press								
4.	Rouse H., "Engineering Hydraulics", John Wiley								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute				Academic Year		2025-26			
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING											
Year		I	Core / ~~Elective~~ / Foundation WRE2227L : Laboratory Practical				Credits / Hours per week		2P		
Semester		II	Year of Introduction : 2006 Year of Syllabus Revision :				Maximum Marks / Grade		50		
Mode of Transaction			Laboratory Experiments, discussion and viva				PSO7 is common for all experiments				
No.	Experiment						Contact Hours	Course Code	BT Level	CO	PSO
1	Analysis of setting velocity of particles						3	2227L	1,2,3	CO1	PSO1, PSO2
2	Analyzing the effect of particles on the fluid viscosity						4	2227L	1,2,3	CO2	PSO1, PSO2
3	Analysis of suspended load models						4	2227L	1,2,3	CO5	PSO1, PSO2
4	Analysis of bed load models						4	2227L	1,2,3	CO4	PSO1, PSO2
5	Analysis of total load models						4	2227L	1,2,3	CO6	PSO1, PSO2
6	Sampling technique for measuring suspended load						3	2227L	1,2,3	CO8	PSO1, PSO2
7	Study of sampling technique for measuring bed load						2	2227L	1,2,3	CO8	PSO1, PSO2
8	Study of sampling technique for measuring total load						2	2227L	1,2,3	CO8	PSO1, PSO2

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Water Resources Engineering and Management Institute					Academic Year		2025-26				
M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING												
Year	I	Core / ~~Elective~~ / Foundation WRE2229 : HYDROLOGIC MODELLING				Credits / Hours per week		3L + 1T				
Semester	II	Year of Introduction : 2000 Year of Syllabus Revision : 2006				Maximum Marks / Grade		100				
Mode of Transaction		Lectures and Tutorials										
Course Outcome (CO) WRE2229 CO1 To understand basic knowledge on development of model & its evaluation CO2 To study fundamentals of probability & statistic & familiar with various probability distribution methods and study hypothesis testing CO3 To understand estimation maximum likelyhood estimation using univariate estimation CO4 To be able to estime the standard error using semivariogram analysis and kriging CO5 To familiar with time series analysis												
Unit No.	Topic				Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1.	Fundamentals of modeling. Concepts of statistical hydrologic models. Development of models. Model evaluation. Modeling and information content of data.	11	20	1,2,3,4,5,6	CO1	PSO1 PSO2 PSO4	Emp/ Ent/SD	L/N/R/G	ES, PE
2. & 3.	Fundamentals of probability and statistics. Statistical frequency distributions. Common probability functions. Confidence intervals. Tolerance limits. Hypothesis testing. Fundamentals of simulation.	11	20	1,2,3,4,5,6	CO2	PSO1 PSO2 PSO4			
4. & 5.	Univariate estimation. The univariate modeling process. Estimation of model parameters. Construction of probability paper. Forms used as frequency distributions. Movement ratio analysis. Data transformations. Risk versus return period. Evaluating the accuracy of prediction. Tolerance limits by simulation. Additional considerations in univariate analysis.	10	20	1,2,3,4,5,6	CO3	PSO1 PSO2 PSO4			
6.	Semivariogram analysis and kriging. The estimation problem. Semivariogram analysis. Estimation of standard errors. Estimation by kriging.	10	20	1,2,3,4,5,6	CO4	PSO1 PSO2 PSO4			
7. & 8.	Time series analysis and synthesis. Components of a time series. Moving – average filtering. Autocorrelation analysis. Cross-correlation analysis. Identification of the random component. Formulation of auto and cross-correlation water yield models. Auto regression and cross-regression.	10	20	1,2,3,4,5,6	CO5	PSO1 PSO2 PSO4			
Reference Books									
1.	Haan, C. T., Johnson, H. P. and Brakensiek, D. L. "Hydrologic Modeling of small watersheds", American Society of Agricultural Engineers, St. Joseph								
2.	Kottegoda, N. T. "Stochastic Water Resources Technology", John Wiley & Sons, New York								
3.	McCuen, R. H. and Synder, W. M. "Hydrologic Modeling : Statistical Methods and Applications", Prentice Hall								
4.	Morel, H. J., Seytoux, Salas, J. D., Sanders, T. G. and Smith, R. E. "Modeling Hydrologic Processes", Water Resources Publications, Colorado, USA								
5.	Svniidze, G. C. "Mathematical Modeling of Hydrologic Series – for Hydroelectric and Water Resources Computations" Water Resources Publications, Fort Collins.								
6.	Yevzevich, V. "Probability and Statistic in Hydrology". Water Resources Publications								

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M.E. (CIVIL) Part-II in WATER RESOURCES ENGINEERING											
Year		I	Core / ~~Elective~~ / Foundation WRE2229L : Laboratory Practical				Credits / Hours per week		2P		
Semester		II	Year of Introduction : 2000 Year of Syllabus Revision : 2006				Maximum Marks / Grade		50		
Mode of Transaction			Laboratory Experiments, discussion and viva								
No.	Experiment					Contact Hours	Course Code	BT Level	CO	PSO	
1	Development of linear rainfall runoff model					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
2	Development of nonlinear rainfall runoff model					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
3	Data analysis by normal distribution					1	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
4	Data analysis by student – T distribution					1	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
5	Data analysis by binomial distribution					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
6	Data analysis by F-distribution					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
7	Data analysis by chi-square distribution					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
8	Development multiple linear hydrological models					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
9	Development of nonlinear hydro logical models					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
10	Selection of data using random number digit method					2	2229L	1,2,3,4,5,6	CO2 CO3	PSO1, PSO2, PSO4	
11	Data analysis by time series method					2	2229L	1,2,3,4,5,6	CO7 CO8	PSO1, PSO2, PSO4	
12	Smoothening of data by moving average method					2	2229L	1,2,3,4,5,6	CO7 CO8	PSO1, PSO2, PSO4	
13	Data analysis using auto correlative analysis					2	2229L	1,2,3,4,5,6	CO7 CO8	PSO1, PSO2, PSO4	
14	Data analysis using cross correlation analysis					2	2229L	1,2,3,4,5,6	CO7 CO8		