Teaching and Examination Schemes with Syllabus

of

Master of Technology

in

(Civil) Water Resources Engineering

Department of Civil Engineering
Sardar Vallabhbhai National Institute of Technology, Surat

Vision and Mission of the Institute

Vision

To be one of the leading Technical Institutes disseminating globally acceptable education, effective industrial training and relevant research output

Mission

To be a globally accepted centre of excellence in technical education catalyzing absorption, innovation, diffusion and transfer of high technologies resulting in enhanced quality for all the stake holders

Vision and Mission of the Department

Vision

To be a global centre of excellence for creating competent professionals in Civil Engineering

Mission

- To provide excellent education producing technically competent, globally employable civil engineers who will be leaders in the chosen field

- To undertake research in conventional and advanced technologies fulfilling the needs and challenges of modern society

Foreword

The post graduate course in Water resources Engineering is established in 1995.The section has well trained and experienced full time professors who impart the technical knowledge of Water Resources Engineering to the UG and PG students of the department. The section has produced not only UG and PG students but also number of Doctoral students who are well placed in academics, government organization and some are practicing as consultants.

The section has well equipped UG and PG laboratories to carry out experimental research work apart from UG and PG practical's. The post graduate course in Water Resources Engineering is framed to meet present and future challenges to Water Resources. In the era of computers, applications of number of software's in solving complex water resources problems are included in the syllabi. Applications of HEC-RAS, MIKE, LINGO, WIN QIP, Storm CAD, ERDAS, ARC GIS etc. are part of the learning process. The students get opportunity to take up field related problems during their professional project studies. Their communication skill and presentation ability is developed through inclusion of seminar and graduate reports in the course of study. During their dissertation work students get chance to carry out in depth study of specific Water Resources related topic. The site visits and expert lectures organized from time to time is an integral part of the study. Many part time and full time research scholars are pursuing research in the section.

The section is also actively involved in a number of research projects sanctioned through organization like DST, AICTE, ISRO etc. The section offers consultancy services to many government and private organizations in various fields. The faculty members also have good number of publications in International and National Journals and authored few books. The section organizes national conferences, workshops and short term training programmes regularly. The course curriculum is revised regularly by conducting workshops wherein experts from IITs, NITs, Government Organizations like SSNL, CWC, Irrigation Engineering Department share their valuable opinion.

Overall, the course is framed to meet with present day requirements and future challenges to be faced by Water Resources Engineers.

Programme Educational Objectives (PEOs)

Graduates of PG Programme in Water Resources Engineering shall be able to:

- PEO-1 Provide environment-friendly solutions for the hydrologic and hydraulic engineering problems in consonance with societal needs and available means.
- PEO-2 Apply modeling and computational techniques for analyzing water resources systems.
- PEO-3 Predict future trends of climatic variables at river basin scales.

Programme Outcomes (POs)

The outcomes of the Master of Technology programme in Environmental Engineering are:

- PO-1 An ability to independently carry out research/investigation and development work to solve practical problems in the field of water resources engineering.
- PO-2 An ability to write and present a substantial technical report/document on water resources engineering.
- PO-3 Students should be able to demonstrate a degree of mastery in water resources engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Programme Specific Outcomes (PSOs)

Graduates of the programme will

- PSO-1: Be able to effectively use acquired knowledge to formulate and implement cost effective as well as sustainable solutions in water resources engineering.

- PSO-2: Exhibit their knowledge in water resources engineering to plan and manage water resources projects as an individual/team member or leader serving the society ethically.

- PSO-3: Continue their self-learning and pursue research in relevant local, regional, and global water resources engineering field.

Teaching Scheme
M. Tech. in (Civil) Water Resources Engineering

SEMESTER – I

Sr. No.	Course	Code	Teaching Scheme Hours per week			Credit	Examination Scheme			Total Marks
			L	Tu	P		Theory	Tutorial	Practical	
1	Advanced Fluid Mechanics	CE 661	3	1	0	4	100	25 (10+15) * **	-	125
2	Free Surface Flow	CE 663	3	1	0	4	100	25 (10+15) * **	-	125
3	Advance Hydrologic Analysis and design	CE 665	3	1	0	4	100	25 (10+15) * **		125
4	Computational Techniques in Water Resources Engineering	CE 667	3	0	2	4	100	-	50 (20+30) * **	150
5	Elective I		3	-	-	3	100		-	100
6	Hydraulic Engineering Laboratory-I	CE 675	0	0	3	2	-	-	75 (30+45) * **	75
7	Seminar/G.R.	CE677			2	1			50 (20+30) * **	50
		Total	**15**	**3**	**7**	**22**	**500**	**75**	**175**	**750**

List of Electives I

CE 669 Flood Control and River Training Works
CE 679 Computational Hydraulics
CE 671 Irrigation and Drainage Systems Engineering
CE 673 Integrated Watershed Management
CE 681 Basics of Climate Change Studies

Total Contact Hours/week = 25 **Total Credits = 22**

* Internal Evaluation
** External Evaluation

SEMESTER – II

Sr. No.	Course	Code	Teaching Scheme Hours per week			Credit	Examination Scheme			Total Marks
			L	Tu	P		Theory	Tutorial	Practical	
1	Advanced Hydraulic Structures	CE 662	3	1	-	4	100	25 (10+15) * **	-	125
2	Hydraulics of Alluvial Rivers	CE 664	3	1	0	4	100	25 (10+15) * **	-	125
3	Geospatial Technologies in Water Resources Engineering	CE 666	3		2	4	100	-	50 (20+30) * **	150
4	Water Resources Systems	CE 668	3	1	-	4	100	25 (10+15) * **	-	125
5	Elective II		3		-	3	100		-	100
6	Hydraulic Engineering Lab- II	CE 682	0	0	3	2	-	-	75 (30+45) * **	75
7	Seminar/G.R	CE 684			2	1			50	50
		Total	**15**	**3**	**7**	**22**	**500**	**75**	**175**	**750**

Total Contact Hours/week = 25 **Total Credits = 22**

Elective II

CE 672 Water Supply Distribution Systems
CE 674 Hydro Power Engineering
CE 676 Ground Water engineering
CE 678 Coastal Engineering
CE 686 Stochastic Hydrology

* Internal Evaluation
** External Evaluation

SEMESTER – III

Sr. No.	Course	Code	Teaching Scheme Hours per week			Credit	Examination Scheme			Total Marks
			L	Tu	P		Theory	Internal	Practical	
1	Seminar	CE 841	-	-	4	**1**	-	20	30	50
2	Dissertation (Preliminary)	CE 843	-	-	8	**4**	-	80 *	120 **	200
3	Professional Project	CE 845			6	**3**		50 *	100 **	150
		Total			**18**	**8**		**150**	**250**	**400**

Total Contact Hours/week = 16 **Total Credits = 8**

* Internal Evaluation
** External Evaluation

SEMESTER – IV

Sr. No.	Course	Code	Teaching Scheme Hours per week			Credit	Examination Scheme			Total Marks
			L	Tu	P		Theory	Internal	Practical	
1	Dissertation	CE 842	-	-	20	10	-	160	240	400
		Total			**20**	**10**	**-**	**-**	**-**	**400**

Total Credits for M. Tech.:

* Internal Evaluation
** External Evaluation

TOTAL CREDIT: 22+22+08+10 = 62
TOTAL HOURS: 25+25+18+20 = 88

Assessment of Performance

Assessment of Theory Courses

The evaluation pattern for the theory courses, *as of now*, shall be as under:

Mid-semester examination: 30 marks
Assignment/Quizzes: 20 marks
Tutorials (if applicable): 25 marks
End-semester exam: 50 marks

The mid- and end-semester examinations are of 1.5 hours and 3 hours, respectively.

Assessment of Seminar

Internal assessment of 40% weightage by guide(s) and Final assessment of 60% weightage by a panel of examiners

Assessment of Dissertation/Projects

Internal assessment of 40% weightage by guide(s) Final assessment of 60% weightage by a panel of examiners including an examiner from outside the institute

For more details please refer to the institute website
https://www.svnit.ac.in/Data/Notice/AcademicRegulations2013-2014.pdf

Course-wise Detailed Syllabus

Semester I

CE 661 Advanced Fluid Mechanics

L	T	P	C
3	1	0	4

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1. Course Outcomes (COs)

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

CO1	Apply conservation equations to solve fluid flow problems.
CO2	Analyze low and high Reynolds number flows using Navier-Stokes equations.
CO3	Use turbulence models in fluid flows.
CO4	Estimate drag and lift forces using boundary layer concepts in real life problems.

2. Syllabus

- **IDEAL FLUID MOTION** **(09 Hours)**
  Review of Fluid mechanics, Kinematics of fluid flow, rotational and irrotational fluid flow, elements of particle motion, stream functions and potential functions, Laplace's equation, flow nets, dynamics of fluid flow, Euler's equation in Cartesian, polar, and vector coordinates, application of ideal fluid motion, Two-dimensional flow, Uniform flow, Source and Sink, Free vortex flow, Source and Uniform flow (Flow past a half body), Superimposed flow patterns, Source-Sink pair, Source and Sink pair in a uniform flow, Doublet, Flow past a Rankine oval body (Source, Sink and a Uniform flow),Flow past a Cylinder (Doublet and Uniform flow), Magnus effect, Kutta Joukowski transformation , Method of images

- **LAMINAR FLOW** **(05 Hours)**
  Concept and characteristics of laminar flow, Navier-Stokes equations, creeping motion, approximate and exact solutions.

- **TRANSITION FROM LAMINAR TO TURBULENT FLOW** **(03 Hours)**
  Concept of stability, stability theories, experimental verification, Rouse Index, factors affecting transition.

- **TURBULENT FLOW** **(06 Hours)**
  Classification and characteristics of turbulent flows, Continuity equation, Reynolds equations, Reynolds Average N-S (RANS) Equation, Statistical theories of turbulence, Flow between parallel plates and in a pipe, turbulence models, Coherent Structures and Turbulent bursting.

- **LAMINAR AND TURBULENT BOUNDARY FLOWS** **(09 Hours)**
  Boundary layer concepts, order of magnitude analysis, Boundary layer parameters, Prandtl's boundary layer equations, Blassius solution for laminar boundary layer flows, von-Karman

Momentum integral equation, Laminar boundary layer, Turbulent boundary layer flows, Laminar sub layer, Boundary layer separation and controls.

- **FLOW AROUND IMMERSED BODIES: DRAG AND LIFT (05 Hours)**
  Introduction, Drag and lift for shear flow, Streamlined and bluff bodies, Drag on a flat plate, Drag & Lift For Shear Flow, Drag on a sphere, Drag and lift on an Airfoil, , Circulation and Lift on a circular cylinder, circulation and lift on an Airfoil, Shear induced Magnus lift.

- **TRANSIENT FLOW IN PIPES (05 Hours)**
  Transient flow concept, classification of flow, oscillation of liquid in U tube, water hammer analysis, transient flow equations, effects of air entrainment, causes of transients, role of valving, column separation, gas release methods of controlling transits.

(Total Lectures: 42 hours)

3. Books Recommended

1. J W Daily and D R F Harlaman, Fluid Dynamics, Addision Weasly,1966.
2. R J Garde, Turbulent Flows, Wiley, 1994.
3. S Narasimhan, Engineering Fluid Mechanics, Vol. I, Orient Longman Ltd, 1975.
4. H Rouse, Fluid Mechanics for Hydraulic Engineers, Dover Pub., New York, 1961.
5. H Schlisting and K Gersten, Boundary Layer Theory, 8th edition, Springer Publication, 2000.
6. S V L Streeter, Fluid Dynamics, McGraw Hill, 2006.
7. S W Yuan, Foundations of Fluid Mechanics, Prentice – Hall India Pvt. Ltd., New Delhi, 1969.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	1
CO2	1	3	1	3	2	2
CO3	3	1	3	3	3	3
CO4	3	1	3	3	3	3

CE 663 Free Surface Flow

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Compute gradually varied flow profiles.
CO2	Identify the location of hydraulic jump and estimate its characteristics.
CO3	Derive and solve unsteady flow equations.
CO4	Apply spatially varied flow equations to practical problems.

2. Syllabus

- **BASIC PRINCIPLES** **(06 Hours)**
  Review of free surface flow concepts including velocity and pressure distribution, Continuity, Momentum and Energy equation, concept of specific energy, computation of critical flow, channel transitions, critical flow venturi-flume, standing wave flume and broad crested weir in discharge measurement.

- **GRADUALLY VARIED FLOW** **(09 Hours)**
  Gradually varied profile and its computations using direct step method, advanced numerical methods, delivery of canal systems.

- **RAPID VARIED FLOW** **(06 Hours)**
  Hydraulic jump in horizontal and sloped open channel bed and its characteristics

- **UNSTEADY OPEN CHANNEL FLOW** **(12 Hours)**
  Wave celerity, classification of water waves according to relative depth, orbital motions, superposition, wave trains and wave energy, transformation of waves, dissipation of wave energy, positive and negative surges in rectangular channel, Momentum and Continuity equations (Saint Venant Equation), two dimensional unsteady flows and their solution by numerical techniques.

- **SPATIALLY VARIED FLOW** **(06 Hours)**
  Basic principles and assumptions, dynamic equation and analysis of flow profiles, Numerical integration method, Isoclinal method, spatially varied steady and unsteady surface flows.

- **INTRODUCTION TO HYDRODYNAMIC AND POLLUTANT TRANSFER IN OPEN CHANNEL** **(03 Hours)**

(Total Lectures: 42 hours)

3. Books Recommended

1. M Chaudhary Hanif, Open Channel Flow, Prantice -Hall of India Pvt. Ltd. New Delhi, 1993.

2. V T Chow, Open Channel Hydraulics, McGraw-Hill Book Company, International Editions, New Delhi,1973.
3. K Subrmanya, Flow in Open Channels, Second Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2001.
4. R Srivastava, Flow Through Open Channels, Oxford University Press, New Delhi, 2008.
5. R H French, Open Channel Hydraulics, McGrawhill Publication, New York, 1985.
6. K G Ranga Raju, Flow Through Open Channels, TATA MC Graw-Graw-Hill Publishing Company Limited, 1997.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	2

L	T	P	C
3	1	0	4

CE 665 Advanced Hydrologic Analysis and Design

1. Course Outcomes (COs)

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

CO1	Synthesize the solution including precipitation, evapotranspiration and infiltration processes.
CO2	Estimate flood hydrographs for gauged and ungauged catchments.
CO3	Apply flood routing models to rivers and reservoirs.
CO4	Derive IDF curves and estimate floods of different return periods.

2. Syllabus

- **MECHANISM AND MEASUREMENTS OF PRECIPITATION AND EVAPORATION (12 Hours)**
  Hydrological processes, Mechanism, Atmospheric water vapour, Green house effect, computation and measurement of precipitation, evaporation, evapotranspiration, abstractionfrom precipitation., spatial and temporal distribution of rainfall.

- **FLOW THROUGH UNSATURATED POROUS MEDIA (08 Hours)**
  Unsaturated flow models- Horton’s equation, Philips equation and Green-Ampt model Computation of excess rainfall hyetograph from observed flood hydrograph, Green-Ampt infiltration equation and SCS method.

- **UNIT HYDROGRAPH THEORY (06 Hours)**
  Unit hydrograph theory, derivation of instantaneous unit hydrograph and synthetic unit hydrograph.

- **PROJECT HYDROLOGY (03 Hours)**
  Design flood PMF storm transportation, PMP and PMF for project by using conceptual models.

- **FLOOD ROUTING (04 Hours)**
  Lumped flow routing, distributed flow routing models including kinematic, diffusion and dynamic wave routing models.

- **HYDROLOGIC STATISTICS (04 Hours)**
  Hydrologic statistics, Flood forecasting and flood frequency analysis.

- **HYDROLOGIC DESIGN (03 Hours)**
  Storm Water Drainage Design

- **INTRODUCTION GLACIER LAKE OUTBURST FLOOD (GLOAF) (02 Hours)**

(Total Lectures: 42 hours)

3. Books Recommended

1. V T Chow, R Maidment David and W Mays Larry, Applied Hydrology, McGraw Hill International Editions, New Delhi, 1988.
2. K N Mutreja, Applied Hydrology, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990.
3. Subramanya K, Engineering Hydrology, Third Edition - Tata McGraw-HillPublishing company Ltd., New Delhi, 2012.
4. Singh Vijay. P, Elementary Hydrology Prentice Hall, INDIA, 1992.
5. Ojha C S P, Bhunya P and Berndtsson P, “Engineering Hydrology” Oxford UniversityPress, Canada, 2008.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3
CO2	3	1	3	1	2	2
CO3	2	1	3	2	3	2
CO4	3	1	3	3	2	2

L	T	P	C
3	1	0	4

CE 667 Computational Techniques in Water Resources Engineering

1. Course Outcomes (COs)

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

CO1	Ascertain use of spreadsheet and statistical techniques in water resources engineering.
CO2	Apply numerical methods and advanced techniques to water resources engineering.
CO3	Solve water resources problems using software and hydro informatics.
CO4	Analyze complex water resources engineering problems using computational techniques.

2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  Introduction to computational Techniques – Database design – Spreadsheet- Usefulness inWater Resources Engineering

- **STATISTICAL TECHNIQUES** **(13 Hours)**
  Presentation of data – Measures of location and dispersion, - Probability concepts and distribution – Tests of significance – Correlation and Regression, Selection of Suitable technique, error analysis

- **NUMERICAL METHODS** **(06 Hours)**
  Finite difference schemes – Method of characteristics – Finite element method

- **ADVANCED TECHNIQUES** **(07 Hours)**
  Genetic algorithm - Artificial Neural Network - Fuzzy logic – Other data driven methods

- **HYDRO INFORMATICS** **(06 Hours)**
  Introduction – Virtual institute – Web based hydro informatics system

- **APPLICATIONS** **(07 Hours)**
  Application with case studies, Selection of suitable technique, Different types of hydraulicengineering software - Salient features – Capabilities and Limitations

(Total Lectures: 42 hours)

3. Books Recommended

1. M B Abbott, Hydroinformatics – Information Technology and The Aquatic Environment, Avebury Technical, Aldershot, 1991.
2. H Adeli and S Hung, Machine Learning – Neural Networks, Genetic Algorithms and Fuzzy Systems, John Wiley, New York, 1995.
3. M H Chaudhry, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 1994.
4. B S Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi.,2001.
5. R S Govindaraju and A R Rao (eds.), Artificial Neural Networks in Hydrology, Kluwer Academic Publishers, Dordrecht, 2000.

6. S Rajsekaron and G A Pai Vijayalakshmi, Neural Networks, Fuzzy Logic and Genetic Algorithams-Synthesis and Applications, PHI Learning Pvt. Ltd., New Delhi, 2010.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	2	2	2	3
CO2	3	1	3	2	2	3
CO3	3	1	3	2	3	3
CO4	3	2	3	3	3	3

CE 669 Flood Control and River Training Works

L	T	P	C
3	0	0	3

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1. Course Outcomes (COs)

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

CO1	Assess morphological behaviour in alluvial rivers.
CO2	Predict local scour in alluvial river.
CO3	Design of river training works.
CO4	Compare flood control methods using soft-computing techniques.

2. Syllabus

- **MORPHOLOGY AND HYDRAULICS OF ALLUVIAL RIVER (16 Hours)**
  Alluvial streams and their hydraulic geometry, bed level variation of alluvial streams, variation in plan form of alluvial streams, Analytical models of river morphology, Numerical models for morphological studies, flood plain analysis, morphology of some Indian rivers

- **FLOOD CONTROL AND ITS ASSESSMENT (10 Hours)**
  Types of Floods, Different methods of Flood control, Floods in major Indian river basins, Types and design of flood forecasting and protection systems,Comparison of levees with bypass channels and off stream storage, reservoir operation for flood control and management, flood damage estimation models.

- **RIVER TRAINING AND FLOOD PROTECTION WORK (16 Hours)**
  Guide lines for planning and design of river embankments (levees), Planning, design, construction and maintenance of guide banks and groynes for alluvial rivers, Application of Geo-synthetics and other materials in river training works.

(Total Lectures: 42 hours)

3. Books Recommended

1. V T Chow, R David Maidment and W Larry Mays, Applied Hydrology, McGraw-Hill Book Company, New Delhi, 1988.
2. R J Garde and K G Ranga Raju, Mechanics of Sediment Transportation and Alluvial Streams Problems, New Age International (P) Limited, Publishers, New Delhi, 2000.
3. R J Garde, River Morphology, New Age International Publishers, New Delhi, 2006.
4. W Larry Mays, Hydraulic Design Handbook, Mc Graw Hill Companies, New Delhi,1999.
5. BIS 10751(1994), 12094 (2000), 12926 (1995), 8408 (1994).
6. P Vijay Singh, Elementary Hydrology, Prentice Hall, INDIA.,1992.
7. K N Mutreja, Applied Hydrology, Tata McGraw-Hill Publishing company Ltd., New Delhi, 1990.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	1
CO2	3	2	1	2	3	1
CO3	3	1	2	2	3	1
CO4	3	1	2	3	2	1

CE 679 Computational Hydraulics

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Recall concepts of fluid motion.
CO2	Derive and apply appropriate flood wave routing models.
CO3	Solve partial differential equations using numerical methods.
CO4	Apply numerical methods for flood waves, flow through saturated porous media and closed conduit flows.

2. Syllabus

- **BASIC CONCEPTS ON FLUID MOTION** **(08 Hours)**
  Basic Concepts – Lagrangian and Eulerian methods of describing fluid motion, acceleration and deformation of fluid elements, Laws governing fluid motion, continuity, Euler's equation, Energy equation,Saint Venant equation, classification of partial differential equations.

- **NUMERICAL TECHNIQUES FOR SOLUTION OF DIFFERENTIAL EQUATIONS** **(18 Hours)**
  Review of linear algebra, solution of simultaneous linear algebraic equations-matrix inversion, solvers-direct methods, elimination methods, ill conditioned systems, Gauss-Seidel method, successive over relaxation method. Finite difference, finite element and finite volume methods.

- **ENGINEERING APPLICATIONS** **(16 Hours)**
  Application to water resources problems in open channel flows, Pressure Flow , ground water flows, and unsaturated flows through porous media.

(Total Lectures: 42 hours)

3. Books Recommended

1. C F Gerald and P O Wheatley, Applied Numerical Analysis, Addison Wesley Publishing Company, NY, 1994.
2. M H Choudhary, Open Channel Flows, Prentice Hall of India, 1994.
3. M B Abbott, Computational Hydraulics, Pitman Publishing House, 1979.
4. J A Cunge, Holly and F M Verway, Practical Aspects of Computational Rive Hydraulics, Pitman Publishing House, 1980.
5. G Pinder and W G Gray, Finite Element Simulation in Surface and Subsurface Hydrology, Academic Press, NY, 1997.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	1	1	1	2	3
CO2	3	3	3	1	3	2
CO3	1	2	3	2	1	3
CO4	3	1	3	2	3	1

CE 671 Irrigation and Drainage Systems Engineering

L	T	P	C
3	0	0	3

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1. Course Outcomes (COs)

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

CO1	Select appropriate irrigation technique.
CO2	Develop suitable models for various irrigation methods.
CO3	Design drainage system for irrigated lands.
CO4	Specify suitable soil conservation measures in watersheds.

2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Available water resources and its present utilization, Development through five year plans, Roles of various commissions on irrigation and agriculture, National water policy for development, Types of irrigation, Irrigation techniques and quality of irrigation water.

- **SOIL WATER CROP RELATIONSHIP** **(08 Hours)**
  Determination of soil moisture, estimation of consumptive use and frequency of irrigation, irrigation efficiencies for economical use of water, design of various irrigation methods, assessment water charges, conjunctive use of surface and ground water, multi-crop irrigation scheduling

- **MODELING OF IRRIGATION SYSTEMS** **(06 Hours)**
  Governing equations and their solutions, computation of inundation front, cumulative infiltration estimation, modeling for sprinklers and other methods of irrigation.

- **SALT AFFECTED LAND AND THEIR RECLAMATION** **(08 Hours)**
  Salt accumulation in soil water, classification of salts affecting the soils and their characteristics, reclamation of saline and alkaline soils, leaching and salinity control.

- **DRAINAGE OF IRRIGATED SOILS** **(08 Hours)**
  Need and purpose of drainage, water logging of agricultural lands and its reclamation, steady state and transient designs of surface and sub-surface drainage systems, drainage by wells.

- **SOIL EROSION AND CONSERVATION** **(07 Hours)**
  Water and wind erosion, design of various types of soil conservation measures.

(Total Lectures: 42 hours)

3. Books Recommended

1. G L Asawa, Irrigation and Water Resources Engineering, New Age International Publishers, New Delhi, 2005.
2. Dan Yaron, Salinity in irrigation and water resources, Morcel Dekker Inc. New York, 1981

3. A M Michael, Irrigation theory and practices, Vikas Publishing House, New Delhi, 1993.
4. H Richard Cuenca, Irrigation system design – An Engineering Approach, Prentice Hall, Englewood Cliffs, New Jercy, 1989.
5. Dilip Kumar Mujumdar, Irrigation Water Management Principles and Practice, PHI Publication New Delhi, 2004.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2
CO2	3	3	1	2	2	3
CO3	1	2	2	3	3	1
CO4	1	3	3	3	2	2

L	T	P	C
3	0	0	3

CE 673 Integrated Watershed Management

1. Course Outcomes (COs)

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

CO1	Apply hydrological models for watershed management.
CO2	Review methods of Controlling soil erosion and salinity in watershed.
CO3	Design surface and subsurface drainage in costal and interior basins.
CO4	Develop precautionary measures for water conservation and Catchment Area

2. Syllabus **(42 Hours)**

- Principles of watershed management through distributed hydrological modeling, soil water conservation practices, integrated planning, multidisciplinary approach, management of agricultural land, structural and non structural measures, erosion and soil salinity problems and controlling techniques, gully control, landslide and correction techniques, watershed modeling Preparation of land drainage scheme, types and design of surface drainage as well as subsurface drainage in coastal and interior basins, types and design of water conservation and Catchment Area Treatment Plant for different types of catchments

(Total Lectures: 42 hours)

3. Books Recommended

1. FAO "Watershed management and Field manuals", UN, Rome, 1988.
2. E M Tideman, "Watershed Management – Guidelines for Indian conditions", Omega Scientific Publishers, New Delhi, 1996.
3. V Sudha Menon, Watershed Management: Case Studies, ICFAI University Press, 2008.
4. J V S Murthy, Watershed Management, New Age International (P) Limited Publishers, New Delhi, Reprint 2004.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	2	1	2	3
CO2	2	1	1	2	2	1
CO3	3	2	2	1	2	2
CO4	3	3	1	3	2	2

L	T	P	C
3	0	0	3

CE 681 Basics of Climate Change Studies

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1. Course Outcomes (COs)

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

CO1	Review of stationary and non- stationary approaches for meteorological variables.
CO2	Assess variability of meteorological variables.
CO3	Predict climatic variables using statistical downscaling technique.
CO4	Appreciate the need of eco-hydro-meteorological cycle in climate change studies.

2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  to hydrological cycle, green house effect, impacts of climate change.

- **BASICS OF CLIMATE CHANGE STUDY** **(09 Hours)**
  Climate, weather and Climate Change; Overview of Earth's Atmosphere; Layers of Atmosphere; Temperature, Radiation and Variation; Heat- Balance of Earth Atmosphere System; Temporal Variation of Air temperature; Temperature Change in Soil; Thermal Time and Temperature Extremes, Hydrologic cycle.

- **CLIMATE VARIABILITY** **(05 Hours)**
  Floods, Droughts, Drought Indicators, Heat waves, Climate Extremes.

- **CLIMATE CHANGE** **(06 Hours)**
  Introduction; Causes of Climate Change; Modeling of Climate Change, Global Climate Models, General Circulation Models, Downscaling; IPCC Scenarios, difference between climate change and climate variability.

- **STATISTICAL METHODS IN HYDRO-CLIMATOLOGY** **(07 Hours)**
  Trend Analysis; Empirical Orthogonal Functions, Principal Component Analysis; Canonical Correlation; Statistical Downscaling with Regression

- **ECOLOGICAL CLIMATOLOGY** **(11 Hours)**
  Leaf energy fluxes and leaf photosynthesis; Plant canopies, ecosystem and vegetation dynamics; Coupled climate vegetation dynamics, Carbon cycle, Introduction to Precipitation Recycling.

(Total Lectures: 42 hours)

3. Books Recommended

1. G B Bonan, Ecological Climatology, Cambridge University Press, 2002.
2. G I Burde and A Zangvil, The Estimation of Regional Precipitation Recycling. Part I: Review of Recycling Models. *J. Climate*, 14, 2497–2508,2001.
3. G G Campbell and J M Norman, An Introduction to Environmental Biophysics, Springer, 1998.
4. H von storch and A Navarra, Analysis of Climate Variability, 2nd Edition Springer-

VerlagBerlin Heidelberg New York 1999.
5. Von Storch and F W Zwiers, Statistical Analysis in Climatic Research, Cambridge, 1999.
6. K McGuffie and Henderson-Sellers, A Climate Modelling Primer, Wily, 2005.
7. IPCC Assessment Report.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	2
CO2	3	2	3	2	2	1
CO3	3	2	3	2	2	1
CO4	2	1	3	1	1	1

L	T	P	C
3	0	0	3

CE 675 Hydraulic Engineering Laboratory-I

1. Course Outcomes (COs)

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

CO1	Synthesise acquired theoretical knowledge with experimental observations for open channel flows.
CO2	Measure boundary layer characteristics and flow resistance on streamlined and bluff bodies.
CO3	Simulate experimentally rainfall, surface flows, and subsurface flows.
CO4	Demonstrate and analyze cavitation phenomenon

2. Syllabus

Experiments related to the following aspects of Hydraulic Engineering:

1. Measurement of velocity distribution in open channel using Pitot tube, current meter and ADV, plotting of isovels and computation of α and β. **(06 Hours)**
2. Establishment of subcritical, critical and supercritical flows in open channel, plotting of specific energy diagram **(03 Hours)**
3. Characteristics of hydraulic jump in open channel. **(03 Hours)**
4. Measurement and computation of Gradually Varied flow profiles in open channel **(06 Hours)**
5. Measurement of development of boundary layer thickness on flat plate **(06 Hours)**
6. Measurement of drag and lift force coefficient for cylinder and spheres. **(06 Hours)**
7. Rainfall and Runoff characteristics using Rainfall Simulator. **(03 Hours)**
8. Infiltrometer to study infiltration capacity of different type of soil. **(06 Hours)**
9. Cavitation Demonstration and Analysis. **(03 Hours)**

(Total Lectures: 42 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	2
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	1
CO4	2	2	3	3	3	1

CE 677 Seminar/G.R.

L	T	P	C
0	0	2	1

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1. Course Outcomes (COs)

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

CO1	Outline the advanced knowledge of the topic through literature review
CO2	Use of audio-visual aids for effective presentation.
CO3	Prepare an effective written technical report intended for technical oral presentation.
CO4	Respond appropriately to the critique on the report and presentation.

2. Syllabus **(28 Hours)**

- Graduate reports on three specific topics based on subjects of the semester are to be prepared in consultation with the faculty advisor and to be submitted in duplicate typed on A4 sheet. One of the report is to be presented on scheduled date. Minimum one expert lecture be arranged on specific relevant topic by expert from academic institute, industry or relevant field.

- Graduate reports are assessed by the P.G. Section at Departmental Level.

(Total Lectures: 28 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	3	3	1	1	2
CO2	3	3	1	2	2	3
CO3	1	3	2	2	1	1
CO4	3	3	3	3	3	2

Semester II

CE 662 Advanced Hydraulic Structures

L	T	P	C
3	1	0	4

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1. Course Outcomes (COs)

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

CO1	Explain reservoir planning and selection of suitable dam sites.
CO2	Review of Codal provisions related to hydraulic structures.
CO3	Design of water storage and diversion structures.
CO4	Develop the concepts for hydraulic design of canal structures.

2. Syllabus

- **PLANNING OF WATER RESOURCES ENGINEERING PROJECT (05 Hours)**
  Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments.

- **GRAVITY DAM (08 Hours)**
  Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam, joints, seals, keys in gravity dams, dam safety and hazard mitigation

- **EMBANKMENT DAM (08 Hours)**
  Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through body and dam foundation, classification of rock filldams and their design considerations.

- **SPILLWAYS AND ENERGY DISSIPATERS (06 Hours)**
  Capacity of spillways, components and profile of different types spillways, Non conventionaltype of spillways, selection and design of energy dissipaters

- **DIVERSION HEADWORKS (08 Hours)**
  Components of diversion head works and their functions, design of weirs and barrages on permeable foundations

- **CANAL STRUCTURES (07 Hours)**
  Canal regulation structures and design of cross drainage works, canal drops, operation andmaintenance of canals.

(Total Lectures: 42 hours)

3. Books Recommended

1. USBR, Design of Gravity Dams, A Water Resources Technical Publication, Denver, Colorado, 1976.
2. USBR, Design of Small Dams, A Water Resources Technical Publication, Oxford and IBH Publishing Co., New Delhi, 1974.
3. W P Creager, J D Justin and J Hinds, Engineering for Dams, Nemchand and Brothers, Roorkee, 1995.
4. R M Khatsuria, Hydraulics of Spillways and Energy Dissipaters, CRC Press, 2005.
5. P Novak, Hydraulic Structures, Taylor and Francis Group Publishers, 2001.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	1	3	3	3
CO2	1	3	2	3	2	1
CO3	3	2	1	3	3	2
CO4	3	2	2	3	3	2

L	T	P	C
3	1	0	4

CE 664 Hydraulics of Alluvial Rivers

1. Course Outcomes (COs)

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

CO1	Predict the incipient motion, bed forms and estimate flow resistance.
CO2	Estimate sediment loads in alluvial rivers.
CO3	Design rigid and alluvial channels using sediment transport concepts.
CO4	Analyze bed level variations in alluvial rivers.

2. Syllabus

- **INTRODUCTION, ORIGIN, PROPERTIES AND INCIPIENT MOTION OF SEDIMENT PARTICLES** **(11 Hours)**
  Nature of sediment problems, Origin and formation of sediments, individual and bulk properties of sediments, competent velocity, lift force and critical tractive stress concept on cohesion less and cohesive soils; regimes of flow; Resistance to flow in alluvial streams, resistance relations based on total resistance and division of resistance into grain and form resistance, preparation of stage discharge curves for alluvial streams, velocity distribution in alluvial channel, sediment Petrography (Sediment sampling)

- **BED LOAD TRANSPORTATION AND SALTATION** **(08 Hours)**
  Bed load computation by empirical equations, dimensional considerations and semi theoretical equations for uniform and non-uniform sediments, saltation.

- **SUSPENDED LOAD TRANSPORTATION** **(08 Hours)**
  Mechanism of suspension, general equations of diffusion. Integration of sediment distribution equation, Differences between actual and theoretical exponents, prediction of reference concentration, Method of integrating curves of concentration and velocity. Simple relations for suspended load, Effect of temperature on suspended load, Wash load, Non equilibrium transport of suspended load.

- **TOTAL LOAD TRANSPORTATION** **(03 Hours)**
  Microscopic, macroscopic methods. Approximate methods of total load determination, sediment yield from catchments.

- **SEDIMENT SAMPLERS AND SAMPLING** **(03 Hours)**
  Bed load and suspended load sampling and computation of total load, Bed material sampling, Sediment spectrography

- **ALLUVIAL RIVER MODELS** **(09 Hours)**
  Hydraulic geometry of alluvial streams, bed level variation of alluvial streams, aggradations and degradation models, reservoir sedimentation, local scours.

(Total Lectures: 42 hours)

3. Books Recommended

1. Hsieh Wen Shen, River Mechanics, Vol. I & II, H W Shen, Colorado, USA, 1971.
2. R J Garde and K G Ranga Raju, Mechanics of Sediment Transportation and Alluvial Stream Problems, Third edition, New Age International (P) Limited, New Delhi, 2000.
3. R J Garde, River morphology, New Age International Publisher, New Delhi-110042, 2006.
4. A J Raudkivi, Loose Boundary Hydraulics, Pergamon Press, Oxford (U. K.), 2nd edition, 1976.
5. M S Yalin, Mechanics of Sediment Transport, Pergamon Press, Oxford (U K),1971.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	3	2	2	1
CO2	2	1	3	2	2	2
CO3	3	1	3	3	2	2
CO4	3	1	3	3	3	2

L	T	P	C
3	0	2	4

CE 666 Geospatial Technologies in Water Resources Engineering

1. Course Outcomes (COs)

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

CO1	Use fundamentals of remote sensing and digital image processing.
CO2	Practice GPS technology in water resources engineering
CO3	Apply GIS in water resources engineering.
CO4	Solve real-life water resources engineering problems using geospatial technologies.

2. Syllabus

- **INTRODUCTION** **(01 Hours)**
  Introduction to Geospatial Technologies – Usefulness in Water Resources Engineering

- **Remote Sensing** **(14 Hours)**
  Fundamentals of remote sensing - Interpretation - Equipments - Techniques of data acquisition – Satellites and sensors – Digital Image processing

- **GPS** **(04 Hours)**
  Introduction to GPS - Working principle of GPS - Measurement and mapping techniques.

- **GIS** **(06 Hours)**
  Introduction - Geo referenced data - Data input & output - Data quality and management - GIS analysis functions - Implementation of GIS

- **GEOSPATIAL ANALYSIS** **(07 Hours)**
  Methods -Measurements - Analysis – GEO visualization

- **SOFTWARE** **(02 Hours)**
  Different geospatial technology software - Salient features – Capabilities and Limitations

- **APPLICATIONS** **(08 Hours)**
  Application of Remote Sensing / GPS / GIS in Water resources Engineering - Case studies, Introduction to Water Resource Information System (WARIS)

(Total Lectures: 42 hours)

3. Books Recommended

1. N K Agrawal, Essentials of GPS, Spatial Network Pvt. Ltd., Hyderabad, 2004.
2. B Bhatta, Remote Sensing and GIS, Oxford University Press, New Delhi, 2008.
3. T M Lillesand and R W Kiefer, Remote Sensing and Image Interpretation, John Willey & Sons, New York, 2004.
4. Stan Aronoff, Geographical Information Systems, WDL Publications, Ottawa, Canada, 1989.

5. Manual of Remote Sensing (Edited), Series of Volumes.
6. R W Lox and K W Albert Yeung Concepts and Techniques of Geographical Information Systems, Prentice-Hall of India Pvt. Ltd. New Delhi, 2006.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	2	2	2	3
CO2	3	1	3	2	3	3
CO3	3	1	3	2	3	3
CO4	3	2	3	3	3	3

L	T	P	C
3	1	0	4

CE 668 Water Resources Systems

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1. Course Outcomes (COs)

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

CO1	Identify basic concepts of systems engineering.
CO2	Apply conventional and soft-computing techniques to optimize use of water resources.
CO3	Simulate water resources systems.
CO4	Evaluate water resources systems project for their technical and economic viability.

2. Syllabus

- **INTRODUCTION** **(03 Hours)**
Introduction to water resources system.

- **ECONOMICS OF WATER RESOURCES SYSTEMS** **(06 Hours)**
Principles of Engineering Economics -Equivalence of Kind, Equivalence of Time, Whose Viewpoint, Sunk Cost, Incremental Cost, Intangible Values, Predictive Uncertainty, Planning Alternatives, Objectives of water resources development, Economic Analysis and Discounting Techniques ,Conditions of Project Optimality

- **CONVENTIONAL OPTIMIZATION TECHNIQUES** **(06 Hours)**
Linear programming by graphical, simplex and Karmarkar algorithms, Dynamic programming and stochastic optimization techniques.

- **SOFT COMPUTING IN OPTIMIZATION** **(12 Hours)**
Optimization using fuzzy sets and fuzzy logics, Genetic Algorithm and Artificial Neural Network.

- **SIMULATION OF WATER RESOURCES SYSTEM** **(06 Hours)**
System Concept, Parts of the water resources system and its functioning, Calibration of system, Validation of system , Operation of system based on if _ then rules, case studies on reservoir simulation for conflicting objectives, Mathematical models for large scale multi-purpose projects.

- **APPLICATION OF OPTIMIZATION TECHNIQUES TO WATER RESOURCES ENGINEERING SYSTEMS** **(09 Hours)**
Applications of various optimization techniques to water resources engineering problems, water quality subsystem, optimum operation model for reservoir systems by incremental dynamic programming, sequence of multipurpose projects.

(Total Lectures: 42 hours)

3. Books Recommended

1. Arthur Mass et al, Design of Water Resources Systems, Macmillan,1970.
2. S Alvin and Goodman, Principles of Water Resources Planning, Prentice Hall, Englewood Cliffs, New Jercey,1984.
3. L D James and R R Lee, Economic of Water Resources Planning, McGraw Hill, 1971.
4. S Vedula and P P Mujumdar, Water Resources System, Tata McGraw Hill Companies, 2005.
5. W A Hall and Jn Dracup, Water Resources Systems Engineering, McGraw Hill , 1970.
6. L W Mays, Water Resources System Engineering, John Wiley and Sons, New York, 2001.
7. P Daniel Loucks and Eelco van Beek, Water Resources Systems Planning and Management :An Introduction to Methods, Models and Applications, Prantice Hall India Private Ltd, New Delhi, 1981.
8. Kalyanmoy Deb, Optimization for Engineering Design, Algorithm and Examples, Prantice Hall India Private Ltd, New Delhi ,2005.
9. Kalyanmoy Deb, Multi objective optimization using Evolutionary Algorithms, Optimization, John Willey and Sons, Chicester, U.K.,2001.
10. M C Chaturvedi, Water Resources System Planning and Management, Tata McGraw Hill Publishing Company,1987.
11. D E Goldberg, Genetic Algorithm in Search, Optimization and Machine learning Technique, Addison Wesley, Reading Mass,1989.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	1
CO2	3	2	2	3	2	1
CO3	3	3	2	3	3	3
CO4	2	2	2	3	3	3

CE 672 Water Supply Distribution Systems

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Plan water intake structures and distribution systems.
CO2	Design water distribution systems.
CO3	Optimize water distribution system
CO4	Analyze surge in the pressurized water supply network

2. Syllabus

- **INTRODUCTION** **(06 Hours)**
  Introduction to Intake structure, Hydraulics of water treatment processes.

- **TYPE OF DISTRIBUTION SYSTEMS** **(10 Hours)**
  Equivalent pipe, parameters in distribution system analysis, parameters interrelationship, formulation of equation. Gravity and Rising main, location and design principles.

- **ANALYSIS OF WATER DISTRIBUTION SYSTEM** **(14 Hours)**
  Methods of analysis : (i) Hardy – Cross method (ii) Newton Raphson method and (iii) Linear theory method.

- **DESIGN AND OPTIMIZATION OF WATER DISTRIBUTION SYSTEM** **(12 Hours)**
  Design: Trial and error method of design, cost- head loss ratio method. Optimization using linear programming techniques. Surge analysis in water distribution systems, Pump duty stations and detailing valves, Pressure transients in pipe flow.

(Total Lectures: 42 hours)

3. Books Recommended

1. P R Bhave, Analysis of Flow in Water Distribution Network, Technomic Publishing Co., Lancaster, USA, 1996.
2. P R Bhave, Optimal Design Of Water Distribution Networks, Narosa Publishing House, New Delhi., 2003.
3. P R Streter and E D Wylie, Fluid Transients , McGraw Hill Book Co., 2006.
4. R Pramod Bhave and Rajesh Gupta, "Analysis of Water Distribution Networks" Published by Narosa Publishing House, New Delhi and Alpha-Science Publication, UK.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	1
CO2	2	1	3	2	3	1
CO3	2	1	3	1	3	2
CO4	3	2	1	1	3	2

CE 674 Hydropower Engineering

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify Issues related to hydropower development in India.
CO2	Assess hydropower potential of river basins.
CO3	Evaluate efficacy of hydropower plants.
CO4	Design intake structures and water conveyance system.

2. Syllabus

- **INTRODUCTION** **(06 Hours)**
  Energy sources for power generation, Power scenarios, Demand and supply of power, need of hydropower, General Hydrology, Environment and Hydro Power Development.

- **POWER POTENTIAL STUDIES** **(06 Hours)**
  Estimation of available water power, Power duration curve, Storage and pondage, Load studies, Technical terms related to hydropower, System integrated operational studies, Load prediction, Installed capacity, Size and number of units.

- **WATER AVAILABILITY AND PROJECT HYDROLOGY** **(06 Hours)**
  Introduction, objectives of planning, Planning for water power development, Economics of hydropower development, Economic value of hydropower, Cost of water power, Total annual cost of a hydro project, Operation and maintenance of hydro plants.

- **CLASSIFICATION AND TYPES OF HYDROPOWER PLANT** **(06 Hours)**
  Classifications, types, Storage power development ,components of storage power development, economic aspects, social and rehabilitation aspects, Run-Off-River power development, types of ROR, components of run-off-river power development, Run-of-power development on canal falls, Underground and pumped storage power plants , advantages, types and location of underground power station, its components, types of layout, limitations of underground power plants. Essential requirements of pumped storage power plant (PSPP), economics of PSPP, Cost of power generated, Canal head power plant

- **TOPOGRAPHICAL SURVEY AND GEO LOGICAL/GEO TECHNICAL INVESTIGATION** **(03 Hours)**
  Geological investigations studies for water power development, Geo technical investigations studies for water power development.

- **SMALL HYDRO POWER DEVELOPMENT** **(03 Hours)**
  Introduction, Advantages of small hydropower, Classification of small hydropower, Components of small hydropower development, Choice of units, Economics of small hydropower schemes.

- **WATER CONVEYANCE SYSTEM** **(06 Hours)**
  Intakes: Types, Location and Alignment of intakes, Losses in Intakes, Air- Entrainment at Intakes, Inlet aeration, Trash racks, Penstocks and Pressure Shafts, Surge shafts Hydraulic Valves and Gates

- **POWER HOUSE PLANNING** **(06 Hours)**
  General layout of the power house and arrangement of hydropower units, Number and sizes of units, space allocation and dimensions, Super structure, Indoor, Semi-outdoor and Outdoor powerhouse, Lighting and Ventilation, Variation in design of power house, Safety requirements, Operation and maintenance of hydro plants.

(Total Lectures: 42 hours)

3. Books Recommended

1. H K Barrows, Water Power Engineering, McGraw Hill Book Co., New York., 1943.
2. Dandekar and Sharma, Water Power Engineering, Vikas Publishing House, New Delhi, 1996.
3. M M Deshmukh, Water Power Engineering, Dhanpat Rai Publications, New Delhi, 1998.
4. N C Nigam, Handbook of Hydro-power engineering, publishers Nem Chand and sons, Roorkee, 1999
5. R K Sharma and T K Sharma, Water Power Engineering S.CHAND & Company, New Delhi, 2003.
6. R S Varshney, Hydropower Structures, Nem chand and Bros., Roorkee (U.P.), 1992.
7. Guthrie Brown, Hydropower Electric Engineering, Blacki and Son, London, 1958.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2
CO2	2	2	1	3	3	3
CO3	2	2	2	3	3	2
CO4	3	3	2	3	3	2

L	T	P	C
3	0	0	3

CE 676 Groundwater Engineering

1. Course Outcomes (COs)

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

CO1	Apply basics of fluid flow through porous media.
CO2	Estimate aquifers characteristics using pumping tests.
CO3	Predict ground water variation using modeling techniques.
CO4	Plan ground water basins, prevent sea water intrusion, and control pollution in aquifers.

2. Syllabus

- **INTRODUCTION (05 Hours)**
  Occurrence of ground water, geological formations as aquifers; types of aquifers, ground water movement, Darcy's law, permeability and its measurement, tracing of ground water movement, fundamental equations for steady and unsteady ground water flow, flow nets.

- **WELL HYDRAULICS (11 Hours)**
  Steady and unsteady flow in confined, semi-confined and unconfined aquifers, radial flow, superposition; multiple well system. Different methods of well construction; construction of well casings and screens, natural and artificial gravel packed wells. Safe yields, estimation, pumping and recuperation tests, Infiltration galleries,

- **ARTIFICIAL RECHARGE OF GROUND WATER (07 Hours)**
  Ground-water replenishment, Artificial recharge of ground water, different methods, merits, demerits , selection criteria for various methods, cone of depression

- **GROUNDWATER MODELING TECHNIQUES (07 Hours)**
  Porous media models, analog models, electric analog models, digital computer models

- **SALT WATER INTRUSION (07 Hours)**
  Concept, interface and its location, control of intrusion.

- **TRANSPORT OF POLLUTANTS IN GROUND WATER (05 Hours)**
  Pollutant transport, Plume Transport, source identification, tracer methods.

(Total Lectures: 42 hours)

3. Books Recommended

1. David Keith Todd, Groundwater Hydrology, John Wiley Publishers, 2004.
2. Jacob and Bear, Hydraulics of Groundwater, McGraw Hill, 1997.
3. K N Mutreja, Applied Hydrology, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990.
4. Raghunath, Groundwater & Well Hydraulics, Wiley Eastern Ltd, New Delhi, 1992.
5. P Vijay Singh, Elementary Hydrology, Prentice Hall, INDIA,1992.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	1	3	2	2
CO2	2	1	1	1	2	1
CO3	1	2	2	2	1	3
CO4	2	3	3	2	1	3

L	T	P	C
3	0	0	3

CE 678 Coastal Engineering

1. Course Outcomes (COs)

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

CO1	Comprehend basics of wave mechanics and associated theories.
CO2	Estimate wave forces and littoral drift.
CO3	Design onshore and off shore structures.
CO4	Identify causes of coastal storms and tsunamis.

2. Syllabus

- Motion parameters – wind, tide, currant and data collection and analysis **(03 Hours)**
- Formulation of wave motion problem, assumption made in two dimensional cases, small amplitude wave theory, orbital motion and pressure, wave energy, finite amplitude wave theory, Stokes's wave theory (third order), mass transport, Gerstner theory, solitary wave theory, generation of waves, wave forecasting, decay of waves. **(06 Hours)**
- Reflection of waves, clapotis or standing waves, superposition of waves, refraction, refraction diagrams, wave fronts and orthogonal methods, diffraction of waves around semi infinite break waters, detached break water of finite length, diffraction through openings.**(06 Hours)**
- Forces on vertical walls due to non breaking waves, breaking waves and broken waves base on linear theory, forces on circular cylinders. **(06 Hours)**
- Long term and short term changes of shores, factors influencing beach characteristics , beach wave interaction, beach profile modification , littoral drift, stability of shores, shore erosion due to sea level, on shore and off shore transport, long shore transport, interaction of shore structures, shore erosion, mud banks. **(07 Hours)**
- Coastal structures, description and effects of break waters, sea walls, groynes of various types, beach nourishment, design of sea walls, break waters, tetra pod, tribar etc. **(06 Hours)**
- Harbour types and features, ship Features related to port planning, site investigation & selection, port layout, on-shore and offshore structures, cargo handling equipments, Navigational aids. **(06 Hours)**
- Causes and occurrences of Tsunami and storms. **(02 Hours)**

(Total Lectures: 42 hours)

3. Books Recommended

1. T Ippen Arthar, Estuary and Coastline Hydrodynamics, McGraw Hill Book Co.,1964.
2. Def Quinn Alonzo, Design and Construction of Ports and Marine Structures, McGraw Hill Book Company, 1972.

3. F Henry Cornik, Dock and Harbour Engineering Vol.–I to IV, Charles Griffin & Company Ltd., London, 1988.
4. L Robert Weigel, Oceanographical Engineering, Prentice Hall Inc., 1964.
5. M Sorensen Robert, Basic Coastal Engineering, Springer, 2006.

4. Mapping of COs with POs

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	2	3	2	1	3
CO2	3	1	2	3	2	1
CO3	3	2	3	2	3	1
CO4	1	3	3	1	2	3

L	T	P	C
3	0	0	3

CE 686 Stochastic Hydrology

1. Course Outcomes (COs)

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

CO1	Evaluate probability of discrete and continuous random variables
CO2	Identify suitable probability distribution to hydrological data
CO3	Analyze trend, periodicity, autocorrelation and spectrum.
CO4	Develop univariate and multivariate seasonal models and predict values of hydrologic variables.

2. Syllabus

- **Fundamental of Statistics** **(11 Hours)**
  Concept of Probability, discrete and continuous variables, Probability distributions including fitting to hydrological data.

- **Time series Analysis** **(08 Hours)**
  Definitions and classification of Time Series and Stochastic processes, Trend analysis, periodicity, Auto-correlation and spectral analysis.

- **Stochastic Models** **(12 Hours)**
  Univariate models: classification of models, univariate annual models with normal and nonnormal distributions, univariate annual models obeying Hurst's law, univariate seasonal models.
  Multivariate models: Multisite Annual Models, Multisite AR models for seasonal flows

- **Case Studies** **(11 Hours)**
  Examples related to fitting probability distributions, trend analysis, stochastic models in hydrologic forecasting

(Total Lectures: 42 hours)

3. Books Recommended

1. P Jayarami Reddy, Stochastic hydrology, Laxmi Publication, New Delhi, 1997.
2. N T Kottegoda, Stochastic Water Resources Technology, The MACMILAN PRESS LTD, 1980.
3. Ven Te Chow, Editor, Handbook of Applied Hydrology, McGraw-Hill, New York, 1964.
4. V Yevjevich, Stochastic Process in Hydrology, Water Resources Publications, Fort Collins, Colorado, 1972.
5. C T Hann, Statistical Methods in Hydrology, First East-West Press Edition, New Delhi, 1995.

4. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	1
CO2	2	2	3	2	2	1
CO3	3	2	3	2	2	1
CO4	2	2	3	3	3	1

L	T	P	C
0	0	3	2

CE 682 Hydraulic Engineering Laboratory-II

1. Course Outcomes (COs)

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

CO1	Synthesize acquired theoretical knowledge with experimental observations for mobile bed channels.
CO2	Estimate experimentally the submergence characteristics of flow measuring structures in open channels.
CO3	Simulate experimentally hydraulic transients.
CO4	Measure experimentally the hydraulic conductivity and cone of depression for an unconfined aquifer

2. Syllabus

1. Study of submergence characteristics and measurement of discharge using critical flow Venturi-flume. **(06 Hours)**
2. Study of submergence characteristics and measurement of discharge using broad crested weir. **(03 Hours)**
3. Incipient motion of sediments in mobile boundary channel **(06 Hours)**
4. Flow through porous media using ground water flow unit. **(03 Hours)**
5. Measurements of bed shear stress by Preston tube **(03 Hours)**
6. Seepage analysis of earthen dam using Electrical analogy **(03 Hours)**
7. Water Hammer pressure analysis **(03 Hours)**
8. Measurement of soil moisture using Tensiometer **(06 Hours)**
9. Analysis of Surge Tank **(03 Hours)**
10. Hele-Shaw apparatus to study fresh water – soil water interface **(06 Hours)**

(Total Lectures: 42 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	1	2	3	3	2	1
CO3	3	1	2	3	2	1
CO4	3	1	2	3	2	1

L	T	P	C
0	0	2	1

CE 684 Seminar/G.R.

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1. Course Outcomes (COs)

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

CO1	Outline the advanced knowledge of the topic through literature review
CO2	Use of audio-visual aids for effective presentation.
CO3	Prepare an effective written technical report intended for technical oral presentation.
CO4	Respond appropriately to the critique on the report and presentation.

2. Syllabus **(28 Hours)**

- Graduate reports on three specific topics based on the subjects of the semester are to be prepared in consultation with the faculty advisor and to be submitted in duplicate typed on A4 sheet. One of the report is to be presented on scheduled date. Minimum one expert lecture be arranged on specific relevant topic by expert from academic institute, industry or relevant field.

- Graduate reports are assessed by the P.G. Section at Departmental Level.

(Total Lectures: 28 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	3	3	1	1	2
CO2	3	3	1	2	2	3
CO3	1	3	2	2	1	1
CO4	3	3	3	3	3	2

Semester III

CE 841 Seminar/G.R.

L	T	P	C
0	0	20	10

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1. Course Outcomes (COs)

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

CO1	Outline the advanced knowledge of the topic through literature review
CO2	Use of audio-visual aids for effective presentation.
CO3	Prepare an effective written technical report intended for technical oral presentation.
CO4	Respond appropriately to the critique on the report and presentation.

2. Syllabus **(56 Hours)**

- Graduate reports on four specific topics are to be prepared in consultation with the faculty advisor and to be submitted in duplicate typed on A4 sheet. Two reports are to be presented on scheduled date. Minimum two expert lectures be arranged on specific relevant topic by expert from academic institute, industry or relevant field.

- Graduate reports are assessed by the P.G. Section at Departmental Level

(Total Lectures: 56 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	3	3	2	3	1
CO2	3	3	1	1	3	1
CO3	1	3	2	1	3	1
CO4	3	3	3	1	3	1

CE 845 Professional Project

L	T	P	C
0	0	6	3

1. Course Outcomes (COs)

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

CO1	Identify a practical problem related to water resources engineering field.
CO2	Compare different methods/solutions through literature review.
CO3	Design and suggest optimum/sustainable solution for the identified problem.
CO4	Inculcate the habit of working in a team.

2. Syllabus

(84 Hours)

- Design project on specific topic is to be prepared in consultation with faculty advisor and is required to be submitted in duplicate typed on A4 sheet. It is to be assessed by P.G. Center. The students may be allowed to depute for Internship in any nearby IIT, Industry or relevant laboratory/ industry /institution, if Institute Rules permits, by approval of competent authority.

(Total Lectures: 84 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	2
CO2	2	2	1	2	2	3
CO3	1	3	3	1	3	2
CO4	2	3	2	3	3	2

L	T	P	C
0	0	8	4

CE 843 Dissertation (Preliminary)

1. Course Outcomes (COs)

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

CO1	Identify and investigate problems related to water resources.
CO2	Conduct the comprehensive literature review and identify research gaps.
CO3	Propose a methodology for solving the identified problem.
CO4	Plan experimental and/or numerical investigation to meet the objective.

2. Syllabus **(112 Hours)**

- Dissertation Preliminaries should clearly identify the goals/objectives and scope of the dissertation work taken up by the student. Details of data identification and field surveys should be clearly highlighted. The study approach and literature review should be discussed. A report shall be submitted at the end of the semester, which shall be assessed.

(Total Lectures: 112 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	2
CO2	2	1	2	2	2	2
CO3	2	1	2	2	2	1
CO4	1	1	2	2	2	1

Semester IV

CE 842 Dissertation

L	T	P	C
0	0	2	1

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1. Course Outcomes (COs)

At the end of the course the students will be able to:
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CO1	Examine the preliminary results and possible modifications in proposed methodology.
CO2	Conduct extensive analytical / modelling / experimental / field work.
CO3	Propose an effective sustainable solution for the identified problem.
CO4	Analyze the data, synthesize the outcomes and present these in the dissertation before its defense.

2. Syllabus

(280 Hours)

TEACHING SCHEME : 20 HOURS

EXAM SCHEME : 400 MARKS

INT. ASS. : 160

MARKS EXT. ASS. : 240 MARKS

CREDIT: 10

(Total Lectures: 280 hours)

3. CO-PO-PSO_Mapping

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	1
CO2	2	1	2	2	2	1
CO3	2	2	3	2	2	1
CO4	3	3	3	3	3	2