M. Tech (Hydraulic Structures)

Civil Engineering Department

Syllabus

Semester I

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE611	Design of Irrigation Works	DC	CE-415	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

This course is aimed to develop the understanding of basic principles and concepts of analysis and design of hydraulic structures on permeable foundation such as weirs and barrages, canal falls and various river training works along with the detailed insight in to the theories of sub-surface flow. The course also intends to learn the detailed design principles of canal transitions and regulation works.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Understand the design aspects of various hydraulic structures on permeable foundation and their causes of failure.
2. Plan and design the efficient silt control structures and relevant river training works.
3. Plan and design suitable transition structures for subcritical and supercritical flow conditions using standard available methods.
4. Plan and design of canal regulation works.

Topics Covered

Unit 1 Principle of design of hydraulic structures on permeable foundation, Mechanics of failure of hydraulic structures on permeable soil, Design of barrage.

Unit 2 Design of silt excluder and silt ejector, Design of guide banks and spurs.

Unit 3 Design of subcritical canal transitions: Hind's method, Vittal and Chiranjeevi's method of transition design, Design of supercritical transition.

Unit 4 Design of head and cross regulators, Design of falls.

Text Books and/or Reference Materials

1. **P. N. Modi,** Irrigation Water Resources and Water Power, McGraw Hill Education (India) Pvt Ltd, N Delhi
2. **Bharat Singh,** Fundamentals of Irrigation Engineering, Nem Chand and Brothers, Roorkee.
3. **S. K., Garg,** Irrigation Engineering and Hydraulic Structures, Khanna Publishers, Delhi.
4. **R S Varshney, S C Gupta and R L Gupta,** Theory and Design of Irrigation Structures Vol. I & II, Nem Chand and Brothers, Roorkee.

Additional Learning Source

1. J. Nemec, "Engineering Hydrology", Mc Graw-Hill, N.Y
2. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE612	Reservoir Engineering	DC	-	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 2 Hour

Course Objective

The course is aimed to provide knowledge of reservoir engineering including reservoir sedimentation, capacity, flood routing and concept of design flood.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Plan and design of a reservoir to meet the demands for various sectors of the water resources.
2. Identify the problems related to reservoir silting and evolve the solution for such major problems of the reservoir.
3. Understand the commonly used methods of e peak floods estimation required for the design of various components of water resources projects
4. Understand the concepts of the flood routing and make assessment of maximum reservoir level leading to proper estimation of free board and height of flood protection works , and flood forecasting

Topics Covered

Unit 1 Types of reservoir, Site selection for a reservoir, Area -elevation curve, Capacity- elation curve, Various zones of reservoir, Reservoir Capacity estimation, Flow mass curve, Sequent Peak Algorithm, Estimation of maintainable demand

Unit 2 Reservoir sedimentation, Mechanics of sedimentation, Estimation of silt load, Distribution of sediment in reservoir. Wind setup and waves in reservoir, Reservoir operation.

Unit 3 Peak flood estimation: Empirical methods, Rational method, Flood frequency analysis, Gumbel's extreme value distribution, Log-Pearson type III distribution, Concept of risk reliability and safety factor for a reservoir.

Unit 4 Concept of flood routing, Factors responsible for flood routing, Routing classification, Reservoir routing.

Text Books and/or Reference Materials

1. **K. Subramanya**, "Engineering Hydrology", TMH, New Delhi, India.
2. **Chow V.T,** "Hand book of Applied Hydrology", Mc Graw-Hill, N.Y., USA.
3. **Wister, and Kohler and Paulhus**, "Hydrology", McGraw Hill, Tokyo, Japan.
4. **Linsley, Kohler and Paulhus**, "Applied Hydrology", Mc Graw Hill, N.Y., USA.
5. **D.K Todd,** "Groundwater Hydrology", John Wiley, N.Y., India..

Additional Learning Source

1. J. Nemec, "Engineering Hydrology", Mc Graw-Hill, N.Y
2. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE613	Fluvial Hydraulics	DC	CE 316 CE 414	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 2 Hour

Course Objective

To understand the behavior of sediment transport in alluvial channels, design the stable alluvial channel and solve various civil engineering problems encountered in fluvial hydraulics.

Course Outcomes

After the successful completion of the course, a student is expected to

1. Understand the basic concepts of sediment movement and regimes of flow in alluvial channels.
2. Get in-depth knowledge of various predictors of bed load and suspended load.
3. Compute the total sediment load carried in alluvial channel and to design the stable channels.
4. Have an understanding of alluvial river models and sediment transport through pipes.

Topics Covered

Unit 1 Sediment properties, incipient motion of sediment, competent velocity, lift concept, critical tractive force of cohesion less and cohesive materials, Regimes of flow, ripple and dune regimes, anti-dune regime, importance and prediction of regimes of flow

Unit 2 Resistance to flow and velocity distribution in alluvial streams, Bed load equations based on dimensional considerations and semi theoretical equations, suspended load, general considerations about sediment distribution equation, prediction of reference concentrations.

Unit 3 Total load transport, microscopic and macroscopic methods based on a single size and fraction wise size calculations, Sediment samplers and sampling, bed load and suspended load sampling. Design of stable channels in alluvium: variables in channel design, general comments on regime and tractive force methods of channel design.

Unit 4 Bed level variation in alluvial streams, local scour, degradation, aggradation, silting of reservoir, River models, Sediment flow through pipes.

Text Books and/or Reference Materials

1. **R.J. Garde and K G Ranga Raju,** Mechanics of sediment transport through alluvial Channels, New Age International (P) Limited, Publishers, New Delhi.
2. **W R White, A D Crabbe, H Milli,** Sediment *Transport*: *New Approach and Analysis*," Journal of the Hydraulics Division, HY11, American Society of Civil Engineers. ... "Shore Protection Manual," Washington, *1975*
3. **A J Raudkivi,** Loose Boundary Hydraulics, CRC Press, Taylor & Francis, USA.

Additional Learning Source

1. Web links to e-learning:*nptel*
2. Web based learning, Journal papers, etc.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE614	Rigid Dam			Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Aim

The course is aimed to train the students in planning and designing of various types of rigid dams such as gravity dam, arch dam and buttress dam.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Plan, analyse and design of gravity dam.
2. Assess the various stresses at key points in general and galleries, monitor quality control and behavior of dam during and after construction using proper instrumentation.
3. Plan, analyse and design of arch dam.
4. Plan, analyse and design of buttress dam.

Topics Covered

Unit 1 Dam: types, characteristics, relative merits and demerits, site investigations and selections, foundation grouting, forces acting on dam,
Gravity dams**:** stability requirements, modes of failure and factor of safety, elementary profile of gravity dam, methods of analysis, zoning of gravity dams, design criteria.

Unit 2 Stress analysis in gravity dams, normal and shear stresses, principal stresses, internal stresses, galleries in dams, stress concentration around openings, joints in dams, construction of gravity dams, instrumentation in gravity dam.

Unit 3 Arch Dam**:** General consideration, types and characteristics, Forces acting on Arch dams, Design criteria, Cylinder theory and elastic theory of design, Construction of arch dams.

Unit 4 Buttress dam**:** Merits, Types and characteristics, Forces acting, design of deck, buttresses, Unit column theory, Construction of buttress dam.

Text Books and/or Reference Materials

1. **R.S. Varshney** "Concrete Dams", by 1982, NCB, Roorkee
2. Design of Small Dams, USBR 1960, Calcutta, Oxford and IBH
3. **W.P. Creager, J. Justin,.Daud Hinds**, "Engineering for Dams" Vol. I-III, Wiley, N.Y., USA.
4. IS: 6512-1984, Criteria for Design of solid Gravity Dams.
5. IS:1893-1984, , Criteria for Earthquake resistant Design of structures.

Additional Learning Source

1. NPTEL course materials from different IITs.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE615	Earth and Rockfill Dams	DC	CE 312 Soil Mechanics	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

The course is aimed to train the students in planning and designing of earth and rockfill dams and inculcate the knowledge of construction, maintenance and safety of these dams.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Plan and design earthen dams and adopt suitable measures for its safety.
2. Assess the seepage discharge and adopt suitable measures for its control.
3. Plan and design rockfill dams and adopt suitable measures for its safety.
4. Adopt appropriate methods of river diversion, monitor quality control and behavior of dam during and after construction using proper instrumentation.

Topics Covered

Unit 1 Basic design aspects, Classification of embankment dams, Criteria for safe design, Free board, Upstream and downstream slope protection, cracking of earth dams, Hydraulic fracturing, Causes of cracking, Preventive and remedial measures.

Unit 2 Seepage theory, Determination of free surface and seepage discharge through dams for isotropic as well as anisotropic soils. Flow net for earth dam under steady seepage condition, Various methods of seepage control, Selection of core materials, Drainage of embankments, Design of transition filters, Use of geo-textiles.

Unit 3 General characteristics of Rock fill dams, Materials for rock fill dams, testing of rockfill material, Design of dam section, Types of membrane, Rock fill placement, Deformation of rock fill dams, Flow through and over rockfill dam, Concrete faced rockfill dam.

Unit 4 Stability analysis, Method of slices, Graphical method, Foundation exploration for Earth and Rock fill dams, Treatment of foundations, Quality control and instrumentation, River diversion during construction of dam.

Text Books and/or Reference Materials

1. **Hind, Creager and Justin**, Engineering for dams, Wiley, 1967.
2. **Bharat Singh**, Embankment Dam Engineering, Nem chand & Bros Roorkee.
3. **Sowers G. I.** Earth and Rockfill Dam Engineering Manual, USBR Publication.
4. **Sharma H. D.**, Embankment Dams, Oxford and IBH Pub., 1991.
5. **Design of Small Dams**, USDI, Oxford and IBH, 1976.

Additional Learning Source

1. Web links to e-learning**: *nptel***

Semester II

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE616	Advanced Engineering Hydrology	DC	CE-219	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

The course is aimed to provide knowledge concept of various approaches to decide the design flood, flood routing and rainfall runoff modelling.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. assess design flood properly with consideration of economy and safety for water resources projects
2. utilize the concept of the random variable and its analysis , theory of probability and statistical methods in the planning and design of water resource projects.
3. apply at site and regional flood frequency analysis for the assessment of reliable flood peak and its frequency for major water resource projects and utilize the knowledge of the reservoir and channel flood routing for the reservoir planning and flood forecasting.
4. apply the knowledge of the hydrograph analysis for rainfall-runoff modeling of the watershed

Topics Covered

Unit 1 Design Storms, Probable Maximum Precipitation, Spillway design flood, Standard project flood, Probable maximum flood. Guide lines for selecting design flood.

Unit 2 Random Variable and Probability, Statistical Analysis of random variables, Probability distribution function, Frequency analysis, Regression analysis, Risk and Reliability analysis of Hydraulic Engineering System

Unit 3 At site flood Frequency analysis, annual and partial duration series, Regional Flood Frequency Analysis, Reservoir and channel flood Routing

Unit 4 Hydrograph analysis, Separation of Stream Flow Components, Unit Hydrograph, Synthetic Unit Hydrograph, Instantaneous unit hydrograph, Dimensionless unit hydrograph, Distribution graph.

Text Books and/or Reference Materials

1. **K. Subramanya**, "Engineering Hydrology", TMH, New Delhi, India.
2. **Chow V.T**, "Hand book of Applied Hydrology", Mc Graw-Hill, N.Y., USA.
3. **Wister, and Kohler and Paulhus**, "Hydrology", McGraw Hill, Tokyo, Japan.
4. **Linsley, Kohler and Paulhus**, "Applied Hydrology", Mc Graw Hill, N.Y., USA.
5. **D.K Todd**, "Groundwater Hydrology", John Wiley, N.Y., India..

Additional Learning Source

1. J. Nemec, "Engineering Hydrology", Mc Graw-Hill, N.Y
2. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE-617	Hydro-Power Structures	DE	CE -219 (Hydrology)	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Oral Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

The main aim of this course is to provide an insight of planning and design of various components of hydro-power structures such as intakes, penstock, tunnels, surge tanks, and draft tubes etc. giving due consideration to safety measures. Further the focus is made on the appropriate selection and setting out of suitable turbines for various types of hydel plants.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Gain knowledge regarding the various sources of energy available in nature, hydel power terminology and assess the power potential of a natural stream.
2. Plan and design various types of hydro power schemes as well as assess their efficiency.
3. Plan and design the various components of hydro power plant such as intake, penstock, power tunnels, surge tank.
4. Select suitable turbine for various type of hydro power schemes, schematically plan, proper dimension and layout of power houses with all safety measures.

Topics Covered

Unit 1 Sources of energy, role of hydropower in a power system, Estimation of power potential of stream, Storage and Pondage studies, load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power and secondary power.

Unit 2 Hydro-power plants, Elements, general arrangement of various Hydel plants such as run off river plants, valley dam plants, diversion canal plants, high head diversion plants, pumped storage power plants etc., Efficiency and Installed capacity of plants.

Unit 3 Intakes, Types, losses, air entrainment, air vent, power channels, forebay, Tunnel, Penstocks, General classification, design criteria, economical diameter, anchor blocks, valves, bends and manifolds, Surge tanks, Classification, Analysis of simple surge, Water hammer.

Unit 4 Selection, setting and cavitation in turbines, Draft tubes, classification, Dimensioning and laying of power houses, Safety measures during construction of power plants.

Text Books and/or Reference Materials

1. **Dandekar M M Sharma, K H**, Water Power Engineering, Vikas Publishing House Pvt Ltd.
2. **Barrows, H K**, Water Power Engineering, Tata McGraw Hill Publishing Company Ltd.
3. **Varshney, R S,** "Hydro Power Structures", Nem Chand & Bros.
4. **Nigam, P S**, "Hydro Electric Engineering", Nem Chand & Bros.
5. **Choudhary, M H,** "Applied Hydraulic Transients", Van Nostrand Reinhold.
6. **Streeter, V.L., and Wylie, B**, "Fluid Transients", McGraw-Hill Book.
7. **Warnick, C.C**., "Hydropower Engineering", Prentice-Hall.
8. **Norwegian Institute of Technology: Hydropower Development**: Vols. 3, 4, 5 & 6, Division of Hydraulic Engineering.

Additional Learning Source

1. NPTEL course materials from different IITs.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE618	Advanced Hydraulics	DC	Open Channel Flow	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

The aim of the course is to impart knowledge regarding the advanced topics on steady, unsteady, spatially varied flows and dispersion of pollutants in natural streams.

Course Outcomes

Upon successful completion of the course the students are supposed to

1. Compute back water and drawdown profiles for various Gradually Varied Flow situations and to assess the stage and discharge in channel during flood and dam break catastrophe.
2. Plan and design various types of weirs for discharge measurement as well as special types such as Labyrinth and Piano key weirs for passing high discharges safely during floods.
3. Plan and design special types of diversion works in hydraulic structures for mountainous region.
4. Assess the impact of aeration in providing suitable free board in hydraulic structures and to assess the impact of pollution caused by disposal of domestic and industrial waste in natural streams.

Topics Covered

Unit 1 Gradually Varied Flow: Computation of GVF profiles using analytical and numerical methods. Unsteady Flow: St. Venant's equations and their solution, hydraulic flood routing, Dam break problem.

Unit 2 Rapidly Varied flow: thin plate weirs, special types of weirs such as linear proportional weir, Labyrinth weir, Piano key weir. Hydraulic jump in non-rectangular channels.

Unit 3 Spatially Varied Flow: Side channel spillway, side weir, De Marchi equation, uniformly discharging side weir, Trench weir.

Unit 4 Air-entrainment, Diffusion, Dispersion and their governing equations, some classical solutions of diffusion equations, Dispersion and diffusion coefficients.

Text Books and/or Reference Materials

1. **K. Subramanya**, Flow in open channel, McGraw Hill Education (India) Pvt Ltd, New Delhi
2. **K. G. Ranga Raju**, Flow through open channels, Tata McGraw Hill Publishing Company Limited, New Delhi.
3. **Rajesh Srivastava**, Flow Through Open Channel, Oxford University press, New Delhi.
4. **M Hanif Chaudhry,** Open Channel Flow, Prentice Hall of India, New Delhi.
5. **Ven Te Chow,** Open Channel Hydraulics, McGraw Hill Book Company, New York.

Additional Learning Source

3. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	AM611	Higher Mathematics	DC	NIL	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

To study solutions of well known differential equations, Fourier and Hankel transforms, linear programming problems and basic probability.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Apply the knowledge of Legendre and Chebychev polynomials.
2. Apply Fourier and Hankel transforms to solve engineering problems.
3. Solve boundary value problem.
4. Apply the probability theory.

Topics Covered

Unit 1 Frobenius method of series solution, Legendre polynomials and their properties, Chebychev polynomials.

Unit 2 Fourier transform and its applications to solution of differential equations. Hankel transformation and its applications.

Unit 3 Solution of boundary value problem by Greens function method. Optimization: Formulation of linear programming problem, solution by graphic and simplex methods, Duality.

Unit 4 Probability, sample space, events. Solution of simple problems using laws of Probability. Conditional Probability. Dependent and Independent events. Addition and Multiplication theorems of Probability. Repeated trials, Random variables, Binomial, Normal and other distributions.

Text Books and/or Reference Materials

1. **R. K. Jain, S.R.K. Iyenger**- Advanced Engineering Mathematics, Narosa Publishing House.
2. **E. Kreyszig** – Advanced Engineering Mathematics, John Wiley and Sons, Inc.
3. **S. S. Rao** – Optimization Theory and Applications, Wiley Eastern, New Delhi.
4. **P. L. Meyer** – Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. Pvt. Ltd.
5. **H. T. H. Piaggio**, An Elementary Treatise on Different Equations and their Applications, CBS Publishers.
6. **M. K. Venkataraman** – Higher Mathematics, National Publishing Company.

Semester III

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE711	Spillways and Energy Dissipators	DC	-	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 2 Hour

Course Objective

This course is aimed to introduce the students the basic design principles and safety criteria involved in the design of various hydraulic structures such as spillways, intake structures and different types of gates used for regulating the flood discharge as well as selection of their feasible location with respect to the hydraulic structure.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Gain the in-depth knowledge on various types of spillways in dams and their basic design principles.
2. Plan and design the most widely used spillways.
3. Plan and design efficient energy dissipaters for the safety of the hydraulic structures.
4. Understand the basic concepts of application for intake works and gates for the efficient regulation of flow in hydraulic structures.

Topics Covered

Unit 1 Spillways: Introduction, Ogee spillway, Side channel spillway, Chute spillway, Shaft spillway, Siphon spillway, volute siphon and saddle siphon, Location of spillway, Design principles of spillways.

Unit 2 Design of Ogee and syphon spillway.

Unit 3 Energy Dissipaters: Energy dissipation below overflow spillways, Hydraulic jump, Jump height curve and Tail water curve, Stilling basins, Chute blocks, Sills and dented sills, Baffle piers, U.S.B.R. Basins. Design of roller bucket type energy dissipaters.

Unit 4 Intake works and Gates: Introduction, Sluiceways or dam outlet, Hydraulics of outlet works, River intakes: Simple submerged intakes, Intake towers, wet intake and dry intake, Trash Racks. Dropping shutters, stop logs and needles, Vertical lift gates, Radial or Tainter gates, Drum gate, Intake gates and valve.

Text Books and/or Reference Materials

1. **R S Varshney, S C Gupta and R L Gupta,** Theory and Design of Irrigation Structures Vol. I & II, Nem Chand and Brothers, Roorkee.
2. **B C Punmia, Ashok K Jain and Arun K Jain,** Irrigation and Water Power Engineering,
3. **S K Garg**, Irrigation Engineering and Hydraulic structures, Khanna Publishers, Delhi.

Additional Learning Source

1. J. Nemec, "Engineering Hydrology", Mc Graw-Hill, N.Y
2. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE780H	General Seminar	DC	B-Tech Civil	Theory	4	3	1	0	4

Course Assessment Method

1. Sessional (60%)
2. End Semester Examination (40%)- 3 Hour

Course Objective

The objective of this course is to expose students to an elaborated academic topic related to water resources engineering domain. The course also prepares students to develop technical report writing and presentation skills.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Select a topic relevant to planning, analysis and operation of hydraulic and water resources systems.
2. Take up minor research activities independently for enhancing subject knowledge.
3. Critically review the academic literature and resources.
4. Master the art of technical report writing as well as presentation skills.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE781H	Preliminary Dissertation Seminar	DC	B-Tech Civil	Theory	4	3	1	0	4

Course Assessment Method

1. Sessional (60%)
2. End Semester Examination (40%)- 3 Hour

Course Objective

This course is aimed to develop skills to access, collect, review academic resources and to take initiatives with regards to planning and execution of the intended research work. The course also intends to develop technical report writing and presentation skills.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Formulate research problems leading to innovative findings by conducting experimental and analytical investigations.
2. Develop the capability to critically and systematically integrate knowledge.
3. Access academic resources and conduct research both independently and collectively.
4. Clearly present the research findings and discuss the conclusions and arguments that form the basis for these findings in excellent academic format.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE791H	Lab/Project	DC	B-Tech Civil	Theory	4	3	1	0	4

Course Assessment Method

1. Sessional (60%)
2. End Semester Examination (40%)- 3 Hour

Course Objective

The object of this course is to expose students to a topic related experimental or design or software based analysis as well as to improve technical knowledge and state-of-the art practice related to the chosen topic. The course also intends to develop technical report writing and presentation skills.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Conduct and analyse practical problems and to formulate analytical and experimental research leading to innovative solutions.
2. Develop confidence to take up experimental activities independently for critically and systematically integrate the subject knowledge.
3. Critically review the academic literature and resources.
4. Develop acumen for higher education and research and master the art of report writing and presentation skills.

Semester IV

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE782H	Final Dissertation Seminar	DC	B-Tech Civil	Theory	4	3	1	0	4

Course Assessment Method

1. Sessional (60%)
2. End Semester Examination (40%)- 3 Hour

Course Objective

This course is aimed to expose students to a detailed academic problem related any one of the following components viz. design of various hydraulic structures, water supply distribution systems, planning designing and scheduling of efficient irrigation systems and management of watershed resources etc. The course also prepares students to develop technical report writing and presentation skills.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Analyse experimental and analytical design problems and learn the methods to formulate research methodologies leading to innovative solutions.
2. Develop confidence to take up research activities independently for critically and systematically integrate the subject knowledge.
3. Critically review the academic literature and resources.
4. Develop acumen for higher education and research and master the art of report writing, presentation and research paper writing skills.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE798H	Dissertation	DC	B-Tech Civil	Theory	4	3	1	0	4

Course Assessment Method

1. Sessional (60%)
2. End Semester Examination (40%)- 3 Hour

Course Objective

This course is aimed to enable the student to develop in-depth subject understanding and capabilities to take initiatives with regards to planning and execution of the intended research work. The course also intends to develop technical report writing and presentation skills.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Demonstrate in-depth knowledge of the major field of study, including deeper insight into current research and development work.
2. Use a holistic view to critically, independently and creatively identify, formulate and execute the framed methodology while utilizing statistical as well stochastic tools to analyze collected data.
3. Systematically integrate knowledge and conduct laboratory experiments to address the given problem.
4. Clearly present the research findings and discuss the conclusions and arguments that form the basis for these findings in excellent academic format.

List of Electives

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE601	Higher Numerical Analysis	DE		Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

Students will be able to apply the numerical methods in the analysis/ designing of Structures using tools like MATLAB and Microsoft Excel

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Be aware of the mathematical background for the different numerical methods introduced in the course.
2. Understand the different numerical methods to solve for the roots of the algebraic equations and to solve system of linear and non-linear equations.
3. Understand the different numerical methods for interpolation, differentiation, integration and solving set of ordinary and partial differential equations.
4. Use the built in functions in MATLAB and MS Excel.

Topics Covered

Unit 1 Types of errors, General formula for errors, order of approximation Non linear equations: Classification of Methods, Approximate values of roots, Bisection Method, Regula Falsi Method, Newton Raphson Method, Fixed Point iteration, Mullers Method. Use built in functions in MATLAB software to solve problems.

Unit 2 Linear Systems of Equations: Direct Method - Matrix Inversion Method, Gauss Elimination Method, Gauss Jordan Elimination Method, Cholesky Method. (ii) Iterative Methods- Jacobi Iteration Method, Gauss Seidel Method . Eigen value problem. Use built in functions in MATLAB software to solve problems .Interpolation and Approximation:, Lagrange and Newton Interpolation, Finite difference operators. Use built in functions in MATLAB software to solve problems

Unit 3 Numerical solution of Ordinary: Introduction, solution by Taylor's series, Picards method of successive approximations, Euler's method: Error estimates for the Euler method, modified Euler's method, Runge-Kutta methods, simultaneous and higher order equations using Taylor's series, Picards method of successive approximations, Euler's method, Boundary Value Problems: Finite Difference method.

Unit 4 Numerical solution of Partial Differential Equations: Introduction, Finite Difference Approximation to derivatives, Laplace's, Parabolic Equations and Hyperbolic Equation: Jacobi's method, Gauss Seidel method, Iterative methods for the solution of equations, Variational and weighted residual methods, Introduction of FEM.

Text Books and/or Reference Materials

1. Numerical Analysis: **Goel & Mittal**
2. Applied Numerical Analysis: **Gerald & Wheatley**
3. Numerical Methods for Engineers: **Chapra & Canale**
4. Introductory Methods of Numerical Analysis**: Sastry**

6. Numerical Methods: Jain and Jain
Additional Learning Source
1. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE661	Flow through Porous Media	DC	CE 219, CE-316	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 2 Hour

Course Objective

The objective of this course is to have an understanding of flow through porous media, well hydraulics and to build up technical competence for artificial recharge of ground water.

Course Outcomes

After the successful completion of the course, a student is expected to

1. Develop a conceptual model of fluid flow through porous media and its application.
2. Understand the principles of well hydraulics and estimate the yield of a well.
3. Understand the characteristics of aquifers, impact of sea water intrusion in coastal aquifers and apply suitable measures for its control.
4. Apply the knowledge of artificial recharge to combat the progressive lowering of ground water table.

Topics Covered

Unit 1 Basic concepts of flow through porous media, Darcys equation, Kozney-Carmon equation and its applications, Fracture flow, Flow through layered system.

Unit 2 Steady and unsteady radial flow into a well penetrating confined and unconfined aquifers, Theis method, Cooper-Jacob method, Chow Method.

Unit 3 Leaky artesian aquifers, Partially penetrating wells, Characteristics of well losses, Method of images, Sea water intrusion in coastal aquifers, control of seawater intrusion.

Unit 4 Concept of Artificial recharge, Recharge methods, Waste water recharge, Recharge mounds, Induced recharge, Artificial recharge for energy purposes.

Text Books and/or Reference Materials

1. **H. M. Raghunath,** Ground Water, Third Edition, New Age.
2. **C S P Ojha, R Berndtsson, P Bhunya,** Engineering Hydrology, Oxford University Press.
3. **Davied Keith Todd**, Ground Water Hydrology, Second Edition, John Wiley & Sons, Singapore.
4. **B. I. Derekand Ioan,**Transport phenomena in porous media, Elsevier.
5. **KambizVafai,** Handbook of Porous Media, Third Edition, CRC Press.

Additional Learning Source

1. Web links to e-learning:*nptel*
2. Web based learning, Journal papers, etc.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE662	Water Resources Engineering	DC	CE 219	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 2 Hour

Course Objective

The objective of this course is to have an understanding of planning and management of water resources project, economic analysis of water resources project and knowledge of flood damage mitigation.

Course Outcomes

After the successful completion of the course, a student is expected to

1. Develop an understanding of planning and management of water resources project,
2. Understand the engineering economic analysis of water resources project,
3. Mitigate floods damage using structural and non-structural measures
4. Apply the theoretical and mathematical knowledge for management of the river basin system.

Topics Covered

Unit 1 Objectives & Planning of water resources developments, Levels of planning, Project formulation and Evaluation, Environmental considerations, Functional requirements in Multiple-purpose projects.

Unit 2 Engineering economy in water resources planning, Annual cost comparisons, Selection of an interest rate for an economy study, Economic design of hydraulic structures.

Unit 3 Flood damage mitigation, Design floods, Flood mitigation reservoirs, Design of levees and flood walls, Flood ways, Channel improvement, Evacuation and flood proofing.

Unit 4 Simplified river-basin system, Conventional planning process, Simulation analysis, Mathematical models.

Text Books and/or Reference Materials

1. **Linsley and Franzini**, Water resource Engineering, Mc Graw-Hill
2. **L.D. James and R.R Lee**, Economics of Water Resources Planning, McGraw-Hill New York.
3. **Loucks, D.P., J.R. Stedinger D.A., Haith**: Water Resources sytems, Planning and Analysis, Prentice Hall.
4. **Biwaswas A.K**. Systems Approach to Water Management, McGraw Hill, Kogakusha Ltd..

Additional Learning Source

1. Web links to e-learning:*nptel*
2. Web based learning, Journal papers, etc.

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	CE664	Hydrogeology and Ground Water Modelling	DE	CE-219	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments and Quizzes (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 3 Hour

Course Objective

1. To develop the concept of quantifying present groundwater resources as well as to evaluate its temporal variation.
2. To develop the concept of analyzing confined aquifers in one dimensional steady flow for various cases.
3. To develop the concept and planning of wells system and analysis of confined and unconfined aquifers for various cases such as steady, unsteady cases etc.
4. To train the students in ground water modelling as well as ground water basin investigations, data collection and field works etc.

Course Outcomes

Upon successful completion of this course, it is expected that students will be able to:

1. Understand the significance of ground water resources as well as the methods for its estimation., and to apply the knowledge in ground water resources projects.
2. Understand the concepts of aquifers in various conditions and to estimate the ground water potential.
3. Understand the Steady/ unsteady, uniform radial flow to a well in a confined, unconfined and leaky aquifer as well as to estimate well flow near aquifer boundaries for special conditions such as partially penetrating horizontal wells & multiple well systems.
4. Develop Ground water modelling through porous media as well as Ground water basin management. They should have concept of Data collection ,field work,& management potential

Topics Covered

Unit 1 Ground water utilization & historical background, Ground water in hydrologic cycle, ground water budget, Ground water level fluctuations & environmental influence, literature data, internet resources, Ground water flow rates & flow directions, general flow equations through porous media.

Unit 2 Aquifers and their characteristics/classification, confined homogeneous and heterogeneous aquifers, Confined one dimensional steady state flow in aquifer. Confined one dimensional flow in Aquifer with varying thickness. Aquifers with and without infiltration, Confined non-leaky Aquifers, Sudden change at the boundary etc.

Unit 3 Steady/ unsteady, uniform radial flow to a well in a confined, unconfined and leaky aquifer, Well flow near aquifer boundaries for special conditions, partially penetrating horizontal wells & multiple well systems, well completion, development, protection and testing for yield. Pumping tests.

Unit 4 Ground water modelling through porous media, Ground water basin management concept, Hydrologic equilibrium equation, Ground water basin investigations, Data collection & field work, Dynamic equilibrium in natural aquifers, management potential & safe yield of aquifers, Stream-aquifer interaction. Three step modelling concept. Time series modelling etc.

Text Books and/or Reference Materials

1. **K. Subramanya**, “Engineering Hydrology”, TMH, New Delhi, India.
2. **Chow V.T,** “Hand book of Applied Hydrology”, Mc Graw-Hill, N.Y., USA.
3. **D. K Todd**, “Groundwater Hydrology”, John Wiley, N.Y., India..
4. **K. R. Karanth**, "Hydrogeology", TataMcGraw Hill Publishing Company.
5. **S. Ramakrishnan**, "Ground water", S. Ramakrishnan

Additional Learning Source

2. **J. Nemec**, “Engineering Hydrology”, Mc Graw-Hill, N.Y
3. Web links to e-learning**: *nptel***

Department	Course No.	Course Title	Course Designation	Pre-Requisites	Course Type	Credit Hours	Contact Hours			Total Contact Hours
							L	T	P	
Civil Engineering	AM612	Computational fluid dynamics	OE	-	Theory	4	3	1	0	4

Course Assessment Method

1. Assignments (15%)
2. Mid-Semester Examination (25%)- 1 Hour
3. End Semester Examination (60%)- 2 Hour

Course Objective

To study the tools of complex analysis, solution of boundary value problems, numerical techniques to solve equations, ordinary differential and partial differential equations.

Course Outcomes

After completing the course the students are expected to be able to

1. Apply the knowledge of complex analysis in ideal fluid flow problems.
2. Solve set of linear and non linear algebraic and differential equations using various numerical techniques.
3. Apply concept of Galerkin and Rayleigh method to formulate finite element problems in fluid flow.
4. Apply solution techniques of partial differential equations related to fluid flow problems.

Topics Covered

Unit 1 Complex Analysis: Equipotential curves and streamlines and their orthogonality, Complex potential, Potential flow, Singularities of potential functions and their types, Sources and sinks, lmage system to form the complex potential, Doublets, Complex integration, Laurentz Series, Residue Theorem and its applications.

Unit 2 Revision of Numerical Solution of system of non-linear equations by Newton-Raphson and general iterative methods. Numerical solution of a system of differential equations: Runge- Kutta methods of order two and four.

Unit 3 Solution of Boundary value problems: Weighted residual methods, Collocation, Galerkin and Rayleigh-Ritz methods, concept of finite element methods.

Unit 4 Numerical solution of partial differential equations: Parabolic equations Schmidt and Crank-Nicholson Schemes, Elliptic equations Five point scheme, Hyperbolic equations-Explicit and implicit schemes

Text Books and/or Reference Materials

1. **E. Kreyszig**, Advanced Engineering Mathematics John Wiley & Sons, Inc.
2. **M. K. Jain, S. R. K.lyengar, R. K. Jain**, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd Publishers. .
3. **W. H. Besant and A. S. Ramsey**, A Treatise on Hydrodynamicsa P.
4. **M. K.Venkataraman**, Numerical Methods, National Publishing Company.
5. **J. N. Reddy**, Finite Element Method, McGraw Hill Publishing.

Additional Learning Source

1. Web links to e-learning:*nptel*
2. Web based learning, Journal papers, etc.