CIVIL ENGINEERING

Course Structure and Syllabi for Pre Ph.D Programme

SUBJECT – 1

S.No	Course Code	Title of the Course
1	26CMEC0TT	Research Methodology for Engineers

SUBJECT – 2

S.No	Course Code	Title of the Course
1	26CEEE0NT	Research and Publication Ethics for Engineers

CORE SUBJECTS

Choose any **Two** subjects from the following list

S.No.	Course Code	Title of the Course
1	24CCIV01T	Advanced Concrete Technology
2	24CCIV02T	Watershed Management
3	24CCIV03T	Ground Improvement Techniques
4	24CCIV04T	Highway Infrastructure Design
5	24CCIV05T	Environmental Engineering
6	24CCIV06T	Advanced Foundation Engineering
7	24CCIV07T	Transportation Planning
8	24CCIV08T	Advanced Structural Design
9	24CCIV09T	Artificial Neural Networks and Fuzzy Logic
10	24CCIV10T	Engineering Hydrology
11	24CCIV11T	Ground Water Management & Modelling
12	24CCIV12T	Sustainable Construction Methods
13	24CCIV13T	Rehabilitation and Retrofitting of Structures
14	24CCIV14T	Finite Element Methods
15	24CCIV15T	Structural Dynamics
16	24CCIV16T	Environmental Impact Assessment

Title of the Course	**:**	Advanced Concrete Technology
Course Code	**:**	24CCIV01T
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of chemical admixtures used in concrete, including their mechanisms of action, properties, applications, and effects on fresh and hardened concrete.
2. To develop an understanding of construction chemicals used for curing, surface hardening, dust control, bonding, and waterproofing to improve concrete performance and serviceability.
3. To impart knowledge of various non-destructive testing (NDT) methods for assessing the strength, quality, integrity, and condition of concrete structures.
4. To analyze the durability of concrete under aggressive environmental conditions, including high temperatures, freeze–thaw cycles, chemical attacks, carbonation, and chloride penetration.
5. To develop expertise in concrete mix design using ACI, DOE, and Indian Standard methods, including the proportioning of pumpable concrete for specific performance requirements.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Analyze the mechanisms, properties, and applications of chemical admixtures, including superplasticizers, retarders, accelerators, air-entraining agents, and other specialized admixtures, for improving concrete performance.
2. Evaluate the selection and application of construction chemicals for curing, floor hardening, dust-proofing, plaster bonding, and waterproofing in concrete structures.
3. Apply and critically evaluate appropriate non-destructive testing methods to assess concrete strength, uniformity, defects, and structural integrity.
4. Analyze the deterioration mechanisms of concrete exposed to thermal, physical, and chemical environments and recommend suitable durability enhancement and surface treatment strategies.
5. Design and optimize concrete mixes using ACI, DOE, and Indian Standard methods, including pumpable concrete, based on specified strength, workability, durability, and performance requirements.

Unit 1 Admixtures **10**

Plasticizers, Action of Plasticizers, Super Plasticizers, Mechanism of Super Plasticizers, Infrared Spectrograph, New Generation Super Plasticizers, Acrylic carboxylates Ester, Multi carboxylate Ether, Retarders, Accelerators, Air Entraining Admixtures, Damp Proofing Admixtures, Waterproofing Admixtures, Gas Forming Agents, Grouting Agents, Shrinkage Reducing Admixtures, Damp Proofers

Unit 2 Construction Chemicals **9**

Membrane Forming Curing Compounds, Floor Hardeners, Dust Proofers, Bond Aid for Plastering, Construction Chemicals for Waterproofing

Unit 3 Non-Destructive Testing (NDT) Methods 10

Schmidt's Rebound Hammer Test, Pull-Out Test, Resonant Frequency Method, Pulse Velocity Method, Radioactive Method, Nuclear Method, Magnetic Method, Electrical Method.

Unit 4 Durability of Concrete 9

Concrete Subjected to High Temperature, Freezing and Thawing, Deicing Effect of Salts, Sulphate Attack, Alkali-Aggregate Reaction, Acid Attack, Concrete in Sea Water, Carbonation, Chloride Attack, Surface treatment of Concrete

Unit 5 Mix Design of Concrete 10

American Concrete Institute (ACI) Method, Department of Environment (DOE) Method, Indian Standard (IS) Method, Mix Design for Pumpable Concrete

Prescribed Textbook:

1. Concrete Technology by M.S. Shetty, 2004, S. Chand and Company.

Reference Books:

1. Concrete Technology by Gambhir, Tata Mc Graw Hill Publishers, New Delhi
2. Concrete Technology by A.R. Santhakumar, 2018, Oxford University Press
3. Non-Destructive Testing and Evaluation of Materials by J. Prasad and C.G. Nair, 2008, McGraw Hill Education
4. Advanced Concrete Technology: Testing and Quality by John Newman and B.S. Choo, 2003, Butterworth-Heinemann.

Relevant Codes and Standards

1. IS 10262:2019, Concrete Mix Proportioning — Guidelines, Bureau of Indian Standards, New Delhi.
2. IS 456:2000, Plain and Reinforced Concrete — Code of Practice, Bureau of Indian Standards, New Delhi.

Title of the Course	**:**	**WATERSHED MANAGEMENT**
Course Code	**:**	**24CCIV02T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of watershed management concepts, stakeholder participation, management policies, strategic planning, water quality protection, and sustainable water recycling and reuse.
2. To develop an understanding of watershed morphometry, soil erosion processes, erosion modelling, sediment yield, sedimentation, and wetland water budgets.
3. To impart knowledge of surface water flow, groundwater–surface water interactions, wetland hydrology, water quality processes, and transport models for evaluating watershed and wetland systems.
4. To analyze wetland hydrological, hydraulic, physical, and biological processes, assess the impacts of anthropogenic activities and climate change, and understand watershed modelling and water harvesting systems.
5. To develop expertise in irrigation water management, conjunctive use of water resources, participatory irrigation management, integrated water resources management (IWRM), drought management, and crop water footprint assessment.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Critically evaluate watershed management strategies, policies, stakeholder roles, water quality guidelines, and sustainable water recycling and reuse practices.
2. Analyze watershed morphometric characteristics, soil erosion and erodibility, sediment yield, sedimentation processes, and wetland water budgets using appropriate assessment and modelling techniques.
3. Apply surface water flow principles, wetland hydrology concepts, water quality assessment techniques, and transport models to investigate flow, mixing, and contaminant movement in aquatic systems.
4. Develop and evaluate wetland hydrological and hydraulic models, assess the effects of climate change and human activities, and recommend suitable watershed development, rainwater harvesting, and wetland treatment strategies.
5. Formulate integrated water management strategies involving irrigation planning, conjunctive use, participatory irrigation management, drought mitigation, and blue, green, and grey water footprint assessment.

Unit I Watershed Management 10

Introduction and Concepts of Watershed Management, Different Stakeholders and Their Relative Importance, Watershed Management Policies and Decision Making, Watershed Management Practices in Arid and Semiarid Regions, Short Term and Long Term Strategic Planning, Types and Sources of Pollution, Environmental Guidelines for Water Quality, Perspective on Recycle and Reuse

Unit II Morphometry **9**

Soil Erosion - Erosion - Factors Affecting Erosion, Effects of Erosion on Land Fertility and Land Capability, Soil Erosion Modelling, Erosivity and Erodibility - Sediment Yield and Sedimentation- Wetland Definitions and The Role of Water in Wetland Structure and Function, Introduction to Wetland Water Budgets and Hydro-Period Components of The Water Budget: Inflows, Outflows, and Storage, Precipitation and Runoff, Evapotranspiration;

Unit III Surface Water Flow **10**

Structures and Channels, Groundwater-Surface Water Exchange in Wetlands, Surface Water Flows lines and Wetland Hydrology Case Studies, Flow and Mixing in Wetlands Wetland Water Quality Information: Nutrients, Organic/Inorganic Contaminants, Sediments and Colloids, Wetland Transport Models-Plug Flow, Cstrs and Cstrs in Series; Intro to Method of Moments.

Unit IV Wet land Hydrology **9**

Physical and Biological Processes, Anthropogenic and Climate Change Impacts on Wetland Hydrology, Modeling Wetland Hydrology, Hydraulics, and Hydrodynamics, Introduction to Wet land Treatment Systems Design - Water Harvesting: Rainwater Harvesting, Catchment Harvesting, Harvesting Structures - Model Watershed – Government and Ngo Projects.

Unit V Rain Water Management **10**

Planning and Operation of Irrigation Systems. Conjunctive Use of Water. Participatory Irrigation Management and Integrated Water Resources Management (IWRM), Water Management Policy During Droughts, Effect of Water Shortage on Crops, Introduction to Water Footprint of Crops and Its Applications. Blue, Green and Grey Water Foot Print.

Prescribed Textbook:

1. J. V. S. Murty, Watershed Management, New Age International, 2013.

Reference Books:

1. Watershed Management by Madan Mohan Das and M.D. Saikia, Prentice Hall of India, 2013.
2. Watershed Hydrology by Peter E. Black, 1996, Prentice Hall.
3. Hydrology and the Management of Watersheds by Kenneth N. Brooks, Peter F. Ffolliott, Hans M. Gregersen, and Leonard F. DeBano, 1997, Iowa State University Press.
4. Hydrology: An Introduction by Wilfried Brutsaert, 2005, Cambridge University Press.
5. Water Resources Engineering by Larry W. Mays, 2011, John Wiley & Sons.

Title of the Course	**:**	**GROUND IMPROVEMENT TECHNIQUES**
Course Code	**:**	**24CCIV03T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of the engineering behaviour of expansive soils, methods of identification, swell pressure determination, soil improvement techniques, and foundation solutions for problematic soils.
2. To develop an understanding of dewatering and grouting techniques, including their principles, methods, applications, and suitability for different ground conditions.
3. To impart knowledge of in-situ densification and consolidation techniques for granular and cohesive soils to improve bearing capacity, reduce settlement, and enhance ground stability.
4. To analyze various soil stabilization methods, including mechanical, cement, lime, bituminous, and chemical stabilization, for improving the geotechnical properties of soils.
5. To develop expertise in the principles, design, and applications of reinforced earth structures and geosynthetics, including geotextiles, geogrids, and geomembranes, for sustainable geotechnical engineering applications.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Evaluate the engineering behaviour and swelling characteristics of expansive soils, interpret identification and swell pressure tests, and recommend suitable soil improvement and foundation techniques.
2. Analyze and select appropriate dewatering and grouting methods based on subsurface conditions, groundwater control requirements, grout properties, and project constraints.
3. Assess and compare in-situ densification and consolidation techniques for granular and cohesive soils to improve strength, bearing capacity, and settlement performance.
4. Evaluate mechanical, cementitious, lime, bituminous, and chemical stabilization methods based on soil properties, engineering performance, and environmental considerations.
5. Apply the principles of reinforced earth design and evaluate the functions, properties, and applications of geosynthetics in retaining structures, soil reinforcement, drainage, filtration, and containment systems.

UNIT I Expansive Soils **10**

Problems of Expansive Soils, Tests for Identification, Methods of Determination of Swell Pressure. Improvement of Expansive Soils, Foundation Techniques in Expansive Soils, Under Reamed Piles.

UNIT II Dewatering & Grouting **12**

Methods of De-Watering Sumps and Interceptor Ditches Single, Multi Stage Well Points, Vacuum Well Points, Horizontal Wells, Foundation Drains, Blanket Drains, Criteria for Selection of Fill Material Around Drains, Electro-Osmosis.

Objectives of Grouting- Grouts and Their Properties, Grouting Methods- Ascending, Descending and Stage Grouting, Hydraulic Fracturing in Soils and Rocks, Post Grout Test

UNIT III Densification Methods in Granular and Cohesive Soils 10

In – Situ Densification Methods in Granular Soils, Vibration at the Ground Surface, Impact at the Ground Surface, Vibration at Depth, Impact at Depth.

In – Situ Densification Methods in Cohesive Soils, Preloading or Dewatering, Vertical Drains, Sand Drains, Sand Wick Giordanis – Stone and Lime Columns, Thermal.

UNIT IV Stabilization 8

Methods of Stabilization, Mechanical, Cement, Lime, Bituminous, Chemical Stabilization with Calcium Chloride, Sodium Silicate and Gypsum.

UNIT V Reinforced Earth 10

Principles, Components, Factors Governing Design of Reinforced Earth Walls, Design Principles of Reinforced Earth Walls. Geotextiles - Types, Functions and Applications, Geogrids and Geo Membranes – Functions and Applications

Prescribed books

1. Ground Improvement Techniques, Dr. P. Purushotham Raj. Laxmi Publications, New Delhi University science press, New Delhi 3rd edition 2023.

Reference Textbooks

1. Engineering Principles of Ground Modification, Hausmann M.R. (1990), McGraw-Hill International Edition.
2. Ground Improvement Techniques by Nihar Ranjan Patra, 2012, Vikas Publishing House.
3. Principles of Geotechnical Engineering by Braja M. Das and Nagaratnam Sivakugan, 2019, Cengage Learning.
4. Ground Improvement by M.P. Moseley and K. Kirsch, 2004, Spon Press, 2nd Edition.

Title of the Course	**:**	**HIGHWAY INFRASTRUCTURE DESIGN**
Course Code	**:**	**24CCIV04T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of highway geometric design, including sight distance, horizontal curves, superelevation, pavement widening, transition curves, and curve resistance, for safe and efficient highway development.
2. To develop an understanding of vertical alignment design, including gradients, summit curves, and valley curves, considering sight distance, safety, comfort, and terrain conditions.
3. To impart knowledge of traffic regulation and control systems, including traffic signs, signals, road markings, one-way streets, and traffic islands, for effective traffic management and road safety.
4. To analyze the structural behaviour and design principles of flexible pavements using wheel loads, load repetitions, stress distribution, deflection analysis, CBR methods, and relevant Indian Roads Congress (IRC) guidelines.
5. To develop expertise in rigid pavement design, including wheel-load, temperature, warping, and frictional stresses, joint design, and the design of dowel bars and tie bars in accordance with applicable IRC guidelines.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Analyze and design highway horizontal alignment elements, including stopping and overtaking sight distances, horizontal curves, superelevation, transition curves, pavement widening, and setback distances, in accordance with applicable standards.
2. Design and evaluate vertical highway alignments, including gradients, summit curves, and valley curves, considering geometric requirements, safety, and operational efficiency.
3. Evaluate traffic regulation and control measures and recommend appropriate traffic signs, signals, road markings, one-way street arrangements, and traffic islands to improve traffic operations and road safety.
4. Analyze wheel-load effects, stress distribution, and deflection in flexible pavements and design pavement layers using the CBR method and applicable IRC guidelines.
5. Evaluate wheel-load, temperature, warping, and frictional stresses in rigid pavements and design concrete pavements, joints, dowel bars, and tie bars using applicable IRC standards.

UNIT I Highway Geometric Design (Horizontal Alignment) 10

Stopping Sight Distance (SSD), Overtaking Sight Distance (OSD), Design of Horizontal Alignment, Horizontal Curves, Super Elevation, Radius of Horizontal Curves, Widening of Pavement on Horizontal Curves, Transition Curves, Set Back Distance on Horizontal Curves,
Curve Resistance

UNIT II Vertical Alignment **8**

Design of Vertical Alignment, Vertical Curves, Types of Gradients, Summit Curves, Valley Curves

UNIT III Traffic Regulation and Control **8**

Traffic Regulations, One-Way Streets, Traffic Signs, Traffic Signals, Road Markings, Traffic Islands

UNIT IV Design of Flexible Pavements **9**

Magnitude of Wheel Loads, Wheel Load Repetitions, Stresses in Flexible Pavements, Vertical Stress Distribution in Homogeneous Mass, Vertical Deflection in Homogeneous Mass, CBR Method for Flexible Pavement Design, IRC Guidelines for Flexible Pavement Design

UNIT V Design of Rigid Pavements **10**

Types of Joints, Stresses in Rigid Pavements Due to Wheel Loads, Temperature Stresses, Warping Stresses, Frictional Stresses, Design of Rigid Pavements, IRC Guidelines, Design of Dowel Bars, Design of Tie Bars

Prescribed books

1. Highway Engineering by C.E.G. Justo, S.K. Khanna, and A. Veeraragavan, 2014, Nem Chand & Bros., Roorkee, 10th Edition.

Reference Textbooks

1. Fundamentals of Transportation Engineering by Papa Costas C.S., Prentice Hall, India.
2. Principles of Highway Engineering and Traffic Analysis by Fred L. Mannering, Scott S. Washburn, and Walter P. Kilareski, 2009, John Wiley & Sons, 4th Edition.
3. Traffic Engineering and Transportation Planning by L.R. Kadiyali, 2013, Khanna Publishers, 9th Edition.

Relevant Codes and Standards

1. IRC:73, Geometric Design Standards for Rural (Non-Urban) Highways, Indian Roads Congress.
2. IRC:37, Guidelines for the Design of Flexible Pavements, Indian Roads Congress.
3. IRC:58, Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, Indian Roads Congress.
4. IRC:6, Standard Specifications and Code of Practice for Road Bridges, Section II — Loads and Stresses, Indian Roads Congress.
5. IRC:81, Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique, Indian Roads Congress.

Title of the Course	**:**	**ENVIRONMENTAL ENGINEERING**
Course Code	**:**	**24CCIV05T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of water supply engineering, water demand estimation, water quality standards, and conventional and advanced water treatment technologies for ensuring safe drinking water.
2. To develop an understanding of wastewater engineering, including wastewater characteristics, sewage collection, treatment processes, sludge management, and wastewater reuse.
3. To impart knowledge of air pollution sources, pollutant characteristics, environmental and health impacts, air quality standards, monitoring techniques, and emission control technologies.
4. To analyze solid waste generation, characterization, collection, transportation, processing, recycling, composting, waste-to-energy conversion, and sanitary landfill management.
5. To develop expertise in advanced environmental management practices, including industrial and hazardous waste management, biomedical waste management, environmental impact assessment, pollution prevention, resource recovery, and emerging sustainable technologies.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Analyze water demand, water quality parameters, and drinking water standards, and evaluate conventional and advanced water treatment technologies for different water sources.
2. Evaluate domestic and industrial wastewater characteristics, design and assess wastewater collection and treatment systems, and recommend appropriate sludge management and wastewater reuse strategies.
3. Assess air pollution sources, pollutant concentrations, environmental impacts, and compliance with air quality standards, and evaluate suitable air pollution monitoring and control technologies.
4. Develop and evaluate integrated solid waste management strategies involving waste characterization, collection, processing, recycling, resource recovery, waste-to-energy conversion, and sanitary landfill management.
5. Formulate sustainable environmental management strategies for industrial, hazardous, and biomedical wastes, conduct environmental impact and monitoring assessments, and evaluate pollution prevention and emerging resource recovery technologies.

UNIT I Water Supply and Treatment **9**

Sources and quality of water. Water demand and water quality standards. Water treatment processes: coagulation, sedimentation and filtration. Disinfection and advanced water treatment methods.

UNIT II Wastewater Engineering **10**

Characteristics and standards of domestic and industrial wastewater. Collection and conveyance of sewage. Primary, secondary and tertiary treatment processes. Sludge treatment, disposal and wastewater reuse.

UNIT III Air Pollution Control **8**

Sources and types of air pollutants. Effects of air pollution on health and environment. Air quality standards and monitoring techniques. Air pollution control devices and emission control methods.

UNIT IV Solid Waste Management **10**

Sources, classification and characteristics of solid waste. Collection, transportation and processing of solid waste. Composting, recycling and waste-to-energy methods. Sanitary landfills and landfill leachate management.

UNIT V Advanced Environmental Management **10**

Industrial waste management and pollution prevention. Hazardous and biomedical waste management. Environmental impact assessment and environmental monitoring. Sustainable waste management, resource recovery and emerging technologies.

Prescribed books

1. Environmental Engineering: Water Supply Engineering by S.K. Garg, 2010, Khanna Publishers, New Delhi.
2. Environmental Engineering: Sewage Disposal and Air Pollution Engineering by S.K. Garg, 2010, Khanna Publishers, New Delhi.

Reference Textbooks

1. Elements of Environmental Engineering, K.N. Duggal, 1st Edition, S.Chand Publishers, New Delhi, 2010.
2. Environmental Engineering by Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous, 1985, McGraw-Hill.
3. 3.Wastewater Engineering: Treatment and Resource Recovery by Metcalf & Eddy, Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, and Franklin Burton, 2014, McGraw-Hill Education, 5th Edition.
4. 4.Air Pollution Control Engineering by Noel de Nevers, 1995, McGraw-Hill.

Title of the Course	**:**	**ADVANCED FOUNDATION ENGINEERING**
Course Code	**:**	**24CCIV06T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of pile foundation behaviour and ultimate load-bearing capacity using established theoretical and empirical methods.
2. To develop an understanding of pile bearing capacity evaluation using SPT, cone penetration tests, static load tests, and dynamic pile-driving formulae.
3. To analyze pile group behaviour, including group efficiency, pile spacing, load distribution, and settlement in cohesionless and cohesive soils.
4. To impart knowledge of the analysis of laterally loaded vertical and batter piles using Winkler's hypothesis, p–y curves, Broms' method, and numerical approaches.
5. To develop expertise in the load-transfer mechanisms and bearing capacity assessment of drilled piers in cohesive and cohesionless soils.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Analyze and compare ultimate load-bearing capacity of pile foundations using Tomlinson's, Meyerhof's, Vesic's, Janbu's, and Coyle and Castello's methods.
2. Evaluate pile bearing capacity using field investigation data, penetration tests, static load tests, and dynamic pile-driving formulae.
3. Assess pile group efficiency, optimum spacing, bearing capacity, and settlement under different soil conditions.
4. Formulate and apply analytical methods for evaluating laterally loaded piles using soil–pile interaction models, p–y curves, and Broms' method.
5. Evaluate load-transfer mechanisms, base resistance, and skin friction of drilled piers in cohesive and cohesionless soils for foundation design.

UNIT I Ultimate load bearing capacity **9**

Tomlinson’s solution, Meyerhof’s method, Vesic’s method, Janbu’s method, Coyle and Castello’s method

UNIT II Bearing capacity of piles **8**

SPT method, Static cone penetration method, load test, dynamic pile driving formula

UNIT III Pile Groups **10**

Number of piles in a group, spacing of piles in a group, Pile group efficiency, bearing capacity of pile groups embedded in sand and gravel, Settlement of piles groups in sand and gravels, Settlement of pile groups in cohesive soils.

UNIT IV Laterally Loaded Vertical and Batter Piles **10**

Winkler's hypothesis, Differential equation, non-dimensional solution, P–Y curves, Broms solutions, direct method.

UNIT V Drilled Piers **10**

Load transfer mechanism, bearing capacity equations for base resistance, Bearing capacity equation for base in resistance in cohesive soil and granular soil, Ultimate skin resistance in cohesive and cohesionless soils.

Prescribed books

1. Geo-Technical Engineering by V.N.S. Murthy, Marcel Decker Inc, New York.

Reference Textbooks

1. Soil Mechanics and Foundation Engineering by K R Arora, Standard Publishers and Distributors, Delhi.
2. Principles of Foundation Engineering by Braja M. Das, 2019, Cengage Learning, 9th Edition.
3. Pile Design and Construction Practice by Michael J. Tomlinson and John Woodward, 2014, CRC Press, 6th Edition.

Title of the Course	**:**	**TRANSPORTATION PLANNING**
Course Code	**:**	**24CCIV07T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of the transportation planning process, including land-use interactions, systems analysis, travel forecasting, plan evaluation, and implementation.
2. To develop an understanding of transportation surveys and data collection techniques for assessing travel patterns and transportation demand.
3. To analyze trip generation and trip distribution using statistical, regression-based, and growth-factor methods.
4. To impart knowledge of traffic assignment and modal split techniques for evaluating transportation network performance and travel behaviour.
5. To develop expertise in land-use and transportation interaction models, including Lowry derivative models and the Garin–Lowry model, for integrated urban and regional planning.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Formulate transportation planning strategies by integrating land-use patterns, travel demand forecasting, alternative evaluation, and implementation considerations.
2. Design and evaluate transportation surveys and interpret travel data for transport demand analysis and planning.
3. Apply regression analysis, category analysis, and growth-factor methods to estimate trip generation and trip distribution.
4. Evaluate traffic assignment techniques and modal split models to analyze route choice, travel behaviour, and transportation network performance.
5. Develop and assess land-use transportation models, including Lowry derivative and Garin–Lowry models, for urban and regional transport planning.

UNIT I Transport Planning Process **10**

Interdependence of land use and traffic, Systems approach to transport planning, Stages in transport planning, Forecasting, Analysis of future conditions and plan synthesis, Evaluation,
Program adoption and implementation

UNIT II Transportation Survey **9**

Home Interview Survey, Post Card Questionnaire Survey, Registration number plate Survey

UNIT III Trip Generation and Trip Distribution **9**

Multiple Linear Regression Analysis, Category Analysis, Uniform Factor Method, Average Factor Method, Fratar Method, Furness Method

UNIT IV Traffic Assignment and Modal Split **10**

All-or-Nothing Assignment, Multiple Route Assignment, Factors affecting Modal Split, Modal Split in Transport Planning Process

UNIT V Land Use Transport Models **10**

Selection of Land Use Transport Model, Lowry Derivative Models, Garin–Lowry Model

Prescribed books

1. Traffic Engineering and Transportation planning by L.R.Kadiyali, Khanna Publishers, Delhi.

Reference Textbooks

1. Introduction to Transportation Planning by Michael D. Meyer and Eric J. Miller, 2001, McGraw-Hill.
2. Urban Transportation Planning: A Decision-Oriented Approach by Michael D. Meyer and Eric J. Miller, 2001, McGraw-Hill, 2nd Edition.
3. Modelling Transport by Juan de Dios Ortúzar and Luis G. Willumsen, 2011, John Wiley & Sons, 4th Edition.

Title of the Course	**:**	ADVANCED STRUCTURAL DESIGN
Course Code	**:**	**24CCIV08T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To develop advanced knowledge of short-term deflection analysis of reinforced concrete beams using IS, British, Eurocode, and ACI procedures.
2. To analyze crack formation, crack-width estimation, shrinkage and thermal cracking, and the design and detailing of deep beams.
3. To impart knowledge of one-way and punching shear in flat slabs, including moment transfer, torsional effects, shear reinforcement, and the influence of openings.
4. To develop an understanding of the design of plain concrete walls under axial and lateral loads, considering slenderness, eccentricity, and detailing requirements.
5. To develop expertise in the classification, analysis, and design of reinforced concrete shear walls for resisting lateral loads and improving structural stability.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Calculate and critically compare short-term deflections of reinforced concrete beams using relevant Indian and international design standards.
2. Evaluate crack widths and design deep beams by applying appropriate analytical procedures, strength checks, and detailing requirements.
3. Analyze one-way and two-way shear in flat slabs and design suitable shear reinforcement and moment-transfer provisions.
4. Analyze and design plain concrete walls subjected to axial loads, eccentricities, slenderness effects, and in-plane horizontal forces.
5. Evaluate lateral-load behaviour and design reinforced concrete shear walls in accordance with applicable structural design codes.

UNIT I Deflection of Reinforced Concrete Beams **10**

Introduction -Short-Term Deflection of Beams -Deflection Due To -Imposed Loads- Short Term Deflection of Beams Due to Applied Loads- Calculation of Deflection By IS 456 - Calculation Of Deflection by BS 8110 - Deflection Calculation by Eurocode – ACI Simplified Method - Deflection of Continuous Beams by IS 456 - Deflection of Cantilevers.

UNIT II Crack Width and Deep Beams **12**

Introduction - Factors Affecting Crack Width in Beams - Mechanism of Flexural Cracking Calculation of Crack Widths - Simple Empirical Method - Estimation of Crack width In - Beams by IS 456 & BS 8110 - Shrinkage and Thermal Cracking.

Deep Beams: Introduction - Minimum Thickness - Steps of Designing Deep Beams - Design by IS 456 - Design According to British Practice - ACI Procedure for Design of Deep Beams – Checking for Local Failures - Detailing of Deep Beams.

UNIT III Shear in Flat Slabs **12**

Introduction - Checking for One-Way (Wide Beam) Shear - Two-Way (Punching) Shear Permissible Punching Shear - Shear Due to Unbalanced Moment (Torsional Moments) Calculation of J Values - Strengthening of Column Areas for Moment Transfer by Torsion Which Produces Shear - Shear Reinforcement Design - Effect of Openings in Flat Slabs - Recent Revisions in ACI 318 - Shear in Two – Way Slabs with Beams.

UNIT IV Design of Plain Concrete Walls **10**

Introduction - Braced and Unbraced Walls - Slenderness of Walls- Eccentricities of Vertical Loads At Right Angles to Wall - Empirical Design Method for Plane Concrete Walls Carrying Axial Load - Design of Walls for In-Plane Horizontal Forces - Rules for Detailing of Steel in Concrete Walls

UNIT V Design of Shear Walls **10**

Introduction - Classification of Shear Walls - Classification According to Behavior - Loads In Shear Walls - Design of Rectangular Shear Walls.

Prescribed books

1. Advanced Reinforced Concrete Design by P.C. Varghese, 2001, PHI Learning, 2nd Edition.

Reference Textbooks

1. Reinforced Concrete Design by S. Unnikrishna Pillai and Devdas Menon, 2017, McGraw Hill Education, 3rd Edition.
2. Reinforced Concrete: Mechanics and Design by James K. Wight and James G. MacGregor, 2012, Pearson, 6th Edition.
3. Design of Concrete Structures by Arthur H. Nilson, David Darwin, and Charles W. Dolan, 2010, McGraw-Hill, 14th Edition.
4. Reinforced Concrete Design to Eurocode 2 by Bill Mosley, John Bungey, and Ray Hulse, 2012, Palgrave Macmillan, 7th Edition.

Title of the Course	**:**	ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC
Course Code	**:**	**24CCIV09T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To introduce the fundamental concepts, architectures, activation functions, learning paradigms, and applications of artificial neural networks in civil engineering.
2. To develop an understanding of supervised and unsupervised learning algorithms, perceptrons, multilayer networks, back-propagation, and model validation.
3. To impart knowledge of fuzzy sets, membership functions, linguistic variables, fuzzy relations, and fuzzy arithmetic for handling uncertainty in engineering problems.
4. To develop expertise in fuzzy inference systems, including fuzzification, rule-based modelling, Mamdani and Sugeno methods, and defuzzification techniques.
5. To investigate hybrid intelligent systems, including ANN–fuzzy integration and ANFIS, for prediction, optimization, and decision-making in civil engineering applications.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Explain and develop artificial neural network architectures and select suitable activation functions and learning approaches for civil engineering problems.
2. Implement and evaluate neural network learning algorithms using appropriate training, validation, testing, and error-analysis procedures.
3. Formulate fuzzy sets, membership functions, fuzzy relations, and fuzzy operations to represent uncertain engineering information.
4. Develop and evaluate fuzzy inference systems using Mamdani and Sugeno approaches for engineering prediction and decision-making.
5. Develop and assess ANN, fuzzy logic, and ANFIS-based hybrid models for prediction, optimization, and decision support in structural, transportation, and environmental engineering.

UNIT I Introduction to Artificial Neural Networks **10**

Introduction to artificial intelligence and neural networks. Biological neuron and artificial neuron models. Activation functions and network architectures. Learning methods and applications in Civil Engineering.

UNIT II Neural Network Learning Algorithms **10**

Supervised and unsupervised learning.Perceptron, multilayer perceptron and back-propagation algorithm. Training, testing, validation and error analysis. Applications of ANN in prediction and modelling of engineering problems.

UNIT III Fuzzy Logic Fundamentals **9**

Introduction and principles of fuzzy logic. Fuzzy sets, membership functions and linguistic variables. Fuzzy relations and fuzzy arithmetic. Fuzzy logic operations and applications in Civil Engineering.

UNIT IV Fuzzy Inference Systems 9

Fuzzy rules and rule-based systems. Fuzzification and defuzzification techniques. Mamdani and Sugeno fuzzy inference systems. Design and development of fuzzy models for engineering applications.

UNIT V Hybrid Models and Civil Engineering Applications 10

Integration of ANN and fuzzy logic techniques. ANFIS and hybrid intelligent systems. Prediction and decision-making in structural, transportation and environmental engineering. Case studies and recent applications in Civil Engineering.

Prescribed books

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications by S. Rajasekaran and G.A. Vijayalakshmi Pai, 2003, PHI Learning.

Reference Textbooks

1. Neural Networks and Learning Machines by Simon Haykin, 2009, Pearson, 3rd Edition.
2. Fuzzy Logic with Engineering Applications by Timothy J. Ross, 2010, John Wiley & Sons, 3rd Edition.
3. Neural Networks for Pattern Recognition by Christopher M. Bishop, 1995, Oxford University Press.
4. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence by Jyh-Shing Roger Jang, Chuen-Tsai Sun, and Eiji Mizutani, 1997, Prentice Hall.

Title of the Course	**:**	ENGINEERING HYDROLOGY
Course Code	**:**	**24CCIV10T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of precipitation, evaporation, infiltration, rainfall estimation, and hydrological losses for watershed assessment.
2. To develop an understanding of unit hydrographs, S-hydrographs, groundwater flow, aquifer characteristics, and groundwater movement under steady-state conditions.
3. To analyze irrigation requirements, crop water demand, irrigation efficiencies, command areas, and water allocation for agricultural development.
4. To impart knowledge of sediment transport theories, regime channels, waterlogging mechanisms, and appropriate mitigation measures.
5. To develop expertise in diversion headworks, seepage analysis, hydraulic failure mechanisms, and canal outlet systems for water resources engineering.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Estimate basin rainfall, evaporation, and infiltration losses using appropriate hydrological methods and field measurement techniques.
2. Derive and apply unit hydrographs and S-hydrographs and analyze groundwater flow through confined and unconfined aquifers.
3. Estimate crop water requirements, irrigation duties, delta, command areas, and irrigation efficiencies for planning and managing irrigation systems.
4. Analyze sediment transport and regime channel theories and assess the causes, consequences, and mitigation of waterlogging.
5. Evaluate diversion headworks, seepage through permeable foundations, hydraulic failure mechanisms, and canal outlet performance using established engineering theories.

UNIT I Precipitation, Evaporation and Infiltration **10**

Precipitation- types and forms, types of rain gauges, computation of average rainfall over a basin, Evaporation - factors affecting evaporation, measurement of evaporation, Infiltration - factors affecting infiltration, measurement of infiltration, infiltration indices

UNIT II Unit Hydrograph and Groundwater Hydrology **10**

Unit Hydrograph, limitations of Unit hydrograph, Application of the unit hydrograph, derivation of unit hydrograph, S-hydrograph. Types of aquifers, Darcy's law, Steady radial flow to a well for confined and unconfined aquifers

UNIT III Irrigation Engineering and Water Requirements of Crops **12**

Necessity and Importance of Irrigation, advantages and ill effects of Irrigation, quality for Irrigation water, Duty and delta, relation between duty and delta. Gross command area, Culturable command area, Culturable cultivated area, Kor depth and Kor period, crop seasons and crop rotation, Irrigation efficiencies, irrigation requirements of crops

UNIT IV Silt Theories and Water Logging **10**

Silt theories, Kennedy's theory, Drawbacks in Kennedy's theory, Lacey's regime theory, Comparison of Kennedy's and Lacey's theory. Water logging, Effects of water logging, Causes of water logging, Remedial measures

UNIT V Diversion Headworks, Seepage Theories and Canal Outlets **10**

Layouts of Diversion Head Works, Causes and Failure of Hydraulic Structures on Permeable Foundations, Bligh's Creep Theory, Khosla's theory. Types of Outlets, Pipe Outlet, Kennedy's Gauge Outlet, Gibb's Module

Prescribed books

1. Engineering Hydrology by K. Subramanya, The Tata McGraw Hill Company, Delhi.

Reference Textbooks

1. Engineering Hydrology by P. Jayarami Reddy, 2011, Laxmi Publications, 3rd Edition.
2. Hydrology and Floodplain Analysis by Philip B. Bedient, Wayne C. Huber, and Baxter E. Vieux, 2013, Pearson, 5th Edition.
3. Applied Hydrology by Ven Te Chow, David R. Maidment, and Larry W. Mays, 1988, McGraw-Hill.
4. Irrigation Engineering and Hydraulic Structures by S.K. Garg, 2017, Khanna Publishers.

Title of the Course	**:**	GROUNDWATER MANAGEMENT AND MODELLING
Course Code	**:**	**24CCIV11T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of groundwater-level fluctuations and their relationships with streamflow, evapotranspiration, meteorological conditions, and tidal effects.
2. To develop an understanding of groundwater contamination sources, pollutant migration, attenuation processes, and subsurface contaminant distribution.
3. To impart knowledge of groundwater flow modelling, including conceptual model development, numerical simulation, two- and three-dimensional modelling, and MODFLOW applications.
4. To evaluate surface geophysical investigation methods, including geological mapping, remote sensing, electrical resistivity, seismic refraction, gravity, and magnetic surveys.
5. To develop expertise in subsurface groundwater investigations using test drilling, water-level monitoring, geophysical logging, resistivity logging, and radiation logging.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Analyze groundwater-level fluctuations and correlate them with hydrological, meteorological, evapotranspiration, streamflow, and tidal influences.
2. Assess groundwater pollution sources, contaminant transport, attenuation mechanisms, and spatial distribution to support groundwater protection and remediation.
3. Develop and evaluate conceptual and numerical groundwater flow models, including two- and three-dimensional simulations using MODFLOW.
4. Select and interpret suitable surface geophysical investigation techniques for groundwater exploration and aquifer characterization.
5. Plan and evaluate subsurface investigations using drilling, water-level measurements, and geophysical logging for groundwater resource assessment.

UNIT I Groundwater levels **10**

Time variation levels, Stream flow and groundwater levels, Fluctuation due to evapotranspiration Fluctuation due to meteorological phenomena, Fluctuation due to tides

UNIT II Pollution of Groundwater **8**

Sources and causes of municipal, industrial, agricultural, attenuation of groundwater, distribution of pollution under ground

UNIT III Groundwater flow modelling techniques **10**

Steps in development of groundwater model, simulation of two-dimensional groundwater system, three-dimensional groundwater flow model, MODFLOW 2000 description

UNIT IV Surface Investigations of Groundwater 10

Geologic method, Remote sensing, Electrical resistivity method, seismic refraction method, Gravity and magnetic methods.

UNIT V Subsurface Investigations of Groundwater 8

Test drilling, water level measurement, geophysical logging, resistivity logging, radiation logging

Prescribed books

1. Ground Water Hydrology by David Keith Todd and Larry W Mays, 3rd Edition, 2005, John Wiley and Sons.

Reference Textbooks

1. Applied Groundwater Modeling: Simulation of Flow and Advective Transport by Mary P. Anderson, William W. Woessner, and Randall J. Hunt, 2015, Academic Press, 2nd Edition.
2. Groundwater by H.M. Raghunath, 2007, New Age International, 3rd Edition.
3. Hydrogeology: Principles and Practice by Kevin M. Hiscock and Victor F. Bense, 2014, Wiley-Blackwell, 2nd Edition.
4. A Guide to MODFLOW by Arlen W. Harbaugh, 2005, U.S. Geological Survey.

Title of the Course : SUSTAINABLE CONSTRUCTION METHODS
Course Code : **24CCIV12T**
Course offered to : CIVIL ENGINEERING
Credits : 4

Course Objectives

1. To introduce sustainability principles, green building concepts, sustainable materials, and environmental benefits associated with energy- and resource-efficient buildings.
2. To develop an understanding of green building rating systems, sustainable construction practices, material efficiency, water conservation, and energy performance assessment.
3. To analyze sustainable building design strategies involving energy demand reduction, renewable energy integration, passive design, and efficient building systems.
4. To impart knowledge of energy-efficient HVAC systems, building energy modelling, equipment selection, indoor lighting, and geothermal heating and cooling applications.
5. To evaluate construction waste minimization, recycled and locally sourced materials, material reuse, indoor environmental quality, and occupational health requirements.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Evaluate sustainable building principles, green materials, and environmental performance criteria for green building development.
2. Compare green building rating systems and assess sustainable strategies for energy, water, and material conservation.
3. Formulate sustainable building design strategies incorporating energy efficiency, passive design, renewable energy, and onsite resource management.
4. Analyze HVAC systems and building energy performance and evaluate efficient cooling, heating, ventilation, and lighting strategies.
5. Develop sustainable construction and waste management strategies incorporating recycled materials, resource conservation, indoor air quality, and occupational health considerations.

UNIT I Sustainability **9**

Definition of sustainable (green) building, Need of Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites of a Green Building, Important Sustainable features for Green Building,

UNIT II Green Buildings and Practices **10**

Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities And Benefits: Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency,

UNIT III Green Building Design 9

Reduction in Energy Demand, Onsite Sources and Sinks, Maximize System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Ecofriendly captive power generation for factory, Building requirement.

UNIT IV Heat Ventilation and Air Conditioning systems 10

CII Godrej Green business center, Design philosophy, Design interventions, Energy modeling, HVAC System design, Chiller selection, pump selection, Selection of cooling towers, Selection of air handing units, Precooling of fresh air, Interior lighting system, Key feature of the building. Eco-friendly captive power generation for factory, Building requirement. Use of Geothermal Energy for Cooling and heating structures..

UNIT V Material Conservation and Handling of Non Process waste 10

waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture; Indoor Environment Quality And Occupational Health: Air. conditioning, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the buildings.

Prescribed books

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.

Reference Textbooks

1. Green Building Handbook by Tom Woolley and Sam Kimmins, 2009, Spon Press.
2. Sustainable Construction: Green Building Design and Delivery by Charles J. Kibert, 2016, John Wiley & Sons, 4th Edition.
3. Green Building: Principles and Practices in Residential Construction by Abe Kruger and Carl Seville, 2013, Cengage Learning.

Title of the Course	**:**	REHABILITATION AND RETROFITTING OF STRUCTURES
Course Code	**:**	**24CCIV13T**
Corse offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To develop an understanding of the causes and mechanisms of deterioration in concrete structures, including corrosion, chemical attack, cracking, spalling, and durability-related damage.
2. To impart knowledge of structural inspection, condition assessment, crack measurement, non-destructive testing, core testing, and structural performance evaluation.
3. To evaluate repair materials and techniques, including cementitious, polymer, epoxy, and fibre-reinforced materials, for restoring structural performance.
4. To develop expertise in strengthening and retrofitting beams, slabs, columns, and foundations using concrete jacketing, steel jacketing, FRP systems, and external post-tensioning.
5. To analyze corrosion protection, structural health monitoring, seismic rehabilitation, and fire-damaged structure repair for extending structural service life.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Diagnose deterioration mechanisms in concrete structures and evaluate their effects on durability, serviceability, and structural safety.
2. Conduct and interpret structural condition assessments using visual inspection, NDT, core testing, crack measurements, and corrosion evaluation.
3. Select and evaluate suitable repair materials and techniques based on damage characteristics, compatibility, and required performance.
4. Design and assess structural strengthening and retrofitting strategies for reinforced concrete members using conventional and advanced techniques.
5. Develop rehabilitation and corrosion protection strategies and evaluate structural health monitoring, seismic retrofitting, and fire-damage repair approaches.

UNIT I Deterioration of Concrete Structures **9**

Causes and mechanisms of deterioration in concrete structures. Physical, chemical and mechanical deterioration.Carbonation, chloride attack, sulphate attack and corrosion. Cracking, spalling, durability and service life of concrete.

UNIT II Inspection and Assessment **9**

Visual inspection and condition assessment of structures. Types, causes and measurement of cracks.Non-destructive testing methods such as rebound hammer and UPV.Core testing, corrosion assessment and structural evaluation.

UNIT III Repair Materials and Techniques **10**

Selection and properties of repair materials. Cementitious, polymer, epoxy and fibre-reinforced materials. Crack repair, grouting, patching and surface treatment. Shotcrete, overlays and other repair techniques.

UNIT IV Strengthening of Concrete Structures **9**

Principles and methods of strengthening existing structures. Strengthening of beams, slabs, columns and foundations. RCC jacketing, steel jacketing and FRP strengthening. Retrofitting and external post-tensioning techniques.

UNIT V Rehabilitation and Corrosion Protection **10**

Corrosion protection and repair of reinforced concrete structures. Protective coatings, corrosion inhibitors and cathodic protection. Structural health monitoring and performance evaluation. Seismic rehabilitation, fire-damaged structures and case studies

Prescribed books

1. Concrete Structures, Repair, Rehabilitation and Retrofitting by J Bhattacharjee, 2nd Edition, 2025, CBS publishers.

Reference Textbooks

1. Maintenance and Repair of Civil Structures by B.L. Gupta and Amit Gupta, 2018, Standard Publishers and Distributors.
2. Concrete Repair and Maintenance Illustrated by Peter H. Emmons, 1993, R.S. Means Company.
3. Diagnosis and Repair of Concrete Structures by S. K. Jain, relevant editions and publications.
4. Rehabilitation of Concrete Structures by P.C. Varghese, 2014, PHI Learning.

Title of the Course	**:**	**FINITE ELEMENT METHODS**
Course Code	**:**	**24CCIV14T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To introduce the fundamental principles of finite element methods, energy formulations, discretization, variational methods, and elasticity theory.
2. To develop an understanding of element formulation, shape functions, displacement models, compatibility, convergence, and coordinate transformations.
3. To formulate stiffness matrices and nodal load vectors for one-dimensional and two-dimensional elements, including triangular and rectangular elements.
4. To impart knowledge of isoparametric element formulation, natural coordinate systems, quadrilateral elements, Lagrangian and Serendipity elements, and axisymmetric analysis.
5. To develop expertise in numerical integration, element assembly, static condensation, and solution techniques for structural analysis under static loading.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Explain and apply finite element principles, energy methods, elasticity relations, and discretization strategies to engineering problems.
2. Formulate suitable element displacement functions and evaluate shape functions, compatibility, convergence, and coordinate transformations.
3. Derive element stiffness matrices and nodal load vectors for bar, triangular, and rectangular elements.
4. Develop isoparametric finite element formulations for two-dimensional and axisymmetric problems using appropriate interpolation functions.
5. Implement numerical integration, element assembly, static condensation, and system solution procedures for static finite element analysis.

UNIT I Introduction 10

Concepts of FEM, steps, merits & demerits, Energy principles, discretization, Rayleigh–Ritz method of functional approximation. Principles of elasticity: equilibrium equations, strain-displacement in matrix form.Constitutive relations for plane stress, plane strain, and axisymmetric bodies.

Unit II Types of Elements **9**

Stiffness matrix for bar element, Shape functions for 1D elements, 2D elements for plane stress/strain, Displacement models, generalized coordinates, Convergence, compatibility, geometric invariance, Natural coordinate system, area & volume coordinates.

Unit III Generation of Elements

Stiffness and nodal load matrices, 3-node triangular element, 4-node rectangular element.

Unit IV Isoparametric Formulation 10

Concepts of Isoparametric elements for 2D analysis, CST element, 4-node and 8-node quadrilateral elements, Lagrangian and Serendipity elements, Axisymmetric analysis with 4-node iso-parametric element

Unit V Solution Techniques 9

Numerical Integration, Static Condensation, Assembly of Elements and Solution Techniques for Static Loads.

Prescribed books

1. Introduction to finite Elements in Engineering by Tirupathi R. Chandrupatla, and Ashok D. Belegundu, Cambridge University Press, 5th edition, 2021.

Reference Textbooks

1. Applied Finite Element Analysis by G. Ramamurthy, I.K. International Publishing House.
2. Concepts and Applications of Finite Element Analysis by Robert D. Cook, David S. Malkus, Michael E. Plesha, and Robert J. Witt, 2002, John Wiley & Sons, 4th Edition.
3. A First Course in the Finite Element Method by Daryl L. Logan, 2016, Cengage Learning, 6th Edition.
4. The Finite Element Method: Its Basis and Fundamentals by O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu, 2013, Butterworth-Heinemann, 7th Edition.

Title of the Course	**:**	STRUCTURAL DYNAMICS
Course Code	**:**	**24CCIV15T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of vibration theory, degrees of freedom, lumped-mass idealization, damping, and free and forced vibrations of single-degree-of-freedom systems.
2. To develop the ability to formulate and solve equations of motion for SDOF systems subjected to harmonic, periodic, impulsive, and general dynamic loads.
3. To analyze multi-degree-of-freedom systems, including structural property matrices, natural frequencies, mode shapes, modal orthogonality, and mode-superposition techniques.
4. To impart knowledge of practical vibration analysis methods, including Stodola's method, fundamental and higher-mode analysis, Holzer's method, and transfer matrix procedures.
5. To develop expertise in earthquake response analysis of SDOF and MDOF systems, code-based analysis, and free-vibration analysis of continuous structural systems.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Analyze free and forced vibrations of SDOF systems and evaluate damping, resonance, logarithmic decrement, and dynamic magnification.
2. Formulate and solve equations of motion for SDOF systems subjected to harmonic, periodic, impulsive, and general dynamic loading.
3. Determine natural frequencies, mode shapes, and dynamic response of MDOF systems using eigenvalue analysis and modal superposition.
4. Apply Stodola's method, Holzer's method, and transfer matrix procedures to solve practical structural vibration problems.
5. Evaluate structural response to earthquake excitation using suitable analytical and code-based methods and analyze flexural vibrations of continuous systems.

UNIT I Theory Of Vibrations **12**

Introduction –Elements of A Vibratory System – Degrees of Freedom-Continuous Systems –Lumped Mass Idealization –Oscillatory Motion –Simple Harmonic Motion – Pictorial Representation Of S.H.M - Free Vibrations of Single Degree of Freedom (SDOF) Systems –Undamped and Damped –Critical Damping –Logarithmic Decrement –Forced Vibrations of SDOF Systems-Harmonic Excitation – Dynamic Magnification Factor- Bandwidth. Fundamental Objective of Dynamic Analysis-Types of Prescribed Loading- Methods of Discretization- Formulation of The Equations of Motion.

UNIT II Single Degree of Freedom System **10**

Formulation and Solutions of The Equation of Motion - Free Vibration Response –Response to Harmonic, Periodic, Impulsive and General Dynamic Loading –Duhamel Integral

UNIT III Multi Degree of Freedom System **10**

Selection of The Degree of Freedom –Evaluation of Structural Property Matrices-Formulation of The MDOF Equations of Motion –Undamped Free Vibrations-Solution of Eigen Value Problem for Natural Frequencies and Mode Shapes- Analysis of Dynamic Response –Normal Coordinates –Uncoupled Equations of Motion –Orthogonal Properties of Normal Modes-Mode Superposition Procedure

UNIT IV Practical Vibration Analysis **8**

Stodola Method- Fundamental Mode Analysis –Analysis of Second and Higher Modes –Holzer's Method –Basic Procedure –Transfer Matrix Procedure.

UNIT V Introduction to Earthquake Analysis **12**

Introduction –Excitation by Rigid Base Translation – Lumped Mass Approach -SDOF And MDOF System- I.S Code Methods of Analysis. Continuous System: Introduction –Flexural Vibrations of Beams- Elementary Case-Equation of Motion – Analysis of Undamped Free Shapes of Simple Beams with Different End Conditions-Principles of Application to Continuous Beams.

Prescribed books

1. Dynamics of Structures: Theory and Applications to Earthquake Engineering by Anil K. Chopra, 2017, Pearson, 5th Edition.

Reference Textbooks

1. Dynamics of Structures by Ray W. Clough and Joseph Penzien, 2003, Computers & Structures, 3rd Edition.
2. Structural Dynamics: Theory and Computation by Mario Paz and Young Hoon Kim, 2019, Springer, 6th Edition.
3. Engineering Vibration by Daniel J. Inman, 2014, Pearson, 4th Edition.
4. Structural Dynamics for Engineers by A.K. Chopra, Pearson Publications.

Title of the Course	**:**	**ENVIRONMENTAL IMPACT ASSESSMENT**
Course Code	**:**	**24CCIV16T**
Course offered to	**:**	CIVIL ENGINEERING
Credits	**:**	4

Course Objectives

1. To provide advanced knowledge of EIA concepts, objectives, environmental legislation, regulatory frameworks, project screening, and terms of reference.
2. To develop an understanding of baseline environmental data collection, impact identification, prediction, evaluation, risk assessment, and carrying capacity analysis.
3. To impart knowledge of environmental management plans, mitigation measures, environmental monitoring, auditing, compliance assessment, and stakeholder participation.
4. To evaluate environmental impacts of industrial, mining, highway, infrastructure, dam, irrigation, and water resource projects, including social impacts and rehabilitation requirements.
5. To develop expertise in strategic and cumulative impact assessment, climate change assessment, carbon footprinting, life-cycle considerations, disaster risk assessment, and EIA report preparation.

Course Outcomes: After successful completion of the course, the research scholar will be able to:

1. Evaluate the EIA process, environmental legislation, regulatory requirements, project screening, and terms of reference for development projects.
2. Apply appropriate EIA methodologies for baseline assessment, impact prediction, environmental risk analysis, and carrying capacity evaluation.
3. Formulate environmental management plans with mitigation measures, monitoring programmes, auditing procedures, and stakeholder engagement strategies.
4. Conduct sector-specific environmental impact assessments for industrial, mining, transportation, infrastructure, and water resource projects, including social impacts.
5. Develop EIA reports incorporating strategic and cumulative assessment, climate change, carbon footprint, life-cycle considerations, and sustainable development recommendations.

UNIT I Introduction to EIA 10

Concept, objectives and importance of Environmental Impact Assessment. Environmental policies, legislation and regulatory framework. Types of environmental impacts and project screening. EIA process, stages and preparation of Terms of Reference.

UNIT II EIA Methodologies 10

Baseline environmental data collection and analysis. Impact identification, prediction and evaluation methods. EIA techniques: checklists, matrices, networks and overlays. Environmental risk assessment and carrying capacity analysis.

UNIT III Environmental Management Plan 9

Environmental Management Plan (EMP) and mitigation measures. Environmental monitoring and compliance assessment. Environmental audit and environmental management systems. Public consultation and stakeholder participation.

UNIT IV EIA for Different Projects 10

EIA for industries, mining, highways and infrastructure projects. EIA for dams, irrigation and water resource projects. Assessment of impacts on air, water, soil, ecology and society. Social impact assessment and rehabilitation measures.

UNIT V Advanced EIA and Case Studies 10

Strategic Environmental Assessment and cumulative impact assessment. Climate change, carbon footprint and life-cycle considerations. Risk assessment, disaster management and sustainable development. Case studies and preparation of EIA reports.

Prescribed books

1. Environmental Impact Assessment by R.K. Jain, L.V. Urban, G.S. Stacey, and H.E. Balbach, McGraw-Hill.

Reference Textbooks

1. Environmental Engineering by Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous, 1985, McGraw-Hill.
2. Environmental Impact Assessment: Theory and Practice by Peter Wathern, 1988, Routledge.
3. Environmental Impact Assessment by Larry W. Canter, 1996, McGraw-Hill, 2nd Edition.
4. Environmental Impact Assessment in Developing Countries by M. N. B. A. Jay et al., supplementary research reference; verify bibliographic details before official inclusion.