Department of Civil Engineering
(Detailed Autonomous Syllabus)

M. Tech., 1st Yr (2nd Semester)

Theory

Construction Equipment and Methods (CEM-201)
L-3, T-1, Credit-4

Prerequisite: Soil Mechanics, Engineering Mechanics, and Engineering Economics.

Module 1: Earthmoving Equipment

Excavators, bulldozers, scrapers, graders; cycle time calculations, productivity factors (soil type, weather, operator efficiency), matching equipment to job conditions, cost analysis.

Module 2: Cranes and Lifting Equipment

Tower cranes, mobile cranes, hoists; load charts, stability analysis, erection/dismantling procedures, safety standards (IS 3177, OSHA), wind effects.

Module 3: Concrete Production and Placement Equipment

Batch plants, transit mixers, pumps, vibrators; capacity selection, automation, slipform pavers, tunnelling equipment (TBM).

Module 4: Equipment Economics and Management

Owning&operating costs (AASHTO method), replacement analysis, queuing models, fleet management and maintenance scheduling.

Module 5: Automation and Emerging Technologies

Robotic total stations, drones for surveying, autonomous haulers, BIM-integrated equipment tracking, and GPS-guided machinery.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain operational principles of major construction and earthmoving equipment.

CO2: Analyze equipment productivity using cycle time and performance factors.

CO3: Evaluate crane stability and lifting operations under safety requirements.

CO4: Select concrete production equipment for efficient construction operations.

CO5: Assess equipment economics using cost and replacement analysis techniques.

CO6: Examine emerging technologies in modern construction equipment management.

Reference Books

1. Construction Equipment and Methods by S. D. Sharma (Khanna Publishers, 2018).
2. Construction Planning, Equipment and Methods by R. L. Peurifoy and G. D. Oberlender (McGraw-Hill, 9th Ed.).
3. Equipment Management in Construction by R. B. Harris (McGraw-Hill).

Contracts and Tendering (CEM-202)

L-3, T-1, Credit-4

Prerequisite: Fundamentals of Civil Engineering Practice, Quantity Surveying and Estimation.

Module 1: Contract Forms and Types

Contracts: Lump sum, item rate, costplus&BOT; Engineering Procurement and Construction(EPC); Indian Contract Act 1872, General conditions of contract (GCC), Different standard forms.

Module 2: Tendering Processes

Notice inviting tenders (NIT), pre-bid meetings, e-tendering,Government e-Marketplace, Bid preparation, two orthree envelope system, earnest money deposit.

Module 3: Estimation and Bid Evaluation and Award

Financial&technical evaluation, Lowest Responsive Bidder (L1 bidder), reverse auction, negotiation, letter of acceptance (LOA), performance security.

Module 4: Claims and Dispute Resolution

Time extensions, price escalation, variations, arbitration, adjudication, dispute review boards.

Module 5: Risk Allocation and Insurance

Force majeure, liquidated damages, insurance clauses, indemnity

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain construction contract types and standard contractual provisions effectively.

CO2: Interpret tendering procedures and bid submission requirements in construction projects.

CO3: Analyze technical and financial criteria during bid evaluation processes.

CO4: Apply contract administration principles for project compliance management

CO5: Examine dispute resolution mechanisms and claim settlement procedures critically.

CO6: Assess contractual risks, insurance provisions, and liability allocation strategies.

Reference Books

1. Contracts Management in Construction by Abdul Rashid (Satya Bhan, 2015).
2. FIDIC Contracts: Law and Practice by Ellis Baker (Informa Law).
3. Construction Contracts by Jimmie Hinze (McGraw Hill, 5th Ed.).

Repair and Retrofitting of Structures (CEM-203)

L-3, T-1, Credit-4

Prerequisite: Concrete Technology, Solid Mechanics, Design of RC Structure, Health Monitoring of Structures.

Module 1: Distress Diagnosis and Assessment

Visual inspection, NDT (rebound hammer, UPV, GPR), core testing, load tests, condition indexing.

Module 2: Materials for Repair

Epoxies, polymers, FRP composites, cementitious grouts, corrosion inhibitors, self-healing concrete.

Module 3: Surface Repair Techniques

Patch repairs, shotcrete, overlays, cathodic protection, electrochemical chloride extraction.

Module 4: Structural Retrofitting

Concrete jacketing, steel plate bonding, FRP strengthening, section enlargement, prestressing. **Module 5: Case Studies and Quality Control**

Case studies related to failed structures: Indian bridges&buildings; repair audits, durability monitoring.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain structural distress mechanisms & assessment procedures for damaged structures.

CO2: Analyze structural conditions using non-destructive and load testing methods.

CO3: Evaluate repair materials for durability and structural rehabilitation applications.

CO4: Apply surface repair techniques for deteriorated concrete structures effectively.

CO5: Assess retrofitting methods for strengthening and restoring structural performance.

CO6: Interpret repair case studies and quality control practices in rehabilitation projects.

Reference Books

1. Concrete Structures: Protection, Repair and Rehabilitation by R. Dodge Woodson (Butterworth-Heinemann).
2. Repair and Rehabilitation of Concrete Structures by V. M. Malhotra (ACI).
3. Retrofitting of Concrete Structures by fib Bulletin 35.

Elective I

Advanced Concrete Technology (CEM-204)

L-3, T-1, Credit-4

Prerequisite: Concrete Technology.

Module 1: Concrete Materials – Advanced Concepts

Cement chemistry: hydration, heat of hydration, role of major compounds, and behaviour of blended cements. Different supplementary cementitious materials& their effects on hydration, strength, and durability. Aggregates: natural, manufactured, and recycled aggregates; microstructure and alkali–silica reactivity.

Module 2: Concrete Mix Design and Rheology

Rheology of fresh concrete: Bingham model, yield stress, viscosity, and thixotropy. Chemical admixtures: superplasticizers, VMAs, accelerators, retarders, and compatibility effects. Mix design approaches through IS Codes, performance-based design. Particle packing concepts and mix design for HSC, HPC, SCC, and lightweight&heavyweight concrete.

Module 3: Special Types of Concrete

High-strength and high-performance concrete: production and applications; Fibre reinforced concrete and self-compacting concrete (tests and behaviour); Ultra-high-performance concrete (UHPC) fundamentals; Overview of emerging concretes: geopolymer, roller compacted, permeable, shotcrete and 3D-printing concrete.

Module 4: Properties and Characterization of Fresh and Hardened Concrete

Fresh concrete: workability, flow and temperature effects; Hardened concrete: strength, creep, shrinkage and fracture behaviour; Microstructure and characterization techniques (SEM, XRD, TGA); Non-destructive testing: rebound hammer and ultrasonic pulse velocity.

Module 5: Durability, Deterioration and Rehabilitation of Concrete Structures

Durability concepts: permeability, carbonation and chloride ingress; Deterioration mechanisms: corrosion, sulphate and acid attack; Service life prediction basics (diffusion models); Rehabilitation and strengthening: grouting, polymer mortars, FRP and corrosion protection.

Course Outcomes (COs)

After completing the course, the student will be able to:

CO1: Explainconcrete materialsand effects of supplementary cementitious materials.

CO2: Analyze concrete rheology & admixture compatibility for mix designs.

CO3: Design specialized concrete mixes using particle packing and IS code provisions.

CO4: Evaluate fresh and hardened concrete properties using characterization techniques.

CO5: Assess durability and deterioration mechanisms affecting reinforced concrete structures.

CO6: Recommend rehabilitation and strengthening methods for damaged concrete structures.

Textbooks & References:

1. A.M. Neville – Properties of Concrete
2. Gambhir – Concrete Technology
3. Relevant IS Codes

Pavement and Foundations(CEM-205)

L-3, T-1, Credit-4

Prerequisite: Transportation Engineering, Pavement Design and Materials, Geotechnical Engineering, and Foundation Engineering.

Module 1: Basic Foundation Engineering Concept

Bearing Capacity determination, Terzaghi's Theory, IS code Method to determine Bearing Capacity and Settlement, Soil behaviour under Seismic condition and machine foundation, Stress Distribution, Ground liquefaction

Module 2: Site Investigations and Pavement Subgrade Characterization

Planning of geotechnical investigation programmes, Methods of site investigations: Direct methods, semi direct methods and indirect methods; Drilling methods: Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record; Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test, subgrade evaluation for pavements

Module 3: Materials for Pavements and Ground Improvement

Aggregates testing; Bitumen binders (VG grades), polymer modified and crumb rubber bitumen; Bituminous mixes; Soil stabilization materials; Marshall mix design and soil stabilization mix design concepts.

Module 4: Pavement and Ground Design Methods

Flexible and rigid pavement design as per IRC & its quality control; IRC layer thickness design and overlay concepts; Mechanistic-empirical pavement concepts; Ground improvement design for pavements and infrastructure.

Module 5: Deep Ground Improvement and Recycling Technologies

Stone columns, sand drains, prefabricated drains, lime columns; Vibro-floatation, dynamic compaction, electro-osmosis, grouting; Dewatering systems for pavement and infrastructure projects; Recycled Asphalt Pavement (RAP), Warm Mix Asphalt (WMA); Perpetual pavements and geopolymer concrete pavements.

Module 6: Case Studies and Forensic Engineering

Pavement failures: rutting, fatigue cracking, roughness (IRI); Industrial structures, earthen dams, landslides and debris flows; National highway pavement case studies and sustainable roads; Forensic geotechnical and pavement investigation.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain foundation behavior under static, seismic, and machine loading conditions.
CO2: Analyze geotechnical investigation data using field and laboratory testing methods.
CO3: Evaluate pavement & stabilization materials for performance requirements.
CO4: Design pavement systems using IRC and mechanistic-empirical design approaches.
CO5: Assess ground improvement & recycling technologies forinfrastructure development.
CO6: Interpret forensic case studies related to pavement and geotechnical failures.
Reference Books:

1. Raj Purushothama, Ground Improvement Techniques, Laxmi Publications.
2. Khanna, S.K. & Justo, C.E.G. Highway Engineering, Nem Chand & Bros
3. Pavement Engineering Principles and Practice – Kandhal & Mallick, CRC Press.
4. Relevant IS and IRC Codes.

Construction of Bridge and Industrial Structures (CEM-206)

L-3, T-1, Credit-4

Prerequisites: Basic knowledge of Structural Engineering, Reinforced Concrete and Steel Structures, Construction Materials and Methods

Module 1: Bridge Construction

Types of bridges in Indian practice: Highway, Railway & Pedestrian bridges; Flyovers, Viaducts &Aqueducts; Culverts & Box Girder Bridge; Bailey Bridge; Foundations and substructures, superstructure construction methods, launching techniques, prestressed concrete bridges, bridge erection equipment and safety practices.

Module 2: Industrial Structures

Industrial buildings and plant structures, steel industrial sheds, chimneys, silos, bunkers, cooling towers, storage tanks, fabrication and erection techniques, industrial safety and quality control.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain construction methods of highway, railway, and pedestrian bridge systems.

CO2: Analyze bridge substructures, superstructures, and launching techniques.

CO3: Evaluate prestressed concrete bridge construction practices&safety requirements.

CO4: Interpret design and construction features of industrial structural systems.

CO5: Apply fabrication and erection techniques for steel industrial structures effectively.

CO6: Assess industrial safety & quality control practices for structural construction activities.

References

1. Construction of Bridges by N. Krishna Raju
2. Design and Construction of Steel Structures by S. S. Bhavikatti
3. IRC Codes and Indian Roads Congress publications
4. Relevant Bureau of Indian Standards Codes

Advanced Quantity Surveying (CEM-207)

L-3, T-1, Credit-4

Prerequisites: Estimation and Costing, Basics of Construction Management, Knowledge of Building Drawings and Specifications

Module 1: Advanced Quantity Take-off & Estimation

Detailed quantity take-off methods, quantity surveying for multistorey buildings, highways and infrastructure projects, bar bending schedules, earthwork estimation.

Module 2: Rate Analysis & Market Intelligence

Resource-Based Analysis: Calculation of labour constants, material wastage factors, and equipment hourly costs; Price Escalation: Mathematical modelling for price adjustments in long-term contracts; Indirect Costs: Allocation of site overheads, head office overheads, and profit margins.

Module 3: Contract Administration & Management

FIDIC and Standard Forms: Study of Red, Yellow, and Silver books; Indian Standard contracts (CPWD/MES); Variations and Claims: Documentation of extra items, price variations, and extension of time (EOT); Interim Payments: Preparation of Running Account (RA) bills and final bill certification.

Module 4: Cost Control & Value Engineering

Project Cash Flow Analysis;Cost optimization techniques; Life Cycle Costing (LCC): Evaluating long-term maintenance and operational costs vs. initial capital expenditure.

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Explain advanced quantity estimation methods for buildings and infrastructure projects.

CO2: Prepare bar bending schedules and earthwork estimates using standard procedures.

CO3: Analyze resource-based rate calculations and price escalation mechanisms effectively.

CO4: Interpret contract administration procedures using FIDIC and Indian standard contracts.

CO5: Develop interim payment documentation and claim management strategies for projects.

CO6: Evaluate project costs using cash flow and life cycle costing techniques.

Reference Books

1. Estimating and Costing in Civil Engineering – B.N. Dutta, UBS Publishers.
2. Construction Cost Engineering Handbook – Keith Potts & Nii Ankrah, Routledge.
3. Construction Project Management – K.K. Chitkara, McGraw-Hill.
4. Relevant IS Codes

Elective II

Construction Economics and Finance (CEM-208)

L-3, T-1, Credit-4

Prerequisite: Engineering Economics.

Module 1: Cost Estimation Techniques

Preliminary estimates, detailed Bill of Quantities (BOQ), unit rate analysis, RS Means method, and parametric estimating.

Module 2: Time Value of Money

Present/future value, Net Present Value (NPV), Internal Rate of Return (IRR), Benefit–Cost Ratio (B/C ratio), depreciation methods – Straight Line Method (SLM), Written Down Value Method (WDV), annuity calculations.

Module 3: Value Engineering

Function analysis, FAST diagramming, life-cycle costing, VE job plan, case studies.

Module 4: Project Financing Models

PublicPrivate Partnership, Hybrid Annuity Model (HAM), ESCROW Account and mechanisms, debt-equity ratio, working capital management, Different funding agencies

Module 5: Risk and Inflation Analysis

Escalation indices by regulatory bodies, sensitivity analysisfinancial risk analysis, insurance&financial derivatives.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain cost estimation methods for construction & infrastructure development projects.

CO2: Analyze investment decisions using time value of money concepts.

CO3: Evaluate project feasibility through financial indicators and depreciation techniques.

CO4: Apply value engineering principles for cost-effective project planning and execution.

CO5: Interpret project financing models and funding mechanisms in construction management.

CO6: Assess financial risks and inflation impacts using sensitivity analysis techniques.

Reference Books

1. Construction Project Scheduling and Control by Saleh A. Mubarak (Wiley, 4th Ed.).
2. Financial Management: Theory & Practice by Prasanna Chandra (Tata McGraw Hill, 10th Ed.).
3. Construction Financial Management by S. Keoki Sears (Wiley).

Human Resource Management in Construction (CEM-209)

L-3, T-1, Credit-4

Prerequisite: Organizational Behaviour.

Module 1: Labour Laws and Regulations

Building Workers Act 1996, Contract Labour Act, Wages Code 2019, PF and ESIC compliance, and migrant worker welfare.

Module 2: HRM Planning and Recruitment

Manpower planning, skill mapping, competency frameworks, contractor labour management, e-HRMS systems.

Module 3: Training and Development

Skill certification (NSTC, MES), safety training, leadership programs, on-site apprenticeship models.

Module 4: Performance Management

KPI setting, 360-degree appraisal, incentive schemes, disciplinary procedures, grievance redressal.

Module 5: Industrial Relations and Conflict Resolution

Collective bargaining, strikes/lockouts, mediation/arbitration, team building, motivation theories (Herzberg, Vroom).

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain labour laws and workforce compliance requirements in construction industries.

CO2: Analyze manpower planning and recruitment strategies for construction organizations.

CO3: Develop workforce training and skill enhancement programs for project personnel.

CO4: Evaluate employee performance using appraisal and incentive management systems.

CO5: Interpret industrial relations practices and grievance handling procedures effectively.

CO6: Assess conflict resolution and motivational approaches for effective team management.

Reference Books

1. Human Resource Management in Construction Projects by Martin Loosemore (Taylor & Francis).
2. Construction Human Resource Management by A. Dainty (Spon Press).
3. Labour Laws for Managers by S. N. Mishra (Excel Books).

Construction Marketing and Business Development (CEM-210)

L-3, T-1, Credit-4

Module 1: Introduction to Construction Marketing

Concepts and scope of project marketing; Characteristics of construction and infrastructure markets; Marketing environment and market segmentation

Module 2: Market Analysis and Opportunity Identification

Market survey and demand forecasting; SWOT and competitor analysis; Identification of business opportunities

Module 3: Business Development Strategies

Strategic planning and growth management; Branding and corporate image; Client relationship and stakeholder management; Joint ventures and strategic alliances

Module 4: Emerging Trends in Construction Business

Digital marketing and e-business tools; Sustainable and green constructionmarkets;International construction business trends; Entrepreneurship and innovation in construction sector.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain marketing concepts and characteristics of construction business environments.

CO2: Analyze market trends using demand forecasting and competitor assessment techniques.

CO3: Identify business opportunities through strategic market and stakeholder analysis.

CO4: Develop branding and client relationship strategies for construction organizations.

CO5: Evaluate joint ventures and strategic alliances for business growth management.

CO6: Assess emerging digital and sustainable trends in construction business development.

Sustainable Techniques in Construction Technology (CEM-211)

L-3, T-1, P-0, Credit-4

Prerequisite: Building Codes, Environmental Engineering and Sciences, Surveying and GIS.

Module 1: Green Material

Sustainable construction materials: recycled aggregates, fly ash bricks, AAC blocks, low-carbon cement, geopolymer concrete, bamboo, and natural fibre composites. Permeability, durability, and embodied carbon assessment of materials.

Module 2: Green Building Rating and Energy-Efficient Systems

LEED/IGBC/GRIHA rating systems, Solar PV panel efficiency testing, cool roof reflectivity and emissivity measurement, daylight factor measurement, building envelope U-value calculations, passive design strategies, and introduction to building energy simulation tools.

Module 3: Water Conservation Techniques

Rainwater harvesting system models, greywater treatment and reuse, dual plumbing and low-flow fixtures, leak detection techniques, water audit procedures, water balance analysis for buildings and campuses.

Module 4: Construction Waste Management & Circular Economy

Construction and demolition (C&D) waste segregation, recycling and reuse potential assessment, lean construction simulation, life-cycle thinking in material reuse, waste quantification, reduction strategies and circular economy

Module 5: Environmental Impact Assessment (EIA) for Construction Projects

Introduction to EIA principles and regulatory framework, screening and scoping for building/infrastructure projects, identification of environmental impacts (air, water, noise, ecology, socio-economic).Preparation of Environmental Management Plan (EMP), mitigation measures, sustainability indicators, compliance monitoring, and environmental audit for construction sites.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain sustainable construction materials and their environmental performance.

CO2: Analyze green building rating systems and energy-efficient building strategies.

CO3: Evaluate water conservation techniques through audits and reuse system analysis.

CO4: Assess construction waste management practices using circular economy principles.

CO5: Interpret environmental impacts of construction projects using EIA methodologies.

CO6: Develop sustainability measures and environmental management plans for construction projects.

Reference Books

1. IGBC Green New Buildings Rating System Manual (IGBC).
2. LEED Reference Guide for Green Building Design (USGBC).
3. Sustainable Construction Technology by Raymond E. Tomeski.

Practical

Quantity Surveying (CEM-291)

L-1, T-0, P-2, Credit-2

Prerequisite: Quantity Surveying, Estimation and Costing.

Project on Bill of quantities of the following: Buildings, Roads and Small Bridges

Rate Analysis of scheduled and non-scheduled items

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain quantity estimation principles for buildings, roads, and bridge projects.

CO2: Prepare detailed bill of quantities using standard measurement procedures.

CO3: Analyze scheduled item rates using standard specifications and cost data.

CO4: Develop rate analysis for non-scheduled construction items systematically.

CO5: Evaluate material, labour, and equipment requirements for project execution.

CO6: Prepare technical project reports incorporating estimation and cost analysis methods.

Dissertation on Literature Review (CEM-281)

L-0, T-2, P-0 Credit-2

A mid-semester and end-semester seminar presentation shall be conducted on a topic selected by the student, which will subsequently be pursued as the dissertation or project internship topic.