CURRICULUM & SYLLABI

M.Tech. CONSTRUCTION TECHNOLOGY AND MANAGEMENT

Effective from AY: 2024-25



NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

WARANGAL, TELANGANA

Table of Contents

VISION AND MISSION OF THE INSTITUTE **3**

VISION AND MISSION OF THE DEPARTMENT **3**

PROGRAM EDUCATIONAL OBJECTIVES **4**

PROGRAM OUTCOMES **5**

CURRICULUM **6**

SYLLABI **9**

Vision and Mission of the Institute
National Institute of Technology Warangal

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product-oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

Vision and Mission of the Department
of Civil Engineering

VISION

To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

MISSION

- Generate a specialized cadre of civil engineers by imparting quality education and training
- Attain international standards in teaching, research and consultancy with global linkages

Program: M.Tech. Construction Technology and Management

Program Educational Objectives

PEO-1	Apply systems, methods, procedures, modern tools and techniques in construction projects.
PEO-2	Identify and apply sustainable, alternative and cost effective construction materials and practices.
PEO-3	Work in team environment and apply tools to optimize resources for achieving project objectives.
PEO-4	Communicate effectively, demonstrate leadership qualities and exhibit professional ethics.
PEO-5	Engage in lifelong learning for career enhancement and adapt to changing societal needs.

Program Articulation Matrix

PEO / Mission Statements	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
Generate a specialized cadre of civil engineers by imparting quality education and training	2	3	3	3	3
Attain international standards in teaching, research and consultancy with global linkages	2	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Program: M.Tech. Construction Technology and Management

Program Outcomes

PO-1	Engage in critical thinking and pursue research/ investigations and development to solve practical problems.
PO-2	Communicate effectively on complex engineering activities with the engineering community and with society, write and present substantial technical reports.
PO-3	Demonstrate higher level of professional skills to tackle multidisciplinary and complex problems related to construction technology & management.
PO-4	Acquire necessary skills to plan, organize, staff, lead and exercise control in the directing and coordinating of resources to achieve construction project objectives.
PO-5	Apply knowledge, techniques, skills, and tools in construction management.
PO-6	Ability to function effectively as members or leaders on construction management/multifunctional teams.

CURRICULUM
M.Tech. Construction Technology and Management

1st Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE16001	Construction Techniques	3-0-0	3
2	CE16003	Lean Construction	3-0-0	3
3	MS16061	Construction Economics and Finance	3-0-0	3
4	CE160XX	Professional Elective – I	3-0-0	3
5	CE160XX	Professional Elective – II	3-0-0	3
6	CE16005	Construction Project Management Software Laboratory	0-1-2	2
7	CE16007	Building Information Modelling Laboratory	0-1-2	2
		Total Credits		**19**

2nd Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE16002	Contract Management and Arbitration	3-0-0	3
2	CE16004	Construction Equipment Management	3-0-0	3
3	CE160XX	Professional Elective – III	3-0-0	3
4	CE160XX	Professional Elective – IV	3-0-0	3
5	CE160XX	Professional Elective – V	3-0-0	3
6	CE16006	Construction Project Studio	0-1-2	2
7	CE16008	Building Science Laboratory	0-1-2	2
8	CE16096	Minor Project	0-0-0	2
		Total Credits		**21**

3rd Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE16089	Seminar and technical writing	0-0-0	2
2	CE16091	Summer Internship/Research experience	0-0-0	2
3	CE16093	Comprehensive Viva voce	0-0-0	2
4	CE16097	Dissertation Part – A	0-0-0	8
			Total Credits	**14**

4th Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE16098	Dissertation Part – B	0-0-0	12
			Total Credits	**12**

The Overall Credit Structure

Cat. Code	Sem-I	Sem-II	Sem-III	Sem-IV	Total
PCC	13	10	0	0	27
PEC	6	9	0	0	15
SEM	0	0	2	0	02
CVV	0	0	2	0	02
SIRE	0	0	2	0	02
MP	0	2	0	0	02
DW	0	0	8	12	20
Total	19	21	14	12	**66**

Abbreviations:

PCC– Program Core Courses
PEC – Program Elective Courses
SEM – Seminar and Technical Writing
SIRE – Summer Internship/Research Experience
MP – Minor Project
CVV – Comprehensive Viva Voce
DW – Dissertation Work

Professional Elective Courses:

Professional Elective-I		
S.No.	**Code**	**Course Title**
1	CE16021	Construction Planning and Management
2	CE16023	Building Information Modelling (BIM) for construction planning and management
Professional Elective-II		
3	CE16025	Building Services
4	CE16027	Sustainable Construction Materials
5	MS16063	Human Resource Management for Construction

Professional Elective-III		
S.No.	**Code**	**Course Title**
1	CE16022	Energy Efficient Buildings
Professional Elective-IV		
2	CE16026	Quality and Safety Management
3	CE16028	Quantitative Methods in Construction Management
Professional Elective-V		
4	CE16024	Formwork Design and Practice
5	MS16062	Strategic Management in Construction

SYLLABI

M.Tech. Construction Technology and Management

1st Semester

CE16001 **3-0-0 (3)**

Construction Techniques

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify various construction techniques and their limitations.
CO-2	Analyze productivity and economics in construction techniques.
CO-3	Comprehend modular construction practices.
CO-4	Implement advanced construction techniques for Civil Engineering projects.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	1	2	2	3	1
CO-2	3	1	2	2	3	1
CO-3	3	1	2	2	3	2
CO-4	3	1	3	2	3	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Prefabricated Structures: Introduction to Prefabricated structures, Planning for pre-casting, Selection of equipment for fabrication, Transport and erection of prefabricated components, Quality measures, Design considerations of precast elements, Safety measure during erection.

Modular Construction Practices: Introduction to Modular Construction, Modular coordination, Modular Standardization, Modular System Building, Limitation and Advantages of Modular Construction

Formwork: Requirements of Formwork, Loads carried by Formwork, Types of Formwork: Timber, Steel, Modular shuttering, Slip forms, Scaffolding, Deep Excavation Methods.

High Rise Buildings: New Design Trends in Geometrical Forms, Construction Techniques of High Rise Buildings, High Rise Construction Techniques, Brick work, Selected High-Tech High-Rise Buildings.

Bridge construction techniques: Introduction, Embankments and Foundations, Conventional Bridge Construction Techniques, Accelerated Bridge Construction, Prefabricated Bridge Construction.

Learning Resources:

Text Books:

1. Robert L.Peurifoy, Clifford, J. Schexnayder, Robert Schmitt and AviadShapira, Construction Planning, Equipment, and Methods, McGraw-Hill Education, 2018, Ninth Edition.
2. S. C. Sharma, Construction Equipment and Management, Khanna Publishing, 2019, First Edition.

Reference Books:

1. Cameron Andres, Ronald Smith and W. Woods, Principles and Practices of Commercial Construction, Pearson, 2018, Tenth Edition.

2. D. S. Vijayan, S. Arvindan and A. Paulmakesh, Construction Materials and Techniques, Notion Press, 2021, First Edition.
3. Edward Allen and Joseph Iano, Fundamentals of Building Construction: Materials and Methods, Wiley, 2019, Seventh Edition.

Other Suggested Readings:

1. http://www.sasurieengg.com/e-course-material/CIVIL/III-Year%20Sem%205/CE%206506%20Construction%20Techniques,%20Equipment%20and%20Practice.pdf
2. https://www.nbmcw.com/product-technology/precast/prefabrication-building-construction-an-indian-perspective.html
3. https://www.sciencedirect.com/topics/engineering/prestressed-concrete

CE16003 **3-0-0 (3)**

Lean Construction

Pre-Requisites: **None**

Course Outcomes:

CO-1	Comprehend the principles and concepts in Lean Construction
CO-2	Apply lean techniques in construction projects
CO-3	Demonstrate lean integration aspects
CO-4	Comprehend the application of lean through Information Technology

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1				3		
CO-2					3	
CO-3	2	2				
CO-4			2			2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Lean Thinking: Introduction to lean concepts and core concepts in lean thinking, Productivity measurements.

Lean Tools in Construction: Work Sampling, process charts, foreman delay survey, Last Planner System, Value stream mapping, 5S, case studies.

Lean Integration: Lean Construction and safety, Lean Construction and sustainable development, Lean and Green, Issues in lean implementation in the construction industry, case studies.

Enabling Lean through Information Technology: Building Information Modelling, Integrated project delivery, case studies.

Value Engineering Techniques in Construction Management: General and Specific Techniques.

Learning Resources:

Text Books:

1. Forbes L., Ahmed, S, Modern Construction-Lean project delivery and integrated practices, CRC Press, New York, 2011.
2. Patricia Tzortzopoulos, Mike Kagioglou and Lauri Koskela, Lean Construction: Core concepts and New Frontiers, Routlege, Taylor and Francis Group, 2020

Reference Books:

1. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014
2. Lincoln H. Forbes and Syed M. Ahmed, Lean Project Delivery and Integrated Practices in Modern Construction, Routlege, Taylor and Francis Group, 2020
3. http://www.leanconstruction.org/readings.htm
4. International Labour Organization (work sampling and Process charts)

MS16061 **3-0-0 (3)**

Construction Economics and Finance

Pre-Requisites: **None**

Course Outcomes:

CO-1	Prepare income, profit and loss statements and implement construction accounting.
CO-2	Evaluate construction project economics, cost-benefit analysis and Breakeven Analysis.
CO-3	Analyze and evaluate construction risks and uncertainties.
CO-4	Manage working capital and employ budgeting and control.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	1	2	3	1
CO-2	3	2	1	2	3	1
CO-3	3	1	1	2	3	1
CO-4	2	2	1	2	3	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Construction Accounting: Income statement and Balance sheet, Depreciation and amortization.

Engineering economics: Time Value of Money, Break even analysis, Benefit-cost analysis.

Capital Budgeting & Methods: Discounted Cash flow, Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI), Annual Rate of Return (ARR), Risks and uncertainties and management.

Taxation and inflation: Cost Elements, bidding and award revision due to unforeseen causes, escalation. Financial planning, multiple sources of finance, Working capital Management. Budgeting and budgetary control, Project Appraisal and Project yield, Performance – appraisal and project yield.

Learning Resources:

Text Books:

1. Danny Myers, Construction Economics: A New Approach, Taylor and Francis Publisher, 2022.
2. Vazirani and chandola, Construction Accounting and Finance, Dhanpat Rai Publications, 8th edition.

Reference Books:

1. Ofori, G, The Construction Industry Aspects of its Economics and Management, Singapore University Press, 1990.
2. Coombs W.E and W.J Palmer, Construction and Finance Management, Mc-Graw-Hill New York,1994.
3. Halpin, D.W.,Financial and Cost concepts for construction Management, John Wiley & sons, New York,1985.

Other Suggested Readings:

1. https://www.financialexpress.com
2. https://economictimes.indiatimes.com
3. https://www.coursera.org › learn › construction-finance

CE16005 **0-1-2 (2)**

Construction Project Management Software Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO-1	Prepare work break down structure of project and estimate resources required in a construction project.
CO-2	Develop precedence diagram and network diagrams.
CO-3	Implement resource allocation and levelling using MSP and Primavera P6.
CO-4	Perform simulation of construction projects using CM tool and demonstrate learning

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	3	2	3	3	3
CO-2	1	3	2	3	3	3
CO-3	1	3	2	3	3	3
CO-4	1	3	2	3	3	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

MS Project (MSP) software: Development of work breakdown structure of a project, Project planning, Scheduling, and resource allocation.

Primavera P6 software: Development of work breakdown structure of a project, Project planning, Scheduling and resource allocation.

Case studies: Implement the MSP and Primavera P6 for planning and scheduling of real-time projects.

Learning Resources:

Text Books:

1. Lewis, C., Chatfield, C., & Johnson, T., Manual for MS Project 2019 Step by Step, Microsoft Press, 2019, First Edition.
2. Cicala, G., The Project Managers Guide to Microsoft Project 2019, Apress, Berkeley, CA 2020.

Reference Books:

1. Harris, P.E., Project Planning and Control Using Primavera P6, Eastwood Harris Pty Ltd, 2010.
2. Project management body of knowledge (pmbok® guide), Guide, A., In Project Management Institute, USA, 2008, 4th Edition.

Other Suggested Readings:

1. https://www.youtube.com/watch?v=2zynTGvNZ2w

CE16007 **0-1-2 (2)**

Building Information Modeling Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply the fundamental concepts of Building Information Modeling (BIM)
CO-2	Create 3D parametric building models using structural grids and support systems
CO-3	Create high-quality and annotated building section drawings
CO-4	Prepare documentation of BIM models

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	–	–	–	–	3	3
CO-2	–	–	2	–	–	–
CO-3	2	2	2	1	3	2
CO-4	–	–	–	–	2	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

BIM basics: Types of modeling, types of BIM authoring software.

3D modeling basics: Autodesk Revit user interface, Navigation, Levels, and Grids.

3D Architecture modeling: Floor, Wall, Roof, Ceiling, Doors, Windows, Staircase, Ramps, Railings and Site topography.

3D Structural modeling: Column, Beam, Slab and Shaft.

3D MEP systems: Basic modeling of plumbing and electrical systems.

Coordination and collaboration: Clash detection, Material, and quantity take-off.

Details and documentation: Construction details, Dimensions, Detail views (sections, plans and elevations) Sheet, Scheduling, Tags, Table, Legends, and Annotations.

Learning Resources:

Reference Books:

1. Autodesk Revit 2024 Architecture Fundamentals, ASCENT, SDC publications, 2023, eBook ISBN 978-1-63056-836-8
2. Autodesk Revit 2024 MEP Fundamentals, ASCENT, SDC publications, 2023, eBook ISBN 978-1-63056-843-6
3. Daniel John Stine AIA, IES, CSI, CDT, Well AP, Residential Design Using Autodesk Revit 2024, SDC publications, 2023.
4. Autodesk Revit 2024 Structure Fundamentals, ASCENT, SDC publications, 2023, eBook ISBN 978-1-63056-840-5

5. Rafael Sacks, Chuck Eastman, Ghang Lee and Paul Teicholz, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, Wiley, 2018, Third Edition.
6. Karen M. Kensek, Building Information Modeling (Pocket Architecture), Routledge, 2014, First Edition.

Other Suggested Readings:

1. https://youtube.com/playlist?list=PLbJykfQm9O8cArlgixHjUnHI4QLbTZpV3
2. https://youtu.be/fiUr9B2yKiI

2nd Semester

CE16002 **3-0-0 (3)**

Contract Management and Arbitration

Pre-Requisites: CE1601, CE1605

Course Outcomes:

CO-1	Prepare contract schedules, notice inviting tender and contract documents.
CO-2	Identify and implement contract formats
CO-3	Implement dispute resolution.
CO-4	Prepare contract management plan as per standards.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	3	2	1	2	
CO-2	2	3	1		2	
CO-3	2	2	3	2	2	3
CO-4	2	2	1		2	

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Contract Formats: FIDIC, CPWD, Special Conditions of Contract (SCC)

Construction contracts: Types of Contracts, Contract specification, types of contract documents used for construction, Contract Procedure, RED Flag Clauses.

Claims and Disputes during Execution Construction Contracts: Claims, Claim Management, Disputes, arbitration and litigation procedure-preparation, settlement, evidence.

Contract Execution: Roles & Responsibilities, Contractor's Liabilities

Contracts – Change Management: Change Management Process & Procedures, Contract Communication & Documentation

Professional Ethics in Construction Industry: Significance of Ethical Practice in an Organization, Professionals and Professional Ethics in Construction Industry, Social Values in Construction, Impact of Professional Ethics on Construction Quality, Code of Ethics, Causes of Unethical Conduct and Ways to Minimize Unethical Conduct.

Learning Resources:

Text Books:

1. B.S. Ramaswamy, Contracts and Their Management, Lexis Nexis, 2016, First Edition.
2. Rashid Hussain, Contracts Management A Life Cycle, 3C Corporate Consulting Contracting, 2020, First Edition.

Reference Books:

1. Arvind Gavade, SunitDhere, Content of Construction Contracts, 2018, First Edition.
2. John Mullen and Peter Davison, Evaluating Contract Claims, Wiley-Blackwell, 2019, Third Edition.

3. J. Roger Knowles, 200 Contractual Problems and their Solutions, Wiley-Blackwell, 2012, Third Edition.
4. Andy Hewitt, Construction Claims and Responses: Effective Writing and Presentation, Wiley-Blackwell, 2016, Second Edition.
5. Brian Greenhalgh, Introduction to Construction Contract Management, Routledge, 2016, First Edition.
6. Geoff Powell, Palgrave Macmillan, Construction Contracts Preparation and Management: From concept to completion, 2016, First Edition.

Other Suggested Readings:

1. Acts and Contract Documents: The Indian Contract Act, 1872. https://legislative.gov.in/sites/default/files/A1872-09.pdf
2. The Arbitration and Conciliation Act, 1996 as amended on Dec 2015. https://lawmin.gov.in/sites/default/files/ArbitrationandConciliation.pdf
3. General Conditions of Contract for Central P.W.D. Works, 2014. http://cewacor.nic.in/Docs/TendersArchieve/ArchieveTender2018/CWVASHITENDER_241218.pdf
4. FIDIC Conditions of contract – Red Book – 1999. https://lauwtjunnji.weebly.com/uploads/1/0/1/7/10171621/fidic_-_conditions_of_contract_for_construction_for_building_and_engineering_works_designed_by_the_employer_(1999).pdf

CE16004 **3-0-0 (3)**

Construction Equipment Management

Pre-Requisites: **None**

Course Outcomes:

CO-1	Select construction equipment appropriate to tasks.
CO-2	Determine equipment ownership and operating costs.
CO-3	Evaluate useful life of equipment and conclude replacement policy
CO-4	Measure the output of equipment based on its performance out of fleet

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	3	2	3	3	3
CO-2	1	3	2	3	3	3
CO-3	1	3	3	3	3	3
CO-4	2	3	2	1	2	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Equipment Economics: Equipment Records, Cost of Capital, Elements of Ownership Cost, Operating Cost, Replacement Decisions, Rent and Lease Considerations.

Planning for Earthwork Construction: Planning, Graphical Presentation of Earthwork, Earthwork Quantities, Mass Diagram, Pricing Earthwork Operations.

Compaction and Stabilization Equipment: Compaction of Soil and Rock, Types of Compacting Equipment, Dynamic Compaction, Stabilizing soils with Lime, Cement Soil Stabilization.

Mobile Equipment Power Requirements: Required Power, Available Power, Usable Power, Performance Charts.

Dozers, Scrapers, Excavators: Introduction, Performance Characteristics of Dozers, Pushing Material, Land Clearing, Scraper Types, Operation, Performance Charts, Production Cycle, Hydraulic Excavators, Shovels, Hoes.

Trucks and Hauling Equipment, Finishing Equipment: Trucks, Productivity, Performance Calculations, Graders, Trimmers.

Lifting Equipment and Concreting Equipment: Types of Cranes, Batching equipments, Concrete Mixtures, Vibrators.

Learning Resources:

Text Books:

1. Gransberg, D. D., & Rueda- Benavides, J. A., Construction equipment management for engineers, estimators, and owners, CRC Press, 2020, 2nd Edition.
2. Peurifoy, R. L., Schexnayder, C. J., Schmitt, R. L., Construction planning, equipment, and methods, McGraw-Hill Education, 2018, 9th Edition.

Reference Books:

1. Sharma S.C. Construction Equipment and Management, Khanna Publishers New Delhi, 2019, 1st Edition.
2. Schaufelberger, J.E. and Migliaccio, Construction equipment management,Routledge, 2019, 1st Edition.

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/103/105103206/

CE16006 **0-1-2 (2)**

Construction Project Studio

Pre-Requisites: **CE1607**

Course Outcomes:

CO-1	Apply parametric modeling concepts and develop 3D parametric models.
CO-2	Apply and modeling concepts in BIM.
CO-3	Identify and estimate resources for the items of the project and prepare detailed project schedule.
CO-4	Perform simulation and track project progress over time and cost.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	–	–	2	–	–	3
CO-2	–	–	2	3	3	3
CO-3	–	3	–	3	3	3
CO-4	3	3	2	3	3	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Development of 3D Revit families: Parametric modeling concept, Foundation, Piers, Girders and Deck slab.

Development of 3D BIM: Develop 3D BIM model of infrastructure projects.

Development of schedule and quantity takeoff: Development of Work breakdown structure, planning, scheduling and resource allocation using MSP and Primavera P6 tool, Estimation and Quantity Take off from Autodesk Revit tool.

4D simulation using Navisworks: Integration of 3D model and schedule of project, Tracking of project progress over time, Perform planned versus actual simulation.

5D Simulation using Navisworks: Tracking of project cost.

6D BIM: Application of BIM approach to perform 6D analysis.

Learning Resources:

Reference Books:

1. J Dodds, S Johnson and M. N. Smith. Mastering Autodesk Navisworks. Symbex, 2013.
2. Eastman, C. M., Eastman, C., Teicholz, P., Sacks, R., & Liston, K., BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons, 2011, 2nd Edition.
3. Brad Hardin, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2015, 2nd Edition.

Other Suggested Readings:

1. https://www.coursera.org/courses?query=bim
2. https://www.edx.org/learn/construction/purdue-university-bim-for-construction

CE16008 **0-1-2 (2)**

Building Science Laboratory

Pre-Requisites: **None**

Course Outcomes:

CO-1	Describe the requirements of Indoor Built Environment.
CO-2	Evaluate and verify the Indoor Built Environment is complying with the specifications provided in the Indian Standards.
CO-3	Integrate Indoor built Environment facilities into software and optimize the facilities provided in a building.
CO-4	Prepare a detailed report on the building performance in terms of its serviceability.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	1	–	3	3
CO-2	2	–	2	–	–	–
CO-3	2	2	2	–	3	2
CO-4	2	2	1	2	2	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Occupant comfort, Energy, Acoustics, Illumination, Time/Motion studies/Ergonomics, Moisture, Construction chemicals/Additives, Non-Destructive Testing.

Experiments:

1. Determination of coefficient of thermal conductivity of a given material using Lee's Disc Apparatus.
2. Non - Destructive Testing: Determination of a compressive strength of a concrete sample using Rebound Hammer.
3. Non - Destructive Testing: Determination of a compressive strength and crack depth in a given concrete sample using Ultra Pulse Velocity Meter.
4. Building Inspection - Building envelope inspection for detection of heat gain/loss using Thermal Imaging Camera.
5. Determination of relative humidity of a given room using a Hygrometer.
6. Measurement of illuminance in a building using Lux Meter.
7. Measurement of the sound pressure levels (in dB) created by different types of sound sources.
8. Testing a given building material behaviour under controlled environmental conditions using Climate chamber.
9. Part A - Energy analysis of a building using software - Revit Architecture.

10. Part B - Optimization of building design for achieving lower energy consumption in buildings.
11. Green Building Rating Systems - Assimilation of complete procedure for green building certification through Indian green building rating tool (GRIHA-Green Rating for Integrated Habitat Assessment).

Learning Resources:

Reference Books:

1. Hand Book of Designing and Installation of Services in High Rise Building Complexes, Jain, V. K. Jain, Khanna Publishers, 2010, Third Edition.
2. David V. Chadderton, Building Services Engineering, Routledge, 2012, Sixth Edition.
3. Fred Hall and Roger Greeno, Building Services Handbook Routledge, 2017, Ninth Edition.
4. Design, O. H. Koenigsberger, T. G. Ingersoll, A. Mayhew and S. V. Szokolay, Manual of Tropical Housing and Building: Climate Universities Press (India) Private Limited, 2020.
5. Joseph Clarke, Energy Simulation in Building Design, Routledge, 2007, Second Edition.
6. Maekawa, Environmental and Architectural Acoustics, Taylor & Francis, 2010, SecondEdition.

Other Suggested Readings:

1. Handbook on Functional Requirements of Industrial Buildings (Lighting and Ventilation), SP 32, Bureau of Indian Standards, 1986. https://law.resource.org/pub/in/bis/S03/is.sp.41.1987.pdf
2. Handbook of Functional Requirements of Buildings (Other than Industrial Buildings), SP 41, Bureau of Indian Standards, 1987. https://law.resource.org/pub/in/bis/S03/is.sp.41.1987.pdf
3. Code of practice for acoustical design of auditoriums and conference halls, IS 2526, Bureau of Indian Standards, 1963.https://www.cracindia.in/admin/uploads/IS-2526.pdf

CE16096 **0-0-0 (2)**

Minor Project

Pre-Requisites: None

Course Outcomes:

CO-1	Identify a field problem.
CO-2	Assimilate literature on the identified problem
CO-3	Investigate causes for the identified problem
CO-4	*Conduct surveys/experiments and analyze the data*
CO-5	*Develop a suitable solution for the identified problem*

Course Articulation Matrix:

CO\PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*3*	-	*2*	-	-	*2*
CO-2	*3*	*3*	*2*	-	-	-
CO-3	*3*	*3*	*2*	-	-	*2*
CO-4	-	*3*	*3*	*3*	-	*3*
CO-5	*3*	*3*	*3*	*3*	*3*	*3*

1: Slightly; 2: Moderately; 3: Substantially

Syllabus:

There is no specific syllabus for this course. However, a student can choose any relevant and current real-world problem related to Transportation Engineering. Students must assimilate their knowledge to investigate and solve the identified field problem. They must conduct suitable field studies or laboratory experiments, analyse the data, and develop cost-effective solutions for the identified problem.

Evaluation Criteria:

The panel will evaluate the student based on the criteria below.

Criteria	Description	Weightage
I	Identification of Problem	10%
II	Study of Existing Systems and establishing clear objectives	15%
III	Planning of project and Methodology Development	15%
IV	Field Data Collection / Lab Experimentation and Analysis	15%
V	Model Development and Solution Generation	15%
VI	Documentation and Technical Writing	15%
VII	Presentation	15%

Learning Resources:

Textbooks:

1. Relevant Textbook based on the field problem identified.

Reference Books:

1. Research Articles / Reports available on the Internet
2. Construction Technology and Management Engineering Journals

Construction Technology and Management Textbooks and Handbooks

3rd Semester

CE16089 **0-0-2 (2)**

Seminar and Technical Writing

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify and chose appropriate topic of relevance.
CO-2	Assimilate literature on technical articles of specified topic and develop comprehension.
CO-3	Prepare technical report.
CO-4	Design, develop and deliver presentation on specified technical topic.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	1	2	1	3	1
CO-2	3	2	1	1	3	1
CO-3	2	3	1	1	3	1
CO-4	1	3	3	1	3	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Student can choose any topic, of his choice, pertaining to Construction Technology and Management. Topic should be a relevant and currently researched one. Students are advised to refer articles published in current journals in the area of Construction Technology and Management for choosing their seminar topics. Student should review minimum of 10 research papers relevant to the topic chosen, in addition to standard textbooks, handbooks, etc. Students are required to prepare a seminar report, in the standard format and give presentation to the Seminar Assessment Committee (SAC) in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Clarity on the topic	The Weightages will be given by the evaluation panel.
II	List of lectures attended	
III	Report	
IV	Presentation	
V	Response to questions	

Learning Resources:

1. Construction Technology and Management Journals
2. Research Articles / Reports available on Internet
3. Construction Technology and Management Textbooks and Handbooks

CE16091 **0-0-0 (2)**

Summer Internship / Research Experience

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify a field / Research Problem
CO-2	Apply engineering principles to real-world problems, gaining practical experience.
CO-3	*Conduct surveys/experiments and analyse the data with ethical considerations.*
CO-4	*Develop a suitable sustainable solution for the identified problem.*
CO-5	*Communicate the learnings through reports and presentations.*

Course Articulation Matrix:

CO\PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	*3*	-	*2*	-	-	*2*
CO-2	*3*	*3*	*2*	-	-	-
CO-3	-	*3*	*3*	*3*	-	*3*
CO-4	*3*	*3*	*3*	*3*	*3*	*3*
CO-5	*2*	*3*	*2*	*2*	*2*	*2*

1: Slightly; 2: Moderately; 3: Substantially

Description:

There is no specific syllabus for this course. Students are expected to undergo at least eight weeks of training in an industry. Alternatively, he can work on a research project under the guidance of a faculty member in any HEI. Students must work on an assigned topic. The topic should be relevant and current. Students must assimilate their knowledge to investigate and find sustainable solutions to the identified field problem. They need to conduct suitable field studies/laboratory experiments. They must analyse the data and develop cost-effective solutions for the identified problem. Students must submit a report and present the work before an evaluation committee.

Evaluation Criteria:

The panel will evaluate the student based on the criteria below. The panel will determine the weightage for each criterion and inform the students.

Criteria	Description	Weightage
I	Relevance of the area of work	10%
II	Performance of the Task	30%
III	**Crucial learnings from the work**	**20%**
IV	Report Preparation	20%
V	Presentation	20%

Each of the above criteria will be assessed at four levels of achievement as indicated below:

a) Unsatisfactory / Inadequate : (0% to 40%)
b) Basic / Satisfactory : (40% - 60%)
c) Proficient / Good : (60% - 80%)
d) Distinguished / Excellent : (80% - 100%)

Learning Resources:

Textbooks:

1. Relevant Textbook based on the field problem identified.

Reference Books:

1. Research Articles / Reports available on the Internet
2. Construction Technology and Management Journals
3. Construction Technology and Management Textbooks and Handbooks

CE16093 **0-0-0 (2)**

Comprehensive Viva voce

Pre-Requisites: **None**

Course Outcomes:

CO-1	Assimilate knowledge of different courses studied.
CO-2	Develop overall comprehension about Construction Technology and Management.
CO-3	Analyse real life engineering problems with theoretical knowledge learned.
CO-4	Interpret and articulate solutions to real life structural engineering problems.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	2	3	–
CO-2	3	3	3	2	3	–
CO-3	3	3	3	2	3	–
CO-4	3	3	3	2	3	–

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

All the subjects studied in I year I semester and II semesters.

Learning Resources:

1. Reading Material of all the courses
2. Case Studies / Consultancy Reports

CE16097 **0-0-0 (8)**

Dissertation Part – A

Pre-Requisites: **None**

Course Outcomes:

CO-1	Define Research Problem Statement.
CO-2	Critically evaluate literature in chosen area of research & establish scope of work.
CO-3	Develop study / experimental methodology.
CO-4	Carryout pilot theoretical study/experiment.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	2	1	3	---
CO-2	3	2	2	1	3	---
CO-3	3	2	2	1	3	---
CO-4	3	2	2	1	3	---

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a topic for his dissertation, based on his/her interest and the available facilities at the commencement of dissertation work. A student shall be required to submit a dissertation report on the research work carried out by him/her.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Identification of Problem Domain	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Study of Existing Systems and establishing clear objectives	
III	Planning of project and work distribution within the team	
IV	Proper Documentation and Technical Writing	
V	Presentation and Response to questions	

Learning Resources:

1. Journal Publications
2. Conference / Seminar Proceedings
3. Handbooks / Research Digests

4th Semester

CE16098 **0-0-0 (12)**

Dissertation Part - B

Pre-Requisites: **CE1697**

Course Outcomes:

CO-1	Expand on the defined research problem
CO-2	Critically evaluate literature in the well-defined research & clearly establish scope of work.
CO-3	Conduct Laboratory studies.
CO-4	Analyze data, develop models and offer solutions.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	2	1	3	–
CO-2	3	2	2	1	3	–
CO-3	3	2	2	1	3	–
CO-4	3	2	2	1	3	–

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project

The method of evaluation should be as per the guidelines stipulated for the M.Tech. Project evaluation. The template for preparation of the project report may be downloaded from (https://www.nitw.ac.in/path/?dept=/nitwForms) under UG Forms. The students are required to submit a report showing that plagiarism is within 20%. The M.Tech. Project work will be evaluated for 100 marks, with the following weightages:

Component	**Weightage**
Periodic evaluation by Guide	40 marks
Mid-term review	20 marks
End Semester viva-voce examination	40 marks
Total	100 marks

If the performance of a student is not satisfactory even after the extended time period, he/ she will have to repeat the project work in the next academic year.

Refer to MTech-Regulations for any further information regarding mid-term review, end-semester evaluation, template for report preparation and plagiarism.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Selection of Topic	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Literature Survey	
III	Objectives and Solution Methodology	
IV	Performance of the Task and clarity on the work	
V	Report Preparation	
VI	Presentation and Response to questions	

Learning Resources:

1. Journal Publications
2. Conference / Seminar Proceedings
3. Handbooks / Research Digests

NOTE: Refer to the following link for the guidelines to prepare dissertation report: https://www.nitw.ac.in/main/PGForms/NITW/

Professional Electives

CE16021 **3-0-0 (3)**

Construction Planning and Management

Pre-Requisites: **None**

Course Outcomes:

CO-1	Plan and develop project organization for executing construction projects.
CO-2	Prepare work break down plan and estimate resources requirements.
CO-3	Learn the techniques used for planning, scheduling and control of construction projects.
CO-4	Apply the techniques for a real-world project and demonstrate the learning.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	3	2	3	2	3
CO-2	2	1	3	3	3	2
CO-3	2	1	2	3	3	3
CO-4	3	2	2	2	2	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Introduction: Phase of project, project management and its relevance, stakeholders of a project, structure of project organization, management levels, and traits of a project manager.

Construction Planning: Introduction, activities involved types of project plan, work breakdown structure. Planning terminologies, Critical path method, forward and backward pass, AOA, AON, Precedence Diagramming Method (PDM), PERT, Line of balance,

Project scheduling and resource levelling: Introduction, Resource allocation and levelling for unlimited resources, Resource allocation for limited resources, Multi resource allocation, Optimal scheduling.

Project Monitoring and Control: Introduction, Project updating, Time Cost Trade off Analysis and Earned Value Analysis. IT tools for project data updating.

Project Risk Management: Risk register, identification, evaluation, allocation, avoidance and sharing of risk. Delay Analysis and Case Studies.

Learning Resources:

Text Books:

1. Mubarak, Saleh A, Construction project scheduling and control, John Wiley & Sons, 2015, 3rd Edition.
2. Jha, Kumar Neeraj, Construction project management: Theory and practice. Pearson Education India, 2011, First Edition.

Reference Books:

1. Cleland, David I. Project management: strategic design and implementation, McGraw-Hill Education, 2007, 5th Edition.

2. Callahan, Michael T., Daniel G. Quackenbush, and James E. Rowings. Construction project scheduling. McGraw-Hill 1992, 1st Edition.
3. Richard H., Glenn A. Sears, and S. Keoki Sears. Construction project management. Clough John Wiley & Sons, 2000, 4th Edition.
4. Oberlender, Garold D. Project management for engineering and construction. McGraw-Hill Education, 2014, First Edition.
5. Harris, Robert Blynn. Precedence and arrow networking techniques for construction. University of Michigan, 1973, First Edition.
6. Goldratt, E. M., Critical chain: A business novel. Routledge, 2017.
7. Project management body of knowledge (pmbok® guide), Guide, A., In Project Management Institute, 2021, Seventh Edition.
8. Construction Project Management - Guidelines: Part 1 General, IS 15883 (Part 1), Bureau of Indian Standards, 2009.
9. Construction Project Management - Guidelines: Part 2 Time Management, IS 15883 (Part 2), Bureau of Indian Standards, 2013.

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/103/105103093/
2. https://onlinecourses.nptel.ac.in/noc19_ce30/preview
3. https://www.pmi.org.in
4. https://www.pma-india.org

CE16023 **3-0-0 (3)**

Building Information Modelling (BIM) for Construction planning and Management

Pre-Requisites: **None**

Course Outcomes:

CO-1	Study the fundamental concepts and principles of Building Information Modeling (BIM).
CO-2	Study the key components of BIM standards
CO-3	Implement BIM workflows and processes for construction planning and management.
CO-4	Study the different applications of BIM in construction projects.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	–	–		3	–	2
CO-2	–	3	3	–	3	
CO-3	3	–	3	3	3	3
CO-4	–	–	3	3	3	–

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Evolution of BIM: Traditional AEC business model and its inefficiencies, BIM process, BIM in construction project lifecycle.

BIM Concepts: Types of modeling, Parametric modeling, Information models, nD modeling, Level of Development. BIM authoring software.

Interoperability and Collaboration: Importance of interoperability in BIM, Different types of data formats, Industry Foundation Classes (IFC), Construction Operations Building Information Exchange (COBie). BIM based Collaboration: BIM Collaboration Format (BCF), Common Data Environment (CDE) and Integrated Project Delivery (IPD).

BIM Implementation: Benefits of implementing BIM, BIM maturity level, National and International BIM standards and frameworks, ISO 19650-BIM standards, Barriers to adoption of BIM, Strategies for adopting BIM, BIM Execution Plan (BEP), Soft landings, Roles and responsibilities in BIM implementation.

BIM Applications: Different applications of BIM in construction projects: Planning, design, construction, operation and maintenance and demolition: Case studies.

Learning Resources:

Text Books:

1. De Wilde, P., Mahdjoubi, L., &Garrigós, A. G., Building Information Modelling (BIM) in Design, Construction and Operations WIT Press, 2019, Volume 192.
2. Eastman, C. M., Eastman, C., Teicholz, P., Sacks, R., & Liston, K. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons, 2011, 2nd Edition.

Reference Books:

1. Kensek, K., & Noble, D., Building information modeling: BIM in current and future practice, John Wiley & Sons, 2014, 1st Edition.
2. Elvin, G., Integrated Practice in Architecture: Mastering Design-Build, Fast-Track, And Building Information Modelling, John Wiley & Sons, 2007, First Edition.
3. Organization and digitization of information about buildings and civil engineering works, including building information modelling -- Information management using building information modelling: Concepts and principles, BS EN ISO 19650-1, The British Standards Institution, 2018.
4. Organization and digitization of information about buildings and civil engineering works, including building information modelling -- Information management using building information modelling: Delivery phase of the assets, BS EN ISO 19650-2, The British Standards Institution, 2018.
5. Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling. Operational phase of the assets, BS EN ISO 19650-3:2020, The British Standards Institution, 2020.

Other Suggested Readings:

1. https://youtu.be/iRMA2TauyvM
2. https://youtu.be/mVsy_ycUD1Q
3. https://www.youtube.com/playlist?list=PLEmWzqc0D6Mi4y3--SvN0v9GKwXb8RNPB

CE16025 **3-0-0 (3)**

Building Services

Pre-Requisites: **None**

Course Outcomes:

CO-1	Design residential buildings from the point of view of grouping and circulation, lighting and ventilation and fire protection.
CO-2	Design vertical transportation in buildings.
CO-3	Prepare a detailed report on the building performance in terms of its serviceability.
CO-4	Plan and design building services.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	–	3	1	3	1
CO-2	2	–	3	1	3	1
CO-3	2	3	3	1	3	1
CO-4	2	3	3	2	3	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Orientation and Planning: Selection of site, Orientation of building, Design of residential buildings with particular reference to grouping and circulation.

General building requirements: Open spaces in and around buildings for lighting and ventilation, Minimum sizes and height of roofs, Rat and Termite proofing of buildings, Lightning protection of buildings.

Fire protection of buildings: Important considerations in fire protection, Fire resisting, Properties of common building materials, Fire safety and exit requirements.

Vertical transportation in buildings: Essential requirements and details of construction of stairs, lifts, escalators and ramps.

Building services: Lighting and Ventilation, Electrical installation, Air-conditioning and heating, Acoustics and Sound insulation, Plumbing services, Building Security and Access control,Smart Buildings Integrated with Internet of Things (IOT), Design of car parking systems and Laundry planning and design.

Learning Resources:

Text Books:

1. Jain, V. K. Jain, Hand Book of Designing and Installation of Services in High Rise Building Complexes, Khanna Publishers, 2000, Third Edition.
2. David V. Chadderton, Building Services Engineering, Routledge, 2012, Sixth Edition.

Reference Books:

1. O. H. Koenigsberger, T. G. Ingersoll, A. Mayhew and S. V. Szokolay, Manual of Tropical Housing and Building: Climate Design, Universities Press (India) Private Limited, 2020, First Edition.

2. Joseph Clarke, Energy Simulation in Building Design, Routledge, 2007, Second Edition.
3. Maekawa, Environmental and Architectural Acoustics, Taylor & Francis, 2010, Second Edition.
4. D Clements-Croome and Derek Clements-Croome, Naturally Ventilated Buildings: Building for the senses, the economy and society, Routledge, 2002, First Edition.
5. Fred Hall and Roger Greeno, Building Services Handbook, Routledge, 2017, Ninthdition.

Other Suggested Readings:

1. Handbook on Functional Requirements of Industrial Buildings (Lighting and Ventilation), SP 32, Bureau of Indian Standards, 1986. https://law.resource.org/pub/in/bis/S03/is.sp.41.1987.pdf
2. Handbook of Functional Requirements of Buildings (Other than Industrial Buildings), SP 41, Bureau of Indian Standards, 1987. https://law.resource.org/pub/in/bis/S03/is.sp.41.1987.pdf
3. National Building Code of India, Bureau of Indian Standards, 2016, Volume – 1 & 2. ps://archive.org/dhttetails/nationalbuilding01. https://archive.org/details/nationalbuilding02
4. Selection, Installation and Maintenance of Control and Indicating Equipments for Fire Detection and Alarm System - Code of Practice, IS 15908, Bureau of Indian Standards, 2011. https://law.resource.org/pub/in/bis/S03/is.15908.2011.pdf
5. Code of Practice for Fire Safety of Building (General): General Principles of Fire Grading and Classification, IS 1641, Bureau of Indian Standards, 2002. https://law.resource.org/pub/in/bis/S03/is.1641.1988.html
6. Code of practice for fire safety of buildings (general): Details of construction, IS 1642, Bureau of Indian Standards, 1989. https://law.resource.org/pub/in/bis/S03/is.1642.1989.pdf

CE16027 **3-0-0 (3)**

Sustainable Construction Materials

Pre-Requisites: **CE1601**

Course Outcomes:

CO-1	Describe the fundamentals of sustainable construction principles.
CO-2	Apply sustainability in the field of construction materials.
CO-3	Develop the solutions for reduction of operational energy.
CO-4	Formulate an action plan for problem solving of complex design challenges using sustainability and resilient principles.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	-	2	-	2	-
CO-2	3	3	3	1	2	3
CO-3	3	1	1	1	3	2
CO-4	3	3	3	-	2	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Introduction to Sustainability: Embodied energy of materials, Operational energy in Building and Life cycle energy, Ecological foot print, Bio-capacity and calculation of planet equivalent.

Role of Material: Material selection, Resources and Reserves in Construction Materials, Carbon from Cement, alternative cements and cementitious material, Alternative fuel for cements for reduction in carbon emission, Sustainability issues for concrete, Role of quality, minimization of natural resource utilization, High volume fly ash concrete, geo-polymer concrete etc. concrete with alternative material for sustainability. Reduction in water consumption in concrete, Recycled aggregate, Energy for grinding crushing of cement aggregate etc. and reduction. Operational energy in building role of materials and thermal conductivity. Clay Bricks, Types kilns, Comparative energy performance emission performance and financial performance, Indoor air quality. Paints, adhesive and sealants for use in building, volatile organic content (VOC) emission issues and indoor air quality for sustainability and health hazard. C & D Waste management practices,

Net Zero Building: Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm. Radiation budget, urban heat island; Surface water balance,

ECBC Guidelines: Effects of trees and microclimatic modification through greening, Use of Building Integrated Photo Voltaic (BIPV) and other renewable energy in buildings, basic concepts and efficiency. Energy codes ECBC requirement. Green Performance rating/ green building assessment tools, requirements of LEED, GRIHA etc.

Learning Resources:

Text Books:

1. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Processes, 1 st Edition, Elsevier, 2003
2. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Constituent Materials, 1st Edition, Elsevier, 2003

Reference Books:

1. Kubba, S, LEED Practices, Certification, and Accreditation Hand book, 1st ed. Elsevier, 2010.

Other Suggested Readings:

1. https://onlinecourses.nptel.ac.in/noc19_ce40/preview

MS16063 **3-0-0 (3)**

Human Resource Management for Construction

Pre-Requisites: **None**

Course Outcomes:

CO-1	Plan and manage key human resource functions within organizations.
CO-2	Analyze current issues, trends, practices, and challenges in HRM.
CO-3	Manage employee performance and contribute to organizational effectiveness.
CO-4	Develop employability skills.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	–	2	3	2	3
CO-2	2	–	2	3	2	3
CO-3	1	–	2	3	2	3
CO-4	–	–	2	3	2	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Introduction: HRM and its functions; Organization and management theory- Contemporary management Theory, Production efficiency- the Classical Approach, Human Behavior theory; Challenges of HRM - Challenges of managing people in construction, Manager's attitude towards people in construction; Expectations of the employment relationship.

Strategic HRM approaches and operational HRM approaches: Models of HRM; Employee resourcing, Recruitment & selection, Employee orientation, Training & Development, Appraisal Systems, Reward management, Mentoring, Career planning and Development.

Employee relations and empowerment: Employees relations, the changing role of trade unions, the effect of unions; Collective bargaining; the evolution of empowerment within HRM.

Diversity, work/life balance & Employment legislations: Workforce diversity, Equal opportunities in construction; Work- life balance; Employee welfare and employment legislations- Workplace health and safety hazards, employment legislations.

Strategic human resource development: Relationship between HRM and business performance, Measuring the performance of HRM – HRM audit, HR scorecard, HR analytics, Digital HRM; Current industry issues and the role of HRM, Future improvements in construction HRM.

Learning Resources:

Text Books:

1. Martin Loosemore, Andrew Dainty, Helen Lingard, Human Resource Management in Construction Projects: Strategic and Operational Approaches, Taylor and Francis, 2014, 2nd Edition.
2. Dessler, G., & Varkkey, B. Human Resource Management, India: Pearson Education, 2024, 17th edition.

Reference Books:

1. David Langford, R.F. Fellows, M. R. Hancock. Human Resource Management in Construction, Routledge, 2014, 1st Edition
2. David A. Decenzo and Stephens P. Robbins, Human Resource Management, John Wiley & Sons, 2016, 12th Edition.

Other Suggested Readings:

1. https://nptel.ac.in/courses/110105069
2. https://onlinecourses.swayam2.ac.in/cec21_mg06/
3. https://www.gsb.stanford.edu/faculty-research/case-studies/adobe-building-momentum
4. https://ocw.mit.edu/courses/15-660-strategic-hr-management-spring-2003/pages/lecture-notes/

CE16022 **3-0-0 (3)**

Energy Efficient Buildings

Pre-Requisites: **None**

Course Outcomes:

CO-1	Comprehend the overview of building design, building physics, ventilation technology, indoor climate and requirements of low energy building design.
CO-2	Apply technologies that will contribute to both energy efficient and healthy buildings.
CO-3	Design energy saving measures in new buildings as well as existing buildings in regard to building services (HVAC) and building technology.
CO-4	Simulate the energy efficiency measures into software and optimize the facilities provided in a building.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	1	–	3	2
CO-2	2	–	2	–	–	–
CO-3	3	2	2	–	3	1
CO-4	2	2	1	–	2	2

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Overview of Energy Efficiency in Buildings: Energy consumption pattern in buildings and role of energy efficiency in buildings.

Energy Efficient Building Design: Planning & Orientation, Insulation, Ventilation, Equipment, Renewable energy

Audits for Healthy Building: Estimation and reduction of environmental impact (embodied energy, carbon footprint etc.) associated with buildings.

Energy Efficient Facility Management: Proactively manage energy-using equipment, Effective use of lighting and HVAC controls, Retrofit existing building systems, Repair and Maintenance of Facility Management.

Software Simulation: Integration of energy efficiency measures and optimize the facilities provided in a building.

Learning Resources:

Text Books:

1. Energy Efficient Buildings In India, MiliMajumdar, The Energy Research Institute (TERI), 2009.
2. Lal Jayamaha, Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance, McGraw-Hill Education, 2007.

Reference Books:

1. Tim Sharpe, Building Integrated Renewable Energy: Technical and Aesthetic Performance of Renewable Energy Systems on Buildings, Springer, 2020, First Edition.
2. Charles Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 2005.
3. John A. Duffie and William A. Beckman, Solar Energy and thermal processes, Wiley, 2013, Fourth Edition.

Other Suggested Readings:

1. Handbook of Functional Requirements of Buildings (Other than Industrial Buildings), SP 41, Bureau of Indian Standards, 1987. https://law.resource.org/pub/in/bis/S03/is.sp.41.1987.pdf
2. Energy Conservation Building Code, Bureau of Energy Efficiency, 2017. https://beeindia.gov.in/sites/default/files/BEE_ECBC%202017.pdf

CE16026 **3-0-0 (3)**

Quality and Safety Management

Pre-Requisites: **None**

Course Outcomes:

CO-1	Distinguish different aspects of quality and apply related tools.
CO-2	Apply techniques of total quality assurance and quality control programme
CO-3	Plan various aspects of safety during construction activity.
CO-4	Apply principles of environmental safety to construction projects.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	1	3	–	–	–
CO-2	3	1	2	–	–	–
CO-3	3	1	–	–	1	–
CO-4	3	1	–	2	–	–

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Quality Management: Quality Gurus, Quality policy in construction industry-Consumer satisfaction-Ergonomics, Quality tools, Quality Function Deployment, Cost of Quality, Statistical Tolerance- Taguchi's concept of quality- Inspection procedures.

Quality Assurance and Control: Total QA/QC Program and cost implication. Statistical Quality Control, Different aspects of quality-Appraisals, failure mode analysis, Stability methods and tools, Influence of drawings, detailing, and specification.

Safety Programmes and organization: Introduction to safety, challenges in the construction sector, accident statistics, accident causation theories, Cost of Safety, Safety acts and Regulations, Safety audit, accident investigation and prevention Techniques, Environmental safety, Social and environmental factors, Application of digital technology in construction safety.

Learning Resources:

Text Books:

1. Phil Hughes and Ed Ferrett, Introduction to Health and Safety in construction, Routledge publications, Fifth Edition, 2016
2. James, J.O Brian, Construction Inspection Handbook: Quality Assurance/Quality Control, Third Edition, 2012

Reference Books:

1. Prof Jha, Patel and Singh, Construction Safety Management, 2021 (In Press)
2. Frank, J.M. and Gryna, F.M , Quality planning and Analysis, Juran Tata McGraw Hill, 2000
3. Abdul RazzakRumane, Quality Management in Construction Projects, CRC Press, 2018, Second Edition,
4. ISO 9000:2015, Quality management systems — Fundamentals and vocabulary

5. ISO 9001:2015, Quality management systems — Requirements
6. ISO 9004:2018, Quality management — Quality of an organization — Guidance to achieve sustained success
7. OHSAS 18001:2007 Occupation Health and Safety Management Systems
8. National Building Code of India 2016, Bureau of Indian standards, IS SP 7 : 2016

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/102/105102206/ Website reference links

CE16028 **3-0-0 (3)**

Quantitative Methods in Construction Management

Pre-Requisites: **None**

Course Outcomes:

CO-1	Formulate and solve the deterministic optimization problems.
CO-2	Model risk and uncertainty in construction projects.
CO-3	Apply stochastic optimization techniques for decision making under uncertainty.
CO-4	Apply simulation techniques in construction projects

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	3	2	3	3	3
CO-2	1	3	2	3	3	3
CO-3	2	3	2	3	3	3
CO-4	1	3	3	3	3	3

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Introduction and concepts of probability and statistics: Probability: Conditional probability, Probability distributions (Normal, Bayesian, Poisson, Exponential), Probability density functions.

Linear programming: Formulation of LP problems: Basic variables, constrains, corner points, augmented form, maximization and minimization problems. Solution methods: Graphical method, Algebraic method, Simplex method (Tabular and Matrix form). Integer linear programming.

Transportation problems: Transportation problem: Basic feasible solutions using N-W Corner rule, Minimum cost method, Vogel's approximation method. Optimal solutions using Stepping Stone Method, Modified distribution method. Assignment problems: Hungarian algorithm.

Decision theory: Decision in certainty: Analytical hierarchy approach, Comparison Matrix, Consistency test, Oil exploration problem, Manpower planning problem. Probabilistic decision making: Expected value approach, sensitivity analysis on payoffs, Optimal decision strategy.

Forecasting: Quantitative methods-Time series (average method, moving average method, exponential smoothing, mean square error), Regression analysis. Qualitative methods.

Simulations applied to construction: Monte-Carlo Simulation, Sensitivity Analysis and Analytical Hierarchy Process (AHP).

Learning Resources:

Text Books:

1. Render, B., & Stair Jr, R. M., Quantitative Analysis for Management, Pearson Education India, 2017, 12th Edition.
2. Taha, H. A., Operations research: an introduction, Pearson Education India, 2013, 9th Edition.

Reference Books:

1. Freund, J.E. and Miller, I.R., Probability and Statistics for Engineers, Prentice - Hall of India, New Delhi, 1994. 5th Edition.
2. J. C. Pant, Introduction to Optimization, Jain Brothers, New Delhi, 2012, 7th Edition.
3. Goel B.S. and Mittal, S.K., Operations Research, PragatiPrakashan, Meerut, 2000.

Other Suggested Readings:

1. https://nptel.ac.in/courses/112/106/112106134/
2. https://nptel.ac.in/courses/112/106/112106131/

3-0-0 (3)

CE16024

Formwork Design and Practice

Pre-Requisites: None

Course Outcomes:

CO-1	Design formwork in Civil Engineering projects.
CO-2	Plan the sequence of construction of civil engineering structures.
CO-3	Plan the safety steps involved in the design of formwork and false work.
CO-4	Select a right material for manufacturing false work and formwork suiting specific requirements.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	3	1	–	3	–
CO-2	1	3	2	1	3	1
CO-3	1	3	1	1	3	1
CO-4	2	3	3	1	3	–

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Introduction: Formwork and false work, Temporary work systems, Requirements, Construction planning and site constraints, Selection, and Classification (Types) of Formwork

Formwork Materials and supports: Timber, plywood, aluminum, and steel formworks, Shoring Towers, and Scaffolds

Formwork Design: Foundation, Wall, Column, Slab and Beam formworks. Design of Decks and False works. Effects of various loads. Loading and moment of formwork, IS Code provisions.

Formwork for Special Structures: Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Nuclear Reactor, Tunnel, and Lift Shaft.

Formwork for Bridge Structures: Cases in Failure of Temporary Support Structures of Bridges

Flying Formworks: Table Forms, Tunnel Formwork System, Column Mounted Shoring System, Gang Forms, Slipform, Formwork for Precast Concrete,

Formwork Failure: Construction Sequence and Safety in use of Formwork, Sequence of construction, Safety use of formwork and false work.

Pre-Award and Post –award Formwork Management Issues: Formwork Issues in Multi-Story Building Construction.

Learning Resources:

Text Books:

1. Jha, K.N., Formwork for Concrete Structures, McGraw Hill, 2012, First Edition.
2. Robert L. Peurifoy and Garold D. Oberiender, Formwork for Concrete Structures, McGraw- Hill, 2010

Reference Books:

1. Slip Form Techniques, Tudor Dinescu and Constantin Radulescu Abacus Press, Turn Bridge Wells, Kent, 2004
2. Austin, C.K., Formwork for concrete, Cleaver - Hume Press Ltd., London, 2010

Other Suggested Readings:

1. https://www.youtube.com/watch?v=p5lzixbac6k
2. https://www.youtube.com/watch?v=xSCYsb_d3Ao

3-0-0 (3)

MS16062

Strategic Management in Construction

Pre-Requisites: **None**

Course Outcomes:

CO-1	Analyze the importance of Strategic Management in a business organization.
CO-2	Identify environmental factors that influence business firm.
CO-3	Analyze the effect of competition on the business environment.
CO-4	Implement different models and strategies used by organizations.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	1	2	2	2	1
CO-2	2	1	2	2	2	1
CO-3	3	1	2	2	2	1
CO-4	3	1	2	2	2	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Syllabus:

Introduction: Strategic management process; Vision, Mission, Purpose, Objectives, goals, Policies and programs, strategy, levels of strategy; 7-S framework; Corporate governance - Board of Directors: Roles, Responsibilities, Structure and composition, Role of top management.

External and Internal Environment Analysis: Macro and Micro environmental factors; SWOT Analysis, Value chain analysis, Resource based approach.

Decision and Analytical Tools: Strategy formulation framework, Competitive Environment-five forces model; Porter's generic strategies - overall cost Leadership, focus and differentiation strategies; Factors driving industry change; Key factors for success in organization.

Corporate Strategies: Growth strategy, stabilization strategy and defensive strategies; Portfolio strategies-G.E, Mckinsey Matrix, B.C.G matrix & Arthur D.Little's model; Corporate parenting strategy, Ansoff's product market grid.

Strategic Management: Evaluation and control: Strategy implementation, Strategy audit, Strategy review, evaluation and control; Measuring organizational performance, Balanced scorecard; Contingency planning-Case studies of Construction Companies.

Learning Resources:

Text Books:

1. David Langford, Steven Male, Strategic Management in Construction, John-Wiley and Sons,2008, 2nd Edition.
2. Thompson & Strickland, Crafting and Executing Strategy, Tata McGraw Hill, 2021, 22nd edition.

Reference Books:

1. Arthur Thompson and Margaret Peteraf and John Gamble and A. Strickland, Crafting & Executing Strategy: Concepts and Cases, McGraw Hill, 2020, 22nd Edition
2. Henry Mintzberg; Bruce W Ahlstrand; Joseph Lampel, Strategy Safari: A Guided Tour through the Wilds of Strategic Management, Free Press, 2005
3. David, F., & David, F. R. Florence, Strategic management: A competitive advantage approach, concepts and cases, Pearson–Prentice Hall, 2019, 17th edition.

Other Suggested Readings:

1. https://archive.nptel.ac.in/courses/110/108/110108047/
2. https://onlinecourses.swayam2.ac.in/imb19_mg08/
3. https://www.strategy-business.com