P.G. Section in
Construction Technology & Management

Curriculum & Syllabus
(*First Revision*)

M.TECH-CONSTRUCTION TECHNOLOGY & MANAGEMENT

(Revised at SVNIT Surat on 23-24 February 2018)

CIVIL ENGINEERING DEPARTMENT
SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY
(SVNIT) ICHCHHANATH, SURAT-395 007

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY

Our Vision

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

Our Mission

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

CIVIL ENGINEERING DEPARTMENT

Vision

To be a global centre of excellence for creating competent professionals in civil engineering

MISSION

M1: To provide excellent education producing technically competent, globally employable engineers who will be leaders in the chosen field

M2: To undertake research in conventional and advanced technologies fulfilling the needs and challenges of modern society

M3: To provide consultancy services and develop partnerships with society, industry and public organizations.

M4: To organize seminars, conferences, symposia, and continuing education programmes for academic and field community

COURSE DETAILS

1. Name of the department : Civil Engineering
2. Name of the course : Post Graduate Program (Construction Technology and Management)

Title of Degree	Specialization	Intake (Full time)	Entry Level Qualification	Admission
M.Tech. CIVIL Engineering (Construction Technology & Management)	Construction Technology & Management	25	B.E./B.Tech. in Civil Engineering, Bachelor of Construction Technology, B. Arch., B. Planning	With valid GATE score of Civil Engineering - (CE) and Architecture and Planning - (AR) through CCMT and / as per institute rules and regulations.

3. Course Structure and Scheme of Evaluation (Semester-wise, along with curriculum details as follows)

POST GRADUATE PROGRAMME IN
CONSTRUCTION TECHNOLOGY & MANAGEMENT

Program Educational Objectives

PEO 1: Excel in professional career and develop research skills in the field of Construction Technology & Management.

PEO 2: Exhibit professionalism through lifelong learning and able to work in teams for collaborative and various task.

PEO 3: Graduates will communicate effectively in their team, adapt to emerging trends for sustained growth in independent and reflective learning and exhibit social responsibility and professional ethics.

POST GRADUATE PROGRAMME IN
CONSTRUCTION TECHNOLOGY & MANAGEMENT

Program Outcomes (POs)

PO1 Acquiring sound knowledge on entire spectrum of activities associated with construction technology & management and develops ability to, evaluate, analyze and integrate existing knowledge with the innovative knowledge.

PO2 Analyze potential complexities critically, understand the project requirements and attempt to mitigate risks in a proactive manner

PO3 Understand the importance of societal, health, safety, legal and cultural considerations in carrying out construction projects

PO4 Design and conduct research experiments for acquisition/generation, analysis and interpretation of data based on literature survey for construction technology & management problems demonstrating higher order skill through appropriate research methodologies, techniques and tools independently or in a team.

PO5 Apply advanced tools, techniques and latest software, applicable to a range of construction applications.

PO6 Contribute positively to collaborative – multidisciplinary scientific research demonstrating capacity for self-management and teamwork, decision making based on open-mindedness, objectivity using knowledge of group dynamics to achieve common goals of advancement in learning for self and others.

PO7 Confidently apply modern management principles and engineering economics in agile environment and engage stakeholders and achieve results through proactive action.

PO8 Communicate effectively through technical reports and presentations with key stakeholders and give and receive clear instructions.

PO9 Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PO10 Apply ethical principles in construction technology & management practices and professional responsibilities.

PO11 Learn from mistakes based on self observation of the outcomes of own actions and take corrective measures.

MAPPING OF POs & PEOs

Programme Outcomes	PEO 1	PEO 2	PEO 3
PO1	3	2	2
PO2	3	2	1
PO3	2	3	2
PO4	3	3	2
PO5	2	2	3
PO6	1	2	3
PO7	1	2	1
PO8	2	1	3
PO9	2	1	2
PO10	1	1	3
PO11	1	3	3

LEVEL OF RELATION- 1: Slightly 2: Moderately 3: Substantially

M. TECH CONSTRUCTION TECHNOLOGY & MANAGEMENT

SEMESTER I

Code	Subjects	L	T	P	Marks		Credit
					Theory	Pract / Tuto.	
CE 711	Construction Project Planning and Control	3	1	0	100	25	4
CE 713	Construction Methods & Equipment	3	1	0	100	25	4
CE 715	Advanced Construction Materials	3	0	0	100	-	3
	Elective I	3	0	0	100	-	3
	Elective II	3	0	0	100	-	3
CE 717	Construction Materials Lab	0	0	4	-	50	2
CE 719	Graduate Report-I	0	0	2	-	25	1
	Total	15	2	6	500	125	20

L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER II

Code.	Subjects	L	T	P	Marks		Credit
					Theory	Pract / Tuto.	
CE 712	Project Appraisal and Finance	3	1	0	100	25	4
CE 714	Construction Contract and Law	3	1	0	100	25	4
CE 716	Construction Quality and Safety	3	0	0	100	-	3
	Elective-III	3	0	0	100	-	3
	Elective-IV	3	0	0	100	-	3
CE 718	Construction Management Lab	0	0	4	-	50	2
CE 722	Graduate Report-II	0	0	2	-	25	1
	Total	15	2	6	500	125	20

L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER III

Code	Subjects	L	T	P	Marks		Credit
					Theory	Pract / Tuto.	
CE871	Professional Project	0	0	6	-	150	3
CE873	Dissertation Preliminaries	0	0	8	-	100	4
CE875	Seminar	0	0	2	-	50	1
CE877	Summer Training	0	0	4	-	100	2
	Total	0	0	20	-	400	10

L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER IV

Code	Subjects	L	T	P	Marks		Credit
					Theory	Pract / Tuto.	
CE882	Dissertation	0	0	20	-	400	10
	Total	0	0	20	-	400	10

L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SUMMARY						
All Subjects & Semesters	L	T	P	Marks		Credit
				Theory	Pract / Tuto.	
Total	30	04	52	1000	1050	60

LIST OF ELECTIVE

Sr. No.	Subjects	L	T	P	Marks		Credit
					Theory	Pract / Tuto.	
CE604	Environment Impact Assessment and Management	3	0	0	100	-	3
CE691	Research Analytical Technique	3	1	2	100		4
CE871	Soft Computing Techniques	3	0	0	100	-	3
CE634	Urban Infrastructure Planning & Management	3	1	0	100	-	4
CE652	Real Estate Management	3	0	0	100	-	3
CE658	Applied Statistical Analysis	3	0	0	100	-	3
AM613	Rehabilitation of concrete structure						
CE724	Formwork for Structure	3	0	0	100	-	3
CE721	Quantitative Methods	3	0	0	100	-	3
CE723	Organization Management	3	0	0	100	-	3
CE725	Lean Construction	3	0	0	100	-	3
CE 726	Low Cost Construction	3	0	0	100	-	3
CE727	Precast and Prestress Construction	3	0	0	100	-	3
CE729	Infrastructure Valuation	3	0	0	100	-	3
CE730	Disaster Management	3	0	0	100	-	3
CE720	Building Information Modeling	3	0	0	100	-	3
CE731	Resilience and Sustainable Infrastructure	3	0	0	100	-	3
CE734	Smart Infrastructure System	3	0	0	100	-	3
ME650	Optimization Technique	3	0	0	100	-	3
CE736	Maintenance and Rehabilitation	3	0	0	100	-	3
CE735	Building Services and Management	3	0	0	100	-	3

NOTE:

- List of elective contains subjects of other departments, other post graduate programme of civil engineering and applied mechanics departments and related to area of construction technology and management in order to make the system more flexible and to offer options to P.G. students of their interest area.

- One external examiner & concerned internal examiners shall conduct end semester examination in case of Practical/Studio and Project. Final examination for dissertation will be conducted as per Institute norms.

- Continuous assessment evaluation of project/seminar will be carried by a panel of 3 examiners including guide / supervisor.

- Two progress evaluations each of dissertation preliminary and dissertation at 3rd and 4th semester will be conducted by the panel of 3 internal examiners, including guide / supervisor.

- There will be 6-8 weeks of mandatory summer training for all the candidates. Assessment of summer training report will be carried out in the 3rd semester by panels of 3 internal examiners.

SEMESTER - I

M. TECH. I (CTM) SEMESTER- I	**L**	**T**	**P**	**C**
CE711 CONSTRUCTION PROJECT PLANNING AND CONTROL	**3**	**1**	**0**	**4**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Understand the principles of project management, resource management and inventory.

CO2 Prepare work break down plan and estimate resources requirements.

CO3 Learn in depth about project scheduling and time management.

CO4 Solve problems of resource allocation and levelling using network diagrams.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	-	1	3	1	1	-	-
CO2	3	3	2	1	1	1	3	-	-	1	1
CO3	3	3	1	1	-	1	2	-	-	1	-
CO4	1	3	3	3	1	-	2	-	-	-	2

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Concept of project Management**

   Pre award to closing- A life cycle approach stakeholders in projects, Initiation, Planning, Execution, Monitoring & control and closing, Bidding stage assumptions and factors influencing project performance, Iron triangle Project Scope, Time& cost, Project Strategy, Project Feasibility

2. **Work Breakdown Structure**

   Scope Management, Project Charter, Scope of Work (SoW), Concept of WBS, WBS Quality principles, typical hierarchy in the WBS of a project, desirable characteristic of work packages, determinants having critical influences on the work packages, scope creep, change management, WBS, OBS & RBS, Control Accounts

3. **Project Planning and Scheduling**

   Importance of sound planning, Scheduling, principles and techniques, Scheduling methods (AOA & AON), critical path method, concept of float, project evaluation and review techniques, line of balance variances in project duration and cost, network scheduling with limited resources, resource allocation, smoothing and leveling, updating the network, master networks, the time -cost trade-off approach, progress review and reporting, risk of schedule delays, missing milestone deliverables and its impact (from client and contractors view point) change management, contemporaneous records, documenting delays and maintaining records.

4. Project Control and Monitoring

Parameters of project performance, time, cost and quality and their interrelationships, schedule and cost control tools and techniques, performance reporting, audit, corrective and preventive actions, fund flow control, management information system and application of management software.

REFERENCES:

1. Baldwin, A and Bordoli, D (2014) A Handbook for Construction Planning and Scheduling, Blakwell Publishers.
2. Jha, K N (2011) Construction Project Management, First Edition, Pearson Publishers.
3. Harris, F, McCaffer, R and Edum-Fotwe, F (2006) Modern Construction Management, sixth edition, Blackwell Publishers.
4. Knutson, K, Schexnayder, C J, Fiori, C. and Mayo, R E (2013) Construction Management Fundamentals, MCGraw Hill Publishers.
5. Whyte, A (2015) Integrated Design and cost for civil Engineers, CRC Press, Taylor and Francis Group.
6. Mubarak, S (2010) Construction project scheduling and control, second edition, John Wiley and sons.
7. Fewings, P (2011) Construction Project Management - An integrated approach, Taylor and Francis.
8. Goetsch, D L (2015) Project Management for construction, Pearson publishers.
9. Ottoson, H (2013) Practical project management for building and construction, CRC Press, Taylor and Francis.

M. TECH. I (CTM) SEMESTER- I	L	T	P	C
CE713 CONSTRUCTION METHODS & EQUIPMENT	3	1	0	4

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To understand different formwork systems and temporary structures.

CO2 To learn in depth about steel and pre-stressed construction.

CO3 To perceive heavy and special construction techniques.

CO4 To judge appropriate selection of construction equipment.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	1	-	1	2	-	2	3	1
CO2	3	3	3	1	2	2	2	-	2	3	-
CO3	3	2	2	-	3	3	3	-	2	1	1
CO4	3	2	3	-	-	2	2	-	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Form Work and Temporary Structures**

   Form work design and scaffolding, slip form and other moving forms, Shoring, Reshoring, and Back shoring in multistoried Building construction.

2. **Steel Construction**

   Shop and in-situ construction techniques, different connections. High strength bolts, Clearances and Tolerances, Erection of steel structures like Bridges, Trusses Chimneys, Power Houses.

3. **Prestressing, Steel and composites construction methods**

   Fabrication and erection of structures including heavy structures, Prefab construction, industrialized construction, Modular coordination.

4. **Special construction methods**

   High rise construction, Bridge construction including segmental construction, incremental construction and push launching techniques, Box pushing method, Top to bottom Construction.

5. **Planning and Selection of Construction Equipment**

   Factors affecting selection of equipment - technical and economic, Analysis of production outputs and costs, Characteristics and performances of equipment for major civil engineering activities such as Earth moving, erection, material transport, pile driving, Dewatering, and Concreting, Ready mix concrete plants.

REFERENCES:

1. Jha K N (2012) Formwork for Concrete Structures, Tata McGraw Hill, New Delhi.
2. Jha, K N (2015) Construction Project Management: Theory and Practice, Second Edition, Pearson Publishers, New Delhi.
5. Day, K W (1995) Concrete Mix Design, Quality Control and Specification, E & FN Spon.
6. Peurifoy, R L, and Oberlender, G D (1996) Formwork for concrete structures, McGrow Hill India.
7. Warszawski, A (1990) Industrialization and robotics in building: a managerial approach. Harpercollins College Division.
8. Harris, F (1989) Modern construction equipment and methods. Longman Scientific & Technical.
9. Smith, R C, and Andres, C K (1993) Principles and practices of heavy construction. Prentice Hall.

M. TECH. I (CTM) SEMESTER- I	L	T	P	C
CE715 ADVANCE CONSTRUCTION MATERIALS	3	0	0	3

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To study fundamentals of material science.

CO2 To analyses the properties of sustainable material.

CO3 To control quality of construction.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	1	-	1	2	1	1	-	-
CO2	3	2	2	1	-	1	1	-	-	-	-
CO3	3	3	1	1	2	1	3	-	-	3	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Material Science**

   Classification, Standardization, Codification and Variety. Details of Micro Structure of Different construction Materials, Different effects on materials of construction.

2. **Properties of Materials**

   Environmental Influences, Thermal effects Effect of Chemicals, Fire resistance, Corrosion and Oxidation, Radiation. Properties of fresh & hardened concrete. Shrinkage & creep of concrete.

3. **Sustainable Materials**

   Introduction, sustainability and goals, current situation, earth's natural system, carbon cycle, role of construction materials, CO2 from fossil fuel vis-à-vis cement and other construction materials. Construction material and indoor air quality. Energy for production, transportation and erection, Estimation methodology, Computation of embodied energy for building. Primary energy and Energy Concepts

4. **Advance Concrete**

   High volume fly ash concrete, geo-polymer concrete and their embodied energy content against OPC concrete. Aggregate resource depletion, recycled aggregate from demolition etc. role of quality control and admixtures in sustainability. Durability of construction material and life cycle sustainability.

5. **Other Material**

   Polymer materials, Thermo - Plastic, Polymer Concrete, Composite, materials, Ferro cement, Ferroconcrete, Building materials from Agricultural,& Industrial wastes, M Sand, Glass, Cladding, Light Weight Concrete

REFERENCES:

1. Wu Chung, H (2006) Advanced Civil Infrastructure Materials, First Edition, Woodhead Publishing Limited.
2. Newman, J and Choo, Ban Sang (2003) Advanced Concrete Technology-Processes, 1st Edition, Elsevier.
3. Kubba, S (2010) LEED Practices, Certification, and Accreditation Hand book, 1st ed. Elsevier.
4. Ministry of Power (2007) Energy Conservation Building Code, Revised Version, Bureau of Energy Efficiency.

M. TECH. I (CTM) SEMESTER- I	L	T	P	C
CE717 CONSTRUCTION MATERIALS LAB	0	0	4	2

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To test the properties of materials.

CO2 To design the concrete.

CO3 To analyze the results of experiments.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3	1	2	3	1	1	2	2	3
CO2	3	2	2	2	2	3	1	1	2	2	1
CO3	2	2	2	2	2	3	1	3	2	2	3

Note: 1: Slightly 2: Moderately 3: Substantially

Tests related to quality control at site, in-situ tests, tests related to damage and deterioration assessment, performance monitoring of structures will be performed.

1. Testing of cements and supplementary cementations materials
2. Testing of chemical admixtures
3. Mixture design of special concretes
4. Moisture profile and acoustic measurements
5. Non destructive tests, half-cell potential, pH measurement, carbonation depth, water and air permeability
6. Effect of high temperature on concrete
7. Calorimetric and shrinkage
8. Alkali Silica Reaction
9. Advanced characterization of construction materials
10. Behavior of construction joints, water-proofing and precast joints

REFERENCES:

1. Richardson, M G (2002) Fundamentals of Durable Reinforced Concrete, First Edition, Spon Press.
2. Mehta, P K and Monteiro, P J M (2006) Concrete Microstructure Properties and Materials, Third Edition, Tata McGraw Hill.
3. Bohni, H (2005) Corrosion in Reinforced Concrete Structures, CRC Press.
4. Bensted, J. and Barnes, P (2002) Structure and Performance of Cements, Second Edition, Spon Press.
5. Newman, J and Choo, B S (2003) Advanced Concrete Technology- Processes, Elsevier.
6. Newman, J and Choo, B S (2003) Advanced Concrete Technology – Testing and Quality, Elsevier.
7. Neville, A M (2006) Properties of Concrete, Fourth Edition, Pearson.

M. TECH. I (CTM) SEMESTER- I	**L**	**T**	**P**	**C**
CE719 GRADUATE REPORT-I	**0**	**0**	**2**	**1**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To develop technical writing and communication skills.

CO2 To find the research gap from the literature.

CO3 To aware about current innovative practices and technology.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	3	2	1	3	2	1	3	3	1	1
CO2	1	3	2	1	3	2	1	3	3	1	1
CO3	1	3	2	1	3	3	1	3	3	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

- Students are expected to prepare graduate reports on various topics of the subjects as assigned by the faculty advisor and submit duly computer typed reports, present & participate in subject wise group discussion.

SEMESTER - II

M. TECH. I (CTM) SEMESTER- II	**L**	**T**	**P**	**C**
CE712 PROJECT APPRAISAL AND FINANCE	**3**	**1**	**0**	**4**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To learn the fundamentals of project formulation and appraisal.

CO2 To monitor and control project.

CO3 To implement concepts of finance management in practice.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	1	1	2	3	1	2	1	1
CO2	3	2	3	1	1	2	3	1	2	2	2
CO3	3	3	3	1	1	2	3	1	1	1	2

Note: 1: Slightly 2: Moderately 3: Substantially

1. Project Formulation

Generation and screening of project ideas, project identification, preliminary analysis, market, technical, financial, economic and ecological-pre-feasibility report and its clearance, project estimates and techno-economic feasibility report, detailed project report, different project clearances required

2. Project Appraisal

NPV, BCR, IRR, ARR, urgency-payback period, assessment of various methods, Indian practice of investment appraisal, international practice of appraisal, analysis of risk, different methods for selection of a project and risk analysis in practice, ownership structures; BOT, BOLT, BOOT models.

3. Project Accounting

Profit and loss, balance sheet, income statement, ratio analysis, depreciation and amortization, preparation of financial statements, inflation accounting and corporate practices in India

4. Working Capital Management

Policy for working capital, estimating working capital need, inventory management, account receivable, credit and cash management, managing payments to supplies and outstanding, capital investment decisions, techniques of capital budgeting, cost of capital. Cash flow analysis

5. Long term financing and Budgeting

Working of financial institutes in India and abroad, self financing, stock exchanges, types of securities, borrowings, debentures, types of budgeting, procedure for master budget, key factor, budget manual, and new approach to budgeting, cash flow forecast.

REFERENCES:

1. Prasanna Chandra (1995) Projects Preparation, Appraisals, Budgeting and Implementation, 3rd Edition, Tata Mc Graw Hill Publishing Co. Ltd.
2. Van Horne, J C (1990). Fundamentals of Financial Management, Printice-Hall of India Ltd.
3. Taylor, G A (1968) Managerial and Engineering Economy. East-West Edition.
4. Thuesen, H G (1959) Engineering Economy, Prentice-Hall, Inc.
5. Brigham, E F (1978) Fundamentals of Financial Management, the Dryden Press, Hinsdale, Illinios.
6. Kolb, R W and Rodriguez, R J (1992) Financial Management D C Heath & Co.
7. Walker, E W (1974) Essentials of Financial Management, Prentice Hall of India Private Limited, New Delhi.
8. Collier, C A and Ledbetter, W B (1982) Engineering Cost Analysis, Harper & Row Publishers.
9. Maheshwari, S N (2002) Cost and Management Accounting, Sultan Chand & Sons.
10. Lifson, N W and Shaifer, E F (1982) Decision and Risk Analysis for Construction Management, John Wliey & Sons.
11. Degoff, R A and Friedman, H A (1985) Construction Management, John Wliey & Sons.
12. McCarthy, J F (2010) Construction project management - A managerial approach, Pareto publishers.

M. TECH. I (CTM) SEMESTER- II **L T P C**

CE714 CONSTRUCTION CONTRACT AND LAW **3 1 0 4**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To prepare contract schedules, notice inviting tender and contract documents.

CO2 To understand laws of construction contract.

CO3 To implement dispute resolution techniques in practice.

CO4 To prepare contract management plan as per standards.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	1	1	2	1	1	3	2
CO2	3	2	2	1	-	1	2	-	1	3	1
CO3	3	3	1	1	2	1	2	-	1	3	2
CO4	3	2	2	2	-	1	2	2	1	3	2

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Construction Contracts**

   Concept of contract, types of contracts, joint venture, merging, acquisition, features and suitability, design of contract documents, international contract document, standard contract document, law of torts, Indian contract act 1872, Introduction to various standard forms of contract such as FIDIC, JCT and NEC.

2. **Tenders**

   Prequalification and Bidding process, potential contractual problems, Rules of interpretation of contract clauses, Concession agreements

3. **Construction Claims and Disputes**

   Sources of claims and disputes, construction claims procedure, methods of dispute resolution, alternative dispute resolution method, comparison of actions and laws, agreements, subject matter, violations, Arbitration and Conciliation act 1996 and recent amendments in 2015, Delay analysis, case studies, professional ethics, duties and responsibilities of parties.

4. **International Construction Contracts**

   Type of contracts, surety bonds, time provisions, safety clause, insurance, Employer's Liability Policy, Builder's risk, Foreign corrupt practice Act, rate of inflation, use of local labor, Differences in Ethic, languages and culture

REFERENCES:

1. Jimmie W Hinze (2013) Construction Contracts, 3rd Edition. McGraw Hill.
2. Joseph T Bockrath (2013) Contracts and the Legal Environment for Engineers and Architects, 6th Edition. McGraw Hill.
3. Indian Contract Act 1872.
4. Arbitration Act (1996) (with amendment 2015)
5. Gajaria, G T (1986) Laws Relating to Building and Engineering Contracts in India, M. M. Tripathi Private Ltd.
6. Bhatt, V and Vyas, P (2015) Laws for Engineers (Contract, Arbitration, Evidence, Limitations), Second Edition, Procare.
7. Gajria, K (2000) Law relating to Building and Engineering Contracts in India, Butterworths India.
8. Ramaswamy, B S (2005) Contracts ad their Management, Lexis Nexis Butterworths.
9. Murdoch, J and Hughes, W (2002) Construction Contracts, Spon Press.
10. Ross, A and Williams, P (2013) Financial Management in Construction Contracting, Wiley-Blackwell.
11. Ndekugri, I and Rycroft, M (2009) the JCT Standard Building Contract: Law and Administration, Elsevier.
12. Fenn, P (2012) Commercial Conflict Management and Dispute Resolution, Spon Press.
13. Atkinson, D (2007) Causation in Construction Law – Principles and Methods of Analysis, Danial Atkinson Limited.
14. Roy Chowdhury, S K, Saharay, H K (1996) Law of Arbitration and Conciliation, Eastern Law House.

M. TECH. I (CTM) SEMESTER- II **L T P C**

CE716 CONSTRUCTION QUALITY AND SAFETY **3 0 0 3**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Understand different aspects of quality and related tools.

CO2 Apply techniques of total quality assurance and quality control programme and cost implication.

CO3 Understand importance of various aspects of safety during execution of construction activities.

CO4 Apply to principles and theories of safety to construction projects.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	2	3	2	-	2	3	2
CO2	2	3	3	1	3	2	1	-	2	3	3
CO3	3	3	3	1	2	1	2	-	2	3	2
CO4	2	3	3	1	3	1	2	-	3	3	3

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Construction Organization**
   Types of organization, inspection, control and enforcement, quality management systems and method, responsibilities and authorities in quality assurance and quality control; architects, engineers, contractors, and consultants, quality circle

2. **Quality Assurance and Control**
   Objectives, regularity agent; owner, design, contract and construction oriented objectives, methods/techniques and needs of QA/QC different aspects of quality, appraisals, factors influencing construction quality-critical, major failure aspects and failure mode analysis stability methods and tools, optimum design, reliability testing, reliability coefficient and reliability prediction selection of new materials.

3. **Total Quality Management**
   Road Map for TQM Implementation, Role of management in TQM, Quality improvement planning measurement, construction site implementation, six sigma in quality management.

4. **Safety and Health in Construction**
   Safety and accidents in construction projects, theories of accident causation, health and illness related with construction works, cost of construction injuries, safety risk analysis and control, personal protective equipment, occupational and safety hazard assessment, legal implications, OSH Management System

5. **Safety Programme and Contractual obligations**

Problem areas in construction safety, elements of an effective safety programme, job site safety assessment, safety meetings, and safety incentives Safety in construction contracts, substance abuse, safety record keeping.

6. Decision for Safety

Safety culture, safe workers, safety and first line supervisors, safety and middle managers, top management practices, company activities and safety, safety personnel, sub contractual obligation, project coordination and safety procedures and workers compensation

REFERENCES:

1. Yang, K. and El-Haik, B S (2009). Design for Six Sigma, Tata McGraw Hill.
2. McCabe, S (1998) Quality improvement techniques in construction, Pearson Education.
3. Rumane, A R (2011) Quality management in construction projects, CRC Press, T&F.
4. Rumane, A R (2013) Quality tools for managing construction projects, CRC Press, T&F.
5. Juran J M and Gryna, F M (1993) Quality Planning and Analysis: From Product Development through Use, 3rd Edition, and Tata McGraw Hill.
6. Levitt, R E and Samelson, Nancy Morse (1993) Construction Safety Management 2nd Edition, Wiley Publisher.
7. Goetsch. David L (2014) Occupational Safety and Health for Technologists, Engineers and Managers, 8th Edition, New Jersey: Pearson. Edu. Inc.
8. Hinzie, J W (1997) Construction safety, Prentice Hall.
9. MacCollum, D V (1995) Construction safety planning, John Wiley & sons.
10. MacCollum, D V (2007) Construction safety engineering principles - designing and managing safer job sites, Tata McGraw Hill.
11. Holt, A S J (2005) Principles of construction safety, Blackwell Publishers.

M. TECH. I (CTM) SEMESTER- II **L T P C**

CE718 CONSTRUCTION MANAGEMENT LAB **0 0 4 2**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To prepare detailed schedule of different construction projects.

CO2 To develop on their own simple algorithms for any construction software

CO3 To integrate software applications for complex problems

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	3	2	2	2	2	1	2
CO2	3	3	3	3	3	1	2	3	2	1	2
CO3	2	3	2	3	3	1	2	2	2	1	2

Note: 1: Slightly 2: Moderately 3: Substantially

Introduction to construction project models - analytical and numerical. Application of software for project planning, scheduling & control. Programming exercises for estimation, network planning and control, LP in construction. MATLAB Programming in linear and non-linear programming

REFERENCES:

1. Van Horne, J C (1990) Management and Policy, Printice-Hall of India Ltd.
2. Harris, F and McCaffer, R (1989) Modern Construction Management. BSP Professional Books.
3. Pilcher R (1966) Principles of Construction Management, McGraw Hill Publishing Co Ltd.
4. Lifson, N W and Shaifer, E F (1982) Decision and Risk Analysis for Construction Management, John Wliey & Sons.
5. Degoff, R A and Friedman, H A (1985) Construction Management, John Wliey & Sons.
6. McCarthy, J F (2010) Construction project management - A managerial approach, Pareto publishers.

M. TECH. I (CTM) SEMESTER- II **L T P C**

CE722 GRADUATE REPORT-II **0 0 2 1**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To develop technical writing and communication skills.

CO2 To find the research gap from the literature.

CO3 To aware about current innovative practices and technology.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	3	2	1	3	2	1	3	3	1	1
CO2	1	3	2	1	3	2	1	3	3	1	1
CO3	3	3	2	1	3	3	1	3	3	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

- Students are expected to prepare graduate reports on various topics of the subjects as assigned by the faculty advisor and submit duly computer typed reports, present & participate in subject wise group discussion.

SEMESTER - III

M. TECH. II (CTM) SEMESTER- III	**L**	**T**	**P**	**C**
CE871 PROFESSIONAL PROJECT	**0**	**0**	**6**	**3**

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To familiarize the field practices

CO2 To identify the gap of standard practice in the field.

CO3 To prepare the technical report

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	3	2	2	3	3	3	2
CO2	2	3	3	3	3	3	2	3	3	3	3
CO3	1	1	1	1	3	2	2	3	3	3	2

Note: 1: Slightly 2: Moderately 3: Substantially

- Twelve weeks including summer vacation training on major construction projects is to be carried at National/State/Local Government Project level after the Second Semester Examination and prior to the first test of third Semester and project report on the same is to be prepared & submitted duly certified by the Project Organization.

M. TECH. II (CTM) SEMESTER- III **L T P C**

CE873 DISSERTATION PRELIMINARIES **0 0 8 4**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To understand current issues and research areas.

CO2 To understand the process and importance of literature review in identifying research area

CO3 To finalize research methodology.

CO4 To define scope, sample size and models.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	3	1	3	3	2	2	2	2
CO2	2	3	3	3	1	3	2	2	2	2	2
CO3	3	3	3	3	3	3	3	2	2	2	2
CO4	1	2	1	3	1	3	2	2	2	2	2

Note: 1: Slightly 2: Moderately 3: Substantially

Dissertation preliminaries should clearly identify the goals & objectives and scope of the dissertation work taken up by the candidate. The focus is on data identification and proposed field surveys, questionnaire design, sample size decision. The study methodology and literature review on the dissertation topic is to be completed and a typed report is to be finalized in consultation with dissertation supervisor and submitted for the assessment at the end of the semester.

M. TECH. II (CTM) SEMESTER- III **L T P C**

CE875 SEMINAR **0 0 3 1**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To understand the process of literature survey.

CO2 To make exposure towards research areas in the field.

CO3 To collect database of inventory available in various topic.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	3	1	1	2	1	1	-
CO2	3	2	2	2	3	1	1	2	1	1	-
CO3	3	2	2	2	3	2	1	2	1	1	-

Note: 1: Slightly 2: Moderately 3: Substantially

- Each student is required to prepare and submit a seminar paper from any area of material/ technology/management with emphasis on development of a project/process/techniques /materials/organization techno economic feasibility studies etc. in consultation with Dissertation Supervisor.
- At least two seminars in area of construction technology and management will be organized by invited professionals, experts, researchers, and policy makers.
- Seminar is to be presented on scheduled date decided by the P.G. Centre. Focus will be on development of attitudes, training of mind, independent and innovative thinking etc.

M. TECH. II (CTM) SEMESTER- IV **L T P C**

CE877 SUMMER TRAINING **0 0 4 2**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To aware about the construction practices and management.

CO2 To make interaction with personnel of projects.

CO3 To develop technical writing and communication skill.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	3	2	2	1	3	2	1	1
CO2	3	2	2	3	2	2	1	3	2	1	1
CO3	1	1	1	1	2	2	1	3	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

Six/Eight week summer training on construction projects, is to be carried at National/State/Local Government Project level after the Second Semester Examination and prior to opening of Third Semester and project report on the same is to be prepared & submitted duly certified by the Project Organization as well as presented in institute.

SEMESTER - IV

M. TECH. II (CTM) SEMESTER- IV	**L**	**T**	**P**	**C**
CE882 DISSERTATION	**0**	**0**	**20**	**10**

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To enhance ability for conception of the idea through conduct of research.

CO2 To enhance ability and confidence to undertake field studies, data collection, analysis and presentation.

CO3 To develop ability of preparing research proposal.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	3	2	1	2	2	2	2
CO2	3	3	3	3	2	3	1	2	2	2	2
CO3	3	3	2	3	3	2	1	3	2	2	2

Note: 1: Slightly 2: Moderately 3: Substantially

- The preliminary dissertation work initiated in Third semester is further extended over fourth semester to cover up the field studies, data analysis, modeling, if any and research finding followed by conclusion etc.

- The main objective of the dissertation work is to provide scope for original & independent research to express the ability of using analytical approach or technical investigation.

- Thesis is to be prepared by each student under the guidance of faculty supervisor and finally submitted in six typed bound sets as per the specified time.

- The assessment of the dissertation work will be carried out in two stages, first during the semester for 160 marks, and final viva-voce exam for 240 marks at the end of the semester.

ELECTIVE SUBJECTS

M. TECH. (CTM)	L	T	P	C
CE604 ENVIORNMENT IMPACT ASSESSMENTS AND MANAGEMENT	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to*

CO1 Identify the environmental attributes for EIA study.

CO2 Identify methodology and prepare EIA reports.

CO3 Identify methods for prediction of impacts.

CO4 Formulate environmental management plans.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	2	3	2	-	1	2	1
CO2	3	2	2	2	2	3	2	-	1	2	1
CO3	3	2	2	2	3	3	2	-	1	2	1
CO4	3	2	1	2	1	3	2	1	2	2	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. EIA: Introduction and Planning

Evolution of EIA – EIA at project – Regional and policy levels – EIA legislative and Environmental clearance procedures in India – EIA methodologies – Screening and scoping criteria – Rapid and Comprehensive EIA – Environmental health impact assessment – Significance of public participation / hearing in EIA – Resettlement and rehabilitation issues.

2. EIA: Methodologies and Strategies

Baseline collection of data – Significant impacts – Assessment of impacts of physical, biological and socio – economic environment – Impact prediction tools / techniques such as Adhoc method, checklist method etc – Development of environment management plan – Post project monitoring – EIA report and EIS – Review process – EIA case studies / histories for industrial projects –water resources and irrigation projects – ports and harbours – mining – transportation and other projects sectors.

3. Environmental Management

Environmental Management plan – Disaster Management – Post project monitoring – Environmental Audit – Life cycle assessment – ISO –14000.

REFERENCES:

1. Betty Bowers Marriott, (1997) Environmental Impact Assessment: A Practical Guide, 1st Edition. McGraw-Hill Professional.
2. Canter L W (1997) Environmental impact assessment, 1st Edition, McGraw-Hill.
3. David P. Lawrence (2003) Environmental Impact Assessment: Practical Solutions to Recurrent Problems, 1st Edition. John Wiley & Sons.

4. Hosetti B, and Kumar A, (1998) Environmental Impact Assessment and Management, Daya Publishing House.
5. UNESCO (1987) Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris.
6. Anjaneyulu. Y. and Manickam. V, (2011) Environmental Impact Assessment Methodologies, 2nd Edition. B.S. Publications.
7. Wathern. P, (2004) Environmental Impact Assessment- Theory and Practice, 1st Edition Routledge Publishers.
8. Larry W. Canter, (1996) Environmental Impact Assessment, Tata Mcgraw Hill Co.
9. Munn R E (1979) Environmental Impact Assessment", John Wiley & Sons.
10. Suresh K. Dhameja, (2004) Environmental Engineering and Management, S. K. Kataria & Sons.

M. TECH. (CTM)	L	T	P	C
CE691 RESEARCH ANALYTICAL TECHNIQUE	3	1	2	5

Course Outcomes: *At the end of the course, students will be able to*

CO-1 Understand and analyse probability distributions.
CO-2 Understand the data types, sampling and choice of method to evaluate
CO-3 Carry out multivariate data analysis and identify correlations.
CO-4 Test hypothesis using goodness of fit measures.
CO-5 Appreciate optimization concepts for solving transportation problems.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	3	1	-	2	-	-	1
CO2	3	3	3	3	3	2	-	2	-	-	2
CO3	3	3	3	3	3	2	-	3	-	-	2
CO4	3	3	3	2	3	2	2	2	-	-	2
CO5	2	3	3	3	-	2	1	1	-	-	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. Social Research Formulation

Design of research - Scaling techniques - Sampling design - Design of questionnaire - Data collection and statistical processing, variables, types of variables, scaling of variables, coding of variables in software tools

2. Statistics & Probability Base

Various probability distributions & their applications - Parameter estimation - Hypothesis testing - Random variables - Method of maximum likelihood - Hypothesis testing to compare multiple population - Statistical quality control

3. Regression Analysis

Simple linear regression, residuals and variances, Assumptions, multiple linear regression, two stage regression, forward, backward and step-wise regression, residual analysis, correlation analysis, type of correlations, coefficient of correlation, Karl-Pearson's coefficient, multivariate data analysis, factor analysis, applications in transportation engineering, goodness-of-fit tests and curve fitting.

4. Hypothesis Testing

Hypothesis testing, types of error in hypothesis, confidence interval, significance tests for comparing variances and means, tests with small and large samples, two-tail and one-tail student's t-test, analysis of variance (ANOVA), non-parametric tests (Chi-square test and Kolmogorov–Smirnov test), central limit theorem, practice with transportation data.

5. Optimization Techniques

Linear programming - Simplex method - Transportation model - Concepts of non– linear programming - Decision theories – Rules - Decision under uncertainty, Applications in Transportation Engineering

PRACTICALS

1. Exercise for measuring central tendency, dispersion and shape of data, graphical representation, plots and pattern, interpretation of results, and histograms using MS office tools and other statistical packages
2. Sampling exercises, data storing, handling, cleaning, and descriptive analysis exercises by using statistical tools.
3. Exercise for fitting probabilistic distributions and hypothesis testing using statistical tools.
4. Exercise for correlation analysis, simple linear and multiple linear regressions, nonlinear regression, using statistical tools.
5. Exercise for parametric and non-parametric tests, test of significance, paired and unpaired sample tests and evaluation, using statistical tools.
6. Exercise for analysis of variance, univariate and multivariate analysis using statistical tools.
7. Exercise for solving optimization problems using solver and using statistical tools.
8. C++ /Java/python/R/MATLAB programming for statistical analysis and probability studies

REFERENCES:

1. Benjamin J R, Cornell C A (1970) Probability Statistics and Decision for Civil Engineers, McGraw-Hill.
2. Kothari, C R (2004) Research Methodology: Method and Techniques, New Age International Publication.
3. Hines W W, Montgomery D C (1990) Probability and Statistics in Engineering and Management Science, John Wiley and Sons.
4. Sharma J K (2000) Operation Research: Theory & Applications, MacMillan India Ltd.
5. Bhandarkar P L, Wilkinson T S (1991) Methodology & Techniques of Social Research, Himalaya Publishing House.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE871 SOFT COMPUTING TECHNIQUES	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Understand the concepts of Genetic Algorithms, Fuzzy Set Theory, Artificial Neural Network

CO2 Develop a programme to apply Genetic Algorithms, Fuzzy Set Theory, Artificial Neural Network

CO3 Develop a model using Genetic Algorithms, Fuzzy Set Theory, Artificial Neural Network

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	2	1	-	1	-	1
CO2	3	3	3	2	3	2	1	-	1	-	1
CO3	3	3	3	2	3	2	1	-	1	-	1
CO4	3	3	3	2	3	2	1	-	1	-	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Genetic Algorithms**

   Goals of optimization - Comparison with traditional methods - Schemata – Terminology in GA – Strings, Structure, Parameter string - Data Structures – Operators - Coding fitness function – Algorithm - Applications.

2. **Fuzzy Logic**

   Concepts of uncertainty and imprecision – Sets - Concepts, properties and operations on Classical sets & Fuzzy Sets - Classical & Fuzzy Relations - Membership Functions - Fuzzy Logic – Fuzzification - Fuzzy Rule based Systems – Fuzzy propositions - Applications.

3. **Artificial Neural Networks**

   Basics of ANN; Models of a Neuron – Topology: Multi Layer Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), and Recurring Neural Network (RNN) – Learning Processes: Supervised and unsupervised learning. Error-correction learning, Hebbian learning; Single layer perceptrons - Multilayer perceptrons - Least mean square algorithm, Back propagation algorithm Applications.

4. **Hybrid Systems**

   Fuzzy neural systems – Genetic Fuzzy Systems – Genetic Neural Systems.

REFERENCES

1. H.J. Zimmermann (2006) Fuzzy set theory and its applications, 4thEdition, Kluwer Academic Publishers.

2. Suran Goonatilake and Sukhdev Khebbal (1995) Intelligent Hybrid Systems, 1st Edition Wiley.
3. Timothy J. Ross (2016) Fuzzy Logic with Engineering Applications, 4th Edition McGraw-Hill.
4. Simon Haykin (2008) Neural Networks and Learning Technique, 3rd Edition Prentice Hall.
5. J.M. Zurada (1992) Introduction to Artificial Neural Systems, 1st Edition. Jaico Publishers.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE634 URBAN INFRASTRUCTURE PLANNING & MANAGEMENT	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Apply urban infrastructure fundamentals

CO2 Review norms and guidelines of urban infrastructure such as sewage, water supply, and solid waste management.

CO3 Apply modern management techniques the better maintenance of infrastructure.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	2	3	2	-	1	2	1
CO2	3	3	2	2	2	3	2	-	1	2	1
CO3	3	3	2	2	2	3	2	-	1	2	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Urban Infrastructure**

   Types, significance, impact on urban form, norms and financial aspects.

2. **Networks And Services Systems**

   Urban services overview, classification and significance. Concepts and theories for design and operation, components, interrelationship, requirements of appropriate technology, cost recovery, Gap analysis.

3. **Water Supply**

   Water Supply: Source, treatment and plant location, pipe network and distribution, location of distribution station, Norms.

4. **Sewerage System**

   House hold collection, pipe network, location of sewerage pumping station, treatment plant and location, disposal site, Norms. Sewerage drainage, refuse collection, storage, recycling and disposal, minimum basic needs, formulation of objectives, norms and standards both for space allocation and quality control, Storm water Network.

5. **Solid Waste Management**

   Types, Generation, collection system, transfer station location, Segregation, transportation, disposal, site selection, Effect of population density, Impact of Urban land use, Bio-medical waste and disposal

6. **Electricity & Communication Network**

   Location, transformer, station, street lighting requirements, telecommunication network requirement

7. **Social Infrastructure**

   Health and Education hierarchy, norms and location. Energy distribution, fire protection requirements, milk distribution system.

REFERENCES:

1. TCPO and Ministry Of Works and Housing, Norms and Standards for Urban Water Supply and Sewerage Services, New Delhi.
2. Joshi, R N, (2010) Public Private Partnership in Infrastructure: Perspectives-Principles-Practices, Vision Books.
3. Carl D Martland (2012) Toward More Sustainable Infrastructure, John Wiley and Sons.
4. Alvin, G and Makarand, H (2006) Infrastructure Planning Handbook: Planning, Engineering, and Economics, McGraw Hill.
5. Delmon, J (2009) Private Sector Investment in Infrastructure, Second Edition, Wolters Kluwer.
6. Willie, T (2007) Principles of Project and Infrastructure Finance, Taylor and Francis.
7. Gómez-Ibáñez, J A (2003) Regulating Infrastructure: Monopoly, Contracts, and Discretion, the Harvard University Press.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE652 REAL ESTATE MANAGEMENT	**3**	**0**	**0**	**3**

Pre Requisite Courses:

Course Outcomes: *At the end of the course, students will be able to-*

CO1 To apply the concept and principles of real estate sector

CO2 To identify the role of urban building industry.

CO3 To prepare and review the urban land policy and its direct government action, legal and physical controls.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	2	3	3	-	2	1	1
CO2	3	2	3	2	2	3	3	-	2	1	1
CO3	2	2	3	2	2	3	3	-	1	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. Economics of location

Factors affecting different land uses such as residential, commercial, industrial, public and semi public; Land value – Concept and factors affecting; Rent and modern theory of rent; Macro and Micro approaches of Location such as trade-off model and environment preference model.

2. Real Estate

Concepts and characteristics; Urban real estate market problems, factors affecting real estate property, rights and interests; Contract law and real estate; Speculation in urban land; betterment and worsenment.

3. Urban land policy

Contents, importance, objectives, measures, instruments for its implementation, direct Govt. action, legal and physical controls; Relationship between economic trends, land market and urban development.

REFERENCES:

1. Lean, W (1982) Aspects of Land use Planning, Gonthic Publications.
2. Paul, B N (1997) Urban Land Economics, The McMillan Press.
3. Singh, B (2011) Urban Infrastructure and Real Estate Management, Surendra Publications.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE658 APPLIED STATISTICAL ANALYSIS	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to*

CO1 Explain the multivariate analysis and its application.
CO2 Analyze the multivariate data using different multivariate model.
CO3 Interpret the outcomes of multivariate models.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	3	2	1	-	1	2	1
CO2	3	3	3	2	3	2	1	-	1	2	1
CO3	3	2	2	2	3	2	1	-	1	2	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. Introduction

Concept, Scope, Introduction to multivariate statistical modelling, univariate descriptive statistics, sampling distribution, estimation, hypothesis testing

2. Basic Multivariate statistics

Multivariate descriptive statistics, multivariate normal distribution, multivariate inferential statistics

3. Regression and Factor Analysis

Analysis of variance, multivariate analysis of variance, multiple regression analysis, multivariate linear regression, principle component analysis, factor analysis

4. Structural Equation Modelling,

Cinfirmatory factor analysis, path model, testing of path model, analysis of output, application of softawres, cluster analysis, correspondence analysis

REFERENCES:

1. Â Johnson, R A and Wichern, D W, (2009) Applied Multivariate Statistical Analysis, 5th Edition, Prentice Hall International.
2. Muirhead, R J (1982) Aspects of Multivariate Statistical Theory, John Wiley and Sons Ltd.
3. Hair, J, Anderson, R, Babin, B J and Black, W (2014) Multivariate data analysis, 7th Edition, Pearson Education Ltd.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
AM613 REHABILITATION OF CONCRETE STRUCTURE	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Identify and define all the terms and concepts associated with deterioration of concrete structures.

CO2 Describe and apply the importance of quality control in concrete construction and significance of protection and maintenance of structures.

CO3 Assess the condition of structures

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	2	3	2	3	1	1	1	1	1
CO2	3	2	2	3	3	3	1	1	2	2	1
CO3	3	2	3	3	3	3	1	1	2	3	3

Note: 1: Slightly 2: Moderately 3: Substantially

1. Causes for Distress in Structure

Philosophy & definition, causes of failure, failure in ancient time & recent times. Deficiency in design drag, material production, maintenance etc. Failure related problems; Manmade and natural failure or damage. Diagnosis of failure; change in appearance on an exposure, chemical deterioration, Mechanical deterioration. Cracking in buildings. Failure of flat roofs, balconies, trenches, dams, piles abutments piers, silos, chimney, cooling towers, R.C.C. frames, Failure information & Analysis. Format of investigation. Shear, Torsion compression failure, Erection difficulty, failure in tanks silos, space frame, precast assemblies prestressed concrete structure, formwork failure, case studies.

2. Maintenance & repair of structures

Need for maintenance and repairs Inspection of Structures for repairs and maintenance methods for repairs, Material and methodology for repairs, Cost of repair & maintenance, Repair to foundation columns, piles, floor, roof and walls.

3. Rehabilitation of Distress Structures

Inspection and testing distressed structures, Techniques for rehabilitation of concrete structures, retrofitting of structures.

4. Structure Assessment & Legal aspects

Art of structure assessment, Method of testing, IS code for testing, Safety assessment, Legal aspects in connection to failure and repair.

5. Preventive measures for durability of structures

Proper selection and specification for material, the use of modern techniques for construction, Proper design, Better workmanship.

REFERENCES:

1. Ted Kay (1992) Assessment and Renovation of Concrete Structures, Wiley.
2. Suran Goonatilake and Sukhdev Khebbal (1995) Intelligent Hybrid Systems, 1st Edition, Wiley.
3. Rakshit, K S (2008) Construction Maintenance & Repair of Highway Bridges, 2nd Edition,

M/s New Central Book Agency (P) Ltd.
4. Raikar, R N (2002) Learning from failures - Deficiencies in Design, Construction and Service, RandD Centre (SDCPL), Raikar Bhavan.
5. Santhakumar, A R (2007) Concrete Technology, Oxford University Press.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE724 FORMWORK FOR STRUCTURE	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to-*

CO-1 Design decking, form work and false work.

CO-2 Understand the sequence of construction of civil engineering structures.

CO-3 Understand the safety steps involved in the design of form work and false work.

CO-4 Select a right material for manufacturing false work and form work suiting specific requirements.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	3	2	1	-	1	1	1
CO2	3	3	3	1	3	2	1	-	1	-	1
CO3	3	2	3	1	3	2	1	-	1	-	1
CO4	3	2	3	1	3	2	1	-	1	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Introduction**

   Formwork and false work, Temporary work systems, Construction planning and site constraints, Materials and construction of the common formwork and false work systems, Special and proprietary forms.

2. **Formwork - Design**

   Concrete pressure on forms, Design of timber and steel forms, Loading and moment of formwork.

3. **Design of Decks and False works**

   Types of beam, decking and column formwork, Design of decking, false work design, Effects of wind load, Foundation and soil on false work design.

4. **Special Forms**

   The use and applications of special forms.

5. **Construction Sequence and Safety in use of Formwork**

   Sequence of construction, Safety use of formwork and false work.

REFERENCES:

1. Austin, C K (1996) Formwork for concrete, Cleaver - Hume Press Ltd.
2. Kumar Neeraj Jha (2012) Formwork for Structure, 1st Edition. McGraw-Hill.
3. Robert L. Peurifoy and Garold D. Oberiender (1996) Formwork for Concrete Structures, McGraw-Hill.
4. Tudor Dinescu and Constantin Radulescu (2004) Slip Form Techniques, Abacus Press, Turn Bridge Wells.

M. TECH. (CTM)	L	T	P	C
CE721 QUANTITATIVE METHODS	3	0	0	3

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To learn basics of statistical methods.

CO2 To understand operation research models.

CO3 To be able to make decisions based on decision theories.

CO4 To be aware about economics of management.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	3	3	2	3	-	1	1	1
CO2	3	3	2	3	3	2	3	-	1	1	1
CO3	3	2	2	3	3	2	3	-	1	1	1
CO4	3	2	2	2	3	2	3	-	1	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Statistics**

   Probability, Sampling, Uni-square and analysis of variance, simple regression and correlation, multiple regression and modeling techniques

2. **Operation Research**

   Introduction to operations research, linear programming, graphical and simplex methods, duality and post-optimality analysis, transportation and assignment problems, queuing theory, queuing model

3. **Production Management**

   Inventory control, EOQ, quantity discounts, safety stock-replacement theory-modification and improvement on PERT and CPM, simulation models.

4. **Decision Theory**

   Decision theory, decision rules, decision making under conditions of certainty, risk and uncertainty, decision trees utility theory, decision making techniques. Deterministic and probabilistic situation, single and multiple person decision making.

5. **Managerial Economics**

   Cost concepts, break-even analysis, pricing techniques, game theory and its applications.

REFERENCES:

1. Winston, L (2003) Operations Research: Application and Algorithms, 4th Edition. Kent P.W.S.
2. Vohra, N D (2017) Quantitative technique in Management, 5th Edition. McGraw Hill Publication.

3. Ravindran, Philips, D T and Solberg, J J (1987) Operations Research: Principles and Practice, 2nd Edition. Wiley.
4. Richard Levin and David S. Rubin (1993) Quantitative Approach to Management, 8th Edition. McGraw Hill Publication.
5. Bazaraa, S, Jarvis J J and Sherali, H D (2009) Linear Programming and Network Flows, 4th Edition. Wiley.
6. Deb, K (1995) Optimization for Engineering Design, Prentice Hall of India.
7. Roa, S S (1984) Optimization Theory and Application, Wiley Easter

M. TECH. (CTM)	L	T	P	C
CE723 ORGANIZATION MANAGEMENT	3	0	0	3

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To study organizational management theories.

CO2 To understand human behavior in terms of organization management.

CO3 To learn employment management and development.

CO4 To understand labour legislations.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2	2	2	3	1	1	2	1
CO2	3	3	3	2	2	2	3	1	1	2	1
CO3	3	3	3	2	2	1	3	1	1	2	2
CO4	3	3	3	2	2	1	3	1	1	3	2

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Manpower Planning**

   History of development of management thoughts, concepts and scope of management, manpower planning, organizing, staffing, directing and controlling and personnel principles.

2. **Organization**

   Concept of organization, span of control, organization charts, staffing plan, development and operation of human resources, managerial staffing, recruitment, selection, placement, training and development.

3. **Human Behavior**

   Introduction to the field of management, basic individual psychology, motivation, job design and performance management, managing groups at work, self managing work teams, inter group behavior and conflict in organizations, leadership, behavioral aspects of decision, making; and communication for people management.

4. **Management and Development Methods**

   Compensation, wages and salary, employee benefits, appraisal and assessment, employee services, safety and health, discipline and discharge, special human resource problems, performance appraisal, employee hand book and personnel manual, job descriptions and organization structure and human relations, productivity of human resources.

5. Labour Legislation

Contract Labour (R &A)Act,1970, Inter-State Migrant labour Act,1979,Factory Act,1948 as applicable to construction agencies, social security and welfare legislation, laws relating to wages, bonus and industrial disputes, Labour Welfare Funds Act,1965 and Workmen's Compensation Act,1923 and labour administration.

REFERENCES:

1. Carleton Counter III and Jill Justice Coulter (1989) The Complete Standard Hand Book of Construction Personnel Management, Prentice Hall, Inc.
2. Josy J. Familaro (1987) Handbook of Human Resources Administration, McGraw Hill International Edition.
3. Monappa, A and Saiyadain, M S (1999) Personnel Management, 2nd Edition. Tata McGraw Hill.
4. Memoria, C B (1997) Personnel Management, 1st Edition. Himalaya Publishing Co.

M. TECH. (CTM)	L	T	P	C
CE725 LEAN CONSTRUCTION	3	0	0	3

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Know unnecessary cost associated with every design & project.

CO2 Target unnecessary cost associated with every design & project.

CO3 Remove unnecessary cost associated with every design & project.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	3	3	2	1	2	1	1
CO2	3	2	3	2	2	3	2	1	2	1	1
CO3	2	2	3	2	2	3	2	-	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. Lean Concept and Principles

History, basic approach, definitions, lean philosophy, role of value engineering and management, effect of cost on design parameters, purpose and application to construction industry, application to design, market value.

2. Value Management Job Plan

Role and purpose of VM job plan, steps of VM job plan, general phase, project selection phase, information phase, functional phase, judicial phase, evaluation phase, recommendation phase and implementation phase.

3. Functional Analysis

Functions, relationship, function analysis systems technique (FAST), application in value management, improvement in systems;

4. Life Cycle Costing

Life cycle cost elements; LCC logic, application to facilities, analysis of the total cost of ownership, escalation & its impact, cost analysis concepts, cost matrix in LCC analysis

5. Costing & Costing Modeling

Cost estimation system; use of cost models; establishing cost targets; objectives of costing; cost target team and organization; classification of costs based on complexity; datum creation; matrix and functional cost model; quality cost model, equipment cost model, billing cost model.

6. Methods of Valuation

Rental method: essential ingredients, forms of rent, year purchase, capitalized value, shares and debentures, bonds of gilt-edged securities, life of structures, case studies in rental method of evaluation. land & building method: cost of construction, estimate on area basis, estimate on cubic basis, estimate by cost index, residual or demolition value of old building and case studies, profit method of valuation with case studies.

REFERENCES:

1. Dell'isola, J. Alphonse (1988) Value Engineering in the Construction Industry, 3rd Edition. Smith, Hinchman & Grylls.
2. James J. O' Brien (1976) Value analysis in design and construction, 1st Edition McGraw Hill Book Company.
3. Namavati, H R (1998) Theory and Practice of Valuation, Lakhani Book Depot.
4. Koskela, L (1999) Management of Production in Construction: A Theoretical View. Proc. 7th Annual Conference of the International Group for Lean Construction (IGLC 7), Berkeley.
5. Howell, G A (1999) What is Lean Construction – 1999, Proc. 7th Annual Conference of the International Group for Lean Construction (IGLC 7), Berkeley, CA, 1-10.
6. Anil Kumar, M (2003) Value Engineering: Concept, Technique and Application, SAGE Publishers.

M. TECH. (CTM) **L T P C**

CE726 LOW COST CONSTRUCTION **3 0 0 3**

Course Outcomes: *At the end of the course, students will be able to*

CO-1 Identify the cost effective material use in construction.

CO-2 Use technique and equipment for low cost construction

CO-3 Generate substantial cost savings construction.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3	1	3	3	1	-	1	2	1
CO2	3	2	3	1	3	3	1	-	1	2	1
CO3	2	2	3	1	3	3	1	-	1	2	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. Concepts of low cost materials

Soil, Fly ash, Ferro cement, Lime, Fibers, Stone Dust, Boulders and oversize metal, Bitumen etc.

2. Low cost building material products

Walls; Stabilized and sun dried, soil blocks & bricks, Hollow concrete blocks, stone masonry blocks, Ferro cement partitions. Roofs ; Precast R.C. Plank & Joists roof, Precast channel roof, Precast L-panel roof, Precast Funicular shells, Ferro cement shells, Filler Slab, Seasal Fiber roof, Improved country tiles, Thatch roof.

3. Low cost construction Techniques and Equipment

Techniques; Rat trap bond construction, Precast R.C. and Ferro cement technique, Mud Technology. Equipments ; Brick molding machine, Stabilized soil block making machine and plants for the manufacturing of concrete blocks, Low Cost Roads.

4. Low cost sanitation

Waste water disposal system, Low cost sanitation for rural and urban areas, Ferro cement Drains

5. Cost analysis and comparison

Low cost materials, Low cost techniques

REFERENCES:

1. Lal, K (2011) Handbook of Low Cost Housing, 1st Edition. New Age International Publisher
2. NBO, Handbook of Housing Statistics, Government of India.

M. TECH. (CTM) **L T P C**

CE727 PRECAST AND PRESTRESS CONSTRUCTION **3 0 0 3**

Course Outcomes: *At the end of the course, students will be able to-*

CO-1 Appreciate modular construction and industrialized construction.
CO-2 Design the precast and pre-stress elements.
CO-3 Apply the construction method using prefabricated elements.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	3	2	2	2	1	1	2	1	1
CO2	3	2	3	3	2	2	1	1	2	1	1
CO3	2	2	3	2	2	2	1	1	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. Prefabricated Construction

Prefabricated construction, necessity, Advantages, disadvantages, Mass produced steel, reinforced concrete and masonry systems, industrialized buildings.

2. Modular Construction

Modular coordination, basic module, planning and design modules, Modular grid systems, National Building Code Specification, Standardization, Dimensioning of products, Preferred dimensions and sizes, tolerances and deviations layout and processes.

3. Prefabricates

Classification, foundation, columns, beams, roof and floor panels, wall panels, clay units, box prefabricates erection and assembly.

4. Design of prefabricated Elements

Lift points, beams, slabs, columns, wall panels, footings, design of joints to transfer axial forces, moments and shear forces

5. Construction Techniques

Large panel construction, Lift slab system, Glover system, Jack block system, Constrain V-Plate system, Bis on system, Silber-Kuhi System, Control of construction processes. Equipments, horizontal and vertical transportation.

REFERENCES:

1. Hass, A M (1983) Precast Concrete Design and Applications, Applied Science Publishers.
2. Promyslolw, V (1980) Design and Erection of Reinforced Concrete Structure, MIR Publishers, Moscow.
3. Structural Design Manual (1978) Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland Betor Verlag.

M. TECH. (CTM) **L T P C**

CE729 INFRASTRUCTURE VALUATION **3 0 0 3**

Course Outcomes: *At the end of the course, students will be able to-*

CO-1 Understand the importance of Infrastructure valuation in a business organization.

CO-2 Apply special techniques in Infrastructure valuation.

CO-3 Apply analytical and decision-making skills in the valuation job.

CO-4 Understand structured phases of value engineering and build teams.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	2	3	1	3	2	1	1	1	1
CO2	3	2	2	3	1	3	2	1	1	1	1
CO3	2	2	2	2	1	3	2	1	1	1	1
CO4	3	2	2	2	1	3	2	-	1	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Concepts**

   Introduction, History of value engineering, Value, Function, Cost, Worth, Case Study Discussions.

2. **General Techniques in Infrastructure Valuation**

   General Techniques -Brainstorming Technique, The Gordon Technique, Feasibility Ranking, The Morphological Analysis Technique, ABC Analysis, Probabilistic Approach, Make or Buy Technique, Case Study Discussions.

3. **Special Techniques in Infrastructure Valuation**

   Special Techniques - Function – Cost – Worth Analysis, Function Analysis System Technique - Technically oriented FAST and Customer-oriented FAST, Weighted Evaluation Method - Equal Importance Method, Descending Order of Importance Method, Numeric Analysis - Forced Distribution Technique, Quantitative Method, Predetermined Minimum Method. Evaluation Matrix. Break-even Analysis. Life Cycle Cost (LCC), Case Study Discussions.

4. **Applications of Infrastructure Valuation**

   Team Dynamics - Team Structure and Team Building, Definition of the creative and structured phases of value engineering, The workshop approach to achieving value, Target setting, Time management, Case Study Discussions.

REFERENCES:

1. Anil Kumar, M (2013) Value Engineering Concepts, Techniques and Applications, Response Books.

2. Anil Kumar, M (2009) Value Engineering Mastermind from Concept to Value Engineering Certification, Response Books.
3. Lawrence, D M (2009) Techniques of Value Analysis and Engineering, McGraw-Hill Book Company.
4. Murthy, M R S (1988) Cost Analysis for Management Decisions, Tata McGraw-Hill Publishing Company Ltd.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE730 DISASTER MANAGEMENT	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Decide emergency, vulnerability and the importance of disaster management to handle the situation.

CO2 Prepare damage assessment of natural and manmade disasters.

CO3 Work out financing relief expenditures and distribution program.

CO4 Prepare emergency management program.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	1	2	3	1	-	1	2	2
CO2	2	2	3	1	2	3	2	-	1	1	2
CO3	2	2	3	1	2	3	2	-	1	1	2
CO4	2	2	2	1	2	3	2	2	1	2	2

Note: 1: Slightly 2: Moderately 3: Substantially

1. Introduction

Concepts of disaster; Types of disaster, natural and manmade: Cyclone, flood, land slide, land subsidence, fire and earthquake. Atmospheric disaster, Issues and concern for various causes of disasters.

2. Disaster Mitigation and Preparedness

Techniques of monitoring and design against the disasters, Mitigation through capacity building, legislative responsibilities of disaster management; disaster mapping, assessment, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation; disaster related infrastructure development

3. Emergency Management Programme

Administrative setup and organization, information management, emergency facilities, equipment necessary, public awareness creation, preparation and execution of emergency management progremme, Role of Media in Disasters

4. Technology in Disaster Management

Electronic Warning Systems, Recent Trends in Disaster Information Provider, Geo Informatics in Disaster Studies, Cyber Terrorism, Remote Sensing & GIS Technology, Laser Scanning Applications in Disaster Management, Statistical Seismology

REFERENCES:

1. Ramakant Gaur (2008) Disaster Management, 1st Edition Saujanay Books, Delhi.
2. Gosh, G K (2015) Disaster Management, Saujanay Books, Delhi.
3. Satish Modh (2006) Citizen's Guide to Disaster Management: How to Save Your Own Life and Help, Macmillan India Ltd.
4. Coppola, D P (2015) Introduction to International Disaster Management, 3rd Edition, Butterworth-Heinemann.

M. TECH. (CTM)	L	T	P	C
CE720 BUILDING INFORMATION MODELLING	3	0	0	3

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Understand Building Information Modelling concepts and theories.

CO2 Use BIM Authoring tools.

CO3 Do the integration of BIM with construction project management.

CO4 Apply BIM in civil engineering.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2	3	3	2	1	1	-	1
CO2	2	2	3	2	3	3	1	1	1	-	-
CO3	2	2	3	2	3	3	1	1	1	-	-
CO4	1	2	3	2	3	3	1	1	1	-	-

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Introduction of BIM**
   Introduction to BIM process and integrated project delivery, nD modelling, BIM software systems and guidelines to choosing different BIM software systems

2. **Basic Modelling**
   Introduction of modelling environment and tools, modelling approaches to producing plans, 3D models, views and sections of buildings, creating an initial sample of 3D BIM model using a BIM authoring software, Modelling of building including basic and vital elements, production of plans, views and 3D models, annotations and preparations of sheets for printing and publishing

3. **Advance Concepts**
   Model customizations, elements and materials, creation of internal components, external elements, massing and site modelling, Elements visibility, visualization and walkthroughs, model/information exchange and merging of models

4. **nD Modelling**
   Introduction to aspects of nD modelling, scheduling and quantity take-offs using BIM-enabled systems and export to spreadsheets, Production of a 4D program in 4D BIM software, cost estimation, producing cost estimates in a 5D BIM software

5. **Interoperability in BIM**
   Basics about interoperability, Export formats and applications, exchange of information through IFC, COBie, BIM 360 Glue, Mobile BIM
6. **Advances in BIM**

Clash detection, Overview of clash detection tools, use of software to detect/resolve clashes in a BIM model, project collaboration using cloud/mobile BIM systems and common data environments

REFERENCES

1. Eastman, C M, Chuck Eastman, Paul Teicholz, and Rafael Sacks (2011) BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, John Wiley & Sons.
2. Hardin, Brad and Dave McCool (2015) BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons.
3. Kymmell, Willem (2007) Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations (McGraw-Hill Construction Series): Planning and Managing Construction Projects with 4D CAD and Simulations, McGraw Hill Professional.

M. TECH. (CTM) **L T P C**

CE731 RESILIENT AND SUSTAINABLE INFRASTRUCTURE SYSTEMS 3 0 0 3

Course Outcomes: *At the end of the course, students will be able to*

CO1 Understand Infrastructure Management basics

CO2 Evaluate Infrastructure Performance Management Strategies.

CO3 Formulate Infrastructure Resiliency Management Strategies.

CO4 Design Infrastructure Sustainability Management Strategies.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	1	2	1	-	1	2	1
CO2	3	3	2	2	1	3	1	-	1	2	1
CO3	3	2	2	1	1	3	2	-	1	1	1
CO4	3	2	3	3	1	3	2	-	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Introduction of Infrastructure Asset Management**
   Infrastructure Asset Management Definitions, Framework and Primers, Infrastructure Asset Management Steps Process and Techniques, Infrastructure Asset Management Hierarch, Inventory, and Register

2. **Advanced Infrastructure Asset Management**
   Advanced Infrastructure Management: Likelihood of Failure, Advanced Infrastructure Management: Likelihood of Failure, Advanced Infrastructure Management: Risk Analysis and Management

3. **Performance of Infrastructure Asset Management**
   Infrastructure Performance Management Definition, Framework and Primers, Infrastructure Performance Metrics, Indices, Tools and Techniques, Infrastructure Performance Management and Real World Application

4. **Infrastructure Asset Management - Sustainability**
   Infrastructure Sustainability Management Definition, Framework and Primers, Infrastructure Sustainability Metrics, Indices, Tools and Techniques, Infrastructure Sustainability Management and Real World Application

5. **Infrastructure Asset Management - Resiliency**
   Infrastructure Resiliency Management Definition, Framework and Primers, Infrastructure Resiliency Metrics, Indices, Tools and Techniques, Infrastructure Resiliency Management and Real World Application

REFERENCES

1. Gopalakrishnan, Kasthurirangan and Srinivas Peeta (2010) Sustainable and Resilient Critical Infrastructure Systems: Simulation, Modeling, and Intelligent Engineering, Springer.
2. Pollalis, Spiro N (2016) Planning Sustainable Cities: An Infrastructure-Based Approach, Routledge.
3. Novotny, Vladimir and Paul Brown (2007) Cities of the Future, IWA Publishing.
4. Elzen, Boelie, Frank W. Geels, and Kenneth Green (2004) System Innovation and the Transition to Sustainability: Theory, Evidence and Policy, Edward Elgar Publishing.

M. TECH. (CTM) **L T P C**

CE734 SMART INFRASTRUCTURE SYSTEM **3 0 0 4**

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To learn fundamentals of modern cities.

CO2 To know about smart infrastructures.

CO3 To learn fundamentals of telecommunication systems.

CO4 To understand the smart transport and ecology.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	3	3	1	3	1	1	2	1	1
CO2	2	3	3	2	2	3	1	-	2	1	1
CO3	3	3	3	2	2	3	1	-	2	1	1
CO4	3	1	2	2	3	1	1	-	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Modern Cities-Characteristics**

   Three layers concept of modern cities (Urban infrastructure, facility & service layers), Understanding the need to reduce carbon emissions and developing sustainable smart solutions. Four facets of smart solutions - Physical, Institutional, Social & Economic Infrastructure; Framework of public information system in smart cities.

2. **Smart Security Infrastructure**

   City surveillance systems, Intelligent Traffic Management Systems, Emergency Response systems & smart solutions to handle crisis management.

3. **Smart Tele communications Infrastructure**

   Wired & wireless network systems, Role of satellite communication, Wi-Fi and RF systems in smart communication, Optical Fiber Cable and DWDM (Dense Wave Division Multiplexing), IPMPCS (Multi Protocol Cable Switching) solutions

4. **Smart Transport Infrastructure**

   Smart transportation, Logistics, Real time Information systems, traffic information management, smart solutions for water supply and waste water engineering; remote sensing & GIS technology

5. **Energy Solutions**

   Renewable energy, Smart grid systems, Reducing carbon emissions without compromising on convenience of users, Community Energy Management systems, Energy on wheels, H2H & V2H (Home to Home & Vehicle to Home) Energy solutions, smart meters, case studies-Japan and Europe countries

REFERENCES:

1. Various papers edited by T.Chou in his book on Remote sensing and smart city WTS press
2. Concept oriented research and development in Information Technology Edited by Kinji Mori WILEY Publ.

M. TECH. (CTM)	**L**	**T**	**P**	**C**
ME650 OPTIMAZATION TECHNIQUES	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to-*

CO1 Know various optimization techniques

CO2 Apply optimization techniques in construction management

CO3 Validate output obtained by using optimization techniques in research

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	3	3	2	-	1	2	2
CO2	3	3	3	2	3	3	2	-	1	2	2
CO3	3	2	3	2	2	3	2	1	1	2	2

Note: 1: Slightly 2: Moderately 3: Substantially

1. **Introduction of Optimization Methods**
   Single and Multivariable optimization methods, constrained optimization methods, Kuhn –Tucker conditions, Necessary & sufficiency theorems.

2. **Linear programming**
   Linear programming- Traveling salesman problem and Transshipment problems –Post optimization analysis.

3. **Integer programming**
   Integer programming- All integer, mixed integer and zero - one programming.

4. **Geometric and Dynamic programming**
   Geometric programming- concept -degree of difficulty - solution of unconstrained & Constrained non- linear problems by geometric programming, Dynamic programming

REFERENCES:

1. Deb, K (1995) Optimization for Engineering Design, Prentice Hall of India.
2. Roa, S S (1985) Optimization Theory and Application, Wiley Easter.
3. Reklaitis G V, Ravindram A, Ragsdell K M (1983) Engineering Optimization Methods & Application, Wiley.

M. TECH. (CTM) **L T P C**

CE736 MAINTANACE & REHABILITATION **3 0 0 3**

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To assess the health condition of structures.

CO2 To inspect and evaluate damaged structures.

CO3 To learn fundamentals of serviceability and durability of structure.

CO4 To understand the techniques for repairing of structures.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	2	1	3	2	1	2	3	1
CO2	2	1	2	2	1	3	2	-	2	3	1
CO3	3	3	3	2	1	3	2	-	2	1	1
CO4	2	2	3	3	3	3	2	-	2	1	1

Note: 1: Slightly 2: Moderately 3: Substantially

1. General

Performance of construction materials and components in services Causes of deterioration, Preventive measurements and maintenance.

2. Influence on Serviceability and Durability

Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, and catholic protection, Principles of assessment of weathering and durability, Characteristics of materials. Diagnosis of construction failures, dealing with cracks.

3. Maintenance and Repair Strategies

Facets of Maintenance importance of Maintenance, Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure causes of deterioration - testing techniques.

4. Materials for Repair

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete.

5. Techniques for Repair and Demolition

Rust eliminators and polymers coating for rebars during repair foamed concrete, painting, water proofing, mortar and dry pack, vacuum concrete, Gunite and Shot crete Epoxy injection, Mortar repair for cracks, shoring and underpinning and special techniques and demolition techniques.

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M. TECH. (CTM)	**L**	**T**	**P**	**C**
CE735 BUILDING SERVICES AND MANAGEMENT	**3**	**0**	**0**	**3**

Course Outcomes: *At the end of the course, students will be able to understand*

CO1 To assess the health condition of structures.

CO2 To inspect and evaluate damaged structures.

CO3 To learn fundamentals of serviceability and durability of structure.

CO4 To understand the techniques for repairing of structures.

Mapping of the Course Outcomes with Program Outcomes:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	3	2	1	2	1	1	2	2	3
CO2	2	3	3	2	1	2	2	1	2	2	2
CO3	2	3	2	2	1	2	1	1	2	3	3
CO4	3	3	3	2	2	3	2	1	2	3	3

Note: 1: Slightly 2: Moderately 3: Substantially

1. Fire protection System

Fire Protection: Process of combustion in fire, Effect of fire load & ventilation condition on enclosure fire, growth and decay of fire in enclosure, Concepts of fire resistant and severity, Effect of fire on materials. Design of elements for given fire resistance, structural fire protection, Site Planning, Internal planning for Escape and refuges, Fire detection & suppression systems, Smoke venting

2. Vertical Transportation and HVAC

Lifts & Vertical Transportation: arrangement of lifts and Design for optimum service condition, HVAC System: Design Consideration. Basic psychrometry, Air conditioning process & system. Methods of Air Conditioning, Problems.

3. Electrical System

Element of Electrical Services in building, Illumination & intelligent building

4. Maintenance and Repair Strategies

Element of Electrical Services in building, Illumination & intelligent building, Definition, Role of building maintenance in construction process Maintenance generators, Expression of Standards, selection of level of maintenance and fixing standards, Maintenance cycle, maintenance profile, repair & replacement models, statistical methods, decision models, optimal renewal cycle, budgeting etc.

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