M.Tech., Infrastructure Engineering & Management (CEM)

(Effective from the Academic year 2024-25)

Program Outcome of this course: After successful completion of the program, the postgraduates will be able to

Sl. No.	Description	POs
1	Demonstrate a degree of mastery over material, design, construction, maintenance and management of infrastructure with due consideration to societal and environmental aspects.	PO1
2	Carry out experimental investigations/ research and development activities to solve real world problems related to infrastructure construction and management	PO2
3	Demonstrate / decipher knowledge about critical issues related to professional practices with special reference to procurement of work, contractual procedures, financial management and construction management	PO3
4	Adopt safe, economical, ethical and sustainable factors in design, construction and management of infrastructure	PO4`
5	Possess critical thinking, familiarity with computational procedures and problem-solving abilities that are essential to infrastructure construction management	PO5
6	Use modern tools for design, analysis and management of infrastructure. Engage in life long learning for professional advancement	PO6
7	Write and orally present project/ technical report articulated in reasonably good English in the domain of infrastructure construction management	PO7
8	Function effectively in multi-disciplinary projects and demonstrate team spirit and leadership qualities	PO8

Semester- 2

Maintenance and Rehabilitation of Infrastructures			
Course Code	**MCEM201**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
This course will enable students to
- Learning the structural properties for causing failures
- Identification of failure phenomenon; New approach in the design aspects
- Understanding the concept of serviceability and durability

Module-1

Durability and Deterioration:
Introduction, Durability of concrete, Causes of distress in concrete structures, Chemical attack on the concrete – Sulphate attack, Chloride attack, Carbonation attack, Alkali Aggregate Reaction. Corrosion of steel reinforcement: Factors influencing corrosion, mechanism, corrosion protection.

Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS

Module-2

Damage Assessment: Introduction, Purpose of assessment, Investigation of damage, Observation, Damage assessment procedure. Destructive Testing system- Testing system of hardened concrete, Direct Load tests. Non-Destructive Testing – Rebound Hammer, Ultrasonic Pulse Velocity. Semi-Destructive Testing: Probe Test, Pull-Out Test, Pull-Off Test, Break-Off Test, Core Test, Half-Cell Potential Measurements, Resistivity Measurements, Carbonation Depth Testing, Tests for determining cement content, chloride content and sulphate content.	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS
Module-3	
Repair Materials: Selection of Repair Materials, Classification of repair materials, Grouts, Resin based materials, sealing materials, Sealant types and properties, Water proofing materials, Bonding materials, Polymer resin-based materials, Cement based coatings, Bituminous materials, SIFCON and SIMCON materials, Carbon wrapping.	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS
Module-4	
Repair of Cracks: Introduction, Factors effect cracking, Measure of cracking, Stages of concrete repair, Types and classification of repair, Methods of Repair- Resin injection, Routing and sealing, Stitching, Dry packing, External stressing, Bonding, Polymer impregnation, Vacuum impregnation. Rehabilitation Techniques Introduction, Replacement mortar, Resin Injection, Dry packing, Sprayed Concrete, Grouting, Slab Jacketing, Tremie concrete. Epoxy bonded dry pack.	

Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS
Module-5	
Strengthening Techniques Introduction, Need for Strengthening, Structural concrete repair, Structural repair technique for R C structure, Jacketing technique, External Post-tensioning, externally bonding technique, externally bonded mild steel plates, Strengthening by SIMCON, Section enlargement.	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. B. Vidivelli, "Rehabilitation of Concrete Structures", 1e, Standard Publishers, ISBN: 978-8180141102, 2009.

References:

1. Ted Kay, "Assessment and Renovation of Concrete Structures", 1e, Longman Scientific & Technical, ISBN: 978-0582057791, 1992.
2. R. T. L. AIlen and S. C. Edwards, "Repair of Concrete Structures", 1e, Blackie & Son, ISBN: 978-0751400861, 1993.
3. Sidney M. Johnson, "Deterioration, Maintenance and Repair of Concrete Structures", McGraw- Hill Book
4. P. H. Perkins, "Repair, Protection and Water proofing of Concrete Structures", 3e, CRC Press, ISBN: 978-0419202806, 1997.
5. R. N. Raikar, "Diagnosis and Treatment of Structures in Distress", Structwel D & C Pvt. Ltd, 1994
6. Ransem W. H, "Building Failures", E & F.N, SPON Ltd, 1981.
7. Ralph Haas, Ronald Hudson and Zaneiswki, "Modern Pavement Management", Kreiger Publications, ISBN: 978-0894645884, 1994.
8. Peter H. Emmons, "Concrete Repair and Maintenance", John Wiley & Sons, ISBN: 978-0876292860, 2002.
9. S. Champion, "Failure and Repair of Concrete Structures", John Wiley & Sons, 1961.
10. Handbook on Concrete Durability, Indian Concrete Institute, Chennai, 2019.
11. Peter H. Emmons, Brandon W. Emmons (Illustrator), Concrete Repair and Maintenance Illustrated: Problem Analysis; Repair Strategy; Techniques, ISBN: 978-0876292860, 1992.
12. Concrete Repair manual (2nd Edition). International Concrete Repair Institute, 2007.
13. ACI publications

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105105213

Skill Development Activities Suggested

- Exposure to latest repair materials available from various manufacturers
- Case studies via site visits
- Review articles / reports on advanced materials available in the market, and its possible application.

COURSE OUTCOMES:

At the end of the course the student will be able to:

Sl. No.	DESCRIPTION	BOs
1	Understand the mechanisms of degradation of concrete structures and design durable concrete structures.	L1, L2, L3
2	Learn how to conduct field monitoring and non-destructive evaluation of concrete structures.	L3, L4, L5
3	Formulate a strategy for repair and rehabilitation by selecting appropriate repair materials and techniques.	L2, L3, L4

Mapping of COs and POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X			X		X		X
CO2	X		X		X	X	X	
CO3		X		X		X		X

HIGHWAY CONSTRUCTION TECHNOLOGY			
Course Code	**MCEM202/MCHT202**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to:

- Understand the various equipment used for road construction and difficulties associated with highway drainage.
- Select suitable equipment for preparation of subgrade in cutting or filling and also the preparation steps for base and sub-base layers.
- Characteristics of different types of bituminous layers and design of bituminous surfacing along with safety aspects needed for roads.
- Design the base course thickness and selection of materials as base layer for CC pavements.
- Analyse the defects in road construction and general pavement failures with remedies.

Module-1

Plants and Equipment: Components of pavement structure, functions and requirements.
Plants and equipment: Excavators, graders, compactors, crushers, bituminous hot mix plants, cement concrete mixers, pavers - uses in road construction.

Teaching-Learning Process	Students can be taken to the construction site. Assignments can be given to evaluate the details of different types of equipment used in road construction
Module-2	
Construction of Subgrade and Subbase: Specifications and steps for construction of subgrade, subbase, quality control tests. Construction of granular layers: Specifications and steps of construction, WBM, WMM, CRM, quality control tests. Construction of Bituminous Layers: Different types of bituminous layers, specifications and construction of bituminous layers, quality control tests.	
Teaching-Learning Process	Students can be given the field assignment to evaluate the degree of compaction of different pavement layers. Practically involving them to observe the methodology of construction.
Module-3	
Construction of Cement Concrete Pavements: Specifications and steps for construction of DLC, Paving Quality Concrete pavements, quality control tests. Specifications and steps for construction of White topping, Interlocking concrete block pavements, quality control tests. Safety during Construction: Safety aspects during construction and maintenance works, road safety furniture.	
Teaching-Learning Process	Students can be given the field assignments to make details note of How rigid pavements are constructed at the site. To make them understand the difference between DLC. PQC, Quality control checks, joints etc.
Module-4	
Drainage: Assessment of drainage requirements for the road, design of various drainage components, drainage materials, surface and sub-surface drainage system for roads, drainage of urban roads.	
Teaching-Learning Process	Ongoing projects field data can be given to evaluate the validity of the given type of drainage, its design or can be given assignment to redesign the drainage.

Module-5	
Maintenance and Rehabilitation of bituminous and concrete pavements: Routine and periodic maintenance, preventive and reactive maintenance for drainage and pavements, Preparation of existing pavement for patching, profile correction, special measures to deal with reflection cracks in pavement overlays, requirements for rehabilitation, recycling. Recycling of pavements- cold recycling, hot recycling, Full Depth Reclamation, road construction in water logged areas, design & construction of RE walls to be added.	
Teaching-Learning Process	Field studies can be offered to the students to evaluate the pavement condition with respect to the distress, and to suggest suitable maintenance program.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course**.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. "Highway Engineering", Khanna and CEG Justo, A. Veeraragavan, Revised 10th edition, published by Nem Chand & Bros, Roorkee, ISBN:978-81-85240-80-0.
2. Prithvi Singh Kandhal, "Bituminous Road Construction in India", ISBN: 978- 8120352582.
3. Delatte N. J., Concrete Pavement Design, Construction, and Performance, CRC Press, Taylor & Francis Group, 2014.

Reference Books:

1. MoRTH "Specifications for Roads and Bridge Works"- 2013 Fifth revision, Indian Roads Congress.
2. MoRTH "Manual for Construction and Supervision of Bituminous Works"- 2001, Indian Roads Congress.
3. MoRTH "Manual for Maintenance of Roads"- 1989, Indian Roads Congress.
4. "Pavement Drainage- Theory and Practice", G.L. Shivakumar Babu, Prithvi S Kandhal, Nivedya Mandankara Kottayi, Rajib Mallick, A. Veeraragavan, CPC Press.
5. Freddy L Roberts, Prithvi S Kandhal et al, "Hot Mix Asphalt Materials, mixture design and construction"- (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA.
6. National Asphalt Pavement Association "Hot Mix Asphalt Paving Hand book"- 5100 Forbes Boulevard, Lanhm, Mary Land, USA.
7. "Hand Book on Cement Concrete Roads"- Cement Manufacturers Association, New Delhi.
8. Relevant IRC Codes

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105101087

Skill Development Activities Suggested

- Site visits when construction is ongoing
- Working on case studies

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand the different types of equipment used in road construction and their importance at different stages of construction	L2
CO2	Understand the construction procedures of sub grade, sub base and base course and bituminous layers in flexible pavement. Acquire the knowledge of quality control checks on the materials before, during construction and after construction	L2
CO3	Understand the construction of CC pavements, quality control checks, concepts of white topping on distressed bituminous layers. Also introduced to the alternate materials being in used instead of conventional ones.	L2
CO4	Understand the importance of drainage in highway construction, design of drainages under different pavement conditions and rain fall data	L2, L3
CO5	Understand the causes for pavement distress of both flexible and rigid pavements, implementing suitable remedial measures at the site.	L3, L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x		x	x				
CO2			x		x			
CO3			x					
CO4			x		x			
CO5						X		

CONSTRUCTION PROJECT MANAGEMENT			
Course Code	**MCEM203**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory+10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

This course will enable students to

- Understand the various management techniques for successful completion of Construction projects.
- Understand the use, effect of management for project organization
- Understand Planning, scheduling and Resources allocation to project activities and use of related Software.

MODULE-1	
Scope, Meaning and Definition of Construction Project, Project Categories, Characteristics of Project, Project Life Cycle and Phases, Project Management Functions, Roles of Project Manager.	
Teaching-Learning Process	Studying on going Civil construction Projects and their respective company organization. NPTEL lectures
MODULE-2	
Planning for Construction Projects, Principles of Planning, Objectives, Resource Planning, calculation and Allocation to activity, Scheduling, Productivity chart, Activity Duration Calculation, Project tracking, Risk Management	
Teaching-Learning Process	Use of Project Planner software and Group based assignment on preparing plan, schedules, productivity charts manually and through software.
MODULE-3	

Project Management through Networks, AOA & AON and Precedence Networks, CPM, Pert, Critical Path, Slack, Floats, Events (Start to Finish, Start to Start, Finish to Start, Finish to Finish), Probability of completion, Resource smoothening and resource levelling, Gantt Chart, Work Break Down Structure	
Teaching-Learning Process	Group based study on network like AOA, AON and Allocation of resources in project, Use of Project Planner software
MODULE-4	
Earned Value Management- meaning and definition, earned value, cost performance index, schedule performance index, cost variances, schedule variance, Final Cost, Final Project Duration	
Teaching-Learning Process	Group based study on effect of using Earned value Management in project and Its interpretation on results generated by EVM. Use of Project Planner software
MODULE 5	
Crashing of networks, Importance of Crashing of Network and its effect on project completion Time and Cost, direct cost, Indirect Cost, Normal cost, crash cost, cost-time optimization, Use of application software for Project Management.	
Teaching-Learning Process	Group based study on crashing of network, its uses in construction projects and effects

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Assignment on Listing of activities and Planning
2	Assignment on Preparation of productivity Chart

3	Assignment on Scheduling, Gantt Chart, Activity on Node, Event to Event Relation
4	Assignment on developing a precedence network, calculation of floats and project crashing.
5	Resource calculation and allotment to each activity – use of computational techniques
6	Assignment on Work Break down Structure – with case studies
7	Assignment on Updating activity Progress & Tracking– use of computational techniques
8	Assignment on Report Generation, Understanding Reports and Corrective actions - use of computational techniques
9	Assignment on using MS Excel, MS Project software software to be done
10	Assignment on any one software used - An estimation and tendering software /primavera software Students are required to operate the software;
11	Case study Example -Residential project
12	Site Visits Minimum Two site visits to study construction techniques and use of major construction equipment associated with ongoing major construction works. Visit Report to be submitted.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum

total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of 25 Marks
2. Two assignments each of 25 Marks/One Skill Development Activity of 50 marks
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to 30 marks.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Books:

1. George.I. Ritz, (1994), "Total Construction Project Management", McGraw – Hill Inc.
2. Sengupta B., Guha M, (1998), "Construction Management and Planning", McGraw Hill Companies.
3. P S Gahlot, B M Dhir, “Construction Planning and Management”
4. Punmia B.C. and Khandelwal K. K., (1989), "Project Planning and Control with PERT and CPM", Laxmi Publication II Edition
5. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Fifth Edition.
6. S. Keoki Sears, Richard H. Clough, Glenn A. Sears, “Construction Project Management: A Practical Guide to Field Construction Management”, John Wiley & Sons, 2008

Web links and Video Lectures (e-Resources):

1. NPTEL – Project Management (Videos Lectures) by Department of Industrial Management engineering IIT Kanpur (link- https://archive.nptel.ac.in/courses/110/104/110104073/#)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning.

1. Preparation of AOA & AON Networks and finding Slack/Float
2. Crashing of Network for the above.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Demonstrate the capabilities related to project scheduling and planning.	L1, L2, L3
CO2	Use the modern tools related to project management,	L3, L4, L5
CO3	Apply the knowledge in resource, and cost management.	L1, L2, L3, L4, L5

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X							
CO2	X							
CO3		X	X	X	X	X	X	
CO4			X	X	X			
CO5						X	X	X

ADVANCED CONCRETE TECHNOLOGY			
Course Code	**MCEM204**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- To study the properties of constituent elements of concrete.
- To study the properties of fresh and hardened concrete.
- To study properties of special types of concrete.

Module-1

Brief review on Concrete and Reinforcement

Cement – Fundamentals, production, tests, and types of cement. Brief review of Conventional Concrete, constituent materials, and admixtures (mineral and chemical).

Reinforcements: Manufacturing process, types, tests reinforcement steel as per IS Code.

SDA: Carryout experiments and prepare test reports on concrete and reinforcement using appropriate software/tools.

Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving

Module-2	
Fresh properties of concrete Rheology of Fresh Concrete: Introduction, Factor affecting the rheology of concrete, Measuring the rheological parameters. Analysis of Fresh Concrete: Basic Concept - Buoyancy (old BS 1881) method - Constant volume (RAM) method. SDA: Tests on rheology of fresh concrete using shear box.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-3	
Hardened properties of concrete Strength of Concrete: Relationship between cube and cylinder strengths, Relationship between compressive strength and tensile strength, Flexural strength of concrete, Concrete Bond Strength, Relation between compressive strength and modulus of elasticity. Microstructure of Concrete: General, Basic Concept - Interfacial Transition Zone (ITZ) effect on strength of concrete. SDA: Expose students to destructive and non-destructive tests on concrete cube and cylinder speCEMens and develop correlation between the values obtained using appropriate tools.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving

Module-4	
HSC & HPC High strength concrete, High performance concrete: Definition, Fresh & Hardened Properties, Applications. Ferro-cement: Definition, Fresh & Hardened Properties, Applications. SDA: Develop high-performance concrete mixes and prepare ferro-cement specimens in laboratory.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-5	
Special Topics Curing Methods: Steam curing, water curing, Curing compounds, Shotcrete: Definition, Wet mix and dry mix process, general use and advantages. Under water concreting: Introduction, Basic requirements. SDA: Group activity on accelerated strength methods of testing.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Neville A.M. “Properties of Concrete”- 5e, Pearson Education India Ltd., ISBN: 978-0273755807, 2012.
2. Mehta P. Kumar & Monteiro, Paulo J.M., "Concrete Microstructure, Properties and Materials", 4e, McGraw Hill Education, ISBN: 978-9339204761, 2017

References:

1. M. L. Gambhir, "Concrete Technology: Theory and Practice", 5e, Tata McGraw-Hill Education, ISBN: 978-1259062554, 2017
2. Aminul Islam Laskar, "Concrete Technology", 1e, Laxmi Publications, ISBN:978-9381159620, 2013.
3. John Newman and Ban Seng Choo, "Advanced Concrete Technology – Process", ISBN: 0750651059, Elsevier Ltd. 2003.
4. John Newman and Ban Seng Choo, “Advanced Concrete Technology Testing and Quality”, Elsevier Ltd, ISBN 0750651067, 2003.
5. Edward G. Nawy, "Concrete Construction Engineering Handbook", 2e, CRC Press, ISBN – 9780849374920, 2008.
6. Raina V.K., "Concrete for Construction", 2e, Tata-McGraw Hill Publishing Co. Ltd. New Delhi, ISBN: 978-8184047530, 2009.
7. IS: 10262:2019 - Guidelines for Concrete Mix Design proportioning, BIS, New Delhi, 2019
8. N Krishna Raju, “Design of Concrete Mixes”, 5e, CBS Publishers and Distributors Pvt Ltd, ISBN: 978-8123924670, 2018.
9. Current Literatures and relevant IS Codes

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105106176
- https://onlinecourses.nptel.ac.in/noc19_ce20/preview

Skill Development Activities Suggested

- Preparation of concrete and testing its fresh and hardened state

Course outcome (Course Skill Set)

Sl. No.	Description	Blooms Level
CO1	To study the properties of constituent elements of concrete.	L1, L2, L3
CO2	To study the properties of fresh and hardened concrete.	L2, L3, L4
CO3	To study properties of special types of concrete.	L3, L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X	X					X	X
CO2	X	X	X			X	X	X
CO3	X	X		X	X		X	X

PREFABRICATED STRUCTURES			
Course Code	**MCEM215A**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Understand types and design principles of RC Prefabricated structures and its design principles
- Understand method of analysis and design of structural elements

Module-1	
Basic Definitions - Types of prefabrication - prefabrication systems and structural schemes-Prefabricated Elements – columns, beams, floor, roof, footing and wall panels. SDA: Group activity - Prepare simple models on elements like slab, beam, and column to understand their behavior in prefab structures.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-2	

Functional Design Principles: Modular coordination – Standardization - Disuniting, Diversity of prefabricates – Material properties - Production – Transportation – Erection - Codal provisions - Lateral load resistance - Location and types of shear walls. SDA: Prepare simple building plan (prefab structure) using modular coordinate system.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-3	
Precast concrete Floors: Types of floor slabs – flooring arrangements, limit state Serviceability – Deflection, limit state of flexure- Ultimate strength calculations in shear and flexure. SDA: Prepare detailing of conventional slab, flat slab using appropriate tools.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-4	
Precast concrete Beams: Introduction - Types of beams – non composite and composite beams - design and detailing of R C precast non composite beams. Walls: Types of wall panels - load bearing wall- stability of wall panels – construction procedure of pre-cast walls. Different Types of joints-their behaviour and design – Leak prevention, Joint sealants. SDA: Prepare the detailing of conventional beams and column manually through sketches/appropriate software tools.	

Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-5	
Components of Industrial Building (Single-Storey) - Purlins, Principal Rafter, Roof Truss, Gantry Girders, Corbel, Column, Bracings. Precast Reinforced Concrete Truss – General, Requirement for Design of Truss, Reinforcement as per IS: 3201-1988, Construction Sequence. Purlins – Design Procedure only. Pre – Cast Columns – Design Procedure only. Corbel- General Consideration as per IS-456:2000, Initial Dimensioning of Corbels as per BS 8110, Design of Corbel - Step by Step Procedure as per BS 8110. SDA: Visit to nearby site or pre-cast plant.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Hass, A.M. “Precast concrete design and Applications”, Applied Science Publishers, 1983.
2. “Handbook on Precast concrete for buildings”, ICI Bulletin 02, Indian Concrete Institute, 2016.

References

1. “National Building Code of India”, BIS, New Delhi, 2016.
2. Kim S Elliott, "Precast concrete structures", Butterworth Heinemann Publications, ISBN-0750650842, 2002.
3. Hubert Bachmann and Alfred Steinle, “Precast Concrete Structures”, Berlin: Ernst & Sohn, ISBN: 978-3433029602, 2011.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=FdbHC4sfqBo

Skill Development Activities Suggested

- Site visits
- Working on case studies

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Distinguish pre-engineered buildings from conventional units.	L1, L2, L3
CO2	Understand general principles of pre-fabrication.	L2, L3, L4
CO3	Plan simple buildings using various types of prefabricated elements.	L4, L5

CO4	Design simple prefabricated elements	L4, L5
CO5	Outline the various phases involved in precast/prefabricated technology	L1, L2

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X		X	X			X	X
CO2		X	X		X	X	X	
CO3	X	X	X	X	X	X		
CO4	X	X	X	X	X	X		
CO5	X	X		X		X	X	

Semester- 2

SOIL MECHANICS			
Course Code	**MCEM215B/ MCHT215B**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Understand the properties and behavior as a highway material under the application of wheelloads.
- Understand and compare the shear strength of soil and stability of slopes when used as subgrade soil and embankment fills or cut slopes
- Understand the permeability characteristics of soils to design proper drainage system and various investigations required to assess the soil properties.
- Understand the type and soil composition affecting the surface runoff and sub-surface water flow in order to design proper drainage system.
- Analyse lack of strength or instability problems in soils due to soil formation or any other reasons and propose suitable strengthening
- methods for the same.

Module-1

Introduction: Soil Mechanics applications to Highway / Infrastructure Engineering. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these.

Soil Compaction: Introduction, Lab Tests, Factors affecting, Structure & Engineering behaviour of compacted cohesive soil, Field compaction specifications, Field compaction control, Different types of Equipment used for

compaction, their choice.	
Teaching-Learning Process	Black board, LCD, data collection through field/site investigation, lab demonstration on certain experiments on properties of soil
Module-2	
Shear strength of soil: Introduction, Importance, Measurements, shear strength of clay, Sand, Elastic properties of soil Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus. **Stability of slopes**: Introduction, Types, Different methods of analysis of slopes for Øu+0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.	
Teaching-Learning Process	Black Board, Slides on Projector, Comparing Different Equipment Manufacturers, performance and its uses
Module-3	
Permeability of soil: Darcy's Law, Validity, Soil-water system, Types, Determination of permeability, problems. **Site Investigation:** Introduction, Planning exploration programmes, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods.	
Teaching-Learning Process	Black Board, Slides on Projector, Field Examples
Module-4	
Special attention for subgrade condition: Problematic soils, compressible &collapsible soils, swelling, subsurface water, frost- susceptible soils. **Surface drainage**, Sub-surface drainage, methods, Design of subsurface drainage system, soil stabilization, soil encapsulation. Base layer requirement-erodibility of bases, bound bases, modified or treated bases, base reinforcement	

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, data collection through field/site investigation, application of modern equipment's for field studies and laboratory studies
Module-5	
Reinforced Earth structures Introduction, Components, Advantages, Types of stability – external, Internal, (No problems), Geo textiles – types, Functions, their uses in road embankments and railway works, other uses. Landslides – definition, classifies, factors producing.	
Teaching-Learning Process	Black board, LCD, laboratory studies.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

- "Basic and Applied soil Mechanics", Gopal Ranjan, ASR Rao, New Age International Publishers.
- "Soil Mechanics & Foundation Engg", Dr.B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications (P) Ltd, 16th edition.
- S.K. Khanna, C.E.G Justo and A. Veeraragavan, "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10th Edition.

Reference Books

- Geotechnical aspects of pavement reference manual", US department of transportation, Publication no: FHWA NHI-05-037, Federal Highway Administration, May 2006, NHI course no:132040
- "Soil Mechanics & Foundation Engg" – K.R. Arora Standard Publishers Distributors.
- "Soil Mechanics for road Engineers" – HMSO, London.

  IRC – Relevant Codes.

Web links and Video Lectures (e-Resources):

- https://youtu.be/V1m3cB-Aqy8
- https://youtu.be/ldNt_O1obP0
- https://nptel.ac.in/courses/105103097

Skill Development Activities Suggested

- Data collection through site investigation
- Carrying out field tests and laboratory tests

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Able to understand different types of soil and their basic properties, analyse the wheelload effects on pavement materials	L1, L2, L3, L4
CO2	Evaluate and compare the shear strength of soil and stability of slopes when used as pavement component.	L1, L2, L3, L4, L5
CO3	Design proper drainage system by knowing the permeability characteristics of soils.	L1, L2, L3, L4
CO4	Design surface runoff and sub-surface drainage system as per field conditions.	L1, L2
CO5	Propose suitable strengthening methods for soil from the knowledge of lack of strength or instability in soils	L2, L3

Program Outcome of this course:

After successful completion of the program, the post graduates will be able to

Sl. No.	Description	POs
1	Independently carryout research / investigation and development work to solve practical problems related to highway technology.	PO1
2	Write and present a substantial technical report /document in the field of Highway technology.	PO2
3	Demonstrate a degree of mastery over materials, analysis, design, construction, maintenance and management of highways considering societal and environmental considerations.	PO3
4	Use modern tool for design, analysis and management of highways.	PO4
5	Adopt safe, economical, ethical and sustainable factors in design, construction and management of highways.	PO5
6	possess critical thinking skills, problem solving abilities, and familiarity with the computational procedures essential to the field.	PO6

7	The Graduates will demonstrate knowledge and understanding of the critical issues for professional practices such as the procurement of works, interaction with contractors during the construction phase of a project, the finance management and managerial capabilities.	PO7	
8	Function effectively in multi-disciplinary projects and demonstrate team building and leadership qualities.	PO8	
9	The student engages in lifelong learning for professional advancement.	PO9	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X	X						
CO2			X					
CO3			X		X			
CO4			X	X	X			
CO5		X				X		X

Semester- 2

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT			
Course Code	**MCEM215C/MCHT215C**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students to

- Focus on the principles of sustainable construction and demolition waste management and resource efficiency
- Examining the environmental impact of building materials.
- Formulating and designing pre–construction and site waste management plans

Module-1

Environmental Impact of Building Materials Embodied energy of materials; impact on the local environment; toxicity of the material; life cycle assessment. Nature and Source Direct and indirect waste; site types and origins; composition; quantity; current recycling/reuse potential of building materials.

Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)

Module-2	
Construction and Demolition Waste Management Plans International good practice; planning requirements; DoEHLG guidance document; company policy; demolition plans; site implementation; supplier agreements; sub–contractor management; role of waste management contractor; training; auditing; skip management; current markets; current disposal options; health and safety; reporting to local authorities. Treatment of Construction and Demolition Waste, waste permits; waste licenses; waste transfer facilities; landfills; treatment technologies; hazardous waste facilities; reporting to EPA	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)
Module-3	
Designing for Waste Prevention and Minimization, Waste prevention and minimization; client, contractor and designer attitudes; proper maintenance of existing buildings; reuse of existing building structure; design flexibility; design for reuse and recycling; dimensional co–ordination and standardization; modular design; material selection and control.	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)
Module-4	
Waste Forecasting Tools Application of WRAP's designing out waste tool for buildings and civil engineering; WRAP net waste tool; BRE SMART Waste; WRAP Site Waste Management Plan Tracker.	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)
Module-5	
Future developments Potential future markets; ‘smart' materials; use of eco–materials.	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Suggested Learning Resources:

Text Books:

1. Springer, "Recycling and Resource Recovery Engineering", Springer – Verlag, Berlin Heidelberg (1996)
2. Greg Winkler, "Recycling Construction and Demolition waste: A LEED - Based Toolkit (Green Source)", 1e, McGraw Hill Professional, ISBN: 978-0071713382, 2010.

Reference Books:

1. V M Tam, Chi Ming Tam, "Reuse of Construction and Demolition Waste in Housing Development", Nova Science Publishers, ISBN: 9781604563627, 2008.
2. JMPQ Delgado, "Sustainable Materials in Building Construction", Volume 11, Building Pathology and Rehabilitation, Springer, ISBN 978-3-030-46799-9 ISBN 978-3-030-46800-2 (eBook), 2020
3. Current Literature.

Web links and Video Lectures (e-Resources):

- http://www.digimat.in/nptel/courses/video/105105160/L48.html

Skill Development Activities Suggested

- Visit to Recycle plants.
- Studies of International standards on waste management

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand the basic concept of embodied energy of construction materials.	L2, L3, L4
CO2	Understand the application of construction and demolition waste to various concrete structures	L3, L4

Program Outcome of this course:

Sl. No.	Description	POs
1	Independently carryout research / investigation and development work to solve practical problems related to highway technology.	PO1
2	Write and present a substantial technical report /document in the field of Highway technology.	PO2
3	Demonstrate a degree of mastery over materials, analysis, design, construction, maintenance and management of highways considering societal and environmental considerations.	PO3
4	Use modern tool for design, analysis and management of highways.	PO4
5	Adopt safe, economical, ethical and sustainable factors in design, construction and management of highways.	PO5
6	possess critical thinking skills, problem solving abilities, and familiarity with the computational procedures essential to the field.	PO6
7	The Graduates will demonstrate knowledge and understanding of the critical issues for professional practices such as the procurement of works, interaction with contractors during the construction phase of a project, the finance management and managerial capabilities.	PO7
8	Function effectively in multi-disciplinary projects and demonstrate team building and leadership qualities.	PO8
9	The student engages in lifelong learning for professional advancement.	PO9

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	x		X							
CO2	x		X	X						

SPECIAL CONCRETE (PEC)			
Course Code	**MCEM215D/MCHT215D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
This course will enable students to
- To study the properties of constituent elements of concrete.
- To study properties of special types of concrete.

Module-1

Salient features of concrete mix design as per Indian standard (IS: 10262:2019).
High Strength Concrete: Definition, Mix Proportioning as per IS 10262-2019, Properties and Applications.

SDA: Preparation of design spreadsheets of different Concrete Mixes.

Teaching-Learning Process	Black board teaching/PowerPoint presentations

Module-2	
Light Weight Concrete: Introduction, Definition, types, Properties and Applications. Geo-polymer Concrete: Brief history of development, Definition, material characterization, mix proportioning, properties, and applications. SDA: Characterization of light weight and geo-polymer concrete / blocks.	
Teaching-Learning Process	Black board teaching/PowerPoint presentations
Module-3	
Self-compacting concrete: Introduction, Materials, Mix design of SCC as per IS 10262-2019; Fresh Properties of SCC - Filling, Passing and Segregation resistance. Hardened Properties of SCC – Compressive strength, Production and transportation, Placement and SCC application. SDA: Group activity - Developing SCC mixes by other than IS method.	
Teaching-Learning Process	Black board teaching/PowerPoint presentations
Module-4	
Fiber-reinforced Concrete: Brief Introduction on FRC, Properties of fibres and matrices, Theoretical stress–strain curves in uniaxial tension, Fresh concrete and Hardened concrete, Applications. Roller Compacted Concrete: Introduction, Materials, Mix design as per IS 10262- 2019, Fresh and Hardened Properties of mass concrete. SDA: Group activity - Application of the fibers in construction materials.	

Teaching-Learning Process	Black board teaching/PowerPoint presentations

Module-5

Temperature controlled concrete, Architectural concrete: Introduction, properties, and applications.
Recycled concrete: Introduction, Properties of recycled aggregate, Methods of recycling and quality, Applications.
CLSM: Brief Introduction, Materials and Properties as per ACI 229R, Applications.

SDA: Group activity – Develop concrete for low strength applications using unconventional and recycled material.

Teaching-Learning Process	Black board teaching/PowerPoint presentations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Suggested Learning Resources:

Text Books:

1. A. M. Neville, “Properties of Concrete”, 5e, Pearson Education India, ISBN: 978- 8131791073, 2012.
2. Mehta P. Kumar & Monteiro, Paulo J.M., "Concrete Microstructure, Properties and Materials", 4e, McGraw Hill Education, ISBN: 978-9339204761, 2017.

References:

1. John Newman and Ban Seng Choo, “Advanced Concrete Technology”, ISBN: 0750651059, Elsevier Ltd., 2003
2. Dr. Edward G Nawy, “Concrete Construction Engineering Handbook”, 2e, CRC Press, ISBN: 9780849374920, 2008.
3. Joseph A. Daczko, “Self-Compacted Concrete by-Applying what we know”, 1e, CRC Press, ISBN: 978-0415590648, 2012.
4. IS: 10262:2019 - Guidelines for Concrete Mix Design proportioning, BIS, New Delhi, 2019.
5. ACI 229R - Report on Controlled Low-Strength Materials, June 2013.
6. ASTM D 6103: Standard Test Method for Flow Consistency of Controlled Low Strength Material.
7. Current Literatures.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ce09/preview
- https://onlinecourses.nptel.ac.in/noc19_ce20/preview
- https://onlinecourses.nptel.ac.in/noc22_ce58/preview

Skill Development Activities Suggested

- Cast of concrete speCEMens and testing physical properties

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Differentiate different properties of constituents of concrete and suggest suitable testing methods to establish the same.	L1, L2, L2
CO2	Demarcate essential properties of special type of concretes and be able to define their suitability.	L2, L3, L4
CO3	Implement mix design procedures appropriate to the kind of concrete chosen.	L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x			x		x	x
CO2	x	x	x	x		x	x	
CO3	x	x	x		x	x	x	

BRIDGE AND GRADE SEPARATED STRUCTURES (PEC)			
Course Code	**MCEM216A/MCHT216A**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Understand historical evolution of bridges and types of bridges.
- Understand the elements of bridge design i.e., forces on bridges, IRC loading standards for road and railway bridges.
- Know in detail about flyovers, their types and related IRC code provisions on geometrical designs.
- Understand substructures, piers, abutments, and appurtenances.
- Explain the quality assurance, bridge inspection and health monitoring.

Module-1

Historical evolution of bridges, classification of bridges, conceptual bridge design, site investigation, preliminary data to be collected, preliminary drawings, economic span of a bridge, ideal bridge, location of piers and abutments, traffic projection, investigation report, importance of proper investigation.

Teaching-Learning Process	Black Board, Slides on Projector, Site Case Studies

Module-2	
Standard specifications for road bridges, clearances, loads to be considered, dead load, IRC standard live loads, other type of loads. General design considerations, minimum reinforcement in beams and slabs, concreting operations, pre-stressed concrete, notations for detailing concrete bridges, traffic aspects of highway bridges, aesthetics of bridges, relative costs of bridge components.	
Teaching-Learning Process	Black Board, Slides on Projector, Site Case Studies
Module-3	
Flyovers, differences between flyovers and bridges, necessity for flyovers, types of flyovers: over pass, trumpet type, diamond shaped, cloverleaf shaped, rotary type, and directional advantages and disadvantages of each. Factors to be considered while building a flyover. Geometric design features, land requirement, spacing, design vehicle, ramps, typical pier and abutment dimensions. Concepts of congestion factor and reduction factors. Landscaping of flyovers.	
Teaching-Learning Process	Black Board, Slides on Projector, Site Case Studies
Module-4	
Bridge substructures, Piers, abutments, foundation types. Bridge bearings, joints and appurtenances, functions rendered by bearings, types of bearings, expansion bearing, fixed bearing, elastomeric pot bearings, bearings for skew bridges, joints, expansion joints, appurtenances, foot paths, handrails, drainage arrangements, wearing course, approach slab. Relevant IRC standards.	
Teaching-Learning Process	Black Board, Slides on Projector, Site Case Studies
Module-5	

Construction of bridges, quality assurance of bridge projects, bridge construction inspection- data to be collected. Construction of short span and long span bridges. Construction of continuous concrete bridges. Formwork and false work for concrete bridges, numbering f bridges, bridge management system. Smart structural health monitoring (SSHM)of bridges. Components of SSHM. Types of monitoring and metrics of monitoring. IoT in bridge health monitoring.	
Teaching-Learning Process	Black Board, Slides on Projector, Site Case Studies

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Johnson Victor, Essentials of Bridge Engineering, 6th edition, Oxford and IBH publishing, New Delhi, 2018.
2. T.R.Jagadeesh , M A Jayaram, Design of Bridge Structures, 3rd Edition, Prentice Hall of India, New Delhi, 2020

References:

1. Ponnu Swamy, Bridge Engineering, Mc_Graw Hill Publishing, 3rd Edition, 2017.
2. Jim J Jhao,D.E.Tonias, Bridge Engineering, 3rd edition, Mc_Graw Hil Publishing, New York, 2017.
3. V.K.Raina, Concrete Bridge Practice, 4th Edition, Shroff Publishers, 2014.
4. Asheesh Kumar, Bridge Engineering, 2nd Edition, Vayu Education India Publishing, 2020.

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc22_ce63/preview

Skill Development Activities Suggested

- Group based studies and site visit

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Elaborate on conceptual bridge design, identify suitable bridge for a given scenario, and be able to prepare a suitable report upon doing site investigation.	L1, L2, L3
CO2	Demonstrate the knowledge on bridge loading standards and IRC-code provisions.	L1, L2, L3

CO3	Identify different types of flyovers and recommend particular type depending on the constraints.	L2, L3, L4
CO4	Differentiate between different types of bearings and recommend a suitable type of bearing.	L2, L3, L4
CO5	Explain construction methods for different types of bridges, and able to decide on suitable health Monitoring procedure	L2, L3, L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X							
CO2	X		x					
CO3	X		x					
CO4	X		x					
CO5	X		x					

IoT AND SMART CITIES (PEC)			
Course Code	**MCEM216B**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- To understand the basic concepts of smart cities and their energy sustainability in urban planning.
- To analyze the security, privacy, and ethics in smart cities planning and development.
- To perform process control and project management in smart cities.

Module-1

Smart City - Complexities of Smart Cities - Urban Network - Sensor Network - Role of Urban Networks - Trends in Urban Development - Community Resource Sensing. Urban Planning - Databases - Principles of Urban Planning - Data Organization - Role of Planning in Smart Cities.

Module-2

Energy Sustainability in Smart Cities 6 hours Energy - Decision Making - Energy as a catalyst for Sustainable Transformation - Cohesion and efficiency of smart cities. Security challenges in smart cities - Security threats in smart cities - IoT related safety measures for a safer smart city.

Module-3

Smart Cities Planning and Development 6 hours City Planning - Understanding Smart Cities - Dimensions of Smart Cities - Global standards and performance benchmark of smart cities - Financing smart cities development - Governance of smart cities.
Module-4
Process Control and Stabilization 7 hours Structural concept - Specific applications - Structural health monitoring - Process control and stabilization - Internet of Vehicle (IoV) Importance - Applications - Security issues - Perspectives on Intelligent Transport Systems (ITS) - ITS Highway safety perspective - Environmental aspects of ITS.
Module-5
Project Management in Smart Cities 6 hours Case studies on project management of smart cities: web applications and mobile based implementations. Contemporary issues in a smart city development.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum mark. The minimum passing mark for SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Carol L. Stimmel, Building Smart Cities Analytics, ICT, Design Thinking, 2016, 1 st edition, CRC Press, Taylor and Francis, UK
2. Andrea Vesco and Francesco Ferrero, Handbook of research on social, economic, and environmental sustainability in the development of smart cities, 2015, 1st edition, Information Science Reference, IGI Global, USA
3. La Scala, Massimo, et al., eds. From smart grids to smart cities: new challenges in optimizing energy grids. 2021, Vol. 2. John Wiley & Sons, USA
4. Angelakis, Vangelis, et al., eds. Designing, developing, and facilitating smart cities: urban design to IoT solutions. 2016, Springer, USA

Web links and Video Lectures (e-Resources):

1. Smart city government of India. http://smartcities.gov.in
2. Reconceptualizing Smart Cities: A Reference Framework for India https://www.niti.gov.in/writereaddata/files/document_publication/CSTEP%20Report%20Smart%20Cities%20Framework.pdf
3. Draft Concept Note on Smart City Scheme". Government of India - Ministry of Urban Development -martcitiesoftomorrow.com/wp-content/uploads/2014/09/CONCEPT_NOTE_3.12.2014__REVISED_AND_LATEST_.pdf

Skill Development Activities Suggested

- Student seminars on related topics that is beyond syllabus.
- Discussion with experts and listening to expert lectures.
- Field visits and making reports on the learnings.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Ascertain and describe the basic concepts of smart and sustainable cities.	L2
CO2	Comprehend the knowledge of urban planning and sustainability in smart cities.	L2 & L3
CO3	Analyze the security issues and challenges of smart cities and their advancements.	L3
CO4	Incorporate project management, planning, and stack holders in the design and development of smart cities.	L2
CO5	Investigate the various ICT and data analytics to connect government, urban planners, universities, city developers, and communities.	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X							
CO2	X		X					
CO3	X		X					
CO4	X	X						
CO5	X		X					

SMART MATERIALS AND STRUCTURES (PEC)			
Course Code	MCEM216C	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the need for smart infrastructure
- To deliberate on applications of various smart materials used in building smart infrastructure.
- To understand the role of bio-inspired material, fibre optic sensors and self-healing materials.
- To explain various sensory systems such as wind, pressure, seismic and level sensors and their utility.
- To describe various non-destructive testing methods, self-healing materials, and self-repairing concrete

Module-1

Introduction to civil structures, loading conditions and environment, materials used in civil structures, design construction and maintenance, necessity for smart structures, definition of smart civil structures, historical development of smart civil structures.:

Teaching-Learning Process	Black board and Power point presentations

Module-2	
Smart materials, shape memory alloys, basic characteristics of shape memory alloys, constitutive modelling of shape memory effect, applications of shape memory alloys in smart civil engineering structures, piezoelectric materials, applications of piezoelectric materials in smart civil structures. magneto strictive materials, basic characteristics, applications in smart civil structures.	
Teaching-Learning Process	Black board and Power point presentations
Module-3	
Electro-rheological and magneto-rheological materials, characteristics, their applications in smart civil structures, optical fibres, characteristics of optical fibres, fibre-optic sensors and their applications in smart civil structures. Bio inspired materials, bio inspired materials for sensing systems, self-healing materials, nano materials.	
Teaching-Learning Process	Black board and power point presentations
Module-4	
Sensors and sensory systems, wind sensors, pressure transducers, wind profile measurements, seismic sensors, load cells, weigh in motion, thermometers, strain gauges, displacement sensors, level sensors, tilt beams, Global navigation satellite system, accelerometers, fibre optic sensors, non-contact sensors, weather stations, chemical and corrosion sensors	
Teaching-Learning Process	Black board and power point presentations
Module-5	
Structural damage detection, non-destructive testing methods, Ultrasonic pulse velocity method, Impact-echo/impulse-response methods, acoustic emission method, radiographic method, eddy current method, infrared thermographic method, concept of structural self-rehabilitation, self-healing materials, and self-repairing concrete.	
Teaching-Learning Process	Black board and Power point presentations, Video Clippings

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. You lin Xu, Jia He, Smart Civil Structures, Taylor & Francis Publications, 2017..
2. Macro Casini, Smart Buildings Advanced Materials and Nanotechnology to Improve Energy-Efficiency and Environmental Performance, Wood Head Publishing, 2016.
3. Caijun Shi, Y.N.Mo, High performance construction materials – science and applications, World scientific publishing, 2008.
4. Joseph N. Pelton, Indu B. Singh, Smart cities of today and tomorrow- Better technology and Infrastructure, Springer International Publishing, 2019.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=FOzBe0ePw68.
https://www.youtube.com/watch?v=6Us25DGQk8c.

Course outcome: After the completion of the course, the students will be able to:		
Sl. No.	Description	Blooms Level
CO1	Elaborate on smart structures concepts and the necessity of smart structures and smart materials	L2, L3
CO2	Present the applications of shape memory alloys, piezoelectric materials, and magneto strictive materials in developing smart civil infrastructure.	L4, L5
CO3	Use the knowledge gained to select appropriate smart materials from among host of available ones.	L2, L5
CO4	Apply the knowledge about sensors to select appropriate sensor to address the situation or the need.	L3, L4
CO5	Deliberate on non-destructive methods and be able to recommend appropriate technique from among host of techniques specific to the nature of structure and nature of distress.	L2, L4

Mapping of Cos and Pos:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**X**	**X**		**X**		**X**		
CO2	**X**	**X**		**X**		**X**		
CO3	**X**	**X**		**X**		**X**		
CO4	**X**	**X**		**X**		**X**		
CO5	**X**	**X**		**X**		**X**		

ENERGY CONSERVATION TECHNIQUES IN BUILDINGS			
Course Code	**MCEM216D**	**CIE Marks**	**50**
Teaching Hours/Week (L:P: SDA)	**2:0:2**	**SEE Marks**	**50**
Total Hours of Pedagogy	**26 Hr. Theory + 26 Hr. SDA**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning Objectives: The objectives of the course are to:

- Understand energy conservation, need and green building concepts.
- Explain the sustainability practices in energy conservation specific to buildings
- Understand different techniques of energy conservation in buildings.
- Understand energy auditing in buildings.

Module-1

Introduction, energy consumption and environment, options, simulation tools, climatic zones in India, solar energy, potentials of world, India, solar passive architecture. Energy conservation options in buildings, analysis of non-air-conditioned buildings. Design concepts of green buildings, case studies.

Teaching-Learning Process	Black board and power point presentations

Module-2	
Sustainability requirements, barriers to implementing sustainable practices, sustainability in the building sector,	
Teaching-Learning Process	Black board and power point presentations
Module-3	
Simulation techniques, climatic data, compliance calculations, energy budget method. Steady state heat gain and loss analysis. Energy conservation options in buildings.	
Teaching-Learning Process	Black board and power point presentations
Module-4	
Shading techniques, insulating materials, thermal conductivity of materials, Energy conservation design guidelines, ventilation techniques, radiation cooling, Internal thermal environment, thermal comfort, thermodynamical properties of building elements. Climate and natural cooling concepts. Heat removal from the building, energy conservation building code-salient points.	
Teaching-Learning Process	Black board and power point presentations
Module-5	
Energy auditing, preliminaries, outcomes, audit team, Energy management, radiation cooling of buildings in hot and dry climate.	
Teaching-Learning Process	Black board and power point presentations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. O.P.Jhakhar, Energy Conservation in Buildings, Khanna Publishing, 2019, New Delhi, ISBN: 9386173468
2. J.R.Waters, Energy Conservation in Buildings, Willey Publications, 2003, ISBN: 978-1405112536
3. Sassan Mohaseeb, Design of Energy Efficient Buildings, NOVA Publications, ISBN: 978-1-53617-862-3
4. Ana Maria Dhabija, Energy Efficient Building design, Spinger, 2020
5. Zakrison, Harry.B., Energy Conservation techniques for Engineers, Van Nostrand Reinhold Publications, 1984.
6. Abe Cruger, Carl sevellie, Green Buildings-Principles and Practices, 2012, Sun Rise Book Store, ISBN: 978-1111135959.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=THph2jK1IwI&list=PL-jxS7aZi_9x8D2zT300SIEfvGpEbxie3
https://www.youtube.com/watch?v=XtQDAtRozxM
https://www.youtube.com/watch?v=xeHcbpP2-kc
https://www.youtube.com/watch?v=oZqSyxAN3f

Course outcomes:

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate the importance of Energy conservation in buildings and be able to suggest the methods.	L2, L3
CO2	Identify sustainability requirements in energy conservation and be able to foresee the barriers.	L2, L3
CO3	Decide on appropriate simulation technique, and be able to decide on energy conservation options in buildings.	L2, L3
CO4	Implement energy conservation design, by selecting appropriate materials and technology or methods.	L3, L4
CO5	Design energy auditing scheme for a given building.	L3, L4

Mapping of Cos and Pos:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X			X		X		
CO2	X			X		X		
CO3	X			X		X		
CO4	X			X		X		
CO5	X			X		X		

Construction Material Testing and evaluation Laboratory (PCCL)			
Course Code	**MCEML207**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

This course will enable students to

- To learn principles of laboratory experiments
- To understand the importance of laboratory testing of materials.

Sl.NO	Experiments
1	**Tests on Soil:** Grain size analysis - Wet sieve analysis, Index Properties (LL, PL, SL), FSI, Compaction Test, Shear Strength Test, CBR, UCS - Precautions
2	**Tests on Aggregates:** Shape Tests (Elongation, Flakiness Index & Combined Index, Angularity Number), Aggregate Impact Value, Los Angeles abrasion value test, Specific gravity & Water absorption test, Stripping value test, Polished stone value test, Sand equivalent test
3	**Tests on Fine Aggregates**: Gradation (zonal classification), Fineness Modulus, Specific Gravity, Water Absorption, Bulk Density
4	**Cement**: Fineness, Specific Gravity, Specific Surface, Consistency, Setting Time, Strength, Soundness. Admixture compatibility and marsh cone test (Plasticizer dosage) Physical properties of fillers (fly-ash and GGBS) – Specific Gravity, Fineness (Specific surface)
5	**Concrete:** Mix design of normal concrete as per IS 10262: 2019; Workability of concrete - Slump test, Compaction Factor test, Flow Table test and slump retention test, DLC & PQC – Fresh and hardened properties, FRC using fibers: Mix design, properties, Self-Compacting Concrete – Fresh and hardened properties- as per IS - 10262-2019
6	Tests for compressive strength of concrete cubes/cylinder; Split Tensile strength of concrete cylinder and Flexural Strength of concrete beam, precautions.

7	**Non-destructive test on concrete** by: (Demonstration) - (a) Rebound Hammer Test; (b) Ultrasonic Pulse Velocity Test; (c) Profilometer
8	Permeability tests on hardened concrete – Demonstration

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Determine the physical properties of cement, fine aggregate and coarse aggregates in laboratory through experiments
- Determine the fresh properties of concrete like Slump value, compaction factor etc.,
- Determine the hardened properties of concrete like Compression, Split tensile strength and Flexural Strength of concrete

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination (SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is 50 Marks.

The split-up of CIE marks for record/ journal and test are in the ratio 60:40.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14 the week of the semester.

- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The test marks are scaled down to 20 marks (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is **50 Marks**.

SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

Reference Books:

1. Khanna, S.K., Justo, C.E.G., and A.Veeraragavan, Highway Materials and Pavement Testing, Nem Chand and Bros, Roorkee, 2015.
2. B C Punmia, Ashok Kumar Jain and Anil Kumar Jain, "Soil Mechanics and Foundations", 16e, Laxmi Publications, ISBN: 978-8170087915, New Delhi, 2017.
3. M. S Shetty, A. K Jain, "Concrete Technology – Theory and Practice", 8e, S. Chand& Co. ISBN: 978-9352533800, 2018
4. Relevant IS Codes / standards.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=oD0qIR6PnlQ
- https://www.digimat.in/nptel/courses/video/105102012/L04.html

COURSE OUTCOMES:

At the end of the course the student will be able to:

Sl. No.	DESCRIPTION	BOs
1	Determine the physical properties of cement, fine aggregate, and coarse aggregates in laboratory through experiments	L2, L3
2	Determine the fresh properties of concrete like Slump value, compaction factor etc.,	L2, L3
3	Determine the hardened properties of concrete like Compression, Split tensile strength and Flexural Strength of concrete	L2, L3

OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT IN CONSTRUCTION PROJECTS			
Course Code	MCEM258A/ MCHT258A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- Understand importance of personal safety, protective measures and training.
- Explain the nature of accidents in construction and hazard analysis.
- Understand various occupational hazards and emergency responses.
- Explain the ways to personal protection and various signs and signals.
- Understand about toxic substances and explosives and ergonomics

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Black board and power point presentations

Module-1

Introduction, nature of construction operation, brief introduction to OSHA, basics of personal safety, personal protective equipment, head protection, hearing, head, face protection, working safety, personal training. company and safety, society first culture, ethics and whistle blowing.

Module-2

The fatal accidents, fatal -4s, falls, protection against fall, safety monitoring systems, electrical injuries, caught-in between hazards, Accident theories, causes of accidents, cost of accidents, incident investigation techniques, impact of an accident on the employer, Time constraints, interruptions and distractions, accident prevention, Injured worker management, compensation laws, types of hazards, Job hazard analysis, Identifying potential hazards, detailed hazard analysis. Failure mode and effect analysis.
Module-3
Promoting safety, safety rules and regulations, prompting safety, work place violence, handling violence situation, policy reviews and preventing internal threats of violence, workplace security, general safety and health provisions, Employee emergency action plans, occupational health, occupational noise exposure, hazardous waste operations an emergency response
Module-4
Personal protection and lifesaving equipment, general criteria, fire protection, equipment, prevention, temporary building, operations, flammable objects, signs, signals, and barricades, accident prevention signals.
Module-5
Toxic and hazardous substances, Asbestos, carcinogens, methods of complains, permissible exposure limits, blasting and use of explosives, surface transportation explosives, use of electric safety fuse, Ergnomics, related problems, ergonomic improvement by employers, engineering and management controls.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Demonstrate the importance of safety measures in construction and possible accidents and risks.
2. Detect the possibility of accidents and find remedial measures appropriate to the situation.
3. Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.
4. Identify possible accidents in construction site and suggest preventive measures.
5. Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. M.Rashad Islam, Construction Safety, Health and OSHA, Mc_Graw Hill Publications, First Edition, 2022, ISBN: 9781264257829.
2. Darill C. Hill, Construction Safety Management and Engineering, American Society of Safety Engineers, II-Edition, 2014.
3. S.C.Sharma, Vineeth Kumar, Safety, Occupational health and Environmental Management in Construction, Khanna Publishers, ISBN: 978-8174092700
4. David L Goetsch, Construction Safety and Health, II edition, Pearson Publications, 2016.
5. Phil Huges, Ed Ferret, Introduction to Health and safety in Construction, Elsevier Publications, 2007, ISBN: 978-0-7506-8111-7

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=LiPNy_WyCTU
https://www.youtube.com/watch?v=NIbacr2i1CQ
https://www.youtube.com/watch?v=S1tabDtr3LM
https://www.youtube.com/watch?v=3eCKfBkSUMU

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Demonstrate the importance of safety measures in construction and possible accidents and risks.	L2, L3
CO2	Detect the possibility of accidents and find remedial measures appropriate to the situation.	L2, L3
CO3	Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.	L2, L3
CO4	Identify possible accidents in construction site and suggest preventive measures.	L3, L4
CO5	Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.	L3, L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		X		X				
CO2		X		X				
CO3		X		X				
CO4		X		X				
CO5		X		X				

SMART CITY INFRASTRUCTURE		Semester	02
Course Code	MCEM258B/ MCHT258B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- To enable the students to apply the basic need and planning concept to solve various Infrastructure problems.
- To develop a basic understanding about various types of Infrastructure and Smart city.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Black board and power point presentations

Module-1

Fundamental of smart city & Infrastructure: Introduction of Smart City, Concept of smart city, Objective for smart cities, History of Smart city world and India. Need to develop smart city, Challenges of managing infrastructure in India and world, various types of Infrastructure systems, Infrastructures need assessment.

Module-2

Planning and development of Smart city Infrastructure: Energy and ecology, solar energy for smart city, Housing, sustainable green building, safety, security, disaster management, economy, cyber security, Project management.

Module-3

Intelligent transport systems Smart vehicles and fuels, GIS, GPS, Navigation system, traffic safety management, mobility services, E-ticketing.
Module-4
Management of water resources and related infrastructure Storage and conveyance system of water, sustainable water and sanitation, sewerage system, flood management, conservation system.
Module-5
Infrastructure Management system & Policy for Smart city Integrated infrastructure management systems for smart city, Infrastructure management. system applications for existing smart city. Worldwide policies for smart city Government of India - policy for smart city, Mission statement & guidelines, Smart cities in India, Case studies of smart city.
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Demonstrate the importance of safety measures in construction and possible accidents and risks. 2. Detect the possibility of accidents and find remedial measures appropriate to the situation. 3. Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures. 4. Identify possible accidents in construction site and suggest preventive measures. 5. Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Smart City on Future Life - Scientific Planning and Construction by Xianyi Li
2. The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies (Regions and Cities) by Nicos Komninos
3. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony Townsend
4. Grig N.S., Infrastructure engineering and management, Wiley-Interseience, 1988
5. Hudson W.R., Haas R., Uddin W., Infrastructure Management, McGraw-Hill, 1997
6. Mission statement &guidelines on Smart City Scheme". Government of India - Ministry of Urban Development http://smartcities.gov.in/upload/uploadfiles/files/Smart City Guidelines (1).pdf

Web links and Video Lectures (e-Resources):

1. Smart city government of India. http://smartcities.gov.in
2. Reconceptualizing Smart Cities: A Reference Framework for India https://www.niti.gov.in/writereaddata/files/document_publication/CSTEP%20Report%20Smart%20Cities%20Framework.pdf
3. Draft Concept Note on Smart City Scheme". Government of India - Ministry of Urban Development -martcitiesoftomorrow.com/wp-content/uploads/2014/09/CONCEPT_NOTE_ 3.12.2014__REVISED_AND_LATEST_.pdf

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Student seminars on related topics that is beyond syllabus.
- Discussion with experts and listening to expert lectures.
- Field visits and making reports on the learnings.

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand the necessity of infrastructural development for smart cities.	L2
CO2	Identify components of infrastructure and Prepare infrastructure plan for smart city.	L2 & L3
CO3	Understand smart transport system for smart cities and its application	L3
CO4	Study of water resources systems for smart city and its application.	L2
CO5	Understand National and Global policies to implement for smart city development	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X							
CO2	X		X					
CO3	X		X					
CO4	X	X						
CO5	X		X					

ROAD SAFETY ENGINEERING AND MANAGEMENT		Semester	02
Course Code	MCEM258C/ MCHT258C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety.
- Plan and design a road safety improvement program.
- Analyze accident data and suggest safety measures.
- Conduct road safety audit.
- Interpret accident data using statistical analysis.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Black Black board, LCD, Skill enhancement through problem solving, case studies

Module-1

Highway Safety in India: traffic crashes on Indian highways, traffic on national highways and state highways, safety on national highways.

Introduction to safety: Road accidents, Trends, causes, Collision and Condition diagrams, Highway safety, human factors, Vehicle factors Road Safety Management System: Multi-causal dynamic systems approach to safety, crash vs accident, road safety improvement strategies, elements of a road safety plan, Safety Data Needs.

Module-2

Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, Advanced statistical methods, Black Spot Identification & Investigations, Case Studies. Urban Safety and Mobility, Traffic Calming.
Module-3
Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, describe methods for identifying hazardous road locations, Vulnerable Road Users, Case Studies.
Module-4
Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.
Module-5
Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety. Road safety management, road safety policy-making, stakeholders involved, developing the road safety management system, capacity building.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety.
2. Plan and design a road safety improvement program.
3. Analyze accident data and suggest safety measures.
4. Conduct road safety audit.
5. Interpret accident data using statistical analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. V.F. Babkov "Road Conditions and Traffic Safety", Mir Publishers.
2. Pignataro, "Traffic Engineering", John wiley & sons.
3. Nicholas J Garber, Lester A Hoel, "Traffic & Highway Engineering"- Third edition, Thompson Learning
4. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
5. Martin Belcher, Steve Proctor and Phil Cook, Practical Road Safety Auditing, Third edition, ICE Publications, 2015
6. Gitam Tiwari, Dinesh Mohan, "Transport Planning and Traffic Safety-making cities, roads & vehicles safer", Published by CRC Press, ISBN-9781498751452

Reference Books:

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997
2. (reprinted 2002)
3. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
4. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
5. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
6. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.
7. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997
8. Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.
9. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.
10. Towards Safe Roads in Developing country, TRL – ODA, 2004.

Web links and Video Lectures (e-Resources):

- https://www.icevirtuallibrary.com/isbn/9780727760166
- https://www.routledge.com/Transport-Planning-and-Traffic-Safety-Making-Cities-Roads-and-Vehicles/Tiwari- Mohan/p/book/9781498751452
- https://www.amazon.in/Highway-Design-Traffic-Engineering-Handbook/dp/0070382956

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Conduct a Road safety audit for a given stretch of SH/NH or rural roads
- Participate / conduct in safety awareness campaigns
- Conduct road safety signage audit for a project stretches and give recommendations.

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety.	L1, L2, L3
CO2	Plan and design a road safety improvement program.	L1, L2, L3
CO3	Analyze accident data and suggest safety measures.	L4, L5
CO4	Conduct road safety audit.	L2, L3, L4, L5
CO5	Interpret accident data using statistical analysis.	L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	X								
CO2		X							
CO3					X	X			
CO4					X	X			
CO5					X	X			

URBAN PUBLIC TRANSPORT			
Course Code	MCEM258D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- Understand the various options for urban public transportation and recommend suitable mode for the given situation.
- Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.
- Understand the management of public transport system and developing strategies for efficient functioning of the system.
- Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc., to know the performance of the system.
- Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Black board, LCD, Skill enhancement through problem solving, field studies

Module-1

System and Technologies: Urban passenger transportation modes, transit classifications and definitions, theory of urban passenger transport modes, rail transit, bus transit, Metro and Mono Rail, Para transit and ride sharing, designing for pedestrians, trends in transit rider ship and use of different modes.
Module-2
Comparing Alternatives: Comparing costs, comparative analysis, operational and Technological characteristics of different rapid transit modes, evaluating rapid transit, Problems.
Module-3
Planning: Transportation system management, system and service planning, financing public transportation, management of public transportation, public Transportation marketing.
Module-4
Transit System Evaluation: Definition of quantitative performance attributes, transit lane capacity, way capacity, station capacity, theoretical and practical Capacities of major transit modes, quantification of performance, Problems.
Module-5
Urban traffic: Classification of transportation systems, conventional transportation systems, non-conventional transportation systems, prototypes and tomorrow's solutions, analysis and interpretation of information on transportation systems, perspectives of future transportation.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Understand the various options for urban public transportation and recommend suitable mode for the given situation.
2. Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.
3. Understand the management of public transport system and developing strategies for efficient functioning of the system
4. Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc., to know the performance of the system.
5. Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.

Assessment Details (both CIE and SEE)

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Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. George E. Gray and Lester A. Hoel, 'Public Transportation', Prentice Hall, New Jersey.
2. Vukan R. Vuchic, 'Urban Public Transportation Systems and Technology', Prentice Hall Inc., New Jersey.

Reference Books:

1. Horst R. Weigelt, Rainer E. Gotz, Helmut H. Weiss,' City Traffic - A Systems Digest', Van Nostrand Reinhold Company, New York John W. Dickey,' Metropolitan Transportation Planning', Tata McGraw-Hill Publishing Co. New Delhi.

Web links and Video Lectures (e-Resources):

- https://dult.karnataka.gov.in/en
- https://archive.nptel.ac.in/courses/105/107/105107067/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- work on case studies
- Formulate the Parking Action Plan for a study area
- Visit to Multimodal Integration of Traffic and Transit Management Centre (TTMC) and understand their activities.
- Mini projects on efficiency of public transport system in urban areas.

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
C01	Understand the various options for urban public transportation and recommend suitable mode for the given situation.	L1, L2
CO2	Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.	L2
CO3	Understand the management of public transport system and developing strategies for efficient functioning of the system	L4
CO4	Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc., to know the performance of the system.	L2, L3, L4
CO5	Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	X								
CO2					X	X			
CO3					X				
CO4						X			
CO5					X	X			