

M.Tech., Infrastructure Engineering & Management (CEM)
(Effective from the Academic year 2024-25)

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

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

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 <ul style="list-style-type: none">• 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			

<p>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.</p>	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS
Module-3	
<p>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.</p>	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS
Module-4	
<p>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.</p>	

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:

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

The sum of three 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:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- 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. Allen 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:

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X			X		X		X
C02	X		X		X	X	X	
C03		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	
<p>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.</p>	
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	
<p>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.</p>	
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)

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Continuous Internal Evaluation:

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

The sum of three 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:

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

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
C01	Understand the different types of equipment used in road construction and their importance at different stages of construction	L2
C02	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
C03	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
C04	Understand the importance of drainage in highway construction, design of drainages under different pavement conditions and rain fall data	L2, L3
C05	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

	P01	P02	P03	P04	P05	P06	P07	P08
C01	x		x	x				
C02			x		x			
C03			x					
C04			x		x			
C05						X		

CONSTRUCTION PROJECT MANAGEMENT (IPCC)			
Course Code	MCEM203	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	39 Hr Theory + 26 Hr. Practice	Total Marks	100
Credits	04	Exam Hours	03
Course objectives:			
This course will enable students to			
<ul style="list-style-type: none"> • 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 smoothing 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 *(May cover all / major modules)*

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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

	P01	P02	P03	P04	P05	P06	P07	P08
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
<p>Course Learning objectives: This course will enable students to</p> <ul style="list-style-type: none"> • 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			
<p>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.</p> <p>SDA: Carryout experiments and prepare test reports on concrete and reinforcement using appropriate software/tools.</p>			
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving		

Module-2	
<p>Fresh properties of concrete</p> <p>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.</p> <p>SDA: Tests on rheology of fresh concrete using shear box.</p>	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-3	
<p>Hardened properties of concrete</p> <p>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.</p> <p>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.</p>	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving

Module-4	
<p>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.</p>	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-5	
<p>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.</p>	
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:

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

The sum of three 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:

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

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
C01	To study the properties of constituent elements of concrete.	L1, L2, L3
C02	To study the properties of fresh and hardened concrete.	L2, L3, L4
C03	To study properties of special types of concrete.	L3, L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C01	X	X					X	X
C02	X	X	X			X	X	X
C03	X	X		X	X		X	X

PREFABRICATED STRUCTURES (PEC)			
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
<p>Course Learning objectives: This course will enable students to</p> <ul style="list-style-type: none"> • Understand types and design principles of RC Prefabricated structures and its design principles • Understand method of analysis and design of structural elements 			
Module-1			
<p>Basic Definitions - Types of prefabrication - prefabrication systems and structural schemes-Prefabricated Elements – columns, beams, floor, roof, footing and wall panels.</p> <p>SDA: Group activity - Prepare simple models on elements like slab, beam, and column to understand their behavior in prefab structures.</p>			
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving		
Module-2			

<p>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.</p> <p>SDA: Prepare simple building plan (prefab structure) using modular coordinate system.</p>	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-3	
<p>Precast concrete Floors: Types of floor slabs – flooring arrangements, limit state Serviceability – Deflection, limit state of flexure- Ultimate strength calculations in shear and flexure.</p> <p>SDA: Prepare detailing of conventional slab, flat slab using appropriate tools.</p>	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving
Module-4	
<p>Precast concrete Beams: Introduction - Types of beams – non composite and composite beams - design and detailing of R C precast non composite beams.</p> <p>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.</p> <p>SDA: Prepare the detailing of conventional beams and column manually through sketches/appropriate software tools.</p>	

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

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

The sum of three 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:

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

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

C04	Design simple prefabricated elements	L4, L5
C05	Outline the various phases involved in precast/prefabricated technology	L1, L2

Mapping of COS and Pos

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X		X	X			X	X
C02		X	X		X	X	X	
C03	X	X	X	X	X	X		
C04	X	X	X	X	X	X		
C05	X	X		X		X	X	

OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT IN CONSTRUCTION PROJECTS(PEC)			
Course Code	MCEM215B	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
<p>Course Learning Objectives: The objectives of the course are to:</p> <ul style="list-style-type: none"> • 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 			
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,			
Teaching-Learning Process	Black board and power point presentations		
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.	
Teaching-Learning Process	Black board and power point presentations, case studies.
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,	
Teaching-Learning Process	Black board and power point presentations
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.	
Teaching-Learning Process	Black board and power point presentations
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.

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:

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

The sum of three 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:

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

Suggested Learning Resources:**Text 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>

Course outcomes:

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

Sl. No.	Description	Blooms Level
C01	Demonstrate the importance of safety measures in construction and possible accidents and risks.	L2, L3
C02	Detect the possibility of accidents and find remedial measures appropriate to the situation.	L2, L3
C03	Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.	L2, L3
C04	Identify possible accidents in construction site and suggest preventive measures.	L3, L4
C05	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
C01		X		X				
C02		X		X				
C03		X		X				
C04		X		X				
C05		X		X				

Semester- 2

SOIL MECHANICS			
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
<p>Course Learning objectives: This course will enable students to</p> <ul style="list-style-type: none"> • 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			
<p>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.</p> <p>Soil Compaction: Introduction, Lab Tests, Factors affecting, Structure & Engineering behaviour of compacted</p>			

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	
<p>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.</p> <p>Stability of slopes: Introduction, Types, Different methods of analysis of slopes for $\phi > 0$ & $C-\phi$ soil, Location of most critical circle, Earth dam slopes stability, Taylor’s stability number. Effect of Earthquake Force, problems on above.</p>	

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:

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

The sum of three 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:

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

1.

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_01obP0
- <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
C01	Able to understand different types of soil and their basic properties, analyse the wheelload effects on pavement materials	L1, L2, L3, L4
C02	Evaluate and compare the shear strength of soil and stability of slopes when used as pavement component.	L1, L2, L3, L4, L5
C03	Design proper drainage system by knowing the permeability characteristics of soils.	L1, L2, L3, L4
C04	Design surface runoff and sub-surface drainage system as per field conditions.	L1, L2
C05	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.	P07
8	Function effectively in multi-disciplinary projects and demonstrate team building and leadership qualities.	P08
9	The student engages in lifelong learning for professional advancement.	P09

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X	X						
C02			X					
C03			X		X			
C04			X	X	X			
C05		X				X		X

Semester- 2

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT			
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
<p>Course Learning objectives: This course will enable students to</p> <ul style="list-style-type: none"> • 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	
<p>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.</p> <p>Treatment of Construction and Demolition Waste, waste permits; waste licenses; waste transfer facilities; landfills; treatment technologies; hazardous waste facilities; reporting to EPA</p>	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)
Module-3	
<p>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.</p>	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)
Module-4	
<p>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.</p>	
Teaching-Learning Process	Blackboard teaching/PowerPoint presentations (if needed)
Module-5	
<p>Future developments Potential future markets; 'smart' materials; use of eco-materials.</p>	
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:

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

The sum of three 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:

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

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.	P01
2	Write and present a substantial technical report /document in the field of Highway technology.	P02
3	Demonstrate a degree of mastery over materials, analysis, design, construction, maintenance and management of highways considering societal and environmental considerations.	P03
4	Use modern tool for design, analysis and management of highways.	P04
5	Adopt safe, economical, ethical and sustainable factors in design, construction and management of highways.	P05
6	possess critical thinking skills, problem solving abilities, and familiarity with the computational procedures essential to the field.	P06
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.	P07
8	Function effectively in multi-disciplinary projects and demonstrate team building and leadership qualities.	P08
9	The student engages in lifelong learning for professional advancement.	P09

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010
C01	x		X							
C02	x		X	X						

SPECIAL CONCRETE (PEC)			
Course Code	MCEM215E/MCHT215E	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
<p>Course Learning objectives: This course will enable students to</p> <ul style="list-style-type: none"> • To study the properties of constituent elements of concrete. • To study properties of special types of concrete. 			
Module-1			
<p>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.</p>			
Teaching-Learning Process	Black board teaching/PowerPoint presentations		

Module-2	
<p>Light Weight Concrete: Introduction, Definition, types, Properties and Applications.</p> <p>Geo-polymer Concrete: Brief history of development, Definition, material characterization, mix proportioning, properties, and applications.</p> <p>SDA: Characterization of light weight and geo-polymer concrete / blocks.</p>	
Teaching-Learning Process	Black board teaching/PowerPoint presentations
Module-3	
<p>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.</p> <p>SDA: Group activity - Developing SCC mixes by other than IS method.</p>	
Teaching-Learning Process	Black board teaching/PowerPoint presentations
Module-4	
<p>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.</p> <p>Roller Compacted Concrete: Introduction, Materials, Mix design as per IS 10262- 2019, Fresh and Hardened Properties of mass concrete.</p> <p>SDA: Group activity - Application of the fibers in construction materials.</p>	

Teaching-Learning Process	Black board teaching/PowerPoint presentations
Module-5	
<p>Temperature controlled concrete, Architectural concrete: Introduction, properties, and applications.</p> <p>Recycled concrete: Introduction, Properties of recycled aggregate, Methods of recycling and quality, Applications.</p> <p>CLSM: Brief Introduction, Materials and Properties as per ACI 229R, Applications.</p> <p>SDA: Group activity – Develop concrete for low strength applications using unconventional and recycled material.</p>	
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:

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

The sum of three 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:

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

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-Appling 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
C01	Differentiate different properties of constituents of concrete and suggest suitable testing methods to establish the same.	L1, L2, L2
C02	Demarcate essential properties of special type of concretes and be able to define their suitability.	L2, L3, L4
C03	Implement mix design procedures appropriate to the kind of concrete chosen.	L4, L5

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X	X			X		X	X
C02	X	X	X	X		X	X	
C03	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			
<ul style="list-style-type: none"> • 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 of 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:

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

The sum of three 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:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- 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
C01	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
C02	Demonstrate the knowledge on bridge loading standards and IRC-code provisions.	L1, L2, L3

C03	Identify different types of flyovers and recommend particular type depending on the constraints.	L2, L3, L4
C04	Differentiate between different types of bearings and recommend a suitable type of bearing.	L2, L3, L4
C05	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

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X							
C02	X		x					
C03	X		x					
C04	X		x					
C05	X		x					

SMART CITY INFRASTRUCTURE (PEC)			
Course Code	MCCEM216B/MCHT216B	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	3
Course Learning objectives: <ul style="list-style-type: none"> 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. 			
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.

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:

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

The sum of three 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:

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

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](http://smartcities.gov.in/upload/uploadfiles/files/Smart%20City%20Guidelines%20(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

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
C01	Understand the necessity of infrastructural development for smart cities.	L2
C02	Identify components of infrastructure and Prepare infrastructure plan for smart city.	L2 & L3
C03	Understand smart transport system for smart cities and its application	L3
C04	Study of water resources systems for smart city and its application.	L2
C05	Understand National and Global policies to implement for smart city development	L2

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X							
C02	X		X					
C03	X		X					
C04	X	X						
C05	X		X					

IoT AND SMART CITIES (PEC)			
Course Code	MCEM216C	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:			
<ul style="list-style-type: none"> • 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 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:

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

The sum of three 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:

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

1.

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
C01	Ascertain and describe the basic concepts of smart and sustainable cities.	L2
C02	Comprehend the knowledge of urban planning and sustainability in smart cities.	L2 & L3
C03	Analyze the security issues and challenges of smart cities and their advancements.	L3
C04	Incorporate project management, planning, and stack holders in the design and development of smart cities.	L2
C05	Investigate the various ICT and data analytics to connect government, urban planners, universities, city developers, and communities.	L2

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X							
C02	X		X					
C03	X		X					
C04	X	X						
C05	X		X					

SMART MATERIALS AND STRUCTURES (PEC)			
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:			
<ul style="list-style-type: none"> • 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:

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

The sum of three 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:

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

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
C01	Elaborate on smart structures concepts and the necessity of smart structures and smart materials	L2, L3
C02	Present the applications of shape memory alloys, piezoelectric materials, and magneto strictive materials in developing smart civil infrastructure.	L4, L5
C03	Use the knowledge gained to select appropriate smart materials from among host of available ones.	L2, L5
C04	Apply the knowledge about sensors to select appropriate sensor to address the situation or the need.	L3, L4
C05	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:

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X	X		X		X		
C02	X	X		X		X		
C03	X	X		X		X		
C04	X	X		X		X		
C05	X	X		X		X		

ENERGY CONSERVATION TECHNIQUES IN BUILDINGS			
Course Code	MCEM216E	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
<p>Course Learning Objectives: The objectives of the course are to:</p> <ul style="list-style-type: none"> • 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, construction sector, waste and pollution management sector, global environmental treaties, social and community impacts of construction practices, global impacts caused by construction projects, supply chain and procurement practices. Renewable energy	
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:

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

The sum of three 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:

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

Suggested Learning Resources:**Text Books:**

1. O.P.Jhakar, 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. Sasan Mohaseeb, Design of Energy Efficient Buildings, NOVA Publications, ISBN: 978-1-53617-862-3
4. Ana Maria Dhabija, Energy Efficient Building design, Springer, 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=THph2jK1lwI&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
C01	Demonstrate the importance of Energy conservation in buildings and be able to suggest the methods.	L2, L3
C02	Identify sustainability requirements in energy conservation and be able to foresee the barriers.	L2, L3
C03	Decide on appropriate simulation technique, and be able to decide on energy conservation options in buildings.	L2, L3
C04	Implement energy conservation design, by selecting appropriate materials and technology or methods.	L3, L4
C05	Design energy auditing scheme for a given building.	L3, L4

Mapping of Cos and Pos:

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X			X		X		
C02	X			X		X		
C03	X			X		X		
C04	X			X		X		
C05	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			
<ul style="list-style-type: none"> • 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
<p>Course outcomes (Course Skill Set): At the end of the course the student will be able to: After studying this course, students will be able to:</p> <ul style="list-style-type: none"> • 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 	

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

Semester- 3

CONTRACT MANAGEMENT			
Course Code	MCEM311	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
<p>Course Learning objectives: This Course will enable the students to</p> <ul style="list-style-type: none"> • Understand the various types of contracts • Understand the use and effect of contracts in construction industry 			
Module-1			
Introduction to contracts: Definitions, Essentials for a legally valid contract, Salient features of contract, discharging of a contract, Documents for an Engineering Contract; Types of contracts: Classification Based on Tendering Process, Economic Consideration, Applicability of the various types of contracts in Construction.			
Teaching-Learning Process	Group based assignment on comparing contract documents of different Categories of project.		
Module-2			

Tendering process: Definitions, List of Documents, EMD, Security Deposit, Invitation for Tenders and sale of Documents, Preparation of Tender Documents and its submission, Receipt of Tender Documents and its opening, Evaluation of Tender and Award of contract–Letter of Award, Letter of Intent, Issues in tendering process: Preregistration, Pre-Qualification, Nominated Tendering, Rejection of Tenders, Repeat Orders, Revocation of Tenders, Unbalanced Bidding.	
Teaching-Learning Process	Group based study on preparing a contract agreement process for a given project.
Module-3	
Administration/Performance of contract: Responsibilities (Duties and Liabilities) of Principal & Contractor, Monitoring and Quality control/assurance, Settlement of claims – Advances, Bills, Extension for time, Extras & Variations, Cost Escalations. Security Deposit, Retention Money, Performance Bond, Liquidated Damages, Penalties, Statutory Requirements.	
Teaching-Learning Process	Group based study on listing roles and responsibilities of principal and Contractor for a contract.
Module-4	
Breach of contract: Definition and Classification, Common Breaches by – Principal, Contractor, Damage Assessment, Claims for Damages.	
Teaching-Learning Process	Group based assignment on case study of breaches.

Module-5	
Dispute resolution: General, Methods for dispute resolution–Negotiations, Mediation, Conciliation, Dispute Resolution Boards, Arbitration, Litigation /Adjudication by courts. Conciliation –Appointment of Conciliator, Role of Conciliator, Special Features of Conciliation Dispute Resolution Boards (DRB), Constitution of DRB, Functioning of DRB, Procedure for Hearings, Status of Award.	
Teaching-Learning Process	Group based assignment on preparing a contract document for a given project inclusive of DRB and its evaluating 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:

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

The sum of three 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:

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

Suggested Learning Resources:**Books**

1. Albett Robert W., (1961/Latest Edition) "Engineering Contracts and Specifications", John Willey and Sons, New York.
2. Patil B. S. (2009) "Civil Engineering Contracts and Estimates", University Press.
3. John G. Betty (1993/ Latest Edition) "Engineering Contracts", McGraw Hills.
4. Vasavada B. J., (1997), "Engineering Contracts and Arbitration", (Self Publication by Jyoti B. Vasavada).
5. Vaid K.N., (1998) "Global perspective on International Construction Contracting Technology and Project Management", NICMAR, Mumbai
6. Prakash V. A., (1997) "Contracts Management in Civil Engineering Projects", NICMAR, Mumbai.

Web links and Video Lectures (e-Resources):

1. NPTEL Lecture Series Advanced Contracts, Tendering and Public Procurement.
<https://archive.nptel.ac.in/courses/129/106/129106006/>

Skill Development Activities Suggested

- Going through Contract Agreements of Public/Private Construction Projects.

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

Sl. No.	Description	Blooms Level
C01	Demonstrate the ability to carry out various aspects of contract management	L1, L2, L3
C02	Implement various steps of contract management to a real-world contractual management scenario.	L1, L2, L3
C03	Device methods and techniques to negotiate arbitration.	L1, L2, L3

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X	X	X					
C02		X	X					
C03				X				

DATA ANALYTICS IN INFRASTRUCTURE ENGINEERING			
Course Code	MCEM312	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
<p>Course Learning objectives: The objectives of the course are to:</p> <ul style="list-style-type: none"> • Get an overall view of data analysis based on CRISP-DM process model. • Study data quality assessment and visualization techniques for data involving two attributes and for higher dimensional data. • Understand principles of modeling by going through various data modeling techniques. • Get a detailed account of data preparation phase. • Study statistical concepts related to data analysis. • Enable students to independently perform data analytic procedures on given data pertaining to civil engineering using Excel. 			
Module-1			
Data and knowledge, criteria to assess the knowledge, descriptive statistics of the data, inferential statistics, exploratory data analysis, knowledge discovery in data bases, data analysis processes, SEMMA, CRISP-DM, methods, tasks and tools.			
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS & web resources		

Module-2	
Attribute understanding, kinds of attributes (nominal, interval, ratio types). Characteristics of one-dimensional data, location measures, dispersion measures, and shape measures. Characteristic measures of multidimensional data, data quality, visual analytics of one-dimensional data, density plots, box plots, scatter plots. Correlation and covariance. Methods for multidimensional data (just briefing). Analysis of data pertaining to civil engineering infrastructure/ highway technology.	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS & web resources
Module-3	
The four steps of modeling, model classes, black-box models, fitting criteria and score functions, error functions for classification problems, measure of interestingness, closed form algorithm for model fitting. Types of errors. Model validation (briefing on methods). Modeling on the data specific to civil engineering infrastructure/ highway technology.	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS & web resources
Module-4	
Selection of data, feature selection, selecting top ranked subset of data, cross product, wrapper approach, and correlation-based filter. Cleaning data, improving data quality, dealing with missing values, construct data, providing operability, assuring impartiality and maximize efficiency. Complex data types. Implementation of methods on data specific to civil engineering infrastructure/ highway technology.	
Teaching-Learning Process	Black board and POWER POINT PRESENTATIONS & web resources

Module-5

Clustering – methods. Hierarchical clustering. Dissimilarity measures; Minkowisci, Euclidian, Manhattan, Chebyshev, and cosine. Deviation measures. Association rules. Brief introduction to self-organizing maps. Implementation of methods on data specific to branch of specialization.

Teaching-Learning Process

Black board and POWER POINT PRESENTATIONS & web resources

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:

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

The sum of three 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:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

1.

Suggested Learning Resources:

Text Book:

1. Michel R. Berthold, Christian Borgelt, Frank Hoopner, Guide to Intelligent Data Analysis, Springer- Verlag Publications, ISBN 978-1-84882-259-7, DOI 10.1007/978-1-84882-260-3, London, 2010

Reference:

1. Charles M.Zudd, Garry H.Mchelland, Carry S.Ryan, Data Analysis: A Model Comparison Approach, Routledge Publication, NY, 2009.
2. Allan Agresty, An Introduction to Categorical Data Analysis, 2 nd Edition, Wiley Publication

Web links and Video Lectures (e-Resources):

- www.kdnuggets.com
- www.kaggle.com
- www.datameer.com

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
C01	Demonstrate a sophisticated understanding of the concepts and methods, know the exact scopes and possible limitations of each method and tasks involved. Apply CRISP-DM data analysis processes to civil engineering related data in decision making.	L2
C02	Apply appropriate data visualization techniques and perform correlation analysis on the real-world data pertaining to allied areas of civil engineering / infrastructure / Highway technology	L3
C03	Develop appropriate model for the data using the suitable algorithm and validate the so developed model using appropriate validation technique.	L4
C04	Decide on appropriate method/ technique for data preparation and provide operability by assuring impartiality and integrity to the given real-world data drawn from various sub domains of civil engineering/ infrastructure/Highway technology	L5
C05	Perform similarity analysis using similarity metrics and to implement simple clustering techniques of the given data set in one and multiple dimensions.	L6

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01					X			
C02					X			
C03					X			
C04					X			
C05					X			

PAVEMENT MANAGEMENT SYSTEM			
Course Code	MCEM313/MCHT313	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
<p>Course Learning objectives: This course will enable students to</p> <ul style="list-style-type: none"> learn evaluation and prediction of pavement performance, to learn Ranking and economic optimization of pavement maintenance and rehabilitation and management. 			
Module-1			
<p>Introduction: Components & principals of pavement management systems, pavement maintenance measures, planning investment, research management. Pavement Management Data Needs, Inventory Data Needs, Project level and network level data needs Structural and functional requirements of flexible and rigid pavements. Pavement Distress survey and different types of failures in pavements.</p> <p>Evaluation of Pavement Surface distress condition surveys – purpose, methods- manual and automated, types of distress, distress survey procedures, equipment used,</p>			
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving, data collection through field/site investigation.		
Module-2			
Functional Evaluation of Pavements:			

Importance of pavement evaluation, functional condition evaluation techniques, network, project level, roughness measurement methods, Identification of uniform sections, serviceability concepts, visual and rating procedures, data collection technologies, pavement deterioration, factors affecting pavement deterioration, modelling, and comparison of different deterioration models.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving, data collection through field/site investigation, application of modern equipment's for field studies
Module-3	
Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving, data collection through field/site investigation, application of modern equipment's for field studies and laboratory studies
Module-4	
Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.	
Teaching-Learning Process	Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving, data collection through field/site investigation, application of instrumentation for pavement testing through test track / Case studies

Module-5

Rehabilitation: Introduction, benefits of recycling, methods, recycling strategies, cold milling, ripping, crushing, recycling batch plant, drum mix plant, mix design, hot in place recycling techniques, cold in place recycling, full-depth reclamation, and current practices for improving riding quality.

Ranking and optimization methodologies, life cycle costing

Expert systems and Pavement Management: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge – based expert systems, case studies.

Implementation of Pavement Management Systems.

Use of software: HDM-4/dTIMS

Teaching-Learning Process

Black board, POWER POINT PRESENTATIONS, Skill enhancement through problem solving, Pavement asset management using modern software

Suggested Learning Resources:

Text Books:

1. Ralph Hass, W.Ronald Hudson with Lyne Cowe Falls., “Pavement Asset Management”-Scrivner Publisher, copyright 2015
2. Ralph Hass, W. Ronald Hudson. W. R., Zaniewisti .J. “Modern Pavement Management” – Krieger Publishing Company, Florida, 1994.

Reference Books:

1. Proceedings of North American Conference on Managing Pavement.

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:

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

The sum of three 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:

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

2. Proceedings of International Conference on Structural Design of Asphalt Pavements.
3. NCHRP, TRR and TRB Special Reports.
4. 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.
5. Highway Hand Book by FAW, Publication from NUS, Singapore.
6. Nicholas J.Garber, Lester A. Hoel, "Traffic and Highway Engineering", Third Edition Thompson Learning
7. IRC 81, 1997, GUIDELINES FOR STRENGTHENING OF FLEXIBLE ROAD PAVEMENTS USING BENKELMAN BEAM DEFLECTION TECHNIQUE
8. IRC SP 16, 2004 Guidelines for Surface Evenness of Highway Pavements

Web links and Video Lectures (e-Resources):

- <https://youtu.be/hiAmA74ya-o>

Skill Development Activities Suggested

- Assessing pavement surface condition for a selected stretch of a road (Visual Road inventory survey)
- Demonstration on portable pendulum skid resistance tester for measuring skid resistance and data analysis
- Data Analysis from Structural and Functional evaluation
- Use of computer applications like HDM-4/dTIMS.

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 structural and functional requirements of pavements, components of PMMS and pavement surface	L1, L2, L4
C02	Functional condition evaluation, condition survey, pavement deterioration modelling	L5, L3, L4
C03	Structural evaluation –BBD and FWD analysis	L5, L3, L4
C04	Evaluation of new pavement materials, model studies,	L5, L3, L4
C05	Recycling strategies, life cycle cost, Expert system and pavement management	L4, L5, L6

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X	X	X				X	X
C02	X	X	X		X	X	X	X
C03	X	X	X	X		X		X
C04	X	X		X	X			
C05	X	X	X	X	X	X	X	

Semester- 3

CONSTRUCTION EQUIPMENT & SAFETY MANAGEMENT			
Course Code	MCEM314	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 <ul style="list-style-type: none"> • Understand the importance of safety in construction industry. • Understand different types of equipment used in construction and its economic consideration. 			
Module-1			
Plants and Equipment for production of materials: Crushers, mixers, Bituminous mixing plants, concrete mixing plants, advantages, choice			
Teaching-Learning Process	Black Board, Slides on Projector, Listing of Equipment Manufacturers		
Module-2			
Construction Equipment: Operations, applications and performance of Dozers, Excavators- Power Shovels, Back Hoe, Back Hoe Loader, Graders, compactors, Pavers for Flexible and Rigid Pavement, Crawler, wheel tractors and its attachments, Cranes, Hauling Equipment's.			

Teaching-Learning Process	Black Board, Slides on Projector, Comparing Different Equipment Manufacturers, performance and its uses
Module-3	
Selection of Construction Equipment: Task considerations, Cost considerations, Engineering considerations, Equipment Acquisition options, Maintenance of Equipment: Repairs, log maintenance, safety during operation, Economical life of equipment.	
Teaching-Learning Process	Black Board, Slides on Projector, Field Examples
Module-4	
Safety in Use of Construction equipment's: Human Factors in Construction Safety management Motivation: Management, Supervisors, Workers, Motivational schemes, Role of first line supervisors, Role of middle managers, Role of workers, top management practices, Safety precautions in Excavation, Heavy Equipment's and in Multi-storey buildings. Lifesaving Equipment's	
Teaching-Learning Process	Black Board, Slides on Projector, Site Case Studies
Module-5	
Safety Management: Safety audit, Safety in site preparation, Design, safety culture, Top Management, Company Activities and Safety – Safety Personnel, Sub-contractual Obligation - Project Coordination and Safety Procedures, Fire causes, prevention and other Common hazards	
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:

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

The sum of three 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:

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

Suggested Learning Resources:**Books**

- Peurifoy, R.L., Ledbette. W.B., Construction Planning, Equipment and Methods, McGraw Hill Co.
- Antil J.M., Civil Engineering Construction, McGraw Hill Book Co.
- SC Sharma, 'Construction equipment and its Management', Khanna Publications.
- Hand Book on Construction Safety Practices, SP 70, BIS 2001.
- Jimmy W. Hinze, Construction Safety, Prentice Hall Inc., 1997
- Richard J. Coble, Jimmie Hinze and Theo C. Haupt, Construction Safety and Health.

Web links and Video Lectures (e-Resources):

1. NPTEL Lecture Series Construction Methods and Equipment Management, Coordinated by IIT Guwhati.
<https://archive.nptel.ac.in/courses/105/103/105103206/>

Skill Development Activities Suggested

- Comparing different manufacturers Construction Equipment-its performance, maximum ability and cost consideration

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
C01	Identify and understand use of equipment and its benefits.	L1, L2
C02	Selection of Equipment's and its application.	L1, L2, L3, L4, L5
C03	Understand necessity of safety management.	L1, L2, L3,L4,L5
C04	Identify importance, need of safety with respect to Client, contractor and subcontractors and site workers.	L1, L2, L3, L4, L5
C05	Safety Implementation at Sites	L2, L3, L4, L5

Mapping of COS and POs

	P01	P02	P03	P04	P05	P06	P07	P08
C01	X	X						
C02			X					
C03			X		X			
C04			X	X	X			
C05		X				X		X

Semester- 3

INDUSTRIAL INTERNSHIP			
Course Code	MINT384	CIE Marks	50
Number of contact Hours	06 Weeks	SEE Marks	50
Credits	06	Exam Hours	03

Course objectives:

Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective is further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics.

Semester III

PROJECT WORK PHASE – 1

Course Code	22PRI481	CIE Marks	100
Number of contact Hours/Week (L:P:S)	00:06:00	SEE Marks	--
Credits	20	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilizing a systems approach.
- Communicate with engineers and the community at large in written an oral form.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Semester IV

PROJECT WORK PHASE -2			
Course Code	MPRJ481	CIE Marks	100
Number of contact Hours/Week (L:P:S)	00:08:00	SEE Marks	100
Credits	22	Exam Hours	03
<p>Course objectives:</p> <ul style="list-style-type: none"> • To support independent learning. • To guide to select and utilize adequate information from varied resources maintaining ethics. • To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly. • To develop interactive, communication, organization, time management, and presentation skills. • To impart flexibility and adaptability. • To inspire independent and team working. • To expand intellectual capacity, credibility, judgement, intuition. • To adhere to punctuality, setting and meeting deadlines. • To instill responsibilities to oneself and others. • To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. 			
<p>Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.</p>			

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

