M.Tech., Highway Technology (MCHT)
(Effective from the Academic year 2024-25)

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domain of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exhibit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Semester- 2

PAVEMENT ANALYSIS AND DESIGN (IPCC)			
Course Code	MCHT201	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

- Understand the factors affecting pavement design and performance
- Evaluate the strength of soil subgrade and factors that affect the behavior of soil.
- Compute the stresses and deflections in flexible and rigid pavement layers under the action of wheel loads.
- Design the thickness of flexible pavements by different methods under different exposure conditions and materials.
- Design the thickness of concrete pavements and joints associated with CC pavements in addition to the computationof stresses in CC pavements.

MODULE-1

Pavements and pavement layers - types, functions, Highway and Airfield pavements, axle load distribution, ESWL, EWL, VDF due to varying loads and CSA. Flexible pavement design factors

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Field studies

MODULE-2

Subgrade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation Pavement Material Characterization,climatic,drainageandenvironmentalfactors,theireffectsandevaluation.Factorsaffectingdesignandperformance of airportpavements.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Lab tests and Field studies

MODULE-3

Stresses in Flexible pavements: Layered System concepts, Stress solution for one, two- and three-layered systems. Applications in pavement design. Problems

Stresses in Rigid Pavements: Westergaard's theory and assumptions, Stresses due to Curling, stresses and deflection due to loading, frictional stresses. Stresses in dowel bars and tie bars.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

MODULE-4

Flexible pavement design: Empirical, semi- empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt Institute methods, Problems. **Application of IIT PAVE software, ANSYS, KENPAVE, KENLAYER, AASHTOWARE**

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Demo and learning of design software

MODULE 5

Rigid pavement design: Rigid pavement design factors, Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigid pavements, General design principle, design of cement concrete pavements (joints and slab thickness) as per IRC/PCA guidelines. Design features of CRCP, SFRC and ICBP, Problems. Application of Design Software

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Demo and learning of design software.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Classified traffic volume studies, Axle load survey.
2	Subgrade strength evaluation tests such as California Bearing Ratio (CBR), Triaxial compression, direct shear test.
3	Determination of field density of pavement layers by sand replacement method, core cutter method.
4	The field CBR test or in–situ CBR value by Dynamic Cone Penetration Test.
5	Tests on Bituminous Pavement Layers: 1. Destructivetest: a. To determine density, void analysis, bitumen content and aggregate gradation after bitumen extractionbyCoredrilling. b. Test Pit investigations.
6	Design of Flexible pavements using IIT-PAVE software for flexible pavement Design as per IRC 37 2018
7	Design of Rigid Pavements as per IRC:58-2015(MS-Excel)

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 components of IPCC

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

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of thesemester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report.Eachexperimentreportcanbeevaluatedfor10marks.Marksofallexperiments'write-upsareaddedandscaleddown 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 50marks.
2. The question paper will have ten questions. Each question is set for 20marks.
3. Therewillbe2questionsfromeachmodule.Eachofthetwoquestionsunderamodule(withamaximumof3sub-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. • SEEwillbeconductedfor100marksandstudentsshallsecure40%ofthemaximummarkstoqualifyintheSEE.Markssecured 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** **Text Books:** 1. Yang H. Huang, "Pavement Analysis and Design", Second Edition, Pearson Education,2008. 2. Rajib B. Mallick and Tahar EL-Korchi., "Pavement Engineering Principles and Practice", Third Edition, CRC Press Taylor and Francis Group. 3. Yoder,E.J.andWitczak,M.W.,"PrinciplesofPavementDesign",SecondEdition,JohnWileyandso ns ReferenceBooks: 1. Huang, "Pavement Analysis"- Elsevier Publications 2. DavidCroney,PaulCroney,"Design&PerformanceofRoadPavements"-McGrawhillBookCo.3.W.RonaldHudson,RalphHaasand Zeniswki 3. "Modern Pavement Management"- McGraw Hill andCo. 4. S.K. Khanna, C.E.G Justo and A. Veeraragavan "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10thEdition. 5. Relevant IRCCode
Web links and Video Lectures (e-Resources): 1) https://www.youtube.com/watch?v=uJntLOgEHD4 2) https://youtu.be/HLVjhGDdsSM 3) https://youtu.be/GxXONAINMBE
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Determining various design factors such as VDF, ESWL, CSA through Problemsolving • LabTestingofsubgradesoilto determineitsbasicpropertiessuchasGrain sizeanalysis,Atterberglimits,MDDandOMC, CBRetc. • Lab testing of other pavement materials such as aggregates, Bitumen, cement, Bituminous mixes and concrete Learning Design Software for flexible and Rigid pavementdesign

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 factors affecting pavement designandperformance.	L1, L2, L3, L4
CO2	Evaluate the strength of soil subgrade and other factors that influencepavementdesign.	L2, L5
CO3	Compute the stresses and deflections in flexible and rigidpavementlayers	L1, L2, L3, L4,L5
CO4	Design the flexible pavements by IRC methods and also know the outline ofotherdesign methods.	L1, L2, L3, L4, L5, L6
CO5	Design the thickness of concrete pavements and joints associated with CC pavementsanddesign outline of special concretepavements.	L1, L2, L3, L4, L5, L6

Program Outcome of this course

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

Semester- 2

HIGHWAY CONSTRUCTION TECHNOLOGY (PCC)			
Course Code	**MCHT202/MCEM202**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

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

Module-1

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

Teaching-Learning Process	Students can be taken to the construction site. Assignments can be given to evaluate the details of different types of equipment used in road construction

Module-2

Construction of Subgrade and Sub base: Specifications and steps for construction of subgrade, sub base, quality control tests **Construction of granular layers:** Specifications and steps of construction, WBM, WMM, CRM, quality control tests **Construction of Bituminous Layers:** Different types of bituminous layers, specifications and construction of bituminous layers, quality control tests

Teaching-Learning Process	Students can be given the field assignment to evaluate the degree of compaction of different pavement layers. Practically involving them to observe the methodology of construction.

Module-3

Construction of Cement Concrete Pavements: Specifications and steps for construction of DLC, Paving Quality Concrete pavements, quality control tests Specifications and steps for construction of White topping, Interlocking concrete block pavements, quality control tests.
Safety during Construction: Safety aspects during construction and maintenance works, road safety furniture.

Teaching-Learning Process	Students can be given the field assignments to make details note of How rigid pavements are constructed at the site. To make them understand the difference between DLC. PQC, Quality control checks, joints etc.

Module-4

Drainage: Assessment of drainage requirements for the road, design of various drainage components, drainage materials, surface and sub-surface drainage system for roads, drainage of urban roads.

Teaching-Learning Process	Ongoing projects field data can be given to evaluate the validity of the given type of drainage, its design or can be given assignment to redesign the drainage.

Module-5

MaintenanceandRehabilitationofbituminousandconcretepavements: Routineandperiodicmaintenance,preventiveandreactive 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 andconstruction of RE walls to be added.

Teaching-Learning Process	Field studies can be offered to the students to evaluate the pavement condition with respect to the distress, and to suggest suitable maintenance program.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark fortheCIEis50%ofthemaximummarks.MinimumpassingmarksinSEEis40%ofthemaximummarksofSEE.Astudentshallbedeemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50%(50marksoutof100)inthesumtotaloftheCIE(ContinuousInternalEvaluation)andSEE(SemesterEndExamination)taken together.

Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Text Books:

1. "Highway Engineering", Khanna and CEG Justo, A. Veeraragavan, revised 10thedition, 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 RoadsCongress
2. MoRTH "Manual for Construction and Supervision of Bituminous Works"- 2001, Indian RoadsCongress
3. MoRTH "Manual for Maintenance of Roads"- 1989, Indian RoadsCongress
4. "Pavement Drainage- Theory and Practice", G.L. Shivakumar Babu, Prithvi S Kandhal, NivedyaMandankaraKottayi, Rajib Mallick, A.Veeraragavan
5. FreddyLRoberts,PrithviSKandhaletal,"HotMixAsphaltMaterials,mixturedesignandconstruction"-(2ndEdition),National Asphalt Pavement Association Research and Education Foundation, Maryland,USA
6. National Asphalt Pavement Association "Hot Mix Asphalt Paving Handbook"- 5100 Forbes Boulevard, Lanhm, Mary Land,USA
7. "HandbookonCementConcreteRoads"-CementManufacturersAssociation,NewDelhi Relevant IRCCodes

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Site visits when construction isongoing
- Working on casestudies

Course outcome (Course Skill Set) S

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

Sl.No.	Description	Blooms Level
CO1	Understand the different types of equipment used in road construction and their importanceat different stages of construction	L2
CO2	Understand the construction procedures of sub grade, sub base and base course and bituminous layers in flexible pavement. Acquire the knowledge of quality control checks on the materials before,during construction and after construction	L2

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CO3	Understand the construction of CC pavements, quality control checks, concepts of white toppingon distressed bituminous layers. Also introduced to the alternate materials being in used instead of conventional ones.	L2
CO4	Understand the importance of drainage in highway construction, design of drainages underdifferent pavement conditions and rain fall data	L2, L3
CO5	Understandthecausesforpavementdistressofbothflexibleandrigidpavements,implementing suitable remedial measures at the site.	L3, L4

Program Outcome of this course:

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

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Semester- 2

ROAD GEOMETRIC DESIGN (PCC)			
Course Code	**MCHT203**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

- Understand the Geometrical design elements.
- Plan the geometric elements for varying conditions ofroads.
- Examine the geometric elements for highway geometricdesign.
- Judge and propose the geometric element facilities for varying highwayconditions

Module-1

Introduction: Importance, Factors governing geometric design, route selection, geometric design consistency, capacity of rural and urban roads.

Cross Section Elements: Right of way and width consideration, roadway, shoulders, Kerbs, traffic barriers, medians, service roads,pavement surface characteristics, cross slope, skid resistance, unevenness.

Teaching-Learning Process	Students can be exposed to practical assignments by collecting the details of road way elements, to evaluatethe vehicular characters and its application in highway geometry

Module-2

Geometric Design Elements for inter-city highways and expressways**:** Sight Distances-SSD, ISD, OSD, factors governing sight distances, Design of horizontal alignment-overturning and skidding, super elevation, extra widening, transition curves, Design of vertical alignment, - gradient, vertical curves.

Teaching-Learning Process	Live data of the road way geometry can be an assignment and its proof checking will make the student to understand the deficiency. Student can able design SSD, OSD and super elevation.

Module-3

Intersection Design: At grade intersections- sight distance consideration and principles of design, Channelization, mini roundabout, roundabout, Inter-changes- major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes.

Teaching-Learning Process	Can understand the importance of controlled intersections, different types of roundabout, channelization of roads

Module-4

Roadway facilities: Pedestrian facilities, bus bay, truck lay bays, frontage roads, parking areas, cattle crossings, lighting, toll plazas, and maintenance center, landscaping and tree plantation.

Teaching-LearningProcess	Can understand the necessity of pedestrian facility, parking areas, bus bays street lighting. Field assignments can beoffered to investigate provision of such facility.

Module-5

Geometric Design of Hill Roads: Classification, width of road land, roadway, carriageway, design speed, sight distances, horizontal alignment, vertical alignment, hairpin bends, passing places, lateral and vertical clearances.
Use of software: Mx Roads/ Open roads, / Civil 3D

Teaching- Learning Process	Can understand the geometry of the hill roads, construction methods in hilly area, providing the passing sight distances, designing of curves, drainage

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to50.
2. The question paper will have ten full questions carrying equalmarks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from eachmodule.
4. Each full question will have a sub-question covering all the topics under amodule.
5. The students will have to answer five full questions, selecting one full question from eachmodule

Suggested Learning Resources:

Books

1) Highway Engineering, S.K. Khanna, C.E.G Justo and A. Veeraragavan, Nem Chand and Bros., Roorkee. Revised 10thEdition, ISBN: 978-8185240930

2) A Policy on Geometric Design of Highways and Streets, (The Green Book) 7thEdition, American Association of State Highway and Transportation Officials (AASHTO) Publishers, 2018, ISBN Number:978-1-56051-676-7

3) Geometric Design Projects for Highways: An Introduction, John G Schoon, 2ndEdition, American Society of Civil Engineers Press, ISBN:978-0-7844-7042-8,2000

4) Relevant Indian Road Congress Code Books(IRC)

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/105/107/105107220/

Skill Development Activities Suggested

- Design the geometrics with the data collected by surveying for a road project by mathematicalmeans
- Designthegeometricswiththedata collectedbysurveyingforaroadprojectbyusingCivil3Dorotherdesignsoftwares.

Course outcome (Course Skill Set)

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

Sl.No.	Description	Blooms Level
CO1	Cross sectional details of the road, road way geometry, concept of arriving at the widthofthesingle lane and multilanes	L2
CO2	Calculate the stopping sigh distance, overtaking sight distance, designing of thesuperelevation,designing of vertical alignments	L4
CO3	Design the intersections, calculating thesightdistance	L4, L3
CO4	Understand the importance of road way facility- frontage, parking areas,pedestrianfacility	L2

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x				
CO2	x		x		x	x
CO3			x	x	x	x
CO4		x			x	

Semester- II

COURSE TITLE: CONSTRUCTION PLANNING AND ECONOMICS (PCC)			
Subject Code	MCHT204	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 03

Course Learning objectives: This course will enable students to

- Analyze construction methods and strategies for highway projects.
- Apply project management tools for construction monitoring and control.
- Understand highway economics principles and concepts.
- Analyze costs and benefits of highway projects.
- Evaluate economic viability of highway projects.

Module -1

Various types of highway development projects in progress in India and their scope. Factors to be considered in planning of new highway /expressway / bypass and up-gradation of existingroads.

Planning of Road Projects –project management framework, scope, project objectives, project environment, causes of project failure, project development process.

Resource planning – human resources, project man power grouping, structuring site organization, construction materials-classification of construction materials, materials usage, materials inventory, cost andbudget.

Teaching- Learning Process	1. Blackboard teaching/PowerPoint presentations (ifneeded) 2. Regular review of students by asking questions based on topics covered in theclass. 3. Compliment the understanding of casestudies.

Module -2

Time planning – project work breakdown, determining activities involved, assessment of duration, CPM / PERT network analysis, work scheduling,methods of work scheduling, factors affecting work scheduling, Problems.

Planning Control System – resource production, project cost, project time, codification and project management, information system, use of software

Use of software's: Primavera V8i, MSP (Microsoft project), PPM (Project Portfolio Management)

Teaching-Learning Process	1. Blackboard teaching/PowerPoint presentations (ifneeded) 2. Regular review of students by asking questions based on topics covered in theclass. 3. Compliment the understanding by discussing casestudies

Module -3

Highway Engineering Economics, principle, supply and demand models, equilibrium, sensitivity of travel demand, Elasticities – types, models (Kraft demandmodel) consumer surplus cost – cost elasticity pricing and subsidy policies, rates ofinterest, Vehicle operation cost, direct and indirect benefits due to road improvement, Total transportation cost, fixed and variable costs. Road user cost studies in India.

Teaching-Learning Process	1. Blackboard teaching/PowerPoint presentations (ifneeded) 2. Regular review of students by asking questions based on topics covered in theclass.

Module -4

Economic analysis, different methods, determination of annual cost, benefit cost ratio, IRR, FIRR, NPV. Sensitivity of economic analysis, Examples of economic analysis for different types of road improvement measures, pavement options, construction of bypasses and upgrading of intersections. Project priorities, methods of dealing with uncertainties.

Module -5

Highway financing, various options for road and bridge projects, special cess, tolling, BOT, BOOT and other options. Economic and financial analysis of highway projects and use of computer software packages. Road investment decisionpackages.

Use of software: HDM-4 software, Primavera V8i, MSP (Microsoft project), PPM (Project Portfolio Management)

Teaching-Learning Process	1. Blackboard teaching/PowerPoint presentations (ifneeded) 2. Regular review of students by asking questions based on topics covered in theclass. 3. Compliment the understanding by discussing casestudies with use of software's

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

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Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester End Examination:

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

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. L.R. Kadiyali "Traffic Engineering and Transport Planning"-Khanna Publishers, New Delhi.
2. K.K. Chitkara. "Construction Project Management Planning, Scheduling and Controlling"- Tata McGraw Hill publications
3. Winfrey, "Economic analysis for Highways", International Textbook Company, Pennslyvania,1969
4. Dr. Vinay Maitri and Dr. P.K. Sarkar "Theory and Applications of Economics in Highway & Transport Planning" Standard Publishers Distributors, Delhi

Reference Books:

1. Prasanna Chandra "Financial Management"-Tata McGraw, New Delhi.
2. Woods K.B, Berry, D.S. and Goetz W.H, "Highway Engineering"-McGraw Hill Book Co.
3. Hewes C.I. and Oglesby, C.H., "Highway Engineering"-Asia Publishing House.
4. Ian G. Heggie, "Transportation Engineering Economics"-McGraw Hill Book Co.
5. "Road User Cost Study in India"- Final Report, Central Road Research Institute, New Delhi, 1982.
6. L.R. Kadiyali, et al, "Value of Travel Time Savings" - Traffic Engineering, HRB
7. Ministry of Road Transport and Highways, "Road Development Plan for India"- 2001-2021, Indian Roads Congress, New Delhi, 2002.
8. IRC "A Manual for the Application of Critical Path Method to Highway Projects in India"
9. Nhai.org, pmgsy.nic.in websites

Standard Data Book on Highway Technology issued by the University may be referred in the PG Examination of VTU.

Web links and Video Lectures (e-resources)

Skill Development Activities Suggested

1. Case Study Analysis: Analyze real-life construction projects, identifying challenges and successes.
2. Cost Estimation Exercise: Estimate costs for a hypothetical project using various methods.
3. Scheduling Exercise: Create a project schedule using Gantt charts or CPM.
4. Financial Analysis: Conduct financial analysis for a construction project.

5.. Research Paper: Write a research paper on a construction management or economics topic

Course outcomes:

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

Sl. No	Description	Blooms Level
CO1	Understand construction planning and scheduling techniques.	L2
CO2	Analyze economic feasibility of highway projects.	L4
CO3	Develop skills in project management and monitoring.	L5
CO4	Students would be able to prepare highway plans, Land use planning and development models.	L1, L3
CO5	They will be able to carry out economic and financial analysis of highway projects.	L4
CO6	Understand the highway planning process and difficulties or failures associated with	L2

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	planning process.	
CO7	Understands the cost of materials, man power and equipment in budget preparations for highway projects.	L2
CO8	Analyse the various tasks involved in a road project and sequence them for effective and optimum outcome using tools like CPM andPERT.	L4

Program Outcome of this course

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS & POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**X**	**X**				
CO2	**X**	**X**	**X**			
CO3	**X**	**X**	**X**	**X**		**X**
CO4	**X**	**X**	**X**		**X**	**X**
CO5	**X**	**X**	**X**			**X**
C06	**X**	**X**	**X**			
CO7	**X**		**X**	X		
CO8	**X**	**X**	**X**		X	**X**

Semester- 2

<table>
<tr><td colspan="4">TRAFFIC ENGINEERING (PEC)</td></tr>
<tr><td>Course Code</td><td>MCHT215A</td><td>CIE Marks</td><td>50</td></tr>
<tr><td>Teaching Hours/Week (L:P: SDA)</td><td>2:0:2</td><td>SEE Marks</td><td>50</td></tr>
<tr><td>Total Hours of Pedagogy</td><td>26 Hours Theory + 26 Hours T/SDA</td><td>Total Marks</td><td>100</td></tr>
<tr><td>Credits</td><td>3</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to
• Analyze the factors affecting performance of road traffic and the various traffic studies needed for the analysis of trafficflow.
• Evaluate level of service and capacity of roadways and intersections using trafficdata.
• Propose and design suitable traffic regulatory system based on traffic requirements such as signs, signals, markings,etc.
• Analyze and design intersections at-grade and grade separated types for smooth and safe movement ofvehicles.
• Propose parking facilities, pedestrian facilities and general safety measures required for highways andexpressways.</td></tr>
<tr><td colspan="4">MODULE-1</td></tr>
<tr><td colspan="4">Traffic Studies & Analysis: Scope, traffic elements - Characteristics-vehicle, road user: and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents - Sample size, study methodology - Data analysis & inferences.
Traffic Forecast – objects, factors governing traffic growth, estimation of traffic growth from past trends, econometric models. Common methods of traffic forecast, Problems.</td></tr>
<tr><td>Teaching- Learning Process</td><td colspan="3">1. Blackboard teaching/PowerPoint presentations (ifneeded)
2. Regular review of students by asking questions based on topics covered in theclass. 3.Engage in conduction of traffic surveys andreporting</td></tr>
<tr><td colspan="4">MODULE-2</td></tr>
<tr><td colspan="4">Traffic Flow Analysis: Macroscopic, Microscopic & Mesoscopic approach – Types of Flow- Traffic stream characteristics – Space – Time diagram – Relationship between speed, flow & density-Level of service & capacity analysis – Shockwave theory. Introduction to Queuing theory: vehicle arrivals, delays at intersections, -Problem</td></tr>
<tr><td>Teaching- Learning Process</td><td colspan="3">1. Blackboard teaching/PowerPoint presentations (ifneeded)
2. Regular review of students by asking questions based on topics covered in theclass.</td></tr>
<tr><td colspan="4">MODULE-3</td></tr>
<tr><td colspan="4">Intersection Design: Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries & at-grade intersections – Signal
design - Grade separated intersections & their warrants.</td></tr>
<tr><td>Teaching- LearningProcess</td><td colspan="3">1. Blackboard teaching/PowerPoint presentations (ifneeded)
2. Regular review of students by asking questions based on topics covered in theclass.</td></tr>
<tr><td colspan="4">MODULE-4</td></tr>
<tr><td colspan="4">Road Safety Audit: Global & Local perspective – Road safety issues – Road safety programs – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures</td></tr>
<tr><td>Teaching- LearningProcess</td><td colspan="3">1. Blackboard teaching/PowerPoint presentations (ifneeded)
2. Regular review of students by asking questions based on topics covered in theclass.</td></tr>
<tr><td colspan="4">MODULE 5</td></tr>
<tr><td colspan="4">Traffic Regulation & Traffic Safety Management: Speed, vehicle, parking, enforcement regulations - Mixed traffic regulation - Management techniques, one-way, tidal flow, turning restrictions etc. – Transportation System Management Process – TSM planning & Strategies

Use of software: PTV VISSIM / VISUM (Traffic Flow Simulations), SIDRA (intersections), etc.</td></tr>
<tr><td>TeachingLearning Process</td><td colspan="3">1. Blackboard teaching/PowerPoint presentations (ifneeded)
2. Regular review of students by asking questions based on topics covered in theclass.
3. Practice sessions and hands on experience using trafficsoftware</td></tr>
</table>

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Text Books:

1. Kadiyali L.R. "Traffic Engineering and constru "-Khanna Publication, NewDelhi
2. Nicholas J.Garber, Lester A. Hoel, "Traffic and Highway Engineering", Third Edition ThompsonLearning

Reference Books

1. Salter RJ and Hounsell NB, "Highway, Traffic Analysis and Design"- Macmillan Press Ltd., London.
2. Matson T M, Smith W S, Hurd F W, "Traffic Engineering, Mc graw Hill Book Co, NY, USA.
3. Drew D R," Traffic Flow Theory and Control", McGraw Hill Book Co, NY,USA.
4. Wohl and Martin, "Traffic System Analysis of Engineers and Planners"-Mcgraw Hill Book Co, New York,USA.
5. May,A.D.,*TrafficFlowFundamentals*,Prentice–Hall,Inc.,NewJersey,1990.
6. O'Flaherty C A, *Highways- Traffic Planning & Engineering*, Edward Arnold,UK
7. Pignataro,"TrafficEngineering",Johnwiley&sons.NicholasJGarber,LesterAHoel,"Traffic &Highway Engineering"- Thirdedition,
8. IRC: SP 43 1994 and other Relevant IRCcodes
9. S.K. Khanna, C.E.G Justo and A. Veeraragavan, "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised10thEdition.
10. Indian Highway Capacity Manual (Indo-HCM) CSIR, New Delhi,2012-2017

Web links and Video Lectures (e-Resources):

(1)https://archive.nptel.ac.in/courses/105/105/105105107/

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

- Conduction of the various trafficstudies
- Computational procedures for safetyeffectiveness
- Interpretation of trafficstudies

Course outcome (Course Skill Set)

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

Sl. No	Description	Blooms Level
CO1	Gets the knowledge of factors affecting performance of road traffic and also thetrafficstudies needed for theanalysis.	L2
CO2	Evaluate level of service and capacity of roadwaysandintersections.	L5
CO3	Propose and design suitable traffic regulatory system such as signs, signals,markings,etc.	L4
CO4	Analyse anddesignintersectionsat-grade andgradeseparatedtypesforsmoothandsafe movement of vehicles.	L4
CO5	Propose parking facilities, pedestrian facilities and general safety measures requiredforhighways andExpressways.	L3

Program Outcome of this course After successful completion of the program, the post graduates will be able to

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

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Semester- 2

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

Course Learning objectives: This course will enable students to

- Understand the properties and behavior as a highway material under the application of wheelloads.
- Understand and compare the shear strength of soil and stability of slopes when used as subgrade soil and embankment fills or cut slopes
- Understandthepermeabilitycharacteristicsofsoilstodesignproperdrainagesystemandvariousinvestigationsrequiredtoass ess the soilproperties.
- Understand the type and soil composition affecting the surface runoff and sub-surface water flow in order to design proper drainagesystem.
- Analyselackofstrengthorinstabilityproblemsinsoils dueto soilformationoranyotherreasonsandproposesuitablestrengthening methods for the same.

Module-1

Introduction: SoilMechanicsapplicationstoHighway/InfrastructureEngineering.Soilformations,Types,RegionalSoildepositsofIndia,Indexproperties,theirdetermination,importance,varioussoilclassificationsystems,HRBclassification,problemsonthese.

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

Teaching- Learning Process	Black board, LCD, data collection through field/site investigation, lab demonstration on certain experiments onproperties of soil

Module-2

Shear strength of soil: Introduction, Importance, Measurements, shear strength of clay, Sand, Elastic properties of soil Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus.

Stability of slopes: Introduction, Types, Different methods of analysis of slopes forØu+0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.

Teaching- Learning Process	Black board, LCD, data collection through field/site investigation,

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, LCD, data collection through field/site investigation, application of modern equipment's for field studies and laboratory studies

Module-4

Special attention for subgrade condition: Problematic soils, compressible &collapsible soils, swelling, subsurface water, frost- susceptible soils.

Surface drainage, Sub-surface drainage, methods, Design of subsurface drainage system, soil stabilization, soil encapsulation.

Base layer requirement-erodibility of bases, bound bases, modified or treated bases, base reinforcement

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, data collection through field/site investigation, application of modern equipment's for field studies and laboratory studies

Module-5

Reinforced Earth structures Introduction, Components, Advantages, Types of stability – external, Internal, (No problems), Geo textiles – types, Functions, their uses in road embankments and railway works, other uses. Landslides – definition, classifies, factors producing.

Teaching- Learning Process	Black board, LCD, laboratory studies.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

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

Suggested Learning Resources:

Text Books:

1. "Basic and Applied soil Mechanics", Gopal Ranjan, ASR Rao, New Age InternationalPublishers.
2. "SoilMechanics&FoundationEngg",Dr.B.C.Punmia,AshokKumarJain,ArunKumarJain,LaxmiPublications(P)Ltd,16th edition.
3. S.K.Khanna,C.E.GJustoandA.Veeraragavan,"HighwayEngineering"-NemChandandBros.,Roorkee.Revised10thEdition.

Reference Books:

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

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

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

Course outcome (Course Skill Set)

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

Sl.No.	Description	Blooms Level
CO1	Able to understand different types of soil and their basic properties, analyse the wheelload effects on pavement materials	L1, L2, L3, L4
CO2	Evaluate and compare the shear strength of soil and stability of slopes when usedas pavement component.	L1, L2, L3, L4, L5
CO3	Design proper drainage system by knowing the permeability characteristics ofsoils.	L1, L2, L3, L4
CO4	Design surface runoff and sub-surface drainage system as per fieldconditions.	L1, L2
CO5	Proposesuitablestrengtheningmethodsforsoilfromtheknowledgeoflackofstrengthor 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	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

Semester- 2

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT (PEC)			
Course Code	**MCHT215C/MCEM215C**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

- Focus on the principles of sustainable construction and demolition waste management and resourceefficiency
- Examining the environmental impact of buildingmaterials.
- Formulating and designing pre–construction and site waste managementplans

Module-1

EnvironmentalImpactofBuildingMaterialsEmbodiedenergyofmaterials;impactonthelocalenvironment;toxicityofthematerial;life cycle assessment. Nature and Source Direct and indirect waste; site types and origins; composition; quantity; current recycling/reuse potentialofbuildingmaterials.

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

Module-2

ConstructionandDemolitionWasteManagementPlansInternationalgoodpractice;planningrequirements;DoEHLGguidancedocument; company policy; demolition plans; site implementation; supplier agreements; sub–contractor management; role of waste management contractor;training;auditing;skipmanagement;currentmarkets;currentdisposaloptions;healthandsafety;reportingtolocalauthorities.
TreatmentofConstructionandDemolitionWaste,wastepermits;wastelicenses;wastetransferfacilities;landfills;treatment technologies; hazardous waste facilities; reporting toEPA

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

Module-3

Designing for Waste Prevention and Minimization, Waste prevention and minimization; client, contractor and designer attitudes; propermaintenanceofexistingbuildings;reuseofexistingbuildingstructure;designflexibility;designforreuseandrecycling;dimensional co–ordinationandstandardization;modulardesign;materialselectionandcontrol.

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

Module-4

Waste Forecasting Tools Application of WRAP's designing out waste tool for buildings and civil engineering; WRAP net waste tool; BRE SMART Waste; WRAP Site Waste Management Plan Tracker.

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

Module-5

Future developments Potential future markets; ‘smart' materials; use of eco–materials.

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

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Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

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

Suggested Learning Resources:

Text Books:

1. "Basic and Applied soil Mechanics", Gopal Ranjan, ASR Rao, New Age InternationalPublishers.
2. "SoilMechanics&FoundationEngg",Dr.B.C.Punmia,AshokKumarJain,ArunKumarJain,LaxmiPublications(P)Ltd,16th edition.
3. S.K.Khanna,C.E.GJustoandA.Veeraragavan,"HighwayEngineering"-NemChandandBros.,Roorkee.Revised10thEdition.

Reference Books:

1. "Geotechnical aspects of pavement reference manual", US department of transportation, Publication no: FHWA NHI-05-037, Federal Highway Administration, May 2006, NHI courseno:132040
2. "Soil Mechanics & Foundation Engg" – K.R. Arora Standard Publishers Distributors. 3."Soil Mechanics for road Engineers" – HMSO,London.

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Visit to Recycleplants.
- Studies of International standards on wastemanagement

Course outcome (Course Skill Set)

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

Sl.No.	Description	Blooms Level
CO1	Theycanabletounderstandthebasicconceptofembodiedenergyofconstructionmaterials	L2
CO2	Understand the applicationof construction and demolition wasteto various concretestructures	L3, L4

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			
CO2			X	X		

Semester- 2

SPECIAL CONCRETES (PEC)			
Course Code	**MCHT215D/MCEM215D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

- To understand the factors affecting pavement design and performance of RuralRoads.
- To relate the concepts of Highway Geometric design to that ofRural roads
- To design the Special pavements which form alternatives for RuralRoads.
- To understandtheconceptsof designofdrainage,CDworksandsmallbridgeswhichformessentialstructuresof Ruralroads

Module-1

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

SDA: Preparation of design spreadsheets of different Concrete Mixes.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, case studies

Module-2

Light Weight Concrete: Introduction, Definition, types, Properties and Applications. Geo-polymer Concrete: Brief history of development, Definition, material characterization, mix proportioning, properties, and applications.

SDA: Characterization of light weight and geo-polymer concrete / blocks

Teaching- Learning Process	. Black board, LCD, Skill enhancement through problem solving, case studies

Module-3

Self-compacting concrete: Introduction, Materials, Mix design of SCC as per IS 10262-2019, Fresh Properties of SCC - Filling, Passing and Segregation resistance, Hardened Properties of SCC – Compressive strength, Production and transportation, Placement and SCC application.

SDA: Group activity - Developing SCC mixes by other than IS method.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, case studies

Module-4

Fiber-reinforced Concrete: Brief Introduction on FRC, Properties of fibers and matrices, Theoretical stress–strain curves in uniaxial tension, Fresh concrete and Hardened concrete, Applications.

Roller Compacted Concrete: Introduction, Materials, Mix design as per IS 10262-2019, Fresh and Hardened Properties of mass concrete.

SDA: Group activity - Application of the fibers in construction materials.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, case studies

Module-5

Recycled concrete: Introduction, Properties of recycled aggregate, Methods of recycling and quality, Applications.

CLSM: Brief Introduction, Materials and Properties as per ACI 229R, Applications. SDA: Group activity – Develop concrete for low strength applications using un-conventional and recycled materials

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, case studies

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

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

Suggested Learning Resources:

Text Books:

1. A. M. Neville, Properties of Concrete, Pearson Education (Singapore)Pvt.Ltd.
2. P. Kumar Mehta and Paulo J. M. Monteiro, "Concrete Microstructure, Properties, and Materials"-McGraw HillEducation

References:

1. John Newman and Ban Seng Choo, Advanced Concrete Technology, ISBN 0 7506 5105 9, ElsevierLtd.
2. Concrete Construction Engineering Handbook by Dr. Edward G. Nawy, CPC Press, 2nd Edition, ISBN9780849374920.
3. Joseph A. Daczko, Self-Compacted Concrete by-Applying what we know, CPC Press, ISBN-13: 978- 0 203-84422-9

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Visit to RMCPlants
- Conduct tests on various type of concretemixes

Course outcome (Course Skill Set)

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

Sl.No.	Description	Blooms Level
CO1	Identify ingredient of concrete material characteristics and different types ofconcretefor their appropriate use inconstruction.	L2, L3
CO2	Design special concrete mixes like Self-compacted concreteandGeo-polymer	L3,L4
CO3	Concrete mixes and asses the fresh and hardened properties usingvariousguidelines.	L2, L3, L4
CO4	Determine the compressive strength of concrete structures byNon-DestructiveMethods.	L3, L4

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			X			
CO2				X	X	X
CO3	X					X
CO4			X	X		

Semester- 2

BRIDGE AND GRADE SEPARATED STRUCTURES (PEC)			
Course Code	MCHT216A/MCEM216A	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

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

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	Blackboard teaching/PowerPoint presentations (if needed)

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	Blackboard teaching/PowerPoint presentations (if needed)

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 ofcongestion factor and reduction factors. Landscaping of flyovers.

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

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, hand rails, drainage arrangements, wearing course, approach slab. Relevant IRC standards.

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

Module-5

Construction of bridges, quality assurance of bridge projects, bridge construction inspection- data to be collected. Construction of short span and long span bridges. Construction of continuous concrete bridges. Formwork and false work for concrete bridges, numbering f bridges, bridge management system. Smart structural health monitoring (SSHM)of bridges. Components of SSHM. Types of monitoring and metrics of monitoring. IoT in bridge health monitoring.

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

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

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

Suggested Learning Resources:

Text Books:

1. D.Johnson Victor, "Essentials of bridge Engineering"- Oxford, IBH publishingcompany.
2. Ponnuswamy, "Bridge Engineering"-McGraw Hill Publication,1989.

Reference Books:

1. Relevant IRCcodes
2. VaziraniRatwani&M.G.Aswani, "Design of Concrete Bridges"- Khanna Publishers, NewDelhi
3. "Design of Bridges"- Dr. Krishna Raju, Oxford & IBH Publishing Company Limited. "Analysis and design of Bridges"- M.A.Jayaram, Sapna Publishers,Bangalore.

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Visual inspection of the grade separatedstructures.
- Construction Sitevisit

Course outcome (Course Skill Set)

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

Sl.No.	Description	Blooms Level
CO1	Elaborate on conceptual bridge design, identify suitable bridge for a given scenario,andbe able to prepare a suitable report upon doing siteinvestigation.	L1, L2, L3
CO2	Demonstrate the knowledge on bridge loading standards andIRC-codeprovisions.	L1, L2, L3
CO3	Identify different types of flyovers and recommend particular type dependingonthe constraints.	L2, L3, L4
CO4	Differentiate between different types of bearings and recommend a suitabletypeof bearing.	L2, L3, L4
CO5	Explainconstructionmethodsfordifferenttypesofbridges,andabletodecideonsuitable health Monitoringprocedure	L2, L3, L4, L5

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and Pos

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

Semester- 2

URBAN PUBLIC TRANSPORT (PEC)			
Course Code	MCHT216B	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

- Understand the various options for urban public transportation and recommend suitable mode for the givensituation.
- Conducteconomicanalysisbetweendifferenttransportmodesandsuggestmost economicalandefficientmodeunderthegiven set ofconditions.
- Understand the management of public transport system and developing strategies for efficient functioning of thesystem.
- Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc., to know the performance of thesystem.
- Forecast the future transportation needs and variations in system components so as to plan for the transportationsystemrequirements.

Module-1

System and Technologies: Urban passenger transportation modes, transit classifications and definitions, theory of urban passenger transport modes, rail transit, bus transit, Metro and Mono Rail, Para transit and ride sharing,designing for pedestrians, trends in transit rider ship and use of different modes.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, field studies

Module-2

Comparing Alternatives: Comparing costs, comparative analysis, operationalandTechnologicalcharacteristics of different rapid transit modes, evaluating rapid transit,Problems.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3

Planning: Transportation system management, system and service planning, financing public transportation, management of public transportation, public Transportation marketing.

Teaching- Learning Process	Black board, LCD, Skill, enhancement through problem solving, case studies

Module-4

Transit System Evaluation: Definition of quantitative performance attributes, transit lane capacity, way capacity, station capacity, theoretical and practical Capacities of major transit modes, quantification of performance, Problems.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-5

Urban traffic: Classification of transportation systems, conventional transportation systems, non-conventional transportation systems, prototypes and tomorrow's solutions, analysis and interpretation of information on transportation systems, perspectives offuture transportation.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

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

Suggested Learning Resources:

Text Books:

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- work on casestudies
- Formulate the Parking Action Plan for a studyarea
- Visit to Multimodal Integration of Traffic and Transit Management Centre (TTMC) and understand theiractivities.
- Mini projects on efficiency of public transport system in urbanareas.

Course outcome (Course Skill Set)

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

Sl. No.	**Description**	**Blooms Level**
C01	Understand the various options for urban public transportation andrecommendsuitable mode for the givensituation.	L1, L2
CO2	Conduct economic analysis between different transport modes andsuggestmost L3 economical and efficient mode under the given set ofconditions.	L2
CO3	Understand the management of public transport system and developingstrategiesfor efficient functioning of thesystem	L4
CO4	Carry out the evaluation of capacities of the system parameters such asroutes,junctions, stations etc., to know the performance of thesystem.	L2, L3, L4
CO5	Forecast the future transportation needs and variations in system components so astoplan for the transportation systemrequirements.	L4

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of Cos and POs

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

Semester- 2

LOW VOLUME ROADS ENGINEERING (PEC)			
Course Code	MCHT216C	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

- To understand the factors affecting pavement design and performance of RuralRoads.
- To relate the concepts of Highway Geometric design to that ofRural roads
- To design the Special pavements which form alternatives for RuralRoads.
- Tounderstandtheconceptsofdesignofdrainage,CDworksandsmallbridgeswhichformessentialstructuresofRuralroads

Module-1

Introduction to Low-Volume Roads (LVR). Significance of LVR, Definition, Design Environments. Planning of rural road, planning data base, concept of network planning Rural roads plan, guidelines laid down in recent 20-year plans and in PMGSY Road alignment and surveys, governing factors for route selection Factors controlling alignment; obligatory points, traffic, geometric designs, economy, special considerations in hilly areas.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, data collection through field/site investigation.

Module-2

Geometric design standards: classification of rural roads, terrain classification, design speed, basic principles of geometric design cross sectional elements, camber, sight distances

Horizontal alignment: general guidelines, super elevation, transition curve, widening and set back distances, vertical alignment: gradient, grade compensation at curves, valleycurves, alignment compatibility, lateral and vertical clearances.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, data collection through field/site investigation.

Module-3

Soil and material surveys, soil investigations for low embankment, high embankment, cut sections, subgrade, Survey for marginal materials and aggregates/ low grade materials Artificial aggregates, waste materials, new materials and stabilizers Designparameters, pavement components Design of flexible pavement: pavement thickness, pavement surfacing Design of semi rigidpavement: dry lean concrete / lime fly ash concrete bases Design of rigid pavement: cement concrete pavement Design of special pavements: concrete block pavement , interlocking concrete block pavement Choice of pavement type and materials, maximize use of Locally available materials, Use of Geo-synthetics in LVR

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, data collection through field/site investigation.

Module-4

Typesofroaddrainage,requirementsofsurfacedrain;roadsidedrains,shoulderdrains,catchwaterdrains.Requirementssubsurfac e

drainCrossdrains;types,requirements,choiceofdifferenttypesofcrossdrainsStandarddesignsofculvertsStandarddesignofsmall bridges.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-5

Selection of materials and methodology, construction techniques, machinery and tools.

Construction of Embankment / subgrade; materials, requirements and construction operations. Choice and requirements of coarse sand sub base, gravel roads. Innovative technology for Low volume roads.

Pavement Maintenance and Rehabilitation Management System (RMS) for LVR. Unpaved, climate resilience LVR.

Teaching- Learning Process	Black board, LCD, Skill enhancement through problem solving, data collection through field/site investigation.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester EndExamination:

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

Suggested Learning Resources:

Text Books:

1. S.K.Khanna,C.E.GJustoandA.Veeraragavan,"HighwayEngineering"-NemChandandBros.,Roorkee.Revised10thEdition.
2. Robert A. Douglas, Low-Volume Road Engineering, Design, Construction, and Maintenance, I edition, CRCPress

Reference Books:

1. IRC: SP:72-2015, Guidelines for the design of Flexible Pavements for Low Volume Roads, FirstRevision
2. IRC: SP:62-2014, Guidelines for Design & Construction of CC pavements for low volumeroads
3. IRC SP 20 Rural RoadsManual
4. Relevant IRCPublications

Web links and Video Lectures (e-Resources):

- http://omms.nic.in/

Skill Development Activities Suggested

- Understand the PMGSY's three-tier Quality Control & Quality Monitoringmechanism.
- Visit nearby roads constructed under PMGSY scheme and evaluate the performance over a period oftime.
- Study the various technology demonstration projects executed underPMGSY

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Get the knowledge of factors affecting pavement design and performance ofruralroads	L2
CO2	ThestudentwillbeabletodifferentiatethedesignandconstructionofLowvolumerural roads with that of the Highways	L2, L3
CO3	The students will be able to infer and review the DPRs prepared for constructionofRural Roads such underPMGSY	L2, L3, L4

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1					**X**	
CO2			**X**		**X**	
CO3		**X**			**X**	**X**

Semester- 2

Road Construction Planning and Management (PEC)			
Course Code	MCHT216D	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	26 Hours Theory + 26 Hours T/SDA	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to

- Understand the highway planning process and difficulties or failures associated with planning process.
- Understands the cost of materials, man power and equipment in budget preparations for highway projects.
- Identify suitable equipment and their selection in the production of pavement materials.
- Analyse the various tasks involved in a road project and sequence them for effective and optimum outcome using tools like CPM and PERT.
- Use the software or management tools to manage the resources, cost and duration of equipment.

Module-1

Various types of highway development projects in progress in India and their scope. Factors to be considered in planning of new highway /expressway / bypass and up- gradation of existing roads.
Planning of Road Projects –project management framework, scope, project objectives, project environment, causes of project failure, project development process

Teaching-Learning Process	Black Board, Slides on Projector

Module-2

Resource planning – human resources, project man power grouping, structuring site organization, construction materials-classification of construction materials, materials usage, materials inventory, cost and budget

Teaching-Learning Process	Black Board, Slides on Projector

Module-3

Construction equipment and choice-type, capacity and number, task considerations, cost considerations, engineering considerations, equipment acquisition options, optimum location of crushing and mixing plants, problems.

Teaching-Learning Process	Black Board, Slides on Projector

Module-4

Time planning – project work breakdown, determining activities involved, assessment of duration, CPM/PERT network analysis, work scheduling, methods of work scheduling, factors affecting work scheduling, Problems.

Teaching-Learning Process	Black Board, Slides on Projector

Module-5

Planning Control System – resource production, project cost, project time, codification and project management, information system, use of software.

Teaching-Learning Process	Black Board, Slides on Projector

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Assessment Details (both CIE and SEE)

TheweightageofContinuousInternalEvaluation(CIE)is50%andforSemesterEndExam(SEE)is50%.Theminimumpassingmark 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 deemedtohavesatisfiedtheacademicrequirementsandearnedthecreditsallottedtoeachsubject/courseifthestudentsecuresnot less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) takentogether.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks

to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Reference Books

- K.K. Chitkara. "Construction Project Management Planning, Scheduling and Controlling"- Tata McGraw Hill publications
- S.C. Sharma "Construction Equipment and its Management"- Khanna Publishers
- Peurifoy / Schexnayder "Construction Planning, Equipment and Methods"-Tata Mc Graw Hill Publications
- IRC "A Manual for the Application of Critical Path Method to Highway Projects in India"
- Nhai.org, pmgsy.nic.in websites

Web links and Video Lectures (e-Resources):

1. https://www.cmu.edu/cee/projects/PMbook/09_Construction_Planning.html
2. https://www.coursera.org/courses?query=construction%20project%20management

Skill Development Activities Suggested

- Analysis of case studies related construction project management
- ABC classification
- Break even analysis – case study

Course outcome (Course Skill Set)

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

Sl. No	Description	Blooms Level
CO1	Understand the highway planning process and difficulties or failures associated with planning process.	L1, L2
CO2	Understands the cost of materials, man power and equipment in budget preparations for highway projects.	L2, L3, L4
CO3	Identify suitable equipment and their selection in the production of pavement materials.	L3, L4
CO4	Analyse the various tasks involved in a road project and sequence them for effective and optimum outcome using tools like CPM and PERT.	L4, L5
CO5	Use the software or management tools to manage the resources, cost and duration of equipment.	L5

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

PAVEMENT MATERIALS AND EVALUATION LABORATORY(PCCL)

Course Code	**MCHTL207**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	03

Course objectives: The objective of this course is to make students learn

- The procedure and test the basic properties of bitumen and modified binders, learn bituminous mixdesign
- Learn field tests on pavementevaluation

Sl.NO	Experiments
1	**Test on Subgrade Soil -** Grain size analysis - Wet sieve analysis, Liquid limit, plastic limit & Shrinkage limit, Free Swell Index, Compaction test, Determination of Effective CBR, Unconfined Compression Strength Test, Soil-Cement Mix Design as per IRC: SP:89-2010.
2	**Tests on Road aggregates -** Shape tests - Combined Index, Aggregate impact value test, Los Angeles abrasion value test, Specific gravity & Water absorption test, Stripping value test, Polished stone value test, Sand equivalent test.
3	**Tests on cement & concrete -** Fineness of Cement, Standard consistency & setting time of cement Soundness, Fresh concrete – workability, Slump test, Compaction Factor test and Flow Table test, Compressive strength of cement, Concrete Mix design Compressive Strength of concrete, Flexural strength of concrete, Concrete Mix design, Compressive Strength of concrete Flexural strength of concrete. DLC & PQC – Fresh and hardened properties
4	**Tests on bitumen / polymer modified binders -** Penetration test, Viscosity test, Specific gravity test, Flash and fire point test Ductility and elastic recovery test, Softening point test and separation test, Tests on bitumen Emulsion & Cutback bitumen.
5	**Tests on bituminous mixes -** Proportioning of materials by Rothfutch's method and Mix design by Marshall Method
6	**Field Tests on Pavement evaluation -** Benkelman Beam deflection studies & analysis, Measurement of Unevenness by Merlin & Bump integrator - Calibration of Bump Integrator, Surface Distress measurements – visual & wind shield survey – Determination of PCI, Non-destructive test on concrete by: (Demonstration) (a) Rebound Hammer Test; (b) Ultrasonic Pulse Velocity Test; (c) Profilometer

Course outcomes (Course Skill Set):

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

CO1: Acquired the expertise to conduct various tests on binder, modified binders and bituminous mixes.

CO2: Gained knowledge on various field tests for the pavement evaluation

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

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

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

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

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

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours.

Suggested Learning Resources:

Pavement Engineering: Principles and Practice" – Rajib B. Mallick & Tahar El-Korchi

- Covers the fundamentals of pavement materials, design, evaluation, and testing procedures.

Highway Engineering" – Khanna & Justo

- A classic textbook used in India for understanding highway materials and pavement testing.

Principles of Pavement Engineering" – Nick Thom

- Offers a practical perspective with modern testing and evaluation methods.

Standards & Codes

1. **IRC (Indian Roads Congress) Codes**
    - *IRC: 37-2018*: Guidelines for the design of flexible pavements
    - *IRC: SP 53*: Guidelines on use of polymer and rubber modified bitumen
    - *IRC: 58*: Guidelines for rigid pavement design
2. **MoRTH Specifications (Ministry of Road Transport & Highways, India)**
    - Specifications for Road and Bridge Works (latest edition)
3. **ASTM Standards**
    - ASTM D6927: Marshall Stability and Flow of Bituminous Mixtures
    - ASTM D1559, D2726, D2041 – Various standards on asphalt and concrete testing
4. **IS Codes (BIS - Bureau of Indian Standards)**
    - *IS 73*: Paving Bitumen
    - *IS 1201 to 1220*: Testing methods for bitumen

- *IS 2386*: Methods of test for aggregates
- *IS 516*: Methods of tests for strength of concrete

Web links and Video Lectures (e-Resources):

-

Skill Development Activities Suggested

-

Course outcome (Course Skill Set)

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

Sl. No	Description	Blooms Level
CO1	Determine the suitability of soil as sub grade materials	L1, L2
CO2	Make use of knowledge acquired on road aggregates and bitumen for their suitability as road material.	L2, L3, L4
CO3	Analyze appropriate concrete mix and Determine strength and quality of concrete	L3, L4
CO4	Examine the quality and suitability of cement for construction work	L4, L5

Program Outcome of this course:

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of CO's & PO's

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	X	X				
CO2	X					
CO3			X		X	
CO4				X	X	

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

Course objectives:

The objectives of the course are to:

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

Teaching-Learning Process (General Instructions)

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

1. Black board and power point presentations

Module-1

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

Module-2

The fatal accidents, fatal -4s, falls, protection against fall, safety monitoring systems, electrical injuries, caught-in between hazards, Accident theories, causes of accidents, cost of accidents, incident investigation techniques, impact of an accident on the employer, Time constraints, interruptions and distractions, accident prevention, Injured worker management, compensation laws, types of hazards, Job hazard analysis, Identifying potential hazards, detailed hazard analysis.

Module-3

Promoting safety, safety rules and regulations, prompting safety, work place violence, handling violence situation, policy reviews and preventing internal threats of violence, workplace security, general safety and health provisions, Employee emergency action plans, occupational health, occupational noise exposure, hazardous waste operations an emergency response,

Module-4

Personal protection and lifesaving equipment, general criteria, fire protection, equipment, prevention, temporary building, operations, flammable objects, signs, signals, and barricades, accident prevention signals.

Module-5

Toxic and hazardous substances, Asbestos, carcinogens, methods of complains, permissible exposure limits, blasting and use of explosives, surface transportation explosives, use of electric safety fuse, Ergonomics, related problems, ergonomic improvement by employers, engineering and management controls.

Course outcome (Course Skill Set)

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

1. Demonstrate the importance of safety measures in construction and possible accidents and risks.
2. Detect the possibility of accidents and find remedial measures appropriate to the situation.
3. Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.

4. Identify possible accidents in construction site and suggest preventive measures.
5. Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

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

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

Course outcome (Course Skill Set)

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

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

Program Outcome of this course:

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

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

Course objectives:

The objectives of the course are to:

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

Teaching-Learning Process (General Instructions)

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

1. Black board and power point presentations

Module-1

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

Module-2

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

Module-3

Intelligent transport systems Smart vehicles and fuels, GIS, GPS, Navigation system, traffic safety management, mobility services, E-ticketing.

Module-4

Management of water resources and related infrastructure Storage and conveyance system of water, sustainable water and sanitation, sewerage system, flood management, conservation system.

Module-5

Infrastructure Management system & Policy for Smart city Integrated infrastructure management systems for smart city, Infrastructure management. system applications for existing smart city. Worldwide policies for smart city Government of India - policy for smart city, Mission statement & guidelines, Smart cities in India, Case studies of smart city.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

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

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

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

Course outcome (Course Skill Set)

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

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

Program Outcome of this course:

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

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

Course objectives:

The objectives of the course are to:

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

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

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

Module-2

Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, Advanced statistical methods, Black Spot Identification & Investigations, Case Studies. Urban Safety and Mobility, Traffic Calming.

Module-3

Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, describe methods for identifying hazardous road locations, Vulnerable Road Users, Case Studies.

Module-4

Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.

Module-5

Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety.

Road safety management, road safety policy-making, stakeholders involved, developing the road safety management system, capacity building.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

Suggested Learning Resources:

Books

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

Reference Books:

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997
2. (reprinted 2002)
3. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
4. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
5. Leonard Evans, Traffic Safety, Science Serving Society, 2004.

6. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.
7. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997
8. Rune Elvik and TrulsVaa, The Handbook of Road Safety Measures, Elsevier, 2004.
9. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.
10. Towards Safe Roads in Developing country, TRL – ODA, 2004.

Web links and Video Lectures (e-Resources):

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

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

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

Course outcome (Course Skill Set)

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

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

Program Outcome of this course

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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

IoT AND SMART CITIES			
Course Code	MCHT258D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- To 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.

Teaching-Learning Process (General Instructions)

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

1. Black board and power point presentations

Module-1

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.

Course outcome (Course Skill Set)

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

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

precautionary measures.

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

Suggested Learning Resources:

Books

1. 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, andenvironmentalsustainability in the development of smart cities, 2015, 1st edition,
3. Information Science Reference, IGI Global, USA
4. 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
5. 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

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

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

Course outcome (Course Skill Set)

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

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

Program Outcome of this course

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

Sl. No.	Description	POs
1	Conduct independent research, investigations, and development activities to address practical Challenges in highway technology.	PO1
2	Prepare and effectively present comprehensive technical report or documentation within the domine of highway technology.	PO2
3	Demonstrate advanced expertise in materials, analysis, design, construction, maintenance, and management of highways.	PO3
4	Apply modern computational tools and technologies for the design, analysis, and management of highways.	PO4
5	Incorporate principles of Safety, economy, ethics, and sustainability in the design, construction, and management of highways.	PO5
6	Exabit multidisciplinary and managerial competencies with a strong commitment to continuous learning and professional growth.	PO6

Mapping of COS and POs

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