Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Transportation Planning	**Course Code**: CEPL101	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Transportation Planning Process & Policies:** Transportation Planning Process, Components of Transportation Planning, Levels of Planning. Policies of Urban Transportation Planning: National Urban Transport Policy (NUTP), Comprehensive Mobility Plan (CMP), etc. Transportation problems and issues in Indian cities.	8
3	**Study Areas and Transportation Surveys:** Zoning System, Screen and Cordon Lines and Transportation Network. Sampling techniques, sample sizes. Transportation Planning surveys – Road Inventory Data, Traffic Volume Survey, Origin and Destination Survey, Household surveys, Pedestrian Survey, Parking Survey, Intermediate Public Transport Survey, Goods Survey, etc.	9
4	**Four-stage Sequential Planning:** Stages of Sequential Planning, Demand Forecasting Techniques. Trip Generation: Types of Trips, Factors influencing trip generation, Models of Trip Generation. Trip Distribution: Growth Factor and Synthetic Models. Modal Split: Factors affecting Modal Split, Types of Modal Split Models. Trip Assignments: Route assignment, Multiple assignment and Network assignment.	12
5	**Land use–Transportation Planning:** Transport land use relationship, Land-use Transport Models: Early-era models; Intermediate-era model and its derivatives, Modern era models.	6
6	**Mobility and Accessibility Consideration in Transport Planning**: Definition of Mobility and Accessibility, Case Studies on Mobility and Accessibility. Mobility Consideration for Gender, Disadvantaged Groups namely: Aged, Children and Poor. **Economic Aspects of Transportation Planning**: Cost-Benefit Analysis. Basic concepts for carrying out Economic Evaluation,. Methods of Economic Evaluation.	9
	Total	**45**

Text Books:

1. Pradip Kumar Sarkar, Vinay Maitri and G. J. Joshi, “Transportation Planning - Principles, Practices and Planning”, PHI Learning; 3rd edition 2022
2. S. Ponnuswamy, Dr. (Late) David Johnson Victor, “Urban Transportation: Planning, Operation and Management”, McGraw-Hill Education Private Limited, 1st Edition 2012
3. B. G. Hutchinson, “Principles of Urban Transport Systems Planning” Scripta Book Co., Washington – 1974

Reference Books:

1. C A O’Flaherty, ed, “Transport Planning and Traffic Engineering”, Butterworth Heinemann, Elsevier, Burlington, MA - 2006
2. C Jotin Khisty and B Kent Lall, “Transportation Engineering – An Introduction”, Prentice Hall of India Pvt Ltd., New Delhi -2003
3. Roy Thomas, “Traffic Assignment Techniques”, Avebury Technical, Aldershot, England – 1991

Prerequisite:
Basics of Transportation Engineering studied at the B.Tech level.

Course Outcomes:

After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL101.1	**Describe** various transportation planning processes and policies.	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL101.2	**Conduct** transportation surveys and studies.	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL101.3	**Apply** four-stage sequential planning and modelling.	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL101.4	**Explain** land use-transportation relationships and apply the various models.	**4**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL101.5	**Analyze** mobility and accessibility considerations in transport planning and understand the economic aspects of transportation planning.	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL101.1	3	-	3	3	3
CEPL101.2	3	-	3	3	3
CEPL101.3	3	3	3	3	3
CEPL101.4	3	3	3	3	3
CEPL101.5	3	3	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Pavement Materials and Construction	**Course Code**: CEPL102	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Soil:** Desirable properties and test methods of Soil: grain size analysis (coefficient of uniformity, coefficient of curvature), liquid limit, plastic limit, shrinkage limit, free swell index, unconfined compressive strength, Proctor Test, CBR test. Modulus of subgrade reaction. IS Soil classification system. **Aggregates:** Desirable properties and test methods of road aggregates: sieve analysis, Impact, Los Angeles Abrasion, Shape, specific gravity, water absorption, soundness test, polish stone value, skid friction coefficient, alkali-aggregate reactivity.	10
3	**Bitumen:** Bitumen sources and constituents, Desirable properties and tests of paving bitumen (Penetration, Softening Point, Ductility, absolute viscosity, kinematic viscosity, flash & fire point, purity test); Modified bitumen (Elastic recovery, rotational viscosity, storage stability), relevant standard values of highway materials confirming to IS 73 and IS 15462. Bitumen rheology. Different bitumen grading systems. Emulsions: classification and application, Long and short term (Rolling thin film oven) aging of bitumen.	9
4	**Bituminous Mixes:** Desirable properties of bituminous mix, fillers, determination of mixing and compaction temperature, gradation and blending of aggregates, volumetric properties of bituminous mixes, Stepwise procedure of Job Mix formulae for bituminous mix to select the optimum binder content (OBC) by Marshall Method confirming to MS-2 (sixth edition). Tests on bituminous mixes: stripping value test, Indirect Tensile Strength (ITS), Tensile Strength Ratio (TSR), Retained Stability.	8
5	**Road Construction:** Bottom to top component layers of flexible pavements, Material specifications & construction methods (as per MoRTH): Subgrade, Granular Sub Base (GSB), Wet Mix Macadam (WMM), Bituminous Mixtures (DBM & BC), Dry Lean Concrete (DLC), and Pavement Quality Concrete (PQC). **Sustainable Road Construction:** Reclaimed Asphalt Pavement (RAP) material, Hot Mix Recycling (In-Place, and In-Plant), Full Depth Reclamation, plastic roads	9
6	**Airport Runway Materials** Stabilization techniques and methods for Subgrade, Subbase, and Base course for runway pavement, Comparison of FAA standard layers' specification with MORTH Specification. Pavement Classification Number (PCN) value.	8

Text Books:

1. Bituminous Road Construction in India, Prithvi Singh Kandhal, A Veeraragavan, Rajan Choudhary, Second Edition, PHI Publications. Print Book ISBN : 9789391818821
2. Manual Series No. 2 2014, Asphalt Mix Design Methods, Asphalt Institute.
3. Ministry of Road Transport and Highways (MoRTH) 2015.
4. Highway Engineering Revised 10th Edition, S.K. Khanna, CEG Justo, A Veeraragavan, ISBN 8185240930.
5. Airport Engineering By Rangwala, 17th Edition 2019 (First Reprint), ISBN : 9789385039355

Reference Books:

1. Read, J. And Whiteoak, D., "The Shell Bitumen Handbook", Fifth edition, Shell Bitumen, Thomas Telford Publishing, London-2003
2. Relevant IRC and IS codes: IRC SP 112, IRC 120.

Prerequisite:

1. A comprehensive understanding of soil mechanics including soil classification.
2. Proficiency in materials science principles, including understanding the properties and behavior of materials like aggregates, and bitumen.
3. Knowledge of transportation engineering principles, including pavement materials, pavement design methods, and construction techniques.
4. Competence in mathematical and statistical analysis is crucial for understanding mix design principles, analyzing test results, and interpreting specifications for pavement materials like bitumen.

Course Outcomes:

After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL102.1	**Understand** the properties and characteristics of soil and aggregate.	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL102.2	**Describe** the physical properties of bitumen as a construction material.	**2**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL102.3	**Design** of bituminous mixes and tests on bituminous mixes	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL102.4	**Discuss** the techniques of road construction and sustainable construction practices	**2**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL102.5	**Understand** stabilization techniques and methods for Subgrade, Subbase, and Base courses for runway pavement	**2**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL102.1	3	-	3	3	3
CEPL102.2	3	-	3	3	3
CEPL102.3	3	-	3	3	3
CEPL102.4	3	-	3	3	3
CEPL102.5	3	-	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Advanced Concrete Technology	**Course Code**: CEPL111	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, scope, and outcomes of the course.	1
2	**Fundamental of Concrete** - constituents, concrete mix design (as per BIS 10262 and IRC-47), transportation, placing and curing, quality control of concrete during construction, effect of superplasticizers	7
3	**Supplementary Cementing Materials (SCM):** Effect of supplementary cementing materials such as fly ash, ground granulated blast furnace slag, silica fume, rice husk ash, and metakaolin on properties of fresh and hardened concrete; their physical and chemical properties.	5
4	**Durability of Concrete** – Creep and shrinkage, alkali aggregate reaction, reinforcement corrosion, freezing and thawing, carbonation, chloride ingress, acid and sulphate attack: Factors affecting, effects, mechanisms, prevention and control.	9
5	**Special concretes** - high strength, low heat of hydration, high early strength, self-compacting, dry lean concrete, pavement quality concrete, fibre reinforced concrete, geopolymer, 3D concrete printing, interlocking paving blocks, White topping, Bonded concrete overlays, roller compacted concrete, pervious concrete pavements, precast concrete pavements for highways and airfield.	9
6	**Introduction to the maintenance of concrete structures** – techniques for non-destructive evaluations (NDE) of concrete, and evaluation criteria.	7
7	**Sustainable Materials:** Characterization, Significance, Use of construction & demolition waste, agricultural and industrial wastes, Introduction to sustainable civil infrastructure development and case studies.	7
	Total	**45**

Text Books:

1. Santha Kumar, A.R., (2018), Concrete Technology, Second Edition, Oxford University Press.
2. Shetty, M.S. (2018), Concrete Technology Theory and Practice, Eight Edition, S.Chand and company, New Delhi.
3. Gambhir, M.L., (2017), Concrete Technology, Fifth Edition, Tata McGraw Hill.
4. Nevile, (2012), Properties of Concrete, Fifth Edition, Longman Publishers.
5. S.S Bhavikatti, (2015), Concrete Technology, First Edition, I.K International Publishing House Pvt. Ltd.

Reference Books:

1. Diagnosis and treatment of structures in distress by R.N.Raikar, Published by R&D Centre of Structwel Designers & Consultants Pvt.Ltd., Mumbai, 1994.
2. Handbook on Repair and Rehabilitation of RCC buildings, Published by CPWD, Delhi, 2002

Prerequisite:

1. Student should be familiar with general construction materials.
2. Student should have basic knowledge of concrete properties.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL111.1	**Explain** the fundamentals of concrete and **interpret** the quality control of concrete.	**4**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL111.2	**Determine** the properties of concrete in a fresh and hardened state using SCM.	**3**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL111.3	**Judge** the type of disintegration in concrete on the basis of durability parameters.	**5**	1.1.1, 1.1.2, 1.2.1, 2.1.1, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL111.4	**Design** the ordinary and special concrete mixes.	**6**	1.1.1, 1.1.2, 1.2.1, 2.1.1, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL111.5	**Examine** a sustainable concrete using NDT.	**3**	1.1.1, 1.1.2, 1.2.1, 2.1.1, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL111.1	3	-	3	3	3
CEPL111.2	3	-	3	3	3
CEPL111.3	3	3	3	3	3
CEPL111.4	3	3	3	3	3
CEPL111.5	3	3	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Ground Improvement Techniques	**Course Code**: CEPL112	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Methods of ground improvement**: mechanical compaction, dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, dynamic consolidation, use of admixtures, injection of grouts, mechanical, cement and chemical stabilization.	10
3	**Design aspects** of stone columns, design examples on preloading with sand drains, Reinforced earth, basic mechanism, constituent materials and their selection; engineering applications – shallow foundations on reinforced earth, design of reinforced earth retaining walls	12
4	**Geosynthetics:** selection and engineering applications, design examples, stabilization/improvement of ground using geomembranes, geocells, geonets, geosynthetic walls, road designs with geosynthetics	8
5	**Soil nailing**: construction of underground structures, landslide controls, deep vertical cuts, contiguous piles	7
6	**Case studies** on Problematic soils, improvement of saline soils, and black cotton soils.	7
	Total	**45**

Text Books:

1. P.Purushothama Raj;Ground Improvement Techniques; Laxmi Publications, Second Edition.
2. Saran, S., “Reinforced Soil and Its Engineering Applications”, I.K. international, Second Edition.
3. Shukla, S.K. “An Introduction to Geosynthetic Engineering” , CRC Press, First Edition.

Reference Books:

1. Moseley, M. P. and Kirsch K.,”Ground Improvement”, Spon press, Second Edition.
2. Shukla, S.K., Yin, Jian-Hua, “Fundamentals of Geosynthetic Engineering”, Taylor & Francis, First Edition
3. Jones, CJFP, “Earth Reinforcement and soil structure”, Thomas Telford, Third Edition.
4. Koerner, R., Designing with Geosynthetics, Prentice Hall, 2005, Sixth Edition.

Prerequisite:

1. Background of Basic Soil Mechanics
2. Geotechnical Engineering and Design

Course Outcomes:

After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom’s Level	PO Indicators	PSO Indicators

CEPL112.1	**Apply** the concept of Geotechnical Engineering to solve problems in the field of modification of ground	**3**	1.1.1, 1.2.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 2.2.2
CEPL112.2	**Apply** the design procedures for the various ground improvement methods.	**4**	1.1.1, 1.1.2, 1.2.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL112.3	**Analyze** the concepts of Geotextiles for ground improvement.	**4**	1.1.1, 1.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL112.4	**Impart** the knowledge of soil nailing, landslide controls, deep vertical cuts, contiguous piles	**2**	1.1.1, 1.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL112.5	**Outline** the solution for problematic soils.	**5**	1.1.1, 1.1.2, 1.2.1,1.2.2, 3.1.1, 3.1.3	2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL112.1	2	-	2	3	2
CEPL112.2	3	-	2	3	2
CEPL112.3	2	-	3	3	2
CEPL112.4	2	-	3	3	2
CEPL112.5	3	-	3	-	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Environmental Impact and Risk Assessment	**Course Code**: CEPL113	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs.	**Teaching Scheme:** 3L+0P+0T	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to Environmental Impact Assessment (EIA):** Definition and Purpose of EIA, Key Components and Stages of the EIA Process: Scoping, baseline studies, impact prediction, mitigation, reporting, and monitoring, Legal and Regulatory Frameworks for EIA, Overview of EIA laws and guidelines (e.g., NEPA, EU EIA Directive, national regulations), Connectedness: connected spaces and subspaces, Connectedness of the real line, Intermediate value theorem	5
3	**Methodologies and Tools for EIA:** Baseline Data Collection and Environmental Monitoring, Prediction and Assessment of Impacts, , Socio-economic and Cultural Impacts, Public Involvement in EIA Impact Management - Mitigation & Preparation of Environment Management Plans (EMP)	9
4	**Introduction to Risk Assessment:** Definition and Types of Risk, Framework and Process of Risk Assessment: Steps in risk assessment including planning, analysis, and decision-making, Hazard Identification and Characterization, Exposure Assessment, Dose-Response Assessment, Risk Characterization, Uncertainty and Variability in Risk Assessment	15
5	**Risk Assessment and Mitigation Measures:** Qualitative and Quantitative Risk Assessment Methods, Probabilistic Risk Assessment (PRA), Risk Matrices and Risk Ranking, Environmental Risk Assessment Models, Human Health Risk Assessment, Ecological Risk Assessment, Cost-Benefit Analysis in Risk Management, Economic evaluation of risk management options and decision-making	10
6	**Case Studies and Practical Applications:** Case Studies of EIA in transportation engineering sectors, Analysis of Successful and Unsuccessful EIA Practices, Real-world Risk Assessment Scenarios	5
	Total	**45**

Textbooks:

1. Wathern P., “Environmental Impact Assessment: Theory and Practice”,Routledge Publishers,1990
2. Shrivastava A.K., Baxter Nicola, Grimm Jacob, “Environmental Impact Assessment”, APH Publishers, 2003
3. Risk Assessment and Risk Management for the Chemical Process Industry" by Stone & Webster Engineering Corporation
4. Environmental Risk Assessment: A Toxicological Approach" by Ted Simon

Reference books:

1. Marriott B., “Environmental Impact Assessment: A Practical Guide”,McGraw-Hill Publication,1997
2. Anjaneyulu Y., Manickam Valli, “Environmental Impact Assessment Methodologies”, CRC Press 2011
3. Glasson J., Therivel Riki, Chadwick Andrew, “Introduction to Environmental Impact Assessment”, Oxford Brookes University 2012/ 4th edition

Prerequisite:

Basics of Environmental Engineering studied at the B.Tech level.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL113.1	Understand the fundamental principles and processes of Environmental Impact Assessment (EIA) and Risk Assessment.	**2**	1.1.1, 1.2.1	1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL113.2	Familiarize students with the legal and regulatory frameworks governing EIA and risk management.	**2**	1.1.1, 1.1.2, 2.1.1, 2.2.1, 3.1.1., 3.1.3	1.1.1, 1.1.2, 1.2.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL113.3	Develop skills in using various tools and methodologies for conducting EIA and risk assessments.	**2**	1.1.1, 1.1.2, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL113.4	Evaluate the effectiveness of mitigation measures and monitoring programs.	**5**	1.1.1, 1.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL113.5	Analyze and interpret case studies to understand real-world applications and challenges in EIA and risk assessment.	**4**	1.1.1, 1.1.2, 1.2.1,1.2.2, 2.2.1, 2.2.1, 3.1.1, 3.1.3	2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL113.1	3	-	-	3	2
CEPL113.2	3	2	2	3	2
CEPL113.3	3	-	2	3	2
CEPL113.4	3	-	2	3	2
CEPL113.5	3	2	2	-	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Geometric Design of Highways	**Course Code**: CEPL114	**Credit**: 03
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** 3L+0P+0T	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Geometric design factors:** Highway functional classification, design hourly volume, terrain classification, design speed. **Pavement surface characteristics:** friction or skid resistance, factors affecting skid resistance, measurement of skid resistance, pavement unevenness, measurement of road roughness, light reflecting characteristics**.**	6
3	**Highway cross-section elements**: carriageway or pavement width, traffic lane capacity, cross slope or camber, shape of cross slope, shoulders, medians, guard rails, kerbs, gutters or drainage, footpath or side-walks, formation width, right of way and land width, typical cross-section of roads, IRC recommendations. **Sight distances**: stopping sight distance, PIEV theory, overtaking sight distance, criteria for sight distance requirements on highways, sight distance at intersections.	8
4	**Horizontal alignment** – design speed, design of circular curves, super-elevation design, attainment of super-elevation, pavement widening, design of horizontal transition curve, set-back, Numerical problems on horizontal alignment. **Vertical alignment** - gradients, types of gradient, grade compensation. Design of vertical curves, combination of horizontal and vertical alignment, lateral and vertical clearances at underpasses, IRC recommendations for alignments, coordination of horizontal and vertical alignments, importance of geometric design in road safety.	10
5	**Intersection at grade:** Various forms of intersection at grade. Parameters of intersection design as per IRC: SP 41: design speed, design traffic volume, radius of curves at intersection, design vehicle, width of turning lanes, auxiliary lanes, visibility at intersections, channelizing islands, capacity of intersections. Rotary intersection: advantages and disadvantages of traffic rotary, design of traffic rotary. Signalized intersections. Grade separated Intersection: functioning of grade separated intersection and interchange ramps, advantages and disadvantages, capacity of different type of intersections. Different type of interchanges, case study of grade separated structures.	10
6	**Hill Roads:** development of hill roads in India. Geometrics of hill roads: design speed, width of pavement, camber, sight distance, super-elevation, radius of horizontal curve, widening at curves, transition curves, set back distance, hair pin bends, summit curves and valley curves as per IRC recommendations. Drainage works on hill roads: surface drainage systems and sub-surface drainage. Special features connected to hill roads: tunnels, protective works and landslides. Maintenance problems on hill roads: maintenance of drainage structures and snow clear.	10
	Total	45

Text Books:

1. Khanna S.K., Justo C.E.G, “Highway Engineering”, Nem Chand & Bros, Roorkee- 2004
2. Sharma S.K., “Principles, Practice and Design of Highway Engineering”, S. Chand and Company Ltd. (Third edition).
3. L R Kadiyali, “Traffic Engineering and Transport Planning”, Khanna Publishers, Delhi – 1999

4. Khisty, C.J. and Lal, B.K., "Transportation Engineering - An Introduction", Prentice Hall of India Pvt. Ltd. 2006

Reference Books:

1. O'Flaherty, A. Coleman, "Highways: The Location, Design, Construction and Maintenance of Road Pavements", 4th Ed., Elsevier - 2006
2. Jack ELeishand Associates, `Planning and Design Guide: At-Grade Intersections'.Illinios.
3. Relevant IRC publications

Prerequisite:

1. Students should have basic knowledge of mathematics.
2. Students should have basic knowledge of basic principle of mechanics.

Course Outcomes:

After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL114.1	**Understand** Road user and vehicular characteristics for geometric design of road.	**2**	1.1.1, 1.1.2	1.1.1, 1.1.2
CEPL114.2	**Determine** the sight distance, horizontal curvature, super elevation, grades, visibility on vertical curves, cross section elements.	**3**	1.2.1, 1.2.2, 1.2.1	1.2.1, 1.2.2
CEPL114.3	**Design** of intersections and grade separators & interchanges	**5**	1.1.1, 1.1.2, 2.1.1, 2.2.2, 3.1.1, 3.1.3	2.1.1, 2.2.1, 2.3.1, 2.3.2
CEPL114.4	**Design** of highway facilities and parking.	**5**	1.1.1, 1.1.2, 2.1.1, 2.2.2, 3.1.1, 3.1.3	2.1.1, 2.2.1, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL114.1	2	-	-	2	-
CEPL114.2	3	-	-	2	-
CEPL114.3	2	2	3	-	2
CEPL114.4	2	2	3	-	2

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Design of Rural Roads	**Course Code**: CEPL115	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	**1**
2	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite. **Introduction to Rural Road Planning and Development**- Importance and role of rural roads in socio-economic development, Characteristics of rural roads, Planning considerations System approach, CRRI model, NATPAC model, Gravity model, Deprivity model, FBRNP model, Funding and financing mechanisms for rural road projects.	9
3	**Geometric Design of Rural Roads**- Design standards and guidelines for rural roads**,** Horizontal and vertical alignment design**,** Cross-sectional elements (width, camber, shoulder, etc.)**,** Sight distance considerations and design controls.	8
4	**Pavement Design and Construction Techniques**- Types of rural road pavements (flexible, rigid, composite)**,** Design considerations for different pavement types**,** Materials selection and testing for rural road pavements**,** Construction techniques and quality control measures.	10
5	**Drainage and Environmental Considerations**- Importance of proper drainage in rural road projects**,** Types of drainage systems (surface, subsurface, side drains)**,** Design principles for effective drainage**,** Environmental considerations in rural road construction.	8
6	**Pavement failure, Maintenance and Management of Rural Roads**- Typical failures of rural roads, Causes of pavement failure, Importance of routine and periodic maintenance**,** Maintenance techniques for rural roads**,** Asset management systems for rural road networks**,** Community participation in road maintenance.	9
	Total	**45**

Text Books:

1. "Highway Engineering" by S.K. Khanna & C.E.G. Justo
2. "Transportation Engineering: An Introduction" by C.Jotin Khisty, B.K. Lall

Reference Books:

1. Rural Roads Manual , IRC: SP-20
2. Document on Rural Road Development, Vol I & II, CRRI -1990
3. PMGSY Operation Manual, NRRDA, Govt of India -2005
4. Specifications for Rural Roads, MoRD, IRC -2004

Prerequisite:

Students should have basic knowledge of different types and components of roads

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL115.1	**Discuss** a preliminary plan for a rural road project incorporating appropriate planning considerations and models	**2**	1.1.1, 1.2.1, 2.1.1, 2.1.2	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL115.2	**Explain** the principles behind horizontal and vertical alignment design for rural roads.	**2**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2,2.2.1	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL115.3	**Apply** pavement design principles to select the most appropriate pavement type for a given rural road project.	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL115.4	**Describe** principles to develop an effective drainage plan for a rural road project.	**2**	1.1.1, 1.1.2,2.1.1,2.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL115.5	**Illustrate** the impact of various factors for pavement failure in rural roads.	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 3.1.1	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL115.1	2	2	-	3	3
CEPL115.2	3	3	-	3	3
CEPL115.3	3	3	3	3	3
CEPL115.4	2	2	-	3	3
CEPL115.5	3	3	2	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Transportation Infrastructure Design	**Course Code**: CEPL116	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Railway:** Transportation and its development, long-term operative plans for Indian railways. Classification of railway lines and their track standards, railway terminology, tram and tractive resistance, hauling capacity and tractive effort of locomotives, and different types of tractions. Permanent way: Alignment surveys, requirements, gauges, track section, coning of wheels, stress in railway track, high-speed track.	12
3	**Design of Railway Components:** Gradient, speed, super elevation, cant deficiency, negative super elevation, curves, length of transition curves, grade compensations.	10
4	**Airports:** Development of air transportation in India, airport site selection, airport obstructions: Zoning laws, imaginary surfaces, approach and turning zone, clear zone, vert. Clearance for highway & railway. Air traffic control: need, network, control aids, instrumental landing systems, Airport Pavement Materials	10
5	**Design of Airport Components:** Runway and taxiway design: Windrose, cross wind component, runway orientation and configuration, basic runway length and corrections, runway geometric design standards. Taxiway layout and geometric design standards. Exit taxiway and other areas.	10
6	**Case studies:** Bullet train project, Dedicated Freight Corridor (DFC), vande bharat, metro, mono rail and related to recent advancements in railways and airports.	2
	Total	**45**

Text Books:

1. Saxena Subhash C and Satyapal Arora, "A Course in Railway Engineering", Dhanpat Rai and Sons, Delhi, 2003
2. Satish Chandra and Agarwal M.M, "Railway Engineering", 2nd Edition, Oxford University Press, New Delhi, 2013.
3. Khanna S K, Arora M G and Jain S S, "Airport Planning and Design", Nemchand and Brothers, Roorkee, 2012.

Reference Books:

1. Rangwala, "Railway Engineering", Charotar Publishing House, 2013.
2. Rangwala, "Airport Engineering", Charotar Publishing House, 2013.
3. Airport Engineering Planning and Design by Saxena S.C.

Prerequisite:

1. The students should know the basic components of railways.
2. Basic knowledge about the components of the airport is necessary.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL116.1	**Understand** the permanent way components and technicalities of railways.	**2**	1.1.1, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL116.2	**Design** the geometry of the railway track.	**5**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL116.3	**Explain** different components and laws governing the site selection of airports.	**2**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL116.4	**Design** various components of the airport.	**5**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL116.5	**Understand** the case studies of latest transportation projects	**2**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL116.1	2	-	3	3	3
CEPL116.2	2	-	3	3	3
CEPL116.3	2	-	3	3	3
CEPL116.4	2	-	3	3	3
CEPL116.5	2	-	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Optimization Techniques	**Course Code**: NP40.01	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to optimization:** Engineering applications of optimization, Mathematical Modeling and simulation, Formulation of structural optimization problems as programming problems. Graphical method.	6
3	**Linear Programming:** Theory of Simplex Method, Standard form of LPP, feasible solution and basic feasible solution, Improving BFS, Optimality condition, Unbounded solution, Alternative optimal solution, Simplex method, Big M Method, Two phase method.	8
4	**Metaheuristics in Optimization:** Genetic algorithms, Tabu search, particle swarm intelligence and their applications in Engineering	7
5	**PERT & CPM:** Objective of CPM & PERT, elements of network, network rules, constraints, error in network, Critical Path Analysis, Activity time and floats, optimization through CPM techniques, PERT and three estimates, critical path analysis of a PERT network, probability of completion of project, controlling and monitoring.	8
6	**Non-linear Programming:** Local and global minima of one and two variables, constraints optimization, Lagrange's Method, K-T conditions, Steepest descent method, Conjugate gradient method.	10
	Total	**45**

Text Books:

1. S. S. Rao, Engineering Optimization: Theory and Practice, Wiley, 2008.
2. K. Deb, Optimization for Engineering design algorithms and Examples, Prentice Hall, 2nd edition 2012.

Reference Books:

1. Operations Research, Hira & Gupta,
2. C.J. Ray, Optimum Design of Mechanical Elements , Wiley, 2007.
3. R. Saravanan, Manufacturing Optimization through Intelligent Techniques , Taylor & Francis Publications, 2006.
4. D. E. Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning , Addison-Wesley Longman Publishing, 1989.

Prerequisite:

Basic knowledge of calculus.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
NP40.1.1	**Determine** Mathematical formulation of given design problem and achieve optimal solution using Graphical method, Cutting plane method.	**3**	1.1, 1.3, 2.1, 2.3	1.1, 1.2, 1.3, 1.4, 2.3
NP40.1.2	**Solve** Linear programming problems using Simplex method, Two Phase method, Big-M method	**3**	1.1, 1.3, 2.1, 2.3	1.1, 1.2, 1.3, 1.4, 2.3
NP40.1.3	**Calculate** nonlinear programming problems using Lagrange's method, K-T conditions and numerical methods like Steepest descent method, Conjugate gradient method.	**3**	1.1, 1.3, 2.1, 2.3	1.1, 1.2, 1.3, 1.4, 2.3
NP40.1.4	**Use** PERT and CPM to control and monitor projects effectively.	**3**	1.1, 1.3, 2.1, 2.3	1.1, 1.2, 1.3, 1.4, 2.3
NP40.1.5	**Analyze** metaheuristics-based optimization and its applications to solve complex optimization problems using genetic algorithms, tabu search and ant colony optimization.	**4**	1.1, 1.3, 2.1, 2.3	1.1, 1.2, 1.3, 1.4, 2.3

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
NP40.1.1	2	2	-	-	1
NP40.1.2	2	2	-	-	1
NP40.1.3	2	2	-	-	1
NP40.1.4	2	2	-	-	1
NP40.1.5	2	2	-	-	1

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Lab Name: Pavement Material Testing Laboratory	**Course Code**: CEPP130	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs	**Teaching Scheme:** 0L+0T+4P	

Module No.	Tests for Characterization and use of Highway materials
1	To determine the Free Swelling Index of soil.
2	To determine the CBR value of soil.
3	To determine the Unconfined Compression strength (UCS) of soil.
4	To determine aggregate polishing and skid resistance of aggregates.
5	To determine the Penetration value and Softening Point of bitumen.
6	Elastic recovery test for polymer-modified bitumen (PMB).
7	To determine rotational viscosity of polymer modified bitumen (PMB).
8	Formulation of design mixes for sub-base and base courses GSB and WMM.
9	Bituminous Mixes: Proportioning of aggregates, preparation of Marshall test specimens and testing, formulation of bituminous mixes, volumetric analysis, indirect tensile strength and tensile strength ratio, determination of percent bitumen content, and gradation of bituminous mix, recovery of bitumen.
10	Concrete Mix: Proportioning of aggregates, preparation of test specimens and testing, design of dry lean concrete (DLC) and pavement quality concrete (PQC).

Text Books:

1. Highway Engineering – S.K. Khanna & C.E.G. Justo. New Chand & Brothers.
2. Asphalt Materials and Mix Design Manual, MS-2, 2014 by Asphalt Institute.

Reference Books:

1. Highway material Testing - S.K. Khanna & C.E.G. Justo.
2. Bituminous Road Construction in India- Kandhal, Prithvi Singh, Veeraragavan, Amirthalingam, Choudhary, Rajan Revised Edition, 2016, PHI Publisher.
3. Ministry of Road Transport and Highways (MoRTH), 2015.

Prerequisite:

1. Understanding foundational concepts in civil engineering, including materials properties, soil mechanics.
2. Basic understanding in geotechnical engineering principles, such as soil classification, compaction, and bearing capacity estimation.
3. Familiarity with basic concepts of pavement engineering.
4. Knowledge of transportation engineering principles.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPP130.1	**Examine** the engineering properties of soil	**3**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP130.2	**Determine** the polishing and skid resistance properties of road aggregates	**3**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP130.3	**Discuss** advance tests on bitumen	**3**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP130.4	**Design** of different bituminous layers of flexible pavement and compare their results with IRC/MoRTH recommendations.	**6**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP130.5	**Design** of DLC and PQC for rigid pavement	**6**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPP130.1	3	3	3	3	3
CEPP130.2	3	3	3	3	3
CEPP130.3	3	3	3	3	3
CEPP130.4	3	3	3	3	3
CEPP130.5	3	3	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: I
Course Name: Transportation Software Lab	**Course Code**: CEPP131	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs	**Teaching Scheme:** 0L+0T+4P	

Module No.	The experiments include
1	To design and draft the road intersections using CAD software
2	To design and draft road furniture drawings for streets
3	To study delineation of transportation zones, marking of external cordons, internal cordons, screen lines using GIS software
4	To draw transportation maps using GIS software
5	To study and analyse traffic data (volume, speed etc.) using SPSS software and MS-Excel
6	To study traffic simulation and modelling softwares
7	To design flexible pavement using IITPAVE software
8	To design rigid pavement using IITPAVE software

Text Books:

1. "Traffic Simulation and Data: Validation Methods and Applications" by Weitian Tong and Leandros Tassiulas.
2. "Geographic Information Science and Systems" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind.
3. "AutoCAD and Its Applications Basics 2022" by Terence M. Shumaker, David A. Madsen, and David P. Madsen.
4. "Principles of Pavement Engineering" by Rajib B. Mallick and Tahar El-Korchi.

Reference Books:

1. Relevant IRC and other codes

Prerequisite:

1. Understanding foundational concepts in civil engineering, including materials properties, soil mechanics.
2. Familiarity with basic concepts of pavement engineering.
3. Knowledge of transportation engineering principles.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPP131.1	**Proficiently** implement CAD software to design and draft road intersections	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP131.2	**Understanding** and application of GIS software	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP131.3	**Analyzing** traffic data including volume, speed, and other relevant metrics using statistical software such as SPSS and MS-Excel	**4**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP131.4	**Apply** knowledge of designing both flexible and rigid pavements using IITPAVE software	**3**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPP131.1	3	3	3	3	3
CEPP131.2	2	3	3	3	2
CEPP131.3	3	3	3	3	3
CEPP131.4	3	2	3	2	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Pavement Analysis and Design	**Course Code**: CEPL201	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	Component layers of flexible, rigid, semi-rigid, and interlocking block pavements. **Flexible Pavements:** Functions of component layers: Subgrade, Granular sub-base-cum-drainage layer, Granular Base Course (WMM), Bituminous Binder Course (DBM), Bituminous Surface Course (BC). Functions of Thin Bituminous Surface Course (Pre Mix Carpet for low volume roads).	6
3	**Stresses in Flexible Pavements:** Vertical stress and deflection in homogeneous mass (Single-layer system), Application of single layer theory in flexible pavement design, Vertical stress and deflection in two-layer elastic system, Application of two layer theory in flexible pavement design, Introduction of three layer elastic system. Effect of superior materials in total thickness of flexible pavements.	8
4	**Elements in Design of Flexible Pavements:** Traffic characteristics – Traffic volume, growth rate, lane distribution factor, Axle configuration, Equivalent single wheel load for different criteria and Equivalent wheel load factor, Axle load survey, distribution, ESAL and computation of the number of repetitions with numerical examples, Influence of climate in material characteristic functions.	8
5	**Design Methods for Flexible Pavements:** Design of flexible pavement using IRC 37 guidelines, Evaluation of flexible pavement using falling weight deflectometer (FWD) and design of overlays.	6
6	**Rigid Pavements:** Stresses in rigid pavements – relative stiffness of slab, modulus of sub-grade reaction, stresses due to loads, stresses due to friction, Westergaard's and Thomlinson's analysis of warping stresses due to temperature differential, Combination of stresses due to different causes.	8
7	**IRC method of Rigid pavement design** – Importance of Joints in Rigid Pavements- Types of Joints – Use of Tie Bars and Dowel Bars. Concept of Continuously Reinforced Concrete Pavement, Design of rigid pavement using IRC 58 guidelines.	8
	Total	**45**

Text Books:

1. Yoder, E.J. and Witczak, M.W., "Principles of Pavement Design 2nd Ed", John Wiley & Songs, Inc. – 1975
2. Highway Engineering by SK Khanna, CEG Justo & A. Veeraragavan (10th Edition); Nem Chand & Bros., Roorkee.
3. C. JotinKhinsty and B. Kent Lall, Transportation Engineering
4. O'Flaherty, A. Coleman, "Highways : the Location, Design, Construction and Maintenance of Road Pavements", 4th Ed., Elsevier - 2006
5. Fwa, T.F., "The Hand Book of Highway Engineering", CRC Press Taylor & Francies Group – 2006

Reference Books:

1. Dr. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khannan Publishers, 7 th Edition, 2007.
2. Papagiannakis, A.T. and Masad, E.A., "Pavement Design and Materials, John Wiley & Sons Inc - 2008

3. Yang H Huang, `Design of Functional Pavements', McGraw Hill BookCo.
4. Huang, 'Pavement Analysis', Elsevier Publications.
5. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers.

Prerequisite:
This is a self-contained course for students and practitioners alike, and hence, no prerequisite is required. For those who do not have an undergraduate degree in civil engineering, familiarity with the construction of bituminous pavements will be helpful.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL201.1	**Understand** the role and functions of different component layers of pavements	**2**	1.1.1, 1.1.2, 1.2.1	1.1.2, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 2.2.2
CEPL201.2	**Analyze** stresses and deflection in flexible pavements using single and two layered system	**4**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.3.1, 2.3.2
CEPL201.3	**Understand** the various design parameters of flexible pavement	**2**	1.1.1, 1.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2
CEPL201.4	**Design** of flexible pavement as per IRC guidelines.	**5**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL201.5	**Design** of rigid pavements including dowel and tie bars	**5**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL201.1	3	-	-	3	2
CEPL201.2	3	-	2	3	2
CEPL201.3	2	-	2	3	2

CEPL201.4	3	-	2	3	3
CEPL201.5	3	-	2	-	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Traffic Engineering	**Course Code**: CEPL202	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Traffic Engineering**: Elements, issues for traffic engineers, road users, vehicles, highways, and control devices, modeling concepts.	8
3	**Traffic Stream Characteristics:** Traffic stream parameters, Time Space diagram, relationship among q,k,u, Macroscopic Fundamental Diagrams (MFD).	9
4	**Traffic Studies:** Traffic volume studies, speed, travel time and delay studies, parking studies, RSI Survey, WTP Survey, accident data collection and analysis, pedestrian studies	9
5	**Design concept for intersection & facilities:** Concept of capacity and LOS, Operational analysis of two-way and all-way stop controlled intersections and Roundabouts by US and Indian methods, design of parking facilities, types of signals, Design of signals by Indian, US and British methods, signal coordination.	9
6	**Management Techniques:** Traffic calming; Congestion and road user pricing; priority movements; traffic regulations and control systems; use of intelligent systems.	9
	Total	**45**

Text Books:

1. William R. Mcshane and Roger P. Roess, “Traffic Engineering”, Pearson (4th Edition). 2013
2. Kadiyali, L.R., “Traffic Engineering and Transport Planning”, Khanna Publishers. 2012
3. C A O’Flaherty, Ed , “Transport Planning and Traffic Engineering”, Butterworth Heinemann, Elsevier, Burlington, MA2006

Reference Books:

1. May, A.D., “Fundamentals of Traffic Flow”, Prentice Hall, Inc. 2nd Ed. 1990
2. Carlos F. Daganzo. “Fundamentals of Transportation and Traffic Operations”, Pergamon 1997
3. Simon P. Washington, Matthew G. Karlaftis and Fred L. Mannering, “Statistical and Econometric Methods for Transportation Data Analysis”, 2nd Edition, CRC Press2011

Prerequisite:

Basics concepts of traffic engineering.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL202.1	**Understand** the concept of capacity	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL202.2	**Conduct** traffic surveys	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL202.3	**Design** the intersections and other facilities	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL202.4	**Understand** the modelling concept in traffic engineering problems	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL202.5	Build safety into every aspect of design	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL202.1	3	3	3	3	3
CEPL202.2	2	3	-	3	2
CEPL202.3	3	3	3	3	3
CEPL202.4	3	2	-	2	3
CEPL202.5	3	3	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Urban Mass Transportation System	**Course Code**: CEPL211	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction:** Mass transit systems, Elements / components of transit systems; Urban Mass Transit systems- types, characteristics, suitability and adaptability of these systems; Evolution of urban transportation.	6
3	**Transit System Planning:** Planning needs; Short-range and long-range planning; Planning procedures and methodology, Data collection; Medium performance transit systems and high performance transit systems; trends in transit planning	7
4	**Transit Demand Estimation and Evaluation**: Transit demand forecasting; transit mode evaluation; comparison and selection of most suitable transit mode.	7
5	**Transit System Operations:** Basic operational elements; transit travel characteristics; transit scheduling; transit line analysis – planning objectives, geometry, types and their characteristics, capacity of transit lines, system procedures for improving transit line capacity.	7
6	**Transit Networks and System Analysis:** Transit networks – types and their characteristics; transfers in transit networks; system analysis in transit – conceptual models, modeling procedures; terminal or station location planning – issues, objectives, station spacing decisions.	7
7	**Economics and Financing of Transit Systems:** Transit system performance and economic measures; transit fares – structure, collection and levels; financing of transit services; public and private integration of transit services.	7
8	Case studies of urban mass transportation systems adopted in India in recent years.	3
	Total	**45**

Text Books:

1. Kadiyali, L.R., Traffic Engineering & Transport Planning, Khanna Publishers, New Delhi
2. Jotin Khisty, S.C. and Kent Lall, B., Transportation Engineering – An Introduction, Prentice-Hall, NJ

Reference Books:

1. Hutchison, B.G., Introduction to Transportation Engineering & Planning, McGraw Hill Book Co.
2. Papacostas, C.S., Fundamentals of Transportation System Analysis, PHI
3. Jotin Khisty, C. and Kent Lall, B., Transportation Engineering – An Introduction, Prentice-Hall, NJ

Prerequisite:

1. The students should have basic knowledge of mass transport facilities.
2. Knowledge of surveys conducted for operations of mass transit facilities.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL211.1	**Understand** the objectives and various options for urban mass transportation.	**2**	1.1.1, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL211.2	**Understand** the steps and data involved in the planning of mass transit systems.	**2**	1.1.1, 1.1.2, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL211.3	**Analyze** the future transportation needs and variations in system components so as to plan for the transportation system requirements.	**4**	1.1.1, 1.1.2, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL211.4	**Understand** Transit Networks and System Analysis.	**2**	1.1.1, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL211.5	**Conduct** economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.	**3**	1.1.1, 1.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL211.1	2	-	3	3	3
CEPL211.2	3	-	3	3	3
CEPL211.3	3	-	3	3	3
CEPL211.4	2	-	3	3	3
CEPL211.5	2	-	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Application of GIS in Transportation Engineering	**Course Code**: CEPL212	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course.	1
2	**Introduction to GIS** Definition and scope of GIS**,** Components of GIS: hardware, software, data, and people, Spatial data types and data models**,** Coordinate systems and map projections. **Spatial Data Acquisition and Processing:** Remote sensing techniques for data acquisition**,** Global Positioning System (GPS) and its applications**,** Data formats and standards in GIS**,** Data quality assessment and validation	8
3	**GIS Data Analysis Techniques:** Spatial analysis methods: buffering, overlay, proximity analysis**,** Network analysis for transportation routing and optimization**,** Geo-statistics and interpolation techniques**,** 3D GIS and terrain analysis.	9
4	**Transportation Planning with GIS:** Role of GIS in transportation planning and decision-making**,** Traffic flow analysis and congestion management**,** Land use-transportation interaction modeling**,** Transit planning and route optimization using GIS.	9
5	**GIS Applications in Transportation Engineering:** Highway and road network planning and design**,** Traffic signal optimization and intelligent transportation systems (ITS)**,** Emergency response and disaster management**,** Environmental impact assessment in transportation projects.	9
6	**Case Studies and Projects:** Analysis of real-world transportation problems using GIS, Project-based learning: development of GIS-based transportation solutions, Presentation and discussion of case studies and projects.	9
	Total	**45**

Text Books:

1. "Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind
2. "Geographic Information Systems for Transportation: Principles and Applications" by Harvey J. Miller and Shih-Lung Shaw

Reference Books:

1. Ian Heywood et al., Geographical Information System, Pearson, 2019
2. Bhatta B., Remote Sensing and GIS, Oxford University Press, New Delhi, 2008
3. Lo C.P. and Yeung Albert K.W., Concepts and Techniques of Geographical Information Systems, Prentice-Hall of India Pvt. Ltd. New Delhi, 2006
4. Burrrough P.A and McDonnell R.A., Principles of Geographic Information Systems, Oxford university press, 1998
5. Stan Aronoff, “Geographical Information Systems”, WDL Publications, Ottawa, Canada, 1989.

Prerequisite:

Basic knowledge of remote sensing and GIS

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL212.1	**Explain** the fundamental principles and components of GIS technology, emphasizing their interrelationships and functionalities.	**2**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL212.2	**Apply** various techniques for spatial data acquisition, processing, and quality assessment in transportation engineering projects.	**3**	1.1.1, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL212.3	**Analyze** transportation networks and traffic flow patterns using GIS-based spatial analysis methods.	**4**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1,3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL212.4	**Evaluate** the role of GIS in transportation planning, decision-making, and land use-transportation interaction modeling. (Bloom's Level: Evaluating)	**4**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1,3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL212.5	**Develop** GIS-based solutions for transportation engineering problems, such as route optimization, traffic signal optimization, and emergency response planning. (Bloom's Level: Creating)	**4**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1,3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL212.1	3	2	3	3	3
CEPL212.2	3	2	3	3	3
CEPL212.3	3	2	3	3	3
CEPL212.4	3	2	3	3	3
CEPL212.5	3	2	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Road Safety Engineering	**Course Code**: CEPL213	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to Road Safety:** Road traffic accidents scenario in India and in world, Road Safety and its importance, Traffic Rules and Driving Behavior, Characteristics of accidents, accidents vs. crash.	9
3	**Planning for Road safety:** Awareness about rules and regulations of traffic, Assisting Traffic control authorities, Multidisciplinary approach to planning for traffic safety and injury control, Vulnerable Road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled.	9
4	**Responsibility of Road accidents and Safety measures:** People responsible for accident prevention: Police, Politicians, Community members, Policy makers, Teachers, Parents, Infrastructure authorities, Drivers and Official road safety body, Reasons of students/ children have accidents. Four E's of Accidents Prevention: Engineering, Enforcement, Encouragement, Education - by gaining and using knowledge.	9
5	**Road Safety Education:** Introduction to Road Safety Education, Five P's of Road safety education: Pre-school road safety education, Practical rather than theory education, Principles of own development as regards to road safety education, Presentations on road safety education, Place for road safety education in syllabus	9
6	**Traffic Management Systems:** Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Approach to Safety, Road Safety Improvement Strategies, ITS and Safety.	8
	Total	**45**

Text Books:

1. American Association of State Highway and Transportation Officials (AASHTO), "Highway Safety Manual", 1st Edition, AASHTO. 2010
2. Simon P. Washington, Matthew G. Karlaftis, Fred L. Mannering, "Statistical and Econometric Methods for Transportation Data Analysis", 2nd Edition, Chapman &Hall/CRC Press, 2010
3. Ezra Hauer, "Observational Before -After Studies in Road Safety", Pergamon Press. 1997

Reference Books:

1. Limpert, Rudolf. "Motor Vehicle Accident Reconstruction and Cause Analysis", 5th Edition, Lexas Publishing, Charlottesville, VA. 1999
2. Indian Roads Congress, "Highway Safety Code", IRC: SP-44:1996
3. Indian Roads Congress, "Road Safety Audit Manual", IRC:SP-88-2010

Prerequisite:

This is a self-contained course for students and practitioners alike, and hence, no prerequisite is required. For those who do not have an undergraduate degree in civil engineering, familiarity with the traffic signs will be helpful.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL213.1	**Generate** awareness about road accidents, traffic rules and characteristics of accident.	**2**	1.1.1,1.1.2, 1.2.1, 1.2.2, 2.1.1,2.1.2,3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.3
CEPL213.2	**Gain** information and knowledge about people responsible for accidents and their duties	**2**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1	1.1.1, 1.2.2, 2.1.1, 2.1.2, 2.2.3
CEPL213.3	**Understand** the importance of multidisciplinary approach to planning for traffic safety and rehabilitation	**2**	1.1.1, 1.1.2, 2.1.1, 2.1.2, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL213.4	**Impart** knowledge and understanding of the causes and consequences of accidents.	**2**	1.1.1, 1.1.2, 1.2.1, 1.2.2,2.1.1,2.1.2,2.2.2 3.1.1	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.3

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL213.1	3	2	2	3	2
CEPL213.2	3	-	2	2	2
CEPL213.3	2	2	3	3	3
CEPL213.4	3	-	3	3	2

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Transportation Economics and Management	**Course Code**: CEPL214	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Transportation Economics**: Definitions and scope of transportation economics, Role of transportation in economic development, Transportation demand and supply analysis. Cost structures in different modes of transportation, Pricing strategies and models, Subsidies and economic regulation. Cost-benefit analysis, Economic impact analysis, Multicriteria decision-making in transportation projects, vehicle operation cost, accident costs and related studies.	12
3	**Transportation Planning and Policy:** Urban and regional transportation planning, Land use and transportation interaction, Sustainable transportation planning. National and international transportation policies**,** Transportation funding and financing**,** Institutional and regulatory framework	8
4	**Logistics and Supply Chain Management:** Principles of logistics management**,** supply chain optimization, and role of transportation in logistics.	6
5	**Financial Management in Transportation:** Financial statements and ratio analysis, Budgeting and financial forecasting**,** Capital structure and financing. Investment appraisal techniques**,** Sources of project financing**,** Public-Private Partnerships (PPP)	9
6	**Risk Management:** Identification and assessment of risks, Risk mitigation strategies, Case studies in transportation finance & smart transportation solutions, Best practices in sustainable transportation & innovations in transportation management.	9
	Total	**45**

Text Books:

1. "Transportation Planning and Traffic Engineering" by Dr. L.R. Kadiyali
2. "Principles of Transportation Engineering" by P. Chakroborty and A. Das
3. "Transportation Engineering and Planning" by C.S. Papacostas and P.D. Prevedouros
4. "Principles of Highway Engineering and Traffic Analysis" by Fred L. Mannering and Scott S. Washburn
5. "Introduction to Transportation Systems" by Joseph Sussman

Reference Books:

1. IRC: 9-1972 - Traffic Census on Non-Urban Roads
2. IRC: 64-1990 - Guidelines for Capacity of Roads in Rural Areas
3. IRC: 106-1990 - Guidelines for Capacity of Urban Roads in Plain Areas

Prerequisite:

Basics of Transportation Engineering studied at the B.Tech level.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL214.1	**Describe** the principles of transport economics	**2**	1.1.1, 1.1.2,2.1.1,2.1.2,2.2.1 ,3.1.3	1.1.1,1.2.1,1.2. 2,2.1.1,2.1.2,2. 1.3,2.2.2,2.3.2
CEPL214.2	**Explain** the transport planning and policy	**2**	1.1.1, 1.1.2,2.1.1,2.1.2,2.2.1 ,3.1.3	1.1.1,1.2.1,1.2. 2,2.1.1,2.1.2,2. 1.3,2.2.2,2.3.2
CEPL214.3	**Discuss** transportation's impact on logistics performance.	**2**	1.1.1, 1.1.2,2.1.1,2.1.2,2.2.1 ,3.1.3	1.1.1,1.2.1,1.2. 2,2.1.1,2.1.2,2. 1.3,2.2.2,2.3.2
CEPL214.4	**Understand** the financial management techniques for transportation projects	**2**	1.1.1, 1.1.2,2.1.1,2.1.2,2.2.1 ,3.1.3	1.1.1,1.2.1,1.2. 2,2.1.1,2.1.2,2. 1.3,2.2.2,2.3.2
CEPL214.5	**Identification** of smart transportation solutions for their effectiveness in risk management	**2**	1.1.1, 1.1.2,2.1.1,2.1.2,2.2.1 ,3.1.1	1.1.1,1.2.1,1.2. 2,2.1.1,2.1.2,2. 1.3,2.2.2,2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL214.1	2	3	2	3	3
CEPL214.2	2	3	2	3	3
CEPL214.3	2	3	2	3	3
CEPL214.4	2	3	2	3	3
CEPL214.5	2	3	2	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Pavement Maintenance and Management System	**Course Code**: CEPL215	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction to Pavement Maintenance and Management System:** Objective, Scope, Course Outcomes, Prerequisites for the Course	2
2	**Pavement Evaluation and Performance** Concepts of Pavement Evaluation, Evaluation of Pavement Performance, Structural Capacity Evaluation, Pavement Distress Evaluation, Pavement Safety Evaluation	5
3	**Types of Pavement Distress** Structural and Functional Distress, Serviceability, Fatigue Cracking, Pavement Deformation and Behavior, Low Temperature Shrinkage Cracking, Factors Affecting Performance, Relation between Performance and Distress	6
4	**Pavement Evaluation Tools and Techniques** Functional Parameters (Roughness, Distress, Rutting, etc.), Structural Parameters (Capacity), Equipment: Benkelman Beam, Bump Integrators, Dynaflect, etc., Digital Ultrasonic Concrete Tester, Radiographic and Infrared Testing, Pavement Skid Resistance and Fatigue Testing Equipment, On-site and On-line Testing with Sensors, LVDTs, etc., Preventive Maintenance Strategies, Life-cycle Cost Analysis	8
5	**Pavement Overlays** Flexible overlays and determination of overlay thickness. Rigid overlays and determination of overlay thickness including thin toppings. Design of Overlay by Benkelman Beam and Falling Weight Deflect meter.	4
6	**Design Alternatives and Evaluation** Framework for Pavement Design, Design Objectives and Constraints, Basic Structural Response Models, Characterization of Design Inputs, Alternative Pavement Design Strategies, Design using IIT Pave and MEPDG, Economic Evaluation of Design Strategies	10
7	**Pavement Management System (PMS)** Introduction to PMS and MMS, Construction, Maintenance, and Rehabilitation Strategies, Feedback Data Systems, Case Studies and Real-world Examples, Implementation of PMS, Risk Assessment and Mitigation, Integration of AI, ML, GIS, and Remote Sensing in pavement evaluation, monitoring, and management.	10
	Total	**45**

Text Books:

1. Hass, R., Hudson, W.R. and Zaniewski, J. “Modern Pavement Management” Krieger.-1994
2. Fwa, T.F., “The Hand Book of Highway Engineering”, CRC Press, Taylor & Francies Group.-2006
3. Shain, M.Y., “Pavement Management for Airports, Roads and Parking Lots”, Kluwer Academic Publishers Group-2004
4. Khanna, S.K. and Justo, C.E.G., “Highway Engineering” Nem Chand & Bros, Roorkee (U.A.) 8th Ed. -2005

Reference Books:

1. Hudson, W.R., Haas, R. and Uddin, W., “Infrastructure Management”, McGraw Hill -1997
2. Hass R. & Hudson, W.R., “Pavement Management System”, Mc Graw Hill Company, Inc. New York -1978

Prerequisite:

1. Understanding basic concepts of civil engineering, such as materials, and construction methods.
2. Familiarity with fundamental concepts of pavement engineering.
3. Basic understanding in mathematics, particularly in areas such as calculus and algebra.
4. Understanding principles of testing and measurement techniques used in civil engineering.

Course Outcomes:

After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL215.1	**Understand** the Fundamentals of Pavement Evaluation and Performance	**2**	1.1.1, 1.1.2, 3.1.3	2.1.1,2.1.2, 2.2.2,2.3.1
CEPL215.2	**Apply** Various Pavement Evaluation Techniques	**3**	1.1.1, 1.1.2, 1.2.1	1.1.1, 2.1.1
CEPL215.3	**Analyze** Pavement Distress and Performance Factors	**4**	1.1.1, 1.1.2, 1.2.2	1.1.1,1.2.1,1.2.2,2.1.1, 2.1.2, 2.2.2, 2.3.1
CEPL215.4	**Design** Optimal Pavement Management Strategies	**5**	1.1.1, 1.1.2, 3.1.2	-
CEPL215.5	**Communicate** Effectively and Professionally in Pavement Engineering	**6**	2.1.1,2.1.2, 2.2.1	-

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL215.1	2	-	2	-	2
CEPL215.2	3	-	-	2	-
CEPL215.3	3	-	-	3	2
CEPL215.4	2	-	2	-	-
CEPL215.5	-	3	-	-	-

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Non Motorized Transport and Management	**Course Code**: CEPL216	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs	**Teaching Scheme:** 3L+0T+0P	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to Non-Motorized Transport:** Definition and importance of NMT and pedestrian traffic in urban planning and sustainability. Overview of different modes of NMT: walking, cycling, skating, etc. Historical evolution and cultural significance of NMT. Challenges and benefits of promoting NMT in urban areas. Infrastructure and Design for NMT and Pedestrian Safety.	9
3	**Principles of urban design for pedestrian-friendly environments:** Infrastructure requirements for safe NMT and pedestrian traffic. Design considerations for sidewalks, crosswalks, bike lanes, and shared spaces. Accessibility and inclusivity in NMT infrastructure. Policy and Planning for NMT Integration.	8
4	**National and local policies promoting NMT and pedestrian-friendly cities:** Planning principles for integrating NMT into transportation networks. Case studies of successful NMT and pedestrian-oriented projects. Stakeholder engagement and community involvement in NMT planning. Safety and Behavior in NMT and Pedestrian Environments.	9
5	**Traffic rules and regulations for pedestrians and NMT users:** Strategies for improving safety awareness among pedestrians and NMT users. Behavioral factors influencing NMT and pedestrian safety. Public education campaigns and enforcement measures to enhance safety. Promoting Active Transportation and NMT Advocacy	9
6	**Health and environmental benefits of active transportation:** Strategies for promoting NMT and pedestrian-friendly policies in communities. Role of advocacy groups and grassroots movements in advancing NMT agendas. Technological innovations supporting NMT and pedestrian traffic.	9
	Total	**45**

Text Books:

1. Pradip Kumar Sarkar, Vinay Maitri and G. J. Joshi, “Transportation Planning - Principles, Practices and Planning”, PHI Learning; 3rd edition 2022
2. "Street Smart: Street Design for Indian Cities" by Kalanidhi Narayanan, Indian Institute for Human Settlements (IIHS) Press

Reference Books:

1. "Beyond Mobility: Planning Cities for People and Places" by Robert Cervero and Erick Guerra (with an Indian perspective), Island Press
2. C Jotin Khisty and B Kent Lall, “Transportation Engineering – An Introduction”, Prentice Hall of India Pvt Ltd., New Delhi -2003
3. Sustainable Urban Mobility Pathways by Oliver Lah, Elsevier

Prerequisite:

Basics of Transportation Engineering studied at the B.Tech level.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPL216.1	**Define** the concept of Non-Motorized Transport (NMT) and its significance in urban planning and sustainability.	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL216.2	**Examine** the challenges and benefits associated with promoting NMT in urban areas.	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL216.3	**Design** pedestrian-friendly infrastructure and urban environments.	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL216.4	**Understand** national and local policies aimed at promoting NMT.	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPL216.5	**Explain** health and environmental benefits, assessing advocacy strategies, and evaluating technological innovations supporting NMT.	**2**	1.1.1, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPL216.1	3	3	3	3	3
CEPL216.2	3	2	2	3	2
CEPL216.3	3	3	3	3	3
CEPL216.4	2	3	2	2	3
CEPL216.5	3	3	3	3	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Lab Name: Pavement Design and Evaluation Lab	**Course Code**: CEPP230	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time:	**Teaching Scheme:** L+T+4P	

Module No.	Tests for Pavement design and Evaluation
1	To estimate design msa (million standard axle) value for a road
2	To estimate the design CBR value of subgrade.
3	To design flexible pavement using IRC 37 and IITPave software.
4	To design longitudinal and transverse joints for rigid pavement.
5	To design dowel and tie bars for rigid pavement.
6	To determine temperature stresses, warping and frictional stresses for rigid pavement.
7	To perform skid resistance value test on a pavement section.
8	To evaluate the existing flexible pavement and to design overlay by falling weight deflectometer.

Text Books:

1. Highway Engineering – S.K. Khanna & C.E.G. Justo. New Chand & Brothers.
2. Asphalt Materials and Mix Design Manual, MS-2, 2014 by Asphalt Institute.
3. Pavement Analysis and Design by Yang H. Huang.

Reference Books:

1. Highway material Testing - S.K. Khanna & C.E.G. Justo.
2. Bituminous Road Construction in India- Kandhal, Prithvi Singh, Veeraragavan, Amirthalingam, Choudhary, Rajan Revised Edition, 2016, PHI Publisher.
3. Indian Roads Congress (IRC)-37, 2018, and IRC 58 (2015) specification.

Prerequisite:

1. Understanding foundational concepts in civil engineering, including materials properties, soil mechanics.
2. Basic understanding in geotechnical engineering principles, such as soil classification, compaction, and bearing capacity estimation.
3. Familiarity with basic concepts of pavement engineering.
4. Knowledge of transportation engineering principles.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPP230.1	**Analyze** the design Parameters for Pavement.	**4**	1.1.1, 1.1.2	1.1.2, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.2.1, 2.3.1
CEPP230.2	**Design** of the Flexible Pavements using IRC 37 and IITPave software.	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.2.1, 2.2.2, 3.1.1, 3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.3.1, 2.3.2
CEPP230.3	**Design** of joints and component layer thickness of Rigid Pavements	**5**	1.1.1, 1.1.2, 2.2.1, 2.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.3.1, 2.3.2
CEPP230.4	**Evaluate** structural strength of flexible pavement for overlay design.	**4**	1.1.1, 1.1.2, 2.1.1, 2.1.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.3.1, 2.3.2
CEPP230.5	**Perform** skid resistance test on pavement	**3**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.2.1, 2.2.2, 3.1.1, 3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.3.1

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPP230.1	2	-	-	3	2
CEPP230.2	3	2	3	3	2
CEPP230.3	2	2	2	3	2
CEPP230.4	2	2	2	3	3
CEPP230.5	3	2	3	3	2

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year**: I	**Semester**: II
Course Name: Traffic Studies and Analysis Lab	**Course Code**: CEPP231	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2hrs.	**Teaching Scheme:** 0L+0T+4P	

Module No.	The experiments includes
1	To determine peak hour factor of a traffic stream.
2	To perform traffic survey and establish Speed-Volume relationship.
3	To design traffic signage and markings as per IRC method.
4	To conduct Parking studies.
5	To identify traffic movement pattern using origin and destination study.
6	To plan and design intersections.
7	To analyse accident data procured from police stations.
8	To conduct the noise study of traffic.

Text Books:

1. C.A.O. Flaherty, “Transportaion Planning and Traffic Engineering”, Butterworth-Heinemann; 4th edition
2. Kadiyali L.R. “Traffic Engineering and Transportation Planning”, Khanna Publications
3. IRC, BIS, ISO codes and specifications

Reference Books:

1. McShane, W.R and Roess, R.P, “Traffic Engineering”, Prentice-Hall, Inc..Newjersey 1990
2. Relevant IRC Codes, Indian Roads Congress, Delhi
3. Khisty, C.J. and Lall, B.K., “Introduction to Transportation Engineering”, Prentice-Hall India

Prerequisite:

1. Different types of traffic studies.
2. Basic of traffic signs and road markings.
3. Knowledge of different types of intersections.

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPP231.1	**Determine** and Analyze Traffic Flow Characteristics	**4**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP231.2	**Design** Traffic Control Measures	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP231.3	**Conduct** and Interpret Traffic Studies	**3**	1.1.1, 1.1.2, 1.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPP231.4	**Analyze** Traffic-Related Environmental Impacts	**5**	1.1.1, 1.1.2, 1.2.1, 1.2.2, 3.1.1, 3.1.2, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPP231.1	3	3	3	3	3
CEPP231.2	3	3	2	3	2
CEPP231.3	3	2	3	3	3
CEPP231.4	3	2	3	2	3

Syllabus

Name of the Programme: M.Tech. in Transportation Engineering	**Year:** I	**Semester:** II
Course Name: Mini Project & Seminar	**Course Code:** CEPD250	**Credit:** 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 Hrs	**Teaching Scheme:** 0L+0T+4P	

Course Outcomes:
After successful completion of course students will be able to

Course Code	Course Outcomes	Bloom's Level	PO Indicators	PSO Indicators
CEPD250.1	**Demonstrate** a sound technical knowledge of their selected mini-project topic	**2**	1.1.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPD250.2	**Undertake** problem identification, formulation and solution.	**2**	1.1.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPD250.3	**Apply** technical knowledge gained from previous courses for project development	**3**	1.1.1, 1.2.2, 2.1.1, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPD250.4	**Demonstrate** effective communication and presentation skills through oral presentations	**3**	1.1.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2
CEPD250.5	**Apply** report writing skills for preparing detailed professional report on new technologies.	**3**	1.1.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 3.1.1, 3.1.3	1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.3.1, 2.3.2

Mapping of COs with POs:

Course Code	PO1	PO2	PO3	PSO1	PSO2
CEPD250.1	2	2	3	3	3
CEPD250.2	2	2	3	3	3
CEPD250.3	2	2	3	3	3
CEPD250.4	2	3	3	3	3
CEPD250.5	2	3	3	3	3