SCHEME & SYLLABUS

FOR

M.TECH.

TRANSPORTATION ENGG. &

MANAGEMENT

2025-26

Department of Civil Engineering
Siddaganga Institute of Technology
Tumakuru – 572 103.

SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

M.Tech in Transportation Engineering and Management

SCHEME OF TEACHING AND EXAMINATION (80 Credits Scheme)

Applicable for students admitted from the Academic Year 2025-27

I Semester

Sl. No.	Course Type and Course Code		Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical / Seminar	Tutorial / Skill Development Activities	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1.	BSC	S1CTMMAT	Applied Statistics for Transportation Engineering	2	0	2	3	50	50	100	3
2.	IPCC	S1CTM01	Pavement Materials (I)	3	2	0	3	50	50	100	4
3.	PCC	S1CTM02	Traffic Engineering and Geometric design	2	0	2	3	50	50	100	3
4.	PCC	S1CTM03	Pavement Construction, Equipment and Technology	2	0	2	3	50	50	100	3
5.	PEC	S1CTME1x	Professional Elective – 1	2	0	2	3	50	50	100	3
6.	PEC	S1CTME2x	Professional Elective – 2	2	-	2	3	50	50	100	3
7.	NCMC	S1PGRM	Research Methodology and IPR	1	0	0	-	50	-	50	PP
8.	PCCL	S1CTML1	Advanced Pavement Materials Testing Lab	1	2	0	3	50	50	100	2
9.	AEC	PGARAS	Aptitude Related Analytical Skills	36 Hrs. for the entire semester				100	-	100	1
	Total			**16**	**4**	**8**		**500**	**350**	**850**	**22**

Professional Elective - 1		**Professional Elective - 2**	
S1CTME11	Construction Project Management	S1CTME21	Intelligent Transport Systems
S1CTME12	Airport Planning and Design	S1CTME22	Urban Public Transport
S1CTME13	Transportation System Management	S1CTME23	Advanced Traffic Engineering
S1CTME14	Introduction to AI and Its Applications	S1CTME24	Pavement Geotechniques

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II Semester

Sl. No.	Course Type and Course Code		Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical / Seminar	Tutorial / Skill Development Activities	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1.	IPCC	S2CTM01	Pavement Analysis and Design (I)	3	2	0	3	50	50	100	4
2.	PCC	S2CTM02	Transportation Planning	2	0	2	3	50	50	100	3
3.	PCC	S2CTM03	Pavement Management Systems	2	0	2	3	50	50	100	3
4.	PEC	S2CTME3x	Professional Elective – 3	2	0	2	3	50	50	100	3
5.	MPS	S2CTMMPS	Mini Project with Seminar	0	4	2	--	100	--	100	3
6.	PCCL	S2CTML1	Design Studio	1	2	0	3	50	50	100	2
7.	NCMC	PGSHS07	Soft Skills	36 hrs. during the entire semester				100	---	100	PP
	Total			**11**	**8**	**6**		**400**	**300**	**700**	**18**

Professional Elective - 3	
S2CTME31	Design of Reinforced Earth Structures
S2CTME32	Transportation Economics
S2CTME33	Environmental Impact Assessment of Transportation Projects
S2CTME34	Ground Improvement Techniques

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M.Tech in Transportation Engineering and Management

SCHEME OF TEACHING AND EXAMINATION (80 Credits Scheme)

Applicable for students admitted from the Academic Year 2025-27

III Semester

Sl. No.	Course Type and Course Code		Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical / Seminar	Tutorial / Skill Development Activities	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1.	PEC	S3CTME41	NPTEL Online Course - 1 (12 weeks duration)					100	-	100	3
2.	PEC	S3CTME52	NPTEL Online Course - 2 (12 weeks duration)					100	-	100	3
3.	PEC	S3CTME63	NPTEL Online Course - 3 (12 weeks duration)					100	-	100	3
4.	INT	S3CTMINT	Internship	(One semester Duration)			3	100	100	200	11
	Total							**400**	**100**	**500**	**20**

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M.Tech in Transportation Engineering and Management

SCHEME OF TEACHING AND EXAMINATION (80 Credits Scheme)

Applicable for students admitted from the Academic Year 2025-27 and onwards

IV Semester

Sl. No.	Course Type and Course Code		Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical / Field work	Tutorial / Skill Development Activities	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1.	PROJ	S4CTMPR	Project Work	0	8	0	3	100	100	200	20
	Total			**0**	**8**	**0**		**100**	**100**	**200**	**20**

Applied Statistics for Transportation Engineering

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S1CTMMAT	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Understand the concepts and applications of probability and statistics in transportation engineering systems. The focus will be on applications and concepts, with less emphasis on proofs and theory.

NOTES:

UNIT I

12 Hours

Introduction and Sampling Techniques: • Role of statistical thinking, data collection, Numerical and graphical summary of data, Frequency distribution; Measure of Central tendency and dispersion – Mean and Standard deviation; Standard error, Skewness; Kurtosis; Graphical summary using different plots; Definitions - Simple random sampling; Stratified sampling; Systematic sampling; Applications in Traffic and Pavement Engineering. •

UNIT II

12 Hours

Probability: • Laws of Probability; Conditional probability and Independent events; Distributions: Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Chi-square test for goodness-of-fit; Applications in Transportation Engineering. •

UNIT III

11 Hours

Regression and Correlation: • Linear regression and correlation; Multiple regression analysis, correlation; Central value; Standard error of estimate; Analysis of Variance; Multi-Variate Data Analysis: Types of data. •

UNIT IV

11 Hours

Simple estimate of Standard deviation, Dispersion, Variance and covariance; Correlation matrices; Principal component analysis; Time series analysis - Introduction, Moving average. Applications in Transportation and Pavement Engineering. •

UNIT V

10 Hours

Exact Sampling Distributions: • Chi-square distribution; Student's T- distribution; Snedector's F-distribution. Types of T tests: One sample T test, Independent two sample T test and Paired T test; Applications in Traffic and Pavement Engineering problems. •

TEXT BOOKS:

1	Benjamin, J. R. and C. A. Cornell	"Probability, Statistics, and Decision for Civil Engineers", Dover Publications; Reprint Edition, 2014

2	Kumar Moluguram and G Shanker Rao	"Statistical Techniques for Transportation Engineering", B S Publications, 2017
3	Dr. L.R. Kadiyali	"Traffic Engineering and Transport planning", Khanna Publishers, 9th Edition, 1999

REFERENCES:		
1	Gupta, S.C and Kapoor K.V.	"Fundamentals of Mathematical Statistics", Sultanchand.1978
2	Jay Devore	"Probability and statistics for Engineering and sciences", 8th Edition, Cenege Publication., 2012
3	Simpson & Kafks,	"Basic Statistics", Oxford & IBH Calcutta, 1969.
4	N. T. Kottegoda, Renzo Rosso,	"Applied Statistics for Civil and Environmental Engineers", Blackwell Publishing Ltd, 2008
5	Ang, A. H. and Tang, W. H. (2007).	"Probability Concepts in Engineering: Emphasis on Applications in Civil & Environmental Engineering", Wiley, 2007
6		

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Adopt suitable sampling method and evaluate descriptive statistics.
CO2	Conceptualize and identify real word events as a function of discrete/continuous distributions.
CO3	Study relationships between various factors using regression and analysis of variance.
CO4	Evaluate multi-variate data using principal component analysis and time series analysis.
CO5	Evaluate sample data using different sampling distributions.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	2			
CO2			3	2			
CO3			3	2			
CO4			3	2			
CO5			3	2			

Pavement Materials

Contact Hours/ week: (L-T-P-S)	3-0-2-3	**Credits:**	4
Total Lecture Hours:	120 = 42 (L)+0(T)+28(P)+50(S)	**CIE Marks:**	50
Sub. Code:	S1CTM01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Understand the different materials used in pavement construction.
2	Design bituminous and cement concrete mixes as per the prevailing standards.
3	Understand the need & use of alternate/marginal materials in pavement construction.

NOTES:

UNIT I

7 Hours

Aggregates: Requirements, properties and tests on road aggregates for unbound and bound granular sub-base and base, design gradation for unbound and bound pavement layers. • Bituminous binders: Conventional and modified binders, criterion for selection of different binders. • Bituminous Emulsions and Cutbacks: Application in pavements. •

UNIT II

8 Hours

Bituminous Mixes: Types, requirements, properties and additives & modifiers in bituminous mixes. Marshall Method of mix design and specifications. Mechanical properties- Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Characterization of bituminous mixes for pavement design. • Weathering and Durability of Bituminous Materials and Mixes: Tests in weathered bituminous materials, Adhesion, failure, mechanism of stripping, tests and methods of improving adhesion. •

UNIT III

9 Hours

Performance based Bitumen Specifications: Superpave physical test using rotational viscometer, dynamic rheometer, binder beam rheometer, direct tension tester for asphalt binders, superpave asphalt binders specifications based on permanent deformation, fatigue cracking, low temperature cracking, selection of Superpave binder grades. • Superpave mix design method: selection of aggregate blend, Superpave gyratory compaction, compaction of samples, selection of optimum asphalt content, Superpave mix design example problems •

UNIT IV

8 Hours

Cement Concrete for Pavement Construction: Materials, requirements, different types of concrete mixes and design of mix for CC pavement (DLC and PQC), IRC and IS specifications and tests, joint filler and sealer materials. Special concrete mixes •

UNIT V
7 Hours
Alternate/Sustainable Pavement Materials: Need, Scope for use of alternate/sustainable materials in pavement construction, various alternate/sustainable pavement materials and their requirement for road application. •
LAB COMPONENT
26 Hours
Assessment of suitability of various materials for pavement construction. • Design of mixes for granular, bituminous and cement concrete layers of the pavement as per the relevant standards. • Design of bituminous mix (HMA) by Marshall method. • Determination of moisture susceptibility of bituminous mix. • Design of cement concrete mix - M40 grade. • Determination of compressive strength of cement concrete mix. •

TEXT BOOKS:		
1	S.K. Khanna, C.E.G. Justo and A. Veeraragavan	"Highway Engineering", Nem Chand and Bros. Roorkee, 10th Edition, 2018.
2	Prithvi Singh Kandhal	"Bituminous Road Construction in India", PHI Learning, Revised Edition, 2016.

REFERENCES:		
1	Yoder E J and Witczak, M.W.	"Principles of Pavement Design"- Wiley India Pvt Ltd., 2nd Edition, 2011.
2	S K Khanna, C E G Justo and A Veeraragavan	"Highway Materials and Pavement Testing", Nem Chand & Bros, 2013.
3		"Asphalt Mix Design Methods – Manual Series 2", 7th Edition, Asphalt Institute, 2015.
4		Superpave Mix Design – Superpave Series No. 2 (SP-2), Asphalt Institute, 3rd Edition, 2001.
5		The Shell Bitumen Handbook, ICE Publishing, 6th Edition, 2015.
6		Relevant IS, IRC, MoRT&H and ASTM publications.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Assess the suitability of various conventional and modified construction materials for pavement application.
CO2	Design, characterize and analyze the bituminous mixes by Marshall method.
CO3	Design the bituminous mixes based on the performance criteria.
CO4	Design the cement concrete mix for CC pavement and assess its strength requirement.
CO5	Describe the need and use of various alternate/sustainable materials for pavement construction.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			2	3			
CO2			2	3			
CO3			2	3			
CO4			2	3			
CO5			2				

Traffic Engineering and Geometric design

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S1CTM02	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Learn the geometric design aspects of urban and rural highways along with expressways.
2	Understand the different aspects of traffic engineering including various traffic studies, analysis, improvement measures, regulations and management techniques.
3	Also, the student will acquire on-site experience of collecting traffic data.

NOTES:

UNIT I

11 Hours

Geometric Design: • Introduction, functional classification of highways, cross sectional elements, elements of design, geometrics of site distance, stopping and passing site distance, intersection site distance, widening section design, Horizontal alignment, Vertical alignment, Numerical examples. • Intersections: • Categories of intersections - uncontrolled, signalized and rotary intersections, characteristics, intersection and signal control, types of intersection controls, critical aspects of operation, conflict areas of intersections. •

UNIT II

11 Hours

Design considerations and objectives, two - way stop controlled intersection, all-way stop controlled intersection, signalized intersection, capacity of rotary intersection, numerical examples. Channelization, unchannelized and channelized intersections. At-grade intersections, grade separated intersections, types of interchanges, ramps – characteristics. •

UNIT III

12 Hours

Introduction to Traffic Engineering: • Traffic characteristics - Road user and vehicular characteristics; Traffic measurement procedures - Volume measurement, data analysis, concepts of ADT and AADT, prediction of traffic growth, design hourly volume and its significance; Concept of PCU, capacity and Level of Service (LOS); Speed measurements: Speed distribution, 15th, 85th and 98th percentile speeds; Speed and delay analysis - Moving car observer method - Estimating the travel time, Running and Journey speeds, Numerical examples. • Traffic Flow Characteristics: • Fundamental parameters and relations of traffic flow, speed and density; space mean speed, time mean speed, time head way, space head way; Relationship between variables, Fundamental diagram of traffic flow, Traffic stream models – Linear relationship between speed and concentration - Greenshield's model. • Skill Development Activities / Field Studies: • Traffic volume data collection at mid-block and at a junction; Spot Speed studies at mid-block; Moving car observer method – Delay, Running speed, Journey speed. •

UNIT IV

12 Hours

Specialized Traffic Studies: • Parking studies - Inventory, Characteristics, Types of parking survey, On and Off street parking; Origin and Destination studies - Objectives, Survey methods, Presentation of the data; Accident studies - Factors affecting accidents, Data collection, Remedial measures, Numerical examples; Toll operation studies – Types of toll collection, Methods, Terminologies, Optimum number of toll booths,

Numerical examples; Pedestrian studies – Terminologies, Factors affecting pedestrian demand, Data collection methods. • Skill Development Activities / Field Studies: • On-street and Off-street Parking studies; Pedestrian studies; Analysis of accident data. •

UNIT V

10 Hours

Traffic Regulation and Management: • Principles of Regulation - Regulation on vehicles, drivers, parking; Traffic signs - Regulatory, Warning and Informatory signs; Principles of traffic signal - Cycle length, Green phase, Red phase, Lost time, Fixed and Traffic actuated signals, Design of Cycle length of fixed time signal by Webster's method and IRC method, Numerical examples; Travel demand management; Traffic management techniques - Restrictions on turning movements, One way streets, Tidal flows, Exclusive bus lanes, Closing side streets. • Self-Study: • Students should study road alignment drawings and analyze the geometric design features in detail. They should make site visits to different intersections to know practical traffic stream characteristics. Student should witness various traffic regulatory measures and management techniques adopted in urban and rural roads. •

TEXT BOOKS:

1	C.Jotin Khisty and B.Kent lall	"Transportation Engineering: An Introduction", PHI Learning Pvt. Ltd., 3rd Edition, (2002).
2	C.S. Papacostas	"Fundamentals of Transportation Engineering", Prentice-Hall of India Private Limited, New Delhi, 3rd edition 2002.
3	Dr. L.R. Kadiyali	"Traffic Engineering and Transport Planning", Khanna Publishers, 9th Edition, (1999).

REFERENCES:

1	Fred L. Mannering, and Scott S. Washburn	"Principles of Highway Engineering and Traffic Analysis", Jhon WILEY Publishers, 7th edition, 2019
2	James H. Banks	"Introduction to Transportation Engineering", McGraw-Hill Education, 2nd Edition, 2001
3	Martin Wohl and Brian V. Martin	"Traffic system Analysis", McGraw-Hill, 1967
4		Relevant IRC codes

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	Design the geometric design features of highways as per IRC guidelines.
CO2	Design of geometric elements of intersections as per IRC guidelines.
CO3	Describe traffic stream characteristics.
CO4	Describe the studies related to parking, origin and destination, accident and toll operation.
CO5	Explain various traffic regulatory measures and traffic management techniques.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	2			
CO2			3	2			
CO3			3	2			
CO4			3	2			
CO5			3	2			

Advanced Pavement Materials Testing Lab

Contact Hours/ week: (L-T-P-S)	1-0-2-1	**Credits:**	2
Total Lecture Hours:	60 = 14 (L)+0(T)+28(P)+18(S)	**CIE Marks:**	50
Sub. Code:	S1CTML1	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Determine the strength of soil and assess its performance when used as a subgrade.
2	Analyse the rheological behaviour of bitumen under both unaged and aged conditions.
3	Design bituminous mixes by Marshall method.
4	Design high strength concrete for highways/runways and assess its performance.

NOTES:

LAB COMPONENT

39 Hours

Resilient modulus of subgrade soil. • Rheology of bitumen under aged and unaged conditions • Bituminous mix design by Marshall method - SMA mix, WMA mix and CMA mix • Design of paving quality concrete with high strength (Special mixes) •

TEXT BOOKS:

REFERENCES:

1	Relevant IS, IRC, ASTM and AASHTO standards.

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	Assess the strength of subgrade soil for pavement design.
CO2	Assess the performance of bitumen through its rheological characteristics under varied aging conditions.
CO3	Design various types of bituminous mixes considering varied environmental conditions.
CO4	Design high strength concrete mix for CC pavement of highways and/or runways and assess its strength.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3	3	3			3
CO2		3	3	3			3
CO3		3	3	3			3
CO4		3	3	3			3

Pavement Construction, Equipment and Technology

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S1CTM03	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	The objective of this course is to introduce the concepts of various equipment, materials, construction technology utilized in the construction of pavements across the world and India that helps to build resilient roadway infrastructure.

NOTES:

UNIT I

11 Hours

Earthwork and Earthwork Equipment • Subgrade, Subgrade volume characteristics, Load and Shrinkage factors, Spoil banks, Spoil piles. • Densification, Compaction control, Borrow area, Mass-haul concept. • Equipment economics – salvage value, owning cost, and operating cost • Equipment type - Hauling, Dozers, Excavators, Loaders, Hauling units, and Graders. • Construction of Subgrade: Materials, Procedure, Quality control checks, and Failures (MoRT&H, IRC and IS specifications) •

UNIT II

11 Hours

Stages of Hot-Mix Asphalt Construction • Hot-mix asphalt (HMA) facilities: Typical layout – Drum mix and Batch mix facilities; Drum mixers- Aggregate feed, Drum, Burners, Drying and Heating process; Asphalt cement injection and fines feeder system; Air quality control system - Primary collectors, wet collectors, and fabric filters . • HMA Transportation: Transportation vehicles – end dump vehicles, bottom dump vehicles; Truck loading procedures; protection during haul; Factors affecting truck cycle. • Pavers: Types, Principles of asphalt pavers; Forces acting on pavers, Components of paver, Mix placement. • HMA Compaction: Compaction equipment – Steel-wheeled rollers, Pneumatic tired rollers, Vibratory steel-wheeled rollers; Rolling patterns •

UNIT III

11 Hours

Innovative Surface layer Construction with Asphalt and Concrete • Kandhal Mix: Specification for readymade bituminous pothole patching mix using cutback bitumen (IRC116-2014 only) • Interlocking Concrete Block pavement: Guidelines for the use of interlocking concrete block pavement (IRC SP 63-2004 only) • Cell Filled Concrete Pavements: Applications and case studies only •

UNIT IV

11 Hours

Innovative Pavement Technology • Panelled Concrete: IRC SP:76-2015 - Guidelines for conventional and thin whitetopping • PMGSY report on whitetopping-2022 • Introduction to Warm mix asphalt (WMA) technology • Introduction to Cold mix asphalt (CMA) technology •

UNIT V

12 Hours

Construction of Cement Concrete Pavements • Foundation preparation- Subgrade, base and Subbase •

Ready mix concrete – Materials feeding; Concrete pavement type selection • Concrete placing and spreading; post paving - finishing, texturing, curing, joint sawing and sealing •

TEXT BOOKS:

1	Peurifoy R L and Clifford J S	"Construction Planning Equipment and Method", 8th Edition, McGraw Hill Book, 2010.
2	Freddy L Roberts, Prithvi S. Kandhal, and E. Ray Brown	"Hot Mix Asphalt Materials, Mixture Design and Construction", National Asphalt Pavement Association, Research and Education Foundation, 2nd Edition, Maryland, USA, 1996
3	US Army Corps of Engineers	"Hot-Mix Asphalt Paving Handbook-2000", Printed in the United States of America, Library of Congress catalog card number LC 00-135314ISBN 0-309-07157-7

REFERENCES:

1	Indian Roads Congress	IRC:36-2010 - Recommended Practice for the Construction of Earth Embankements and Subgrade for Road Works.
2	Indian Roads Congress	IRC SP: 24-1984 - Guidelines on the Choice and Planning of Appropriate Technology in Road Construction.
3	Indian Roads Congress	IRC116-2014: Specification for readymade bituminous pothole patching mix using cutback bitumen.
4	Indian Roads Congress	IRC SP: 63-2004 - Guidelines for the use of interlocking concrete block pavement.
5	Indian Roads Congress	IRC SP:76-2015 - Guidelines for conventional and thin whitetopping.

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	The student will be able to independently solve problems or provide technical suggestions to subgrade (PO2, PO3) related issues. The student will also gain knowledge (PO1) on various equipment utilized in the construction of earthwork
CO2	The student will be able to showcase a degree of mastery on the topic of hot-mix asphalt facilities. HMA transportation involving their components, working mechanisms and quality control on requirements by any institute (PO1, PO2)
CO3	The student will be introduced innovative surface layer preparation of pavements involving asphalt mixtures and concrete mixtures.
CO4	The student will be able to showcase a degree of mastery on the topic of Whitetopping
CO5	The student will be able to recommend the correct construction practices in delivering a durable concrete pavement

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2		2				
CO2	2		2				
CO3	2	2					
CO4	2	2					
CO5	2	2					

Introduction to AI & Its Applications

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	SCTME14	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Understand the concepts of computational intelligence algorithms and programming.
2	Acquiring advanced technologies like ANN, ML, Deep learning
3	Acquire advanced skills to develop genetic algorithms and programming

NOTES:

UNIT I

11 Hours

Introduction to AI: • Introduction to AI, definition of AI, Historical evolution of AI, AI types, brief introduction to the branches of AI, Machine learning, Natural Language processing, computer vision, robotics, expert systems, Artificial neural networks and deep learning, evolutionary computation, cognitive computing, and swarm intelligence. Applications in civil engineering in each branch of AI. •

UNIT II

11 Hours

Machine Learning: • Introduction to ML, Machine learning process model, Concept learning, general-to-specific ordering, version spaces, inductive bias, general to specific ordering, introduction to different kinds of machine learning, supervised, unsupervised, semi supervised, reinforcement, transfer learning and federated learning. The related algorithms under each type of ML, Applications of different ML techniques in Civil Engineering. Well posed learning problem, designing a learning system, examples. •

UNIT III

11 Hours

Artificial neural networks (ANN): • Introduction, biological motivation, appropriate problems in ANN learning, perceptron's, the representational power of perceptions, multilayer networks, back propagation. Introduction to recurrent neural networks, and deep learning. Illustrative real-world examples on applications of neural networks in highway/ infrastructure construction management and other civil engineering domains. •

UNIT IV

12 Hours

Learning under uncertainty and ambiguity • Learning under uncertainty and ambiguity, fuzzy logic, linguistic variables, fuzzy sets, membership functions, fuzzy set operations, fuzzy expert systems, fuzzification, defuzzification, fuzzy rules, fuzzy inferences. Fuzzy inference system, Illustrative examples of engineering applications of fuzzy logic with specific reference to civil engineering. •

UNIT V

11 Hours

Introduction to Computer Vision: • Definition and scope, history and evolution, Image acquis ion, image representation (grey scale and color), basic operations like filtering, thresholding. Primitives of image

processing, geometric primitives, 2d Transforms, 3D transforms, photometric image formation, lighting, reflectance and shading, the digital camera, sampling and aliasing. Applications of computer vision in Civil engineering. •

TEXT BOOKS:

1	Stuart Russell and Peter Norvig	Artificial Intelligence a Modern Approach, Pearson Education, Third edition, 2010
2	Ben Coppin	Artificial Intelligence Illuminated, Narosa Publications, First Edition, 2014
3	Margaret A Boden,	Artificial Intelligence, Academic Press London, First Edition, 1996
4	Kothari Dwarkadas Pralhaddas, Samui Pijush	Artificial Intelligence in Civil Engineering, Lambert Academic Publishing, First Edition, 2012

REFERENCES:

1	David. L.Poole , Alan K. Mackworth	Artificial Intelligence – Foundations of Computational Agents, Cambridge University Press, 2nd Edition, 2010
2	Kevin Warwick	Artificial Intelligence-The Basics, Routledge Publications, USA,2012
3	Nikos D. Lagaros and Vagelis Plevris	Artificial Intelligence Applied in Civil Engineering, MDPI, 2022
4	Paul D.Harrison	Artificial Intelligence Applications in Material Science and Engineering, Kindle Edition, 2023

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	Gain insights into the role of AI in modern civil engineering practices and how it can enhance decision-making and efficiency.
CO2	Acquire knowledge of basic Machine Learning algorithms and techniques and develop the ability to implement and evaluate ML models for solving complex civil engineering problems
CO3	Comprehend the structure and functioning of Artificial Neural Networks, including various architectures and learning algorithms, and apply ANN techniques to model and solve real-world civil engineering problems
CO4	Learn the principles of Fuzzy Logic and its application in handling uncertainty and imprecision in Civil engineering problems
CO5	Understand the basics of computer vision and image processing techniques, and their relevance in civil engineering will be able to implement computer vision methods for automated inspection, monitoring, and analysis of civil infrastructure

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			2		2		
CO2			2		2		
CO3			2		2		
CO4			2		2		
CO5			2		2		

Pavement Geotechniques

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	0
Sub. Code:	S1CTME24	**SEE Marks:**	0

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Introduce to the fundamental aspects of soil mechanics, compaction, shear strength, permeability stability analysis of slopes with the background of transportation structures.
2	Details on geotechnical exploration and characterization of in-place and constructed subgrades as well as unbound base and sub-base materials.
3	Design details for drainage features and base/sub-base material requirements are covered, along with the evaluation and selection of appropriate remediation measures for unsuitable subgrades

NOTES:

UNIT I

11 Hours

Introduction: • Soil Mechanics applications to Highway / Infrastructure Engineering. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems. • Soil Compaction: • Introduction, Lab Tests, Factors affecting, Structure & Engineering behavior of compacted cohesive soil, Field compaction specifications, Field compaction control, Different types of Equipment used for compaction, their choice. •

UNIT II

12 Hours

Elements of elasticity: • Equations of equilibrium (rectangular & polar) in 2D & 3D, stress function, Boussinesq's and Westergaard's stress analysis, Isobars, Stresses for line, strip, circular, rectangular, triangular and embankment loading, Burmister's analysis for stress in two- layered soils. • 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. •

UNIT III

11 Hours

Stability of slopes: • Introduction, Types, Different methods of analysis of slopes for Øu = 0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems. • Permeability of Soil: • Darcy's Law, Validity, Soil-water system, Types, Determination of permeability, problems. •

UNIT IV

11 Hours

Site Investigation: • Introduction, Planning exploration programmes, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods. • Excavation for Roadway and Drains: • Scope, Classification of Excavated material, Construction Operations, Plying of Construction Traffic, Preservation of Property, Preparation of Cut Formation, Finishing Operations, Measurements for Payment, Rates. • Embankment Construction: • Scope, Materials and General Requirements, Construction Operations, Construction of Embankment and Subgrade under Special Conditions. •

UNIT V	
	11 Hours
Special attention for subgrade condition: • Problematic soils, compressible &collapsible soils, swelling, subsurface water, frost-susceptible soils. • Drainage • Surface drainage, Sub-surface drainage, methods, Design of subsurface drainage system. Base layer requirement-erodibility of bases, bound bases, modified or treated bases, base reinforcement •	

TEXT BOOKS:		
1	Donald P. Coduto, Man-chu Ronald Yeung, William A. Kitch	"Geotechnical Engineering Principles and Practices", Pearson, 2nd Edition, 2011, ISBN-13: 978-0-13-603428-5, ISBN-10: 0-13-603428-4
2	Gopal Rajan and ASR Rao	"Basic and Applied Soil Mechanics", New Age International (P) Limited, 5th Edition (2024)
3	P. Purushothama Raj	"Ground Improvement Techniques", Laxmi Publications; First Edition (1999), ISBN-10: 8131808572, ISBN-13: 978-8131808573

REFERENCES:		
1	Braja M Das	"Advanced Soil Mechanics", McGraw Hill Book Company, 4th Edition (2014)
2	Graham Branes	"Soil Mechanics", Principle and Practice, 3rd Edition (2010)
3	Road Research Laboratory (Great Britain)	"Soil Mechanics for Road Engineers," HMSO, London, 1952.
4	Barry R. Christopher, Charles Schwartz, and Richard Boudreau.	"Geotechnical Aspects of Pavements', Reference Manual", US Department of Transportation, Publication No: FHWA NHI-05-037, Federal Highway Administration, May 2006, NHI course no:132040.
5	Indian Roads Congress	"Specifications for Road and Bridge Works," Ministry of Road Transport and Highways, published by Indian Roads Congress, New Delhi, 5th Revision, 2013.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Describe the various basic properties of soil including classification and compaction necessary for pavement engineering along with the relevant guidelines.
CO2	Evaluate the stresses induced in soils by Boussinesq's, Westergaard's and Burmister's analysis.
CO3	Evaluate the shear strength of soil and analyze the stability of slopes under different soil conditions.
CO4	Evaluate permeability characteristics of soil for pavement application.
CO5	Describe the sub-soil exploration techniques and prepare the investigation report.
CO6	Describe the methodology adopted in the excavation and construction works for embankments and roads.
CO7	Describe the scenario demanding special attention for subgrade and design drainage system.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				2			
CO2				2			
CO3				2			
CO4			1	2			
CO5			1				

Research Methodology and IPR

Contact Hours/ week: (L-T-P-S)	2-0-0--2	**Credits:**	0
Total Lecture Hours:	0 = 28 (L)+0(T)+0(P)+-28(S)	**CIE Marks:**	50
Sub. Code:	S1PGRM	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Identify the area of research and set the Objectives
2	Define the research problem and carryout literature
3	Develop Research design and framework for experimentation
4	Interpret Sampling design, Measurement and scaling techniques in RM
5	Develop data collection and hypothesis testing procedure
6	Interpret and write research and technical report.

NOTES:

UNIT I

6 Hours

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology -Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research -Developing a research plan. •

UNIT II

6 Hours

Defining the research problem - Selecting the problem - Necessity of defining the problem -Techniques involved in defining the problem - Importance of literature review in defining a problem- Survey of literature - Primary and secondary sources Identifying gap areas from literature review. •

UNIT III

6 Hours

Research design and methods – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design –- Developing a research plan - Exploration, Description, • Diagnosis, and Experimentation - Determining experimental and sample designs. •

UNIT IV

5 Hours

Sampling design - Steps in sampling design - Characteristics of a good sample design - Types of sample designs - Measurement and scaling techniques - Measurement in Research, Measurement Scales, Sources Of Error In Measurement, Tests Of Sound Measurement, Technique Of Developing Measurement Tools • Methods of data collection – Collection of primary data - Data collection instruments Testing of hypotheses - Basic concepts - Procedure for hypotheses testing flow diagram for hypotheses. •

UNIT V

5 Hours

Interpretation and report writing - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis. • IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs) - A brief summary of Patents, Copyrights, Trademarks, Industrial Designs. •

TEXT BOOKS:		
1	Kothari, C.R	Research Methodology: Methods and Techniques. New Age International. 418p
REFERENCES:		
1	Garg, B.L., Karadia,R., Agarwal, F. and Agarwal, U.K.	An introduction to Research Methodology, RBSA Publishers, 2002.
2	Subbarau NR	Handbook on Intellectual Property Law and Practice, S Viswanathan Printers and Publishing Private Limited, 1998

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Identify research categories and develop research plan.
CO2	Conduct and investigate the research problem and carryout literature review.
CO3	Investigate and Develop Research design and framework for experimentation.
CO4	Analyse and Develop Measurement and scaling techniques in their research & hypothesis testing procedure
CO5	Develop data collection and hypothesis testing procedure
CO6	Plan and develop systematically the research and technical report.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1							
CO2							
CO3							
CO4							

Pavement Analysis and Design

Contact Hours/ week: (L-T-P-S)	3-0-2-3	**Credits:**	4
Total Lecture Hours:	120 = 42 (L)+0(T)+28(P)+50(S)	**CIE Marks:**	50
Sub. Code:	S2CTM01	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Understand the components of pavement structure.
2	Analyse the stresses in both flexible and rigid pavements.
3	Design flexible and rigid pavements as per the relevant codes of practice.

NOTES:

UNIT I

8 Hours

Pavements and pavement layers - types, functions, choice. Factors affecting design and performance of flexible and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL, VDF due to varying loads and CSA, Subgrade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests. • Concept of ESWL: ESWL for single and two-layer system in flexible pavement. Equivalent load factors. Applications to complex problems in pavement design using relevant software. •

UNIT II

8 Hours

Stresses and Deflection / strain in flexible pavements: Application of elastic theory, stresses, deflections / strains in single, two and three-layer system, multilayer theory. • Stresses in rigid pavements: General principle, stresses in rigid pavements, types of stresses, factors influencing the stresses, computation of stresses due to wheel loads and temperature variations, frictional stresses, stresses under worst conditions. •

UNIT III

7 Hours

Flexible pavement design: Empirical, semi empirical and theoretical design approaches, principle, advantages and applications. Design of flexible pavement as per IRC, AASHTO and Asphalt Institute methods using relevant software for specific highway projects for high volume roads and low volume roads. •

UNIT IV

8 Hours

Design of rigid pavements: Types of CC pavements, IRC method of design for high and low volume roads. Design of continuously reinforced concrete pavements, whitetopping. Types of joints in cement concrete pavements and their functioning, joint spacing; design of joint details for longitudinal joints, contraction joints and expansion joints. •

UNIT V

8 Hours

Designing with Geosynthetics: Property requirements and selection criteria of geosynthetics based on function, Design of reinforced unbound pavement layers, Design of asphalt reinforcement, Designing for separation, filtration and drainage applications. • Designing with alternate/sustainable materials:

Requirements of various layers while designing with alternate/sustainable materials, Design of pavement sections with alternate/sustainable materials. •
LAB COMPONENT
26 Hours
Traffic survey • Axle load survey • Analysis of flexible pavement – KENPAVE, IITPAVE • Analysis of rigid pavement – KENSLAB • Analysis of airfield pavement – FAARFIELD •

TEXT BOOKS:		
1	Yoder E J and Witczak M W	"Principles of Pavement Design"- Wiley India Pvt Ltd., 2nd Edition, 2011.
2	Rajib B Mallick and Tahar EL-Korchi	"Pavement Engineering Principles and Practice", CRC Press, 3rd Edition, 2017.
3	Huang	"Pavement Analysis and Design", Pearson Education, 2nd Edition, 2008.
4	R. Srinivasa Kumar	"Pavement Design", Orient Blackswan Pvt. Ltd., New Delhi, 2013.

REFERENCES:		
1	Yang	"Design of functional pavements", Mc Graw Hill Book Co., 1972.
2	David Croney and Paul Croney	"Design & Performance of Road Pavements", Mc Graw Hill Book Co., 1997.
3	W. Ronald Hudson, Ralph Haas and Zeniswki	"Modern Pavement Management", McGraw Hill and Co., 1st Edition, 1994.
4	S.K. Khanna, C.E.G. Justo and A. Veeraragavan	"Highway Engineering", Nem Chand and Bros. Roorkee, 10th Edition, 2014.
5		Relevant IRC and AASHTO standards.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Describe the various components of pavements and their functions.
CO2	Analyze and evaluate the stresses in both flexible and rigid pavements
CO3	Design the flexible and rigid pavement structure as per the relevant codes of practice.
CO4	Design the pavement section using various alternate/sustainable materials and geosynthetics.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			2	2			
CO2			2	3			
CO3			2	3			
CO4			3	3			

Transportation Planning

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S2CTM02	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1 Learn the elements of urban transportation planning process, travel demand estimation, trip generation, trip distribution, mode choice, route assignment analysis and Land use Transportation Model.

NOTES:

UNIT I

11 Hours

Urban Transportation Planning Process & Concepts: • Role of Transportation and Changing Concerns of Society in Transportation Planning; Transportation Problems and Problem Domain; Objectives and Constraints; Flow Chart for Transportation Planning Process- Inventory, Model Building, Forecasting and Evaluation Stages, Planning in System Engineering Framework. •

UNIT II

12 Hours

Methods of Travel Demand Estimation: • Travel Demand Forecasting methods - Introduction to Transportation Planning Practices; Definition of Study Area, Zoning. • Trip Generation Analysis: • Trip Generation Models- Zonal Models, Category analysis, Household Models, Problems on Trip generation models. •

UNIT III

11 Hours

Trip Distribution Analysis: • Trip Distribution Models - Factors governing trip generation and attraction, Growth Factor Models, Gravity Models, Opportunity Models and their calibration; Application of the Gravity Model. •

UNIT IV

11 Hours

Mode Split and Route assignment analysis: • Mode Split Analysis- Mode Choice Behaviour, Competing Modes, Mode Split Curves, Probabilistic Models and Two Stage Mode Split Analysis; Route Split Analysis- Elements of Transportation Networks, Diversion Curves, All-or-Nothing Assignment, Capacity Restrained Assignment, Multipath Assignment. •

UNIT V

11 Hours

Land use Transportation Models: Location models • Opportunity Models, Lowry based Land use Transportation Models – Allocation Function, Constraints, Travel Demand Estimation – Iterative Solutions, Matrix Formulation; Urban Forms & Urban Structures. •

TEXT BOOKS:		
1	C.S. Papacostas and P.D. Prevendouros	"Transportation Engineering and Planning", Prentice-Hall of India Private Limited, New Delhi, (2001).
2	C.Jotin Khisty, B.Kent lall	Transportation Engineering - An Introduction", PHI Learning Pvt. Ltd., 3rd Edition, (2003)
3	Dr. Kadiyali, L.R.	"Traffic Engineering and Transportation Planning", Khanna Publication, 9th Edition, (1999).

REFERENCES:		
1	Hutchinson, B.G.	"Principles of Urban Transport System Planning", McGraw Hill Book Co., 1974
2	Bruton M J	"Introduction to Transportation Planning", UCL Press, 1992

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Explain planning process for an effective transportation system.
CO2	Explain the travel demand estimation, model the trip production and attraction.
CO3	Evaluate the zonal trip generation and attraction for inter-zonal trip distribution.
CO4	Evaluate the modal split and transport system for assigning travel trips to various routes.
CO5	Describe the land use transportation models.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	2			
CO2			3	2			
CO3			3	2			
CO4			3	2			
CO5			3	1			

Pavement Management Systems

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S2CTM03	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	The objective of the course is to identify, evaluate, analyze and report the distress incurred on pavements and interpret the situation by conducting functional and structural assessments of the pavements by various techniques, while selecting and making decisions on appropriate pavement maintenance and/or rehabilitation methods.

NOTES:

UNIT I

11 Hours

Introduction to Pavement Management • Pavement Management Components Levels and functions • Definition-Components of Pavement Management Systems • Network level versus project level PMS functions •

UNIT II

11 Hours

Pavement Distress • Types, Identification, Measurement and reporting of pavement distress data • Pavement condition surveys- Manual, Automated • Distress survey procedures (visual and rating) • Problems •

UNIT III

11 Hours

Functional Performance Evaluation • Equipment types, operating procedures • Pavement condition index (PCI); Roughness- roughness components, International roughness index (IRI) • Riding qualities by using Bump Integrator; Unevenness using MERLIN • Present serviceability index (PSI) • Problems •

UNIT IV

11 Hours

Structural Performance Evaluation • Equipment types, Operating procedures • Overlay design using BBD • FWD-back calculation of layer moduli • AASHTO and IRC overlay design method • Problems •

UNIT V

12 Hours

Pavement Maintenance and Rehabilitation • Types of maintenance; classification of maintenance activities; case studies • Recycling strategies, benefits of recycling; full-depth reclamation; case studies •

TEXT BOOKS:

1	W Ronald Hudson, Ralph Hass and Zeniswki	"Modern Pavement Management", Krieger Publishing Company, Original Edition, 1994
2	E.J. Yoder and M.W. Witczak	"Pavement Design", Wiley India Pvt Ltd., 2nd Edition 2011.

REFERENCES:		
1	Indian Roads Congress	IRC 81-1997: Guidelines for Strengthening of flexible road pavements using Benkelman Beam Deflection technique
2	Indian Roads Congress	IRC: 115-2014 - Guidelines for structural evaluation and strengthening of flexible road pavements using falling weight deflectometer technique

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	The student will be able to describe the levels and needs of a Pavement management system component for a road agency.
CO2	The student will be able to describe the means to identify, evaluate, analyze and report the distress incurred on pavements
CO3	The student will be able to describe to evaluate pavement based on surface conditions and interpret the situation.
CO4	The student will be able to describe to assess the structural strength of the pavements by various techniques
CO5	The student will be able to describe to select and prioritize appropriate pavement maintenance and rehabilitation methods

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1					
CO2	2	1	2				
CO3	2	1	2				
CO4	2	1					
CO5	2	1					

Design of Reinforced Earth Structures

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	0
Sub. Code:	S2CTME31	**SEE Marks:**	0

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Comprehend the basic principles of reinforced soil for its applications in geotechnical engineering
2	Appraise different codal provisions for reinforced geotechnical structures
3	Design suitable ground improvement and reinforced soil structures using Geosynthetics

NOTES:

UNIT I

11 Hours

Reinforced Earth Structures • Introduction, basic mechanism of Reinforced earth, Basic components of reinforced soil, Soil or Fill matrix, Reinforcement (Strips, Grids, Sheet Reinforcement), Facing Elements - Metal facing, Concrete Panel facing, Strength characteristics of Reinforced soil - Basic concept of strength development: rupture and sliding failure, Theoretical models: Sigma and Tau models, Stress strain behavior of reinforced sand. •

UNIT II

11 Hours

Designing with Geosynthetics • Introduction, materials, Geotextiles Functions and Mechanisms - Separation, Reinforcement, Filtration, Drainage, Contaminant. Geotextiles Properties and Test Methods - Physical properties, Mechanical properties, Hydraulic properties. • Use of Geosynthetics for filtration and drainage • Introduction, Background, Applications, Conventional Granular Filter Design criteria, Geotextile Filter Requirements, Boundary conditions, Drain and filter properties, Design criteria, Soil retention criteria, Geotextile permeability criteria, Anti-clogging criteria, Survivability criteria, Durability criteria. •

UNIT III

11 Hours

Use of Geosynthetics in Roads • Introduction, Geosynthetics in Roadways, Applications, Temporary and permanent roads, Benefits, Role of sub grade conditions, Design, The Giroud and Noiray Approach, Geotextile Survivability, Application in Paved Roads. • Reinforced Soil Wall • General, Stability analysis - External stability, Internal stability. Effect of vertical and horizontal line loads-External stability, Internal stability, Drainage requirements. •

UNIT IV

11 Hours

Embankments on soft soil • Introduction, Analysis- Internal stability, Overall stability, Stability in the foundation. Influence of Reinforcement Extensibility, Relationships for design, Deformation in foundation, Settlement analysis, Overall stability with respect to bearing, Safety factors. • Foundations on Reinforced Soil Beds • Introduction, Failure modes, Analysis and design of reinforced soil beds •

UNIT V
12 Hours
Soil Nailing • General, Applications, Advantages Limitations of the system, Comparison of soil nailing with reinforced soil, Method of soil nailing, Construction sequence, Components of system, Analysis and Design-Assumptions, Geometry of Rupture surface, Forces acting on the wedge, Parametric study, Design, Case Histories. • Design of Reinforced Soil slopes • Introduction, General approach, Jewell's Method, Choice of design values for parameters and use of charts, Soil properties, Properties of reinforcement materials, Interaction parameters, Steps for simplified design, Design examples. •

TEXT BOOKS:		
1	Swami Saran	"Reinforced Soil and its Engineering Applications", Dreamtech Press, 3 Edition (2019), ISBN-10: 9389307902, ISBN-13: 978-9389307900
2	Sivakumar Babu G. L	"An introduction to Soil Reinforcement and Geosynthetics", Universities Press; First Edition (2005), ISBN-10: 8173714819, ISBN-13: 978-8173714818

REFERENCES:		
1	Koerner. R.M	"Design with Geosynthetics", Prentice Hall; 2nd edition (1990), ISBN-10 : 0132023008, ISBN-13 : 978-0132023009
2	Sanjay Kumar Shukla and Jian-Hua Yin	"Fundamentals of Geosynthetic Engineering", CRC Press; 1st edition (2006), ISBN-10 : 0415394449, ISBN-13 : 978-0415394444
3	Venkattappa Rao, G., & Suryanarayana Raju., G. V.S,	"Engineering with Geosynthetics," Tata McGraw Hill Publishing Company Limited., New Delhi. (1990)
4	Joseph E. Bowles	"Foundation Analysis & Design", McGraw-Hill Education, 5th edition (2001), ISBN-10 : 0071188444, ISBN-13 : 978-0071188449

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Describe the strength characteristics and strength development in reinforced soil along with the failure modes, theoretical models and stress – strain characteristics.
CO2	Describe the function and mechanisms o f geosynthetics test methods for the determination of geotextile properties to formulate design criteria for filtration and drainage applications with due consideration to serviceability and durability criteria.
CO3	Design geosynthetic reinforced roads by Giroud – Noiray approach.
CO4	Analyze the internal stability failure mechanism of a reinforced soil wall system.
CO5	Analyze and design reinforced soil beds for improved bearing capacity.
CO6	Design and analyze the soil nailed slopes and describe the construction practice.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			2	3			
CO2			2	3			
CO3			2	3			
CO4			2	3			
CO5			2	3			
CO6			2	3			

Transportation Economics

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S2CTME32	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	Learn the basic concepts of economics, evaluation of the benefits associated with improvements and their costs and enable them to perform economic analysis of road projects.

NOTES:

UNIT I

11 Hours

Introduction: Significance of transport, Demand and supply of transport, Elasticity of demand and supply concepts and principles of highway engineering economy. Costs and Benefits Identification and measurements of transportation costs and benefits, Capital cost, Inflation cost Interest during construction, Maintenance cost, Road user costs, Fixed and operating costs. •

UNIT II

11 Hours

Benefits due to transport improvements: Direct benefits- Reduced vehicle operation cost, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost. Negative impacts due to increased noise and air pollution, Indirect benefits: increased land value, increased development and demand. •

UNIT III

11 Hours

Transportation costs: Fixed and variable cost, cost of improvement, maintenance cost and other related cost, cost estimation methods, accounting for inflation, theory of transport supply and road planning. Accident cost, Methodology for monetary evaluation of passenger's travel time, Value of increased comfort and convenience, Congestion cost and pricing, Consumer's surplus and social surplus criteria, Fare policy for bus transit. •

UNIT IV

12 Hours

Economic analysis: The generation and screening of project ideas. Different methods of economic analysis – capital budgeting. Case studies. • Economic Evaluation of Transportation Plans – Different Methods, Rate of return methods – Benefit cost (B/C) and First Year Rate of Return method, Discounting cash flow (DCF) methods – Net Present Value (NPV) method and Internal Rate of Return (IRR) method. •

UNIT V

11 Hours

Application of Economic Theory in Traffic Assignment Problem: User optimal assignment and system optimal assignment. Economic analysis of projects – financing of road projects, methods of financing – PPP, toll collection. Economic variability of Build-Operate-Transfer schemes – Risk analysis. •

TEXT BOOKS:		
1	Robley Winfrey	"Economic Analysis for Highways", International Textbook Company, 1969
2	Emile Quinet, Roger Vickerman.,	"Principles of Transport Economics", Edward Elgar Publishing, 2004
3	James L.Riggs, David D.Bedworth, and Sabah U. Randhawa.,	"Engineering Economics", Tata McGraw Hill, Delhi,2009

REFERENCES:		
1	Sasmita Mishra	"Engineering Economics and Costing", PHI, New Delhi.
2	Sarkar P K., Maitri V	"Economics in Highway and Transportation Planning", Standard Publisher, New Delhi, 2010.
3	David A. Hensher, Ann M. Brewer	"Transport: An Economics and Management Perspective", Oxford University Press, 2001.
4	Emile Quinet, Roger Vickerman,	"Principles Of Transport Economics", Edward Elgar Publishing, 2005.
5	Ian G. Heggie,	"Transportation Engineering Economics", McGraw Hill, 1972.
6	Federal Highway Administration	"Transportation systems Management and Operations – Benefit-Cost Analysis Compendium," US Department of Transportation – 2020.
7		Relevant FHA, US Department of Transportation Publications on Economic Development.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Describe the fundamental concepts of economics in connection with transportation projects.
CO2	Evaluate various transportation costs and benefits associated with improvements.
CO3	Apply economic theory for different transportation costs.
CO4	Analyze costs of various aspects of transportation such as accidents, public bus transit.
CO5	Apply economic theory to traffic assignment problems.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	1			
CO2			3	1			
CO3			3	2			
CO4			3	2			
CO5			3	2			

Environmental Impact Assessment of Transportation Projects

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	50
Sub. Code:	S2CTME33	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:

This course will enable students to:

1	The student will be introduced to information on the environmental consequences for decision making. Promoting environmentally sound and suitable development by identifying appropriate alternatives and mitigation measures related to transportation projects

NOTES:

UNIT I

11 Hours

Introduction to Environmental Impact Assessment (EIA) • Objectives and Needs- development of EIA • National Environmental Protection Act 1986 – Key features • Rapid EIA – Comprehensive EIA – Strategic EIA- procedure for EIA in India • Formulation of EIA team interdisciplinary approach -Screening – Scoping - checklist, matrix and network methodologies • Identification of Impacts – Collection and documentation of baseline data • Need for Prediction and Mitigation Measures •

UNIT II

11 Hours

Application of EIA in Transportation Projects • Public participation in Environmental decision making - techniques for conflict management and dispute resolution in transportation projects • Role of GIS and RS in environmental impact assessment of transportation projects •

UNIT III

11 Hours

Assessment and prediction of Impacts on Water Environment • Basic water quality, sources and effects of water pollution • Assessment and prediction of impacts • Streeter Phelps equation and its application in EIA studies • Mathematical modeling for prediction of water pollution on account of transportation projects • Mitigation measures • legislations •

UNIT IV

11 Hours

Assessment and prediction of Impacts on Air and Noise Environment • Air quality, sources and effects of air pollution • Assessment and prediction of impacts • Gaussian distribution for air pollution for point and line sources • Mitigation measures and legislations • Basic information, sources and effects of noise pollution • Mitigation measures and legislations •

UNIT V

12 Hours

Socio-economic impacts in EIA studies • Ecological impacts – Ecological foot-prints– Environmental Indices • Introduction to Environmental Management Systems • Cost Benefit Analysis • Environmental Audit - Life cycle Assessment – Environmental Risk assessment – Case studies from India and across the globe •

TEXT BOOKS:		
1	John. G Rau and David C Wooten	"Environmental Impact Analysis Hand Book", 1st Edition, McGraw Hill, 1980
2	Canter L W	"Environmental Impact Assessment", 1st Edition, McGraw Hill New York 1996

REFERENCES:		
1	Petts. J	"Handbook of environmental Impact Assessment, M Land", 1st Edition Blackwell Science, London, 1999
2	Suresh K. Dhameja	"Environmental Engineering and Management", 1st Edition, S.K. Kataria & Sons, 2010
3	Davis, M. L., and Cornell, D. A.	"Introduction to Environmental Engineering", 1st Edition, Mc Graw Hill International Editions, 1998
4	Betty Marriott	"Environmental Impact Assessment: A Practical Guide", 1st Edition, McGraw Hill Professional, 1997.

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Understand and remember the concept, development and methodologies of environmental impact assessment.
CO2	Learn the application of environmental impact assessment in transportation.
CO3	Understand the impact of transportation projects on water
CO4	Understand the impact of transportation projects on the air environment including the impact of noise.
CO5	Learn the socio-economic impacts of environmental impact assessment studies.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1					
CO2	1	1					
CO3	1	1					
CO4	1	1					
CO5	1	1					

Ground Improvement Techniques

Contact Hours/ week: (L-T-P-S)	2-2-0-2	**Credits:**	3
Total Lecture Hours:	90 = 28 (L)+28(T)+0(P)+34(S)	**CIE Marks:**	0
Sub. Code:	S2CTME34	**SEE Marks:**	0

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	introduce different types problematic soils and to familiarize with different ground improvement techniques for improving these soils.
2	Impart knowledge of mechanical modification techniques such as deep compaction, blasting, vibrocompaction, dynamic tamping and compaction piles.
3	Develop the understanding of the students regarding the concept of reinforced earth, geosynthetics and soil reinforcement in ground improvement.

NOTES:

UNIT I

11 Hours

Introduction: • Engineering properties of soft, weak and compressible deposits, problems associated with weak deposit, Requirements of ground improvements, introduction to engineering ground modification, need and objectives. •

UNIT II

11 Hours

Soil Stabilization: • Science of soil stabilization – Mechanical modification, Hydraulic modification, Dewatering systems, Chemical modification, Modification by admixtures like lime, cement, bitumen, etc., Grouting, Deep jet mixing methods •

UNIT III

12 Hours

Recent Ground Improvement Techniques: • Stabilization using industrial waste, modification by inclusion and confinement, stone column, compaction piles, dynamic compaction, prefabricated vertical drains, preloading, electro – osmosis, soil freezing vacuum consolidation, deep explosion, dry powdered polymers, enzymes •

UNIT IV

11 Hours

Soil reinforcement: • Historical background, RCC – Vidalean concept of reinforced earth, mechanisms, types of reinforcements, Soil – Reinforcement interaction studies – Internal & External stability criteria, Design principles of steep reinforced soil slops, embankments on soft soils. •

UNIT V

11 Hours

In Situ Soil Treatment Methods • Soil nailing and ground anchors, rock anchoring, micro-piles, design methods, construction techniques, Functions and applications of geosynthetics – geotextiles, geogrids, geomembranes; soil reinforcement using strips, bars and geosynthetics. •

TEXT BOOKS:		
1	Purushothama Raj, P	"Ground Improvement Techniques," Laxmi Publications; First Edition (1999), ISBN-10 : 8131808572, ISBN-13: 978-8131808573
2	Sivakumar Babu G. L	"An introduction to Soil Reinforcement and Geosynthetics", Universities Press; First Edition (2005), ISBN-10: 8173714819, ISBN-13: 978-8173714818

REFERENCES:		
1	Koerner R.M	“Construction and Geotechnical Methods in Foundation Engineering," McGraw Hill Pub. Co. (1984), ISBN-10 : 0070352453, ISBN-13 : 978-0070352452
2	Manfred Hausmann	“Engineering principles of ground modification”, McGraw-Hill Inc., US, (1989), ISBN-10 : 0070272794, ISBN-13 : 978-0070272798
3	Bell, F.G.	“Methods of treatment of unstable ground," Butterworth and Company Publishers Limited (1975)
4	Ingles. C.G. and Metcalf J.B	“Soil Stabilization: Principles and Practice”, Butterworth-Heinemann Ltd (1973), ISBN-10 : 0409482153, ISBN-13 : 978-0409482157
5	Sanjay Kumar Shukla and Jian-Hua Yin	"Fundamentals of Geosynthetic Engineering", CRC Press; 1st edition (2006), ISBN-10 : 0415394449, ISBN-13 : 978-0415394444

COURSE OUTCOMES: Upon completion of this course the student will be able to:	
CO1	Identify the type of problems in problematic soils and to suggest different ground improvement techniques to solve these problems.
CO2	Describe the various conventional and latest ground improvement techniques.
CO3	Describe the various geosynthetic materials, their functions, design and analyze the improved deposits for bearing capacity and settlement.
CO4	comprehend the in-situ soil improvement techniques such as use of ground anchors, rock bolts, micro-piles, soil nails.
CO5	

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			2				
CO2			2				
CO3			2				
CO4			2				

Design Studio

Contact Hours/ week: (L-T-P-S)	1-0-2-1	**Credits:**	2
Total Lecture Hours:	60 = 14 (L)+0(T)+28(P)+18(S)	**CIE Marks:**	50
Sub. Code:	S2CTML1	**SEE Marks:**	50

CIE- Continuous Internal Evaluation, SEE-Semester End Examination

COURSE OBJECTIVES:
This course will enable students to:

1	Learn modern tools for performing statistical analysis and managing construction projects.
2	Learn modern tools for the design of intersections, highway design and analysis.
3	Learn modern tools for the quantity and cost estimation of road projects.

NOTES:

LAB COMPONENT

39 Hours

Statistical analysis – Minitab • Project scheduling and cost analysis – MS Project • Design of intersection and traffic simulation - VISSIM • Geometric design and Highway - Civil3D, OpenRoads • Quantity and Cost estimation of Road projects – MS Excel Spread Sheet •

TEXT BOOKS:

REFERENCES:

1	Relevant IRC codes of practice and user manuals.

COURSE OUTCOMES: Upon completion of this course the student will be able to:

CO1	Use statistical tool to perform the analysis of the data set.
CO2	Use project management tool for handling construction projects.
CO3	Use modern tool for the design of intersections and traffic simulation.
CO4	Use modern tools for the design and analysis of highways.
CO5	Prepare MS Excel spread sheets for the estimation of quantity and cost of road projects.

CO-PO Mapping: 1=> Low, 2=> Medium, 3 => Strong mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3	3	3	3		3
CO2		3	3	3	3	3	3
CO3		3	3	3	3		3
CO4		3	3	3	3		3