COURSE STRUCTURE AND SYLLABI

M.Tech in Transportation Engineering

2025-26 Batch

Centurion UNIVERSITY

Shaping Lives...
Empowering Communities...

SCHOOL OF ENGINEERING AND TECHNOLOGY
CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT
Odisha-761211, India

Web Site: - www.cutm.ac.in

CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT, ODISHA

CERTIFICATE

Centurion UNIVERSITY
Shaping Lives...
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This is to certify that the syllabus of the Programme M.Tech in Transportation Engineering of the School of Engineering and Technology is approved in the 15th Academic Council Meeting held on 22nd November 2025.

Dean
School of Engineering and Technology,
CUTM, Odisha

Pro Vice Chancellor
CUTM, Odisha

Centurion University of Technology and Management, Odisha

Course Structure & Syllabus

M. Tech in Transportation Engineering

2-Years Programme

School of Engineering & Technology

2025-2026

Index

Programme Objectives: At the end of the program, students will be able to;

PO	Outcomes
PO1	Engineering knowledge: Apply knowledge of mathematics, science, Engineering fundamentals, and civil engineering to the solution of engineering problems
PO2	Problem analysis: Identify, formulate, review literature and analyze civil engineering problems to design, conduct experiments, analyze data and interpret data
PO3	Design /development of solutions: Design solution for civil engineering problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in civil engineering
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and tools including prediction and modelling to civil engineering activities with an understanding of the limitations
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to civil engineering practice
PO7	Environment and sustainability: Understand the impact of the civil engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the civil engineering practice
PO9	Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in civil engineering
PO10	Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in civil engineering
PO11	Project Management and finance: Demonstrate knowledge & understanding of the civil engineering principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in civil engineering
PO12	Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in civil engineering

PEOs/PSOs

Programme Educational Objectives (PEOs):

PEO1: Provide an education that incorporates recent advancements in transportation engineering, including emerging mobility technologies, smart transportation systems, and sustainable infrastructure development.

PEO2: Develop transportation engineers with the analytical capability, flexibility, and technical understanding required to evaluate and manage transportation systems under varying traffic, geometric, environmental, and operational conditions**.**

PEO3: Provide comprehensive knowledge in modern transportation planning, traffic engineering, highway design, pavement materials, and intelligent transportation systems through advanced analytical tools, simulation techniques, and field-based learning**.**

Programme Specific Outcomes (PSOs):

PSO1: Gain technical expertise in the field of civil engineering as well as fundamental knowledge in science and engineering to solve complicated issues by conducting advanced research and development work in the field of civil engineering.

PSO2: To study practical engineering issues and create applications in the field of civil engineering, by using contemporary engineering software tools.

PSO3: Acquire proficiency in effective verbal as well as written communication to collaborating within a team, and cultivating a sense of accountability within specified timelines, all while upholding professional ethics and acknowledging the significance of ongoing learning.

Course Outcomes Attributes

Course Outcomes	**Attributes**
CO1	Knowledge
CO2	Analytical skill and Critical Thinking
CO3	Problem Solving and Decision taking ability
CO4	Use of Tool, Design and Development (Hands-on/Technical skill)
CO5	Research

Master of Technology(M.Tech in Transportation)	
Programme Structure – Post-Graduate Study	
Type of Course	**2 Years**
Major (Core) Courses	**34**
Elective Core/ Domain	**6**
Skill + AEC	**4**
Internship	**2**
Research Project	**34**
TOTAL	**80**

Course Structure

Transportation Engineering

SEMESTER - I					
Sl No	**Code**	**Subject name**	**Credits**	**T+P+J**	**NcRF Level**
1	CUTM2387	Bridge Engineering	3	3+0+0	6.5
2	CUTM2397	Road Materials and Characterization	3	2+1+0	6.5
3	CUTM4445	Urban Transportation Planning	3	3+0+0	6.5
4	CUTM2445	Transportation Infrastructure Design	3	2+1+0	6.5
5		Elective-1	3		6.5
6	CUTM4446	Traffic and Material Characterizations Lab for Road	4	0+2+2	6.5
7	CUTM2400	Term Paper	2	0+0+2	6.5
		TOTAL	**21**		
SEMESTER - II					
1	CUTM4447	Pavement Analysis and Design	3	2+0+1	6.5
2	CUTM4448	Highway Project Formulation and Economics	3	3+0+0	6.5
3	CUTM4449	Traffic Safety	3	2+0+1	6.5
4	CUTM2378	Research Methodology & IPR	4	2+0+2	6.5
5		Elective-2	3		6.5
6	CUTM2403	Practice on Application of Numerical Analysis	3	0+0+3	6.5
7		SKILL	4	0+2+2	6.5
		TOTAL	**23**		
SEMESTER - III					
1	CUTM4442	Internship	2	0+0+2	7
2	CUTM4443	Dissertation Part-I	16	0+0+16	7
		TOTAL	**18**		
SEMESTER - IV					
1	CUTM444	Dissertation Part-I	18	0+0+18	7
		TOTAL	**18**		

Electives

Sl No.	**Code**	**Electives (1 & 2, choose any two)**	**Credits**	**T+P+J**	**NcRF Level**
1	CUTM2447	Remote Sensing and GIS for Transportation Engineering	3	2+0+1	6.5
2	CUTM2448	Pavement Evaluation, Rehabilitation and Maintenance	3	2+1+0	6.5
3	CUTM4450	Intelligent Transport System	3	3+0+0	6.5
4	CUTM2449	Environmental Impact Assessment for Transportation Projects	3	2+1+0	6.5
5	CUTM2405	Pavement Soil Advancement Techniques	3	2+1+0	6.5

Bridge Engineering (3-0-0) (45 Hours)

Course	Code	T-P-Pr	Credit
Bridge Engineering	CUTM2387	3-0-0	3

Course Objectives:

- To develop an understanding of and appreciation for basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.
- To develop a clear understanding of conceptual design, and to carry out a design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements.
- To model and analyze bridge structures subjected to different types of loads.

Course Outcomes:

At the end of the program, students will be able to;

- **CO1**: Understand the principles of bridge engineering, including structural behavior, loading conditions, and materials selection.
- **CO2**: Analyze different types of bridge structures, including beam bridges, truss bridges, arch bridges, and suspension bridges.
- **CO3**: Apply structural analysis techniques to assess the performance of bridges under various loading conditions, including dead loads, live loads, and environmental loads
- **CO4**: Design bridge components such as superstructures, substructures, foundations, and bearings according to industry standards and codes.
- **CO5**: Understand the principles of bridge construction, including construction materials, methods, and techniques.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3				2		2									
CO4			3												
CO5	2												2		

***High-3, Medium-2, Low-1**

Module-1: **Fundamentals (11 Hrs)**

Theory

Classification and different components of a standard bridge, Engineering and aesthetic requirements of a standard bridge, Standard specifications of bridges (Bridge codes).

Investigation for bridge: Site selection, data drawing, design discharge linear water way, economical span, location of piers and abutments, vertical clearance above HFL, scour depth and choice of bridge type.

Standard Loadings for Road Bridges: Dead load, Live loads, Impact effect, Wind load, Longitudinal forces, Centrifugal forces, Horizontal forces due to water current, Buoyancy effect, Earth pressure, Deformation stresses, Erection stresses, Temperature effects, and Seismic force.

Module 2: **Bridge Foundation (11 Hrs)**

Theory

Types of foundation i.e., open foundation, pile foundation and well foundation; design of piers, abutments, wing wall and bed blocks.

Bridge sub-structures design: Design of Culverts i.e., design of pipe culvert (hydraulics and structural), design of slab culvert; design of rectangular box culvert.

Module 3: **Bridge girder design: (11 Hrs)**

Theory

Design and detailing T-beam bridge (without footpath), load distribution, design and orthographic plate analysis of bridge deck. Bearings: Bearings for slab bridges and girder bridges, design of elastomeric bearing. Joints: Design and construction of expansion joints.

Module 4: **Long span bridges**: **(11 Hrs)**

Theory

Arch bridges, Cable stayed bridges, suspension bridges, pre-stressed concrete bridges (pre-tensioned and post-tensioned) and steel bridges.

Inspection and Maintenance of Bridges:

Types of inspection (routine inspection, principal inspection and special inspection), Types of maintenance (Ordinary maintenance and specialized maintenance).

Text Books:

1. N.K. Raju, " Design of bridges", Oxford & IBH Publishing Co. pvt. ltd.
2. D.J. Victor, " Essentials of bridge engineering", Oxford & IBH Publishing Co. pvt. ltd.

Reference Books:

1. V. K. Raina, Concrete Bridges Practice – Analysis, Design and Economics, Shroff Publications, New Delh12nd Ed.2005.
2. Principles and Practice of Bridge Engineering, SP Bindra, Dhanpat Ra1Publications
3. Design of Bridge Structures, by T. R. Jagadeesh, PHI.
4. IRC Manual.

Road Materials and Characterization (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Pavement Materials and Construction	CUTM2397	2-1-0	3

Course Objectives:

- To learn about characteristic of subgrade soil and road aggregates.
- To learn about characteristic of paving grade bitumen.
- To learn about characteristic of cement used in road construction.

Course Outcomes:

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

- **CO1:**Assess the knowledge for understand the suitability of conventional and sustainable aggregates used in various layers of pavement as well as the bitumen used in the wearing course
- **CO2:**Demonstrate the utility of various bitumen products through analysis and design**.**
- **CO3:**Prioritize the sequential stages involved in the problem solving of flexible and rigid pavements
- **CO4:**Test the quality of pavement layers in flexible and rigid pavements using modern tools.
- **CO5:**Develop the research capability for the construction, quality of pavements, and its operation by the contextual knowledge to assess societal, health, safety, and legal issues.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2								
CO2		2	3												
CO3				3								2			
CO4					3										
CO5						3								2	

***High-3, Medium-2, Low-1**

Module I

Subgrade Soil Characterization **(15 Hours)**

Properties of subgrade layers; different types of soils, Mechanical response of soil; SPT, DCPT, CPT, CBR, Plate Load test & resilient modulus; Field compaction and control. Soil gradation, Shear test, Stabilization

Practice

SPT, DCPT, Plate Load test, Shear test of subgrade soil

Module II

Aggregate Characterization **(15 Hours)**

Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; Maximum aggregate size, NMSA, gradation proportioning and blending of aggregates: Super pave gradation, Use of locally available materials in lieu of aggregate.

Practice

Gradation using trial and error method, Gradation using blending, Aggregate polish test.

Module III

Bitumen & Bituminous Concrete Mixes **(15 Hours)**

Chemistry of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, stiffness modulus of bitumen, long term and short-term ageing, Cutback, Tar, Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications, Introduction to super pave mix design.

Practice

Absolute Viscosity test, Dynamic Viscosity test

Module IV

Cement and Concrete Mixes **(15 Hours)**

Basic cement properties, Special cements; Quality tests on cement; Introduction to advanced concretes like self-compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; Nano technology applications in cement concrete.

Practice

Superpave mix design, Nondestructive test for concrete

Text Book(s)

1. Khanna, S.K., and Justo, C.E.G., Highway Engineering, 9th Edition, Nem Chand and Bros. Roorkee, 2011.
2. Das, A. And Chakroborty, P. Principles of Transportation Engineering, 1st Edition, PHI Learning Pvt Ltd., 2012.

Reference(s)

1. Atkins, N. Harold, Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice-Hall.
2. Kerbs Robert D. and Richard D. Walker, Highway Materials, McGraw-Hill, 1971.

Urban Transportation Planning (45 Hours)

Subject Name	Code	T-P-PR	(Credit)
Urban Transportation Planning	CUTM4445	3-0-0	3

Course Objectives:

- To learn the planning methodology of urban transportation systems.
- To learn methods of data collection for planning and travel demand models.
- To learn Planning for sustainable urban mobility.

Course Outcomes:

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

- **CO1:** Develop a basic knowledge of the fundamental in urban transportation systems**.**
- **CO2:** Develop analysis skill on identify the study zone based on real problem case study and develop its solution**.**
- **CO3:** Able to define the critical problem-solving procedures for demand estimation and level of service analysis using available resources and investigations**.**
- **CO4:** Understand the supply-demand planning and elements of traffic operations with safety and societal contexts.
- **CO5:** Able to develop models for transportation planning and travel demand considering the societal and environmental contexts**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3											3		
CO3			2												
CO4				3											
CO5					2										

***High-3, Medium-2, Low-1**

Module I

Transportation System Management in UTP (10 Hours)

LOS, Factors affecting Capacity and LOS of Urban/Rural Highway, Measures for Improving vehicular flow, one-way Streets, Fixed Time signals, Determination of Optimum Cycle length and Signal setting for Fixed Time signals, Transit Stop Relocation, Parking Management, Reversible lanes- Reducing Peak Period Traffic, Strategies for working hours, Congestion Pricing, Differential Toll Policies.

Module-II

Data Collection and Inventories (10 Hours)

Collection of data – Organization of surveys and Analysis, Study Area, Zoning, Types and Sources of Data, Road Side Interviews, Home Interview Surveys, Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors, Accuracy Checks, Use of Secondary Sources, Economic data – Income – Population – Employment – Vehicle Owner Ship.

Module-III

Travel Demand and Supply Planning (10 Hours)

Long term Vs Short term planning on demand function, Travel Attributes, Assumptions in Demand Estimation, Detailed approach on 4 step travel demand estimation, Planning for sustainable urban mobility, congestion pricing, Urban travel and transportation system characteristics, Data management and use in decision making , Demand analysis , Urban activity analysis, Supply analysis; Plan preparation and evaluation, Impacts of New Development on Transportation Facilities.

Module-IV

Automatic Traffic Counting and Classification (ATCC)

Concept and Purpose, Technologies Employed and methods, Vehicle Classification and data storage, ATCC System Components, Data Analysis and Interpretation, Case Studies and Challenges.

Text book:

1. Introduction to Transportation Planning – M.J.Bruton; Hutchinson of London Ltd.

Reference books:

1. Introduction to Urban System Planning - B.G.Hutchinson; Mc Graw Hill.
2. Traffic Engineering and Transport Planning - Kadiyali L.R., Khanna Publishers
3. Lecture notes on UTP - Prof. S. Raghavachari , R.E.C.Warangal.
4. Metropolitan transportation planning – John W. Dickey, Tata Mc Graw Hill, New Delhi,1975.

Transportation Infrastructure Design (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Transportation Infrastructure Design	CUTM2445	2-1-0	3

Course Objectives:

- To learn geometric design of cross-sectional elements of various types of roads
- To learn Geometric Design of Horizontal and Vertical Alignment of Roads
- To learn transportation system management

Course Outcomes:

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

- **CO1**: Able to get basic knowledge to fundamentals to design various elements of highway.
- **CO2**: Build knowledge on problems and its analysis of the intersection elements through interpretation of case study.
- **CO3**: Develop the skill to design the interchanges, and parking facilities using available tools.
- **CO4**: Able to design and develop facilities for bicyclists with environment and society friendly.
- **CO5**: Able to design and develop facilities for pedestrians with the contextual knowledge to assess societal, health, and safety.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3											3		
CO3			2												
CO4				3											
CO5					2										

***High-3, Medium-2, Low-1**

Module I

Basic in Transportation Infrastructure Design (15 Hours)

Functional Classification of Highway System Controlling factors – Topography, Traffic Characteristics, Capacity and Level of Service, Design Speed. Objectives of Geometric Design, Cross Section Elements: Design specifications; Pavement Surface characteristics – Skid Resistance, Road Roughness; Camber, Objectives, design standards. Specifications for hill roads.

Practice

Level of Service, Road Roughness

Module II

Parameters in Transportation Infrastructure Design (15 Hours)

Horizontal Alignment of Roads: Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance; Elements of horizontal curves; Super elevation; Extra-widening on Curves, setback distance, radius; Transition Curves – Objectives and Design.

Practice

Falling Weight Deflectometer (FWD) Test, Benkelman Beam Deflection Test

Module III

Alignment Design of Transportation Infrastructure (15 Hours)

Vertical Alignment of Roads: Gradients – Types of Gradients, Design Standards; Vertical Curves – Summit Curves, Valley Curves and Design criteria for Vertical Curves; Importance of Sight Distances for Horizontal and Vertical Curves, Grade Compensation

Practice

Nuclear Density Gauge Test, Core Sampling and Testing

Module IV

Design of Intersections (15 Hours)

Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards. Miscellaneous Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays –Types and Guide lines; Design of On-street and Off-street Parking facilities – Guidelines for lay out Design, Traffic Signs and Markings.

Practice

Air Quality Monitoring, Dynamic Friction Tester, British Pendulum Tester, Retroreflectivity test

Text book:

1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal.

Reference books:

1. Highway Engineering, C.E.G.Justo and S.K.Khanna, Nem Chand and Brothers.
2. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.

Traffic and Material Characterizations Lab for Road (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Traffic and Material Characterizations Lab for Road	CUTM4446	0-2-2	4

Course Objectives:

- To learn the various quality tests road construction aggregates and bitumen used for flexible pavement.
- To learn the various tests on soil for using a pavement construction material.
- To understand the performance of traffic studies.

Course Outcomes:

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

- **CO1:** Understand the various fundamentals on quality control tests done on aggregates**.**
- **CO2:** Understand various aging tests skills on bitumen for performance of binder through conducting experiments**.**
- **CO3:** Understand the various problem analysis and design on soil through field investigations**.**
- **CO4:** Knowledge on use of modern tools/ hands-on training to do traffic studies.
- **CO5:** Able to characterize new pavement construction materials based on traffic condition and environmental contexts**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3											3		
CO3			2												
CO4				3											
CO5					2										

***High-3, Medium-2, Low-1**

Aggregates (8 Hours)

Aggregates Sampling, Gradation- Shape tests- Elastic recovery - Aggregate Impact Test- Los Angeles Abrasion Test – Crushing strength of Aggregates- Specific Gravity Test and Water Absorption Test - bulking of sand.

Bitumen & Bituminous Mixes (8 Hours)

Penetration Test -Ductility Test- Elastic recovery- Softening point test - Viscosity test - Marshall Mix Design- Binder content determination.

Soil (6 Hours)

CBR Test, Cone penetration test.

Traffic studies (8 Hours)

Traffic volume, speed, parking

Projects

- Analysis of Traffic Volume and Speed Characteristics in Urban Arterials.
- Study on Peak Hour Traffic Flow and Intersection Delay Patterns.
- Impact of Vehicle Composition on Roadway Capacity and Service Level.
- Traffic Data Collection and Pattern Analysis Using Manual and Automatic Methods.
- Evaluation of Parking Demand and On-Street Parking Characteristics in CBD Areas.
- Characterization of Bituminous Mixes Using Marshall Stability and Flow Tests.
- Study on the Mechanical Properties of Quarry Dust Blended Concrete.
- Performance Evaluation of Subgrade Soils Using CBR and Proctor Tests.
- Assessment of Recycled Aggregates for Use in Base and Sub-base Layers.
- Durability and Strength Analysis of GGBS-Based Cementitious Composites.

Term Paper

Subject Name	Code	T-P-PR	(Credit)
Term Paper	CUTM2400	0-0-2	2

Interpret the literature to link the earlier research with the contemporary technologies as well as communicate effectively as an individual to present ideas clearly and coherently. This may enhance the quality of review the research findings and its correlation to the latest applications. After review, prepare the documents and present the concepts clearly and coherently in front of panel member which inculcate the spirit of enquiry for self-learning. For this subject, two stage of evaluation process will be. In first stage two times presentation of the review and at the end of presentation one report need to be submit (second stage).

Area of Study

- Cost-Benefit Analysis of Rural Highway Upgradation Projects in India.
- Application of Net Present Value (NPV) and Benefit-Cost Ratio in Highway Economic Evaluation.
- Environmental and Economic Assessment of Highway Expansion Using Life Cycle Costing.
- Role of Public-Private Partnerships (PPP) in Highway Infrastructure Development.
- Analysis of Road Crash Data for Identifying and Mitigating Black Spots.
- Impact of Road Geometry and Signage on Highway Safety: A Case Study Approach.
- Role of Road Safety Audits in Reducing Accident Rates on National Highways.
- Implementation of Intelligent Transport Systems for Urban Traffic Management.
- Use of Adaptive Traffic Signal Control Systems to Minimize Urban Congestion.
- Role of Vehicle-to-Infrastructure (V2I) Communication in Enhancing Road Safety.

Pavement Analysis and Design (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Pavement Analysis and Design	CUTM4447	2-0-1	3

Course Objectives:

- Understand the functions and classifications of pavements, alongside key variables influencing design like material properties and axle loads.
- Analyze stresses and strains in pavements using layer theories, considering factors such as wheel loads, temperature variations, and friction, with an introduction to the three-layer theory.
- Gain proficiency in the IRC design methodology for pavements, including the application of IRC: 37 (2018) and IRC: 58 (2011) guidelines for pavement design.

Course Outcomes:

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

- **CO1** Knowledge of the diverse functions and classifications of pavements through design, conduct experiments, analyze data and interpret data**.**
- **CO2** Skill to find material characteristics and axle loads to assess variables influencing pavement design**.**
- **CO3** Analyze stresses and strains in pavements using layer theories, and research-based knowledge and research methods including design of experiments by apply appropriate techniques.
- **CO4** Technical skill to utilize the IRC design methodology for pavements, including the application of IRC guidelines to demonstrate the knowledge and need for sustainable development**.**
- **CO5** Research proficiency in evaluating pavement surface conditions through solutions in societal and environmental contexts to engage in independent research and lifelong.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2													
CO2			3												
CO3				2	3										
CO4						3							3		
CO5							2					3			

***High-3, Medium-2, Low-1**

Module I

Introduction to Pavement Engineering (15 Hours

Functions of Pavements; Types of Pavements: Flexible, Rigid, Composite Pavements; Variables Considered in Pavement Design: Material Characteristics, Factors related to Axle and Wheel Loads, Concept of Equivalent Single Wheel Load (ESWL).

Module II

Stresses and Strains (15 Hours

Stresses and Strains: Stresses and Strains in Flexible Pavement using: Single layer and Double layer theory; Stresses and Strains in Rigid Pavement for: Wheel Load, Temperature and Friction. Intro to Three-layer theory.

Module III

Design of Components in Flexible and Rigid Pavement (15 Hours

Overview of IRC design method for Flexible Pavement and Rigid Pavement; Design of Flexible Pavement: Salient features of IRC: 37 (2018), Design of Flexible Pavement using IRC: 37 (2018) guidelines, Design of Rigid Pavement using IRC: 58 (2011) guidelines; Design of Joints in Rigid Pavements: Dowel Bars, Tie Bars.

Module IV

Evaluation of Surface Condition (15 Hours

Methods of measurement of skid resistance, unevenness, ruts and cracks. Pavement surface condition evaluation by physical measurements. Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design. Road Profiling Van. LIDAR survey.

Projects:

- Design and Comparative Analysis of Flexible and Rigid Pavements Using IRC Guidelines
- Evaluation of Pavement Layer Thickness Using CBR and Mechanistic Methods
- Influence of Subgrade Strength Variations on Pavement Performance
- Design of Low-Volume Rural Roads Using Locally Available Materials

- Fatigue and Rutting Performance Evaluation of Bituminous Pavement Layers
- Pavement Design Optimization Using Reclaimed Asphalt Pavement (RAP)
- Performance-Based Design of Bituminous Pavement Using Marshall and Superpave Methods
- Finite Element Modeling of Multi-Layer Pavement Structures Under Repeated Loading
- Analysis of Temperature and Moisture Effects on Pavement Performance
- Comparative Study of Conventional and Geosynthetic-Reinforced Pavement Design

Text Book(s)

1. Yoder, E. J., and Witczak, M. W., Principles of Pavement Design, 2nd Edition, John Willey and Sons, 1975.
2. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A., Highway Engineering, 10th Edition, Nem Chand Brothers publications, 2017.

Reference(s)

1. Huang, Y. H., Pavement Analysis and Design, Prentice Hall Publications, Englewood Cliffs, New Jersey.
2. IRC-37:2018, Guidelines for the Design of Flexible Pavements, Indian Roads Congress,
3. Das, A., and Chakraborty, P., Principles of Transportation Engineering, PHI Learning Pvt, Ltd., New Delhi, 2017,

Highway Project Formulation and Economics (45 Hours)

Subject Name	Code	T-P-PR	(Credit)
Highway Project Formulation and Economics:	CUTM4448	3-0-0	3

Course Objectives:

- Understand the requirements and components involved in project formulation, including criteria fixation, non-monetary and monetary considerations, and decision-making criteria.
- Learn the guidelines for preparing Detailed Project Reports (DPRs), encompassing cash flow diagrams, cost-benefit analysis, discounting criteria, and highway planning principles.
- Evaluate transportation plans economically, considering principles such as welfare economics, social costs, and various evaluation methods.

Course Outcomes:

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

- **CO1:** Knowledge in understanding and implementing requirements for project formulation, including criteria fixation and identification of project components**.**
- **CO2:** Analyze the non-monetary and monetary criteria effectively in project formulation and management considering decision-making inputs crucial for project success**.**
- **CO3:** Utilize guidelines for preparing detailed project reports encompassing environmental contexts and commit to professional ethics and responsibilities**.**
- **CO4:** Design transportation plans economically and applying principles of welfare economics using modern engineering and tools**.**
- **CO5:** Evaluate the environmental impacts of transportation projects comprehensively, conducting research considering health, safety, legal and cultural issues**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3									2				
CO3				1			2	1						1	
CO4					2										
CO5						3		1							

***High-3, Medium-2, Low-1**

Module I

Project Formulation (10 Hours)

Requirements in project formulation, Criteria fixation, Components of project, non-monetary and monetary Criteria in formulation of project, Decision making Criteria input in Project formulation. Preparation of DPR –Guidelines

Module II

Transport Projects Formulation and Economic Evaluation (10 Hours)

Development of cash flow diagrams, Cost and benefit components, Discounting criteria, Preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development. Economic evaluation of Transportation plans; Need for Economic Evaluation; Principles of economic evaluation; Welfare economics; Social costs, Vest change, Rate of return.

Module III

Basic methods of economic analysis and Project Appraisal (15 Hours)

Equivalent Uniform Annual Cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net present value method; Benefit cost ratio method; Rate of Return Method. Applications of these methods to highway projects.

Module IV

Environmental Impact Assessment (10 Hours)

Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety and Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies.

Text Books

1. Economic Analysis for Highways - Winfrey.R; International Text Book Company.
2. Traffic Engineering and Transport Planning - L.R Kadiyali, Khanna Publishers.

Reference Books

1. Road User Cost Study, CRRI
2. Road Project Appraisal, for Developing Countries, J.W.Dickey ,John Wiley & Sons.
3. a). Chisty Fundamental of T.P. Engineering, by C.J. Chisty.
   b). Transportation Engineering & Planning by C.S. Papacostas.

Traffic Safety (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Traffic Safety	CUTM4449	2-0-1	3

Course Objectives:

- Understand road accident trends, causes, and factors including human and vehicle elements, and differentiate between crashes and accidents.
- Learn strategies for road safety improvement, including crash analysis methods, black spot identification, and GIS applications.
- Identify key elements of road safety audits, investigate crash locations, and implement accident prevention measures through planning, design, and operational strategies.

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

- **CO1:** Comprehensive knowledge on understanding of road accidents, their trends, causes, and contributing factors, including human and vehicle-related aspects**.**
- **CO2:** Acquire proficiency in analysing collision and condition diagrams for analysing road accidents and implementing effective highway safety measures**.**
- **CO3:** Apply problem solving skill with advanced statistical methods and before-after crash analysis techniques using modern tools**.**
- **CO4:** Hands on in road safety audits and investigations, employing methods for crash analysis and hazardous road location identification**.**
- **CO5:** Implement accident prevention strategies through independent research to improved traffic safety measures during highway construction and maintenance**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		2	3												
CO3				1	3										
CO4						2									
CO5												3			1

***High-3, Medium-2, Low-1**

Module I

Road Safety Management **(15 Hours)**

Road accidents, Trends, causes, Collision and Condition diagrams, Highway safety, human factors, Vehicle factors, crash vs accident, road safety improvement strategies, elements of a road safety plan, Safety data needs.

Module II

Statistical Analysis of Crash Data **(15 Hours)**

Before -after methods in crash analysis, advanced statistical methods, Black Spot Identification & Investigations – spot map method, accident frequency method, accident rate method, GIS application in black spot studies, Cause of accident.

Module III

Road Safety Audits **(15 Hours)**

Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, methods for identifying hazardous road locations.

Module IV

Mitigation Measures **(15 Hours)**

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

Projects

- Identification and Mitigation of Accident-Prone Black Spots Using Road Safety Audit (RSA).
- Comprehensive Road Safety Audit of an Urban Arterial Corridor.
- Impact of Road Geometry on Crash Severity: An RSA-Based Approach.
- Evaluation of Pedestrian Safety Using RSA Near School and Hospital Zones.
- Effectiveness of Traffic Calming Measures in Accident Reduction: A Road Safety Audit Study.

- Crash Data Analysis and Prioritization of Countermeasures Using GIS and RSA Techniques.
- Role of Road Safety Audit in Enhancing Safety at Intersections.
- Assessment of Human and Vehicle Factors in Road Accidents and RSA Recommendations.
- Comparative Study of Safety Performance: Signalized Intersections vs. Roundabouts Using RSA.
- Integration of Road Safety Audit in Highway Planning and Design Stages.

Textbook(s)

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002). 2. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.

3. Leonard Evans, Traffic Safety, Science Serving Society, 2004.

4. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.

Reference(s)

1. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.

2. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997

3. Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.

4. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.

5. Towards Safe Roads in Developing country, TRL – ODA, 2004

Research Methodology and IPR (60 Hrs)

Subject Name	Code	T-P-PR	(Credit)
Research Methodology & IPR	CUTM2378	2-0-2	4

Course Objective

- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.

Course outcome At the end of the program, students will be able to;

- **CO1** Understand the principles of research design and data collection methods as well as the legal framework of intellectual property rights**.**
- **CO2** Develop research proposals and formulate research questions**.**
- **CO3** Identify different types of intellectual property such as patents, trademarks, copyrights, and trade secrets.
- **CO4** Develop the ability to critically evaluate research studies with appropriate techniques, resources which will lead to evaluate the strengths and limitations of different types of intellectual property protection.
- **CO5** Develop the ability to critically evaluate research studies with appropriate techniques, resources which will lead to evaluate the strengths and limitations of different types of intellectual property protection.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3												
CO2				3		2									
CO3		2		3											
CO4					2										
CO5							2	3							

***High-3, Medium-2, Low-1**

Module I

Elementary Research Methodology **(15 Hours)**

Research Concept, Objective, characteristics, Steps and Significance of Research, Arbitrary and Scientific Research, Research approaches. Types of research: Historical, Descriptive, Analytical, Case Study, Quantitative vs. qualitative, Conceptual, Empirical Action Research, Research Methods vs Methodology. Research Problems: Selection and definition of the research problems, formulating a research problem, identifying variables and Constructing hypothesis; Choosing a mentor, lab and research question; maintaining a lab notebook; Selection of problems - stages in the execution of research.

Module II

Academic Writing and Presentation **(15 Hours)**

Technical writing skills - types of reports; layout of a formal report; standard of Journal (Impact Factor, Citation Index), Scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Module III

Scientific Communication Skills **(15 Hours)**

Concept of effective communication- setting clear goals for communication; determining outcomes and results; barriers to effective communication; non-verbal communication- importance of body language, power of effective listening; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search.

Module IV

Introduction to IPR **(15 Hours)**

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related

rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; IP as a factor in R& D; IPs of relevance to biotechnology and few case studies; plant variety protection and farmers rights.

Module V

Types of Patents **(15 Hours)**

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; filing of a patent application; role of a Country Patent Office; precautions before patenting-disclosure/non-disclosure – patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications.

Projects

1. Write a review article and submit to a journal
2. Write a book chapter/ book for publishing
3. Write an original article for a journal

Text Books

1. Geoffrey Marczyk, David DeMatteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.
2. Carol Ellison (2010) McGraw-Hill's ConcisevGuide to WritingvResearch Papers, McGraw-Hill
3. Kothari CR (2016) Research Methodology: Methods and Techniques, New Age Pvt Ltd
4. Ganbawale RM, (2017) Bioststistics and Research Methodology, New Central Book Agency

Reference books:

1. Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess Ess Publications. 2 volumes.
2. Trochim, W.M.K., (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
3. Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
4. Neuman, W.L. (2008). Social research methods: Qualitative and quantitative approaches, Pearson Education

Practice on Application of Numerical Analysis (45 Hours)

Subject Name	Code	T-P-PR	(Credit)
Practice on Application of Numerical Analysis	CUTM2403	0-0-3	3

Course Objectives:

- To learn the stress strain analysis of flexible and rigid pavements through software.
- To gain knowledge on application of GIS in transportation engineering.
- To understand the statistical distributions process and its application in traffic engineering.

Course Outcomes:

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

- **CO1** Gain knowledge on application of GIS for transportation engineering
- **CO2** Analyze and design the problems on stress strain function of flexible pavements
- **CO3** Solve the problems on stress strain analysis of rigid pavements by conducting design of experiments
- **CO4** Relate statistical IT tools for process and its application in traffic engineering
- **CO5** Implement research on highway construction and maintenance with advance materials and softwires.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	2												
CO3				3											
CO4					3										
CO5	2			2								3		2	

***High-3, Medium-2, Low-1**

Flexible pavement: (20 Hours)

1. IITPAVE: Stress strain analysis and pavement thickness
2. IITKGPBACK: Elastic modulus and overlay design
3. KENPAVE: Stress strain analysis

Rigid pavement: (20 Hours)

1. Design of rigid pavement – IRC 58 [2015]

Remote Sensing and GIS: (25 Hours)

1. Geo-referencing
2. Digitization
3. Spatial interpolation
4. Digital elevation model preparation

Statistical Techniques: (20 Hours

1. Random numbers generation
2. Chi-square test
3. Regression analysis
4. Analysis of variance [ANOVA]
5. Introduction to WEKA tool

Projects

- Statistical Modeling of Fatigue and Rutting Behavior in Flexible Pavement Layers
- Regression Analysis of Rigid Pavement Performance Based on Field Distress Data
- Pavement Deterioration Prediction Using Machine Learning and Statistical Tools
- Analysis of CBR and Modulus Correlations for Pavement Design Using ANOVA and Regression
- Reliability-Based Pavement Design for Varying Traffic and Subgrade Conditions
- Remote Sensing-Based Land Use Classification for Highway Corridor Planning
- GIS-Based Identification of Accident Black Spots and Prioritization of Safety Measures
- Assessment of Pavement Condition Using High-Resolution Satellite Imagery and GIS Mapping
- Spatial Analysis of Traffic Congestion and Road Network Performance Using GIS Tools
- Integration of Remote Sensing and GIS for Sustainable Road Alignment Optimization

Remote Sensing and GIS for Transportation Engineering (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Remote Sensing and GIS for Transportation Engineering	CUTM2447	2-0-1	3

Course Objectives:

- To learn the basics and characteristics of remote sensing.
- To learn pre-processing and information extraction techniques of remotely sensed data.
- To learn basics and application of GPS in transportation engineering.

Course Outcomes:

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

- **CO1** Interpret various knowledge on remotely sensed images with the help of acquired knowledge in remote sensing technology**.**
- **CO2** Able to develop skill on the GPS instrument in field for various applications identify data interpretation**.**
- **CO3** Build knowledge on global positioning system and able to solve problem of manual information collection problems focusing to engineer health and safety.
- **CO4** Extend knowledge on use of modern tool usage to intelligent transportation systems in electronics engineering practice**.**
- **CO5** Implement research on application of GIS in highway construction**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			3	1											
CO4					3	2									
CO5	2			2										2	

***High-3, Medium-2, Low-1**

Module I

Basic in Remote Sensing **(15 Hours)**

Basic Principles – Introduction, Electromagnetic waves and its properties, interaction with Earth surface materials, recent developments in Remote sensing, Social and legal implications of Remote Sensing, status of Remote Sensing. Characteristics of imaging remote sensing instruments, satellite remote sensing system – a brief over view, other remote sensing satellites.

Module II

Pre-Processing of Remotely Sensed Data **(15 Hours)**

Introduction, cosmetic operation; Geometric connection and registration, atmospheric correction. Image Transforms: Introduction, arithmetic operations, empirically based image transforms, Principal component analysis, multiple discriminant analysis etc.

Module III

Enhancement Technique and Filtering Techniques **(15 Hours)**

Introduction, human visual system, contrast enhancement; Pseudo colour enhancement. Thematic information extraction, classification and accuracy assessment and change detection. Hyper spectral and radar sensors Filtering Technique Classification Low-pass (smoothing filters) High pass (sharpening) filters, edge detection, frequency domain filters, geometrical basis, classification, unsupervised and supervised classification, classification accuracy. Rectification of digital land satellite imagery. Image enhancement, spectral and spatial filtering.

Module IV

Global Positioning Systems **(15 Hours)**

Introduction, Elements of satellite surveying, global positioning system, GPS satellites, Adjustment computations, GPS observables, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS .

Applications of Remote sensing and GPS in Transportation Engineering: Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning

Text book:

1. GPS Satellite Surveys, Alfred Leick, Willey & Sons

Reference books:

1. Principles of Remote Sensing, Paul Jumani, ELBS, 1985.
2. Computer processing of remotely sensed Images an Introduction – Paul M.Mather, John Wiley.

Pavement Construction Management and Maintenance (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Pavement Construction Management and Maintenance	CUTM2448	2-1-0	3

Course Objectives:

- To learn the fundamental issues in pavement management system.
- To understand the strategies and economic evaluation on pavement maintenance.
- To learn the expert systems in project appraisal and its elements in pavement management systems.

Course Outcomes:

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

- **CO1** Extend knowledge on fundamental issues in pavement management system**.**
- **CO2** Dissect skill in design strategies and economic evaluation on pavement maintenance problem analysis**.**
- **CO3** Make use of expert systems in pavement management systems and decision making by synthesis of the available information through prediction and modeling.
- **CO4** Develop the technical skill on project appraisal and its elements assess to societal and environmental contexts.
- **CO5** Extend future research and special pavement projects for real-time traffic problems and safety context**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	1												
CO3				2	1										
CO4						2	1								
CO5						2		1					1		

***High-3, Medium-2, Low-1**

Module I

Pavement management system: An Introduction (15 Hours)

Pavement management system Components of PMS and their activities; Major steps in implementing PMS; Inputs; Design, Construction and Maintenance; Rehabilitation and Feedback systems; Examples of HDM and RTIM packages; Highway financing; Fund generation; Evaluating alternate strategies and Decision criteria ; Pavement Maintenance Management Components of Maintenance Management and Related Activities – Network and Project Level Analysis; Prioritization Techniques and Formulation of Maintenance Strategies

Practice

Development of a Pavement Management System (PMS) using HDM-4 Software

Prioritization of Road Maintenance using Multi-Criteria Decision Analysis (MCDA)

Evaluation of Maintenance Strategies using Life Cycle Cost Analysis (LCCA)

Module II

Pavement Inventories and Evaluation (15 Hours)

Pavement Inventories and Evaluation Serviceability Concepts ;Visual Rating ;Pavement Serviceability Index; Roughness Measurements ;Distress Modes – Cracking Rutting Etc; Pavement Deflection – Different Methods, Skid Resistance, Roughness, Safety – Aspects; Inventory System – Assessment of Deficiencies

Practice

Visual Condition Survey and Rating of Flexible Pavement (using PCI or PSI methods)

Pavement Roughness Measurement using Bump Integrator or Smartphone App (IRI estimation)

Structural Evaluation of Pavement using Benkelman Beam or Falling Weight Deflectometer (FWD)

Module-III

Construction and Management of Pavement (15 Hours)

Construction of Base, Subbase, Shoulders and Drain Roadway and Drain Excavation, Excavation and Blasting, Embankment Construction, Construction of Gravel Base, Cement Stabilised Sub-Bases, WBM Bases, Wet Mix Construction; Crushed Cement Bases, Shoulder Construction; Drainage Surface, Turfing Sand Drains; Sand Wicks; Rope Drains, Geo Textile Drainage; Preloading Techniques.

Practice

Field Compaction Quality Control for Subbase and Base Layers using Sand Cone

Demonstration of Subsurface Drainage System Using Geotextile

Module-IV

Maintenance of Pavement **(15 Hours)**

Bituminous Pavement Construction and Cement Concrete pavement construction: Preparation and Laying of Tack Coat; Bituminous Macadam ,Penetration Macadam, Built up Spray Grout, Open Graded Premix, Mix Seal, Semi-Dense Asphalt Concrete- Interface Treatments and Overlay Construction, IRC Specifications, Introducing Mechanical Mixers, Pavers, Finishers ; Cement Concrete Pavement Analysis - Construction of Cement Roads, Manual and Mechanical Methods, Joints in Concrete and Reinforced Concrete Pavement and Overlay Construction –Related Equipment

Practice

Marshall Stability Test on Bituminous Mix with Reclaimed Asphalt Pavement (RAP)

Joint Sealing and Crack Repair Demonstration on Concrete Pavement Models

Text Books:

1. Haas and Hudson , W. R. Pavement management systems –McGraw Hill publications
2. Sargious, M. A. – Pavements and surfacing for highways and airports – Applied Science Publishers ltd

References:

1. Bridge and Pavement maintenance- Transportation Research Record no.800, TRB
2. Shahin M.Y, 1994- Pavement management for airports, roads and parking lots
3. Bent Thagesan, 1996- Highway and Traffic engineering for developing country

Intelligent Transport System (45 Hours)

Subject Name	Code	T-P-PR	(Credit)
Intelligent Transport System	CUTM4450	3-0-0	3

Course Objectives:

- To understand ITS user services and its application in road user safety.
- To understand the interpret importance of AHS in ITS.
- To learn ITS applications and role of sensors in ITS.

Course Outcomes:

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

- **CO1** Knowledge to differentiate the ITS user services and its application in road user safety.
- **CO2** Able to analyze the interpret importance of AHS in ITS through electronics engineering problems to design**.**
- **CO3** Gain knowledge and research methods on solving traffic problems using ITS applications
- **CO4** Understand the role of modern tools like sensors in ITS relevant to electronics engineering practice.
- **CO5** Extend future research and special projects on ITS for real-time traffic problems and safety context**.**

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		2	1												
CO3				3											
CO4					2										
CO5						2							2		

***High-3, Medium-2, Low-1**

Module I

Fundamentals of ITS **(10 Hours)**

Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS.

Module II

Sensor Technologies and Data Requirements of ITS **(15 Hours)**

Importance of telecommunications in the ITS. Information Management, Traffic Management Centers (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI).

Module III

ITS User Needs and Services **(10 Hours)**

Functional areas – Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveller Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS).

Module IV

ITS Applications **(10 Hours)**

Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions - Vehicles in Platoons – Integration of Automated Highway Systems, ITS Programs in the World – Overview of ITS implementations in developed countries.

Textbook(s)

1. Ghosh, S., and Lee, T. S., Intelligent Transportation Systems: New Principles and Architectures, CRC Press, Washington D.C., 2000.

2. Chowdhury, M. A., and Sadek, A. W., Fundamentals of Intelligent Transportation Systems Planning, Artech House Inc., Norwood, MA, 2003.
3. Roess, R. P., Prassas, E. S., and McShane, W. R., Traffic Engineering, 4th Edition, Pearson Higher Education Inc., New Jersey, 2011.

Reference(s)

1. Sussman, J.M., Perspectives on Intelligent Transportation Systems, Springer, Berlin, 2010.
2. Perallos, A., hernndex-Jayo, U, Onieva, E., and Garcia-Zuazola, I., Intelligent Transport Systems: Technologies and Applications, John Wiley & Sons Ltd., West Sussex, United Kingdom, 2016.

Environmental Impact Assessment for Transportation Projects (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Environmental Impact Assessment for Transportation Projects	CUTM2449	2-1-0	3

Course Objectives:

- To understand the sources of pollution and control methods in transportation.
- To learn different steps within environmental impact assessment.
- To learn the key aspects of environmental impact assessment and different case studies.

Course Outcomes:

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

- **CO1:** Knowledge to identify the sources for pollution and control methods in transportation.
- **CO2:** Analyze the different steps within environmental impact assessment through review the literatures**.**
- **CO3 :** Compare both orally and written form the key aspects of environmental impact assessment and can develop the decision-making skill by synthesis of the information to provide valid conclusions in electronics engineering
- **CO4 :** Develop technical skills on different case studies/examples of EIA in practice assess to societal and environmental contexts**.**
- **CO5 :** Extend future research and special projects on EIA for real-time environment problems in transport development.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		2	1												
CO3				3											
CO4						3	2								
CO5							2							3	

***High-3, Medium-2, Low-1**

Module-I:

Introduction **(15 Hours)**

Environment and its interaction with human activities – Environmental imbalances - Attributes, Impacts, Indicators and Measurements - Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA

Practice

Assessment of Air Quality Index (AQI) in a Selected Urban Area

Measurement of Noise Pollution Levels and Mapping using GIS

Evaluation of Environmental Parameters of a Local Ecosystem (water, soil, and air sampling)

Module II

Environmental Indicators **(15 Hours)**

Indicators for climate - Indicators for terrestrial subsystems- Indicators for aquatic subsystems Selection of indicators - Socio-economic indicators- Basic information - Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

Practice

Analysis of Climatic Indicators Using Meteorological Data (Temperature, Rainfall Trends)

Study of Soil and Water Quality Indicators in Different Land Use Zones

Socio-Economic Indicator Survey and Statistical Analysis

Module III

Environmental Impact Assessment for Transportation Projects **(15 Hours)**

Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety &Capacity Impacts– Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies.

Practice

Field Study on Vehicular Emission Impacts on Nearby Land Use and Public Health

Traffic Congestion Mapping and Safety Impact Assessment using Real-Time Data

Case Study Analysis of a Highway/Road Project with EIA Components

Module IV

Methodologies for Carrying Environmental Impact Assessment **(15 Hours)**

Overview of Methodologies Adhoc, Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria.

Practice

Comparative Study of EIA Methods: Checklist vs. Matrix for a Proposed Construction Project

Simulation of Environmental Impacts Using Network or Overlay Techniques in GIS

Cost-Benefit Analysis of a Transportation Project Incorporating Environmental Parameters

Text Books:

1. Jain, R.K., Urban, L.V., Stracy, G.S., (1991), "Environmental Impact Analysis", Van Nostrand Reinhold Co., New York
2. Rau, J.G. and Wooten, D.C., (1996), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York

References:

1. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris
2. Canter, L.W., (1997), "Environmental Impact Assessment", McGraw Hill Pub. Co.

Pavement Soil Advancement Techniques (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Pavement Soil Advancement Techniques	CUTM2405	2-1-0	3

Course Objectives:

- Understand the need and objectives of soil improvement techniques, assessing their suitability and feasibility for different applications.
- Gain insight into emerging trends in soil improvement methods, including mechanical modification, compaction principles, and compaction control measures.
- Explore various soil stabilization techniques using admixtures like cement, lime, and fly ash, alongside grouting methods and dewatering techniques for open sumps and ditches.

Course Outcomes:

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

- **CO1** Build knowledge on importance and application of Gabion walls and crib walls**.**
- **CO2** Able to apply analytical skill on problems of ground improvement to a given site condition and the environmental considerations**.**
- **CO3** Able to take the right decision and technique to improve different difficult grounds through research-based knowledge and research methods**.**
- **CO4** Able to design and develop the best suitable ground modification technique for different grounds based on societal and environmental contexts.
- **CO5** Gain proficiency in utilizing different types of geotextiles, waste materials, along with their functions, applications, and properties in soil improvement projects through research.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		2	1												
CO3				3											
CO4						3	2								
CO5												3		3	

***High-3, Medium-2, Low-1**

Module I

Introduction to Soil Modification (15 Hours)

Need and objectives of Soil Improvement, Classification of Soil improvement Techniques-suitability and feasibility, Emerging Trends in soil improvement. Mechanical Modification; Principles and methods of soil compaction, Compaction control, Compaction piles, dynamic compaction, controlled blasting for compaction.

Practice

Standard and Modified Proctor Compaction Tests with Varying Energy Levels

Model Study of Dynamic Compaction Using Drop Hammer Setup

Controlled Blasting Simulation on Granular Beds

Module II

Physical, Chemical Modification and Grouting (15 Hours)

Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Grout materials, Grouting techniques and control.

Practice

Unconfined Compressive Strength Test on Chemically Stabilized Soil

Permeability and Strength Test of Soil after Pressure Grouting

Laboratory-Scale Jet Grouting on Soft Soil

Module III

Hydraulic Modification and Geo-textiles (15 Hours)

Methods of dewatering open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering; Pre-loading without and with sand drains, strip drains and rope drains. Types of Geo-textiles, Woven and non-woven fabrics, Geo-membranes, Geo grids, Geo-composites, Geo-nets, Functions and applications, Properties of geo-textiles.

Practice

Electro-Osmosis Setup for Clayey Soil Dewatering

Preloading with and without Vertical Drains in Consolidation Cell

Tensile Strength and Filtration Tests on Various Geo-textiles

Module IV

Reinforced Earth and In-Situ Soil Treatment for Slopes (15 Hours)

Concept of soil reinforcement, reinforcing materials, Backfill criteria, Design and construction

of reinforced earth structures. Soil nailing, Rock anchoring, Micro-piles, design methods, construction techniques; Gabion walls, Soil Nailing-Rock anchoring, Crib wall.

Practice

Model Testing of Reinforced Earth Retaining Wall in a Geotechnical Box

Pullout Resistance Test of Reinforcement Elements in Sand

Miniature Soil Nailing and Shotcrete Simulation on Sloped Soil Bed

Text Book(s)

1. Hansmann, M. R., Engineering principles of ground modification, McGraw-Hill Publications, New York, 1990.
2. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Limited, New Delhi, 2005.

Reference(s)

1. Koerner, R. M., Construction and Geotechnical methods in Foundation Engineering, McGraw-Hill Publications, New York, 1984.
2. Fang, H., Foundation Engineering Hand Book, 2nd Edition, Van Nostrand Reinhold Co., New York, 1991.