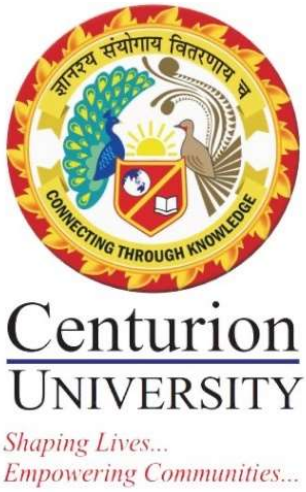
Centurion University of Technology and Management Odisha

M. Tech in Transportation Engineering

(Two years Programme)



School of Engineering & Technology

Centurion University of Technology and Management, Odisha

2022

Centurion UNIVERSITY
Shaping Lives...
Empowering Communities...

Index

Programme Objectives; Job/Higher studies/Entrepreneurship

POs: Engineering Graduates 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: To provide fundamental and advanced knowledge and expertise in order to produce competent, creative and imaginative engineers with a strong scientific acumen.

PEO2: To familiarise the recent advancements in the field of Sustainable Urban Development, Traffic Engineering and Management, Systems Dynamics Approach to Transport Planning, Highway Design and Construction, Economic and Environment Evaluation of Transport Projects.

Programme Specific Outcome s(PSOs):

PSO1: Able to recognize, devise and solve intricate transportation problems and research need.

PSO2: Able to plan, design and implement safe, efficient, cost effective, sustainable transportation projects to meet societal and environmental needs.

PSO3: Able to intend and conduct multifarious transportation engineering experiments, surveys as well as to analyze and interpret the experimental/collected data.

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
CO6	Environment and Sustainability
CO7	Ethics & Team work
CO8	Soft skill

Transportation Engineering

Programme Objectives

- To provide fundamental and advanced knowledge and expertise in order to produce competent, creative and imaginative engineers with a strong scientific acumen.
- To introduce the recent advancements in the field of Sustainable Urban Development, Traffic Engineering and Management, Systems Dynamics Approach to Transport Planning, Highway Design and Construction, Economic and Environment Evaluation of Transport Projects.

Eligibility Criteria

Bachelor's degree in Engineering / Technology or equivalent degree in Civil Engineering with minimum CGPA of 6.5 or 60% of marks or First Class in the qualifying degree.

Selection Process

The selection processes is through central counseling on the basis of merit in qualifying CUEE or PGAT or GATE score. GATE qualified candidates are eligible for scholarship through AICTE.

Award of degree

After successful completion of degree, student will be awarded with Master of Technology in Transportation Engineering by Centurion University.

Course Structure

This is a 2-year full-time post graduate program which involves first year (Semester- I & II) of intense coursework and second year (Semester- III & IV) Internship and project at construction companies or Consultancy firm for hands on experience.

Total Credit: 74

Domain Focus: Transportation Engineering

Course Structure

(1st Semester)

Sl No	Code	Subject name	T	P	Pr.	Credits
		Theory Courses				
1	CUTM2444	Traffic Engineering and Management	2	1	0	3
2	CUTM2397	Road Materials and Characterization	2	1	0	3
3	CUTM2398	Urban Transportation Planning	2	1	0	3
4	CUTM2445	Transportation Infrastructure Design	2	1	0	3
5		Elective-1				3
		Practice				
6	CUTM2399	Traffic and Material Characterizations Lab for Road			2	2
7	CUTM2400	Term Paper				2
		TOTAL				**19**

(2nd Semester)

Sl No	Code	Subject name	T	P	Pr.	Credits
		Theory Courses				
1	CUTM2401	Pavement Analysis and Design	2	1		3
2	CUTM2446	Highway Project formulation and Economics	2	1		3
3	CUTM2402	Traffic Safety	2	1		3
4	CUTM2378	Research Methodology & IPR	2		2	4
5		Elective-2				3
		Practice				
6	CUTM2403	Practice on Application of Numerical Analysis			3	3
		TOTAL				**19**

(3rd Semester)

Sl. No	Code	Subject Name	T	P	Pr	Credits
1	CUTM2391	Industry Internship Project			18	18
		TOTAL				**18**

(4th Semester)

Sl No	Code	Subject Name	T	P	Pr.	Credits
1	CUTM2392	Project			18	18
		TOTAL				**18**

Electives

Sl No.	Code	Electives (1 & 2 , choose any two)	T	P	Pr.	Credits
1	CUTM2447	Remote Sensing and GIS for Transportation Engineering	2	0	1	3
2	CUTM2448	Pavement Evaluation, Rehabilitation and Maintenance	2	1	0	3
3	CUTM2404	Intelligent Transport System	2	1	0	3
4	CUTM2449	Environmental Impact Assessment for Transportation Projects	2	1	0	3
5	CUTM2405	Pavement Soil Advancement Techniques	2	1	0	3

Traffic Engineering and Management

Subject Name	Code	T-P-PR	(Credit)
Traffic Engineering and Management	CUTM2444	2-1-0	3

Course Objectives:

- To learn traffic studies, their analysis and their interpretation.
- To learn analysis of LOS.
- To learn design of signal.
- To learn transportation system management.

Course Outcomes:

Cos	Course Outcomes	POs
CO1	Develop a basic Knowledge of the fundamental and complex issues in traffic engineering.	**PO1 (3), PO4 (1)**
CO2	Conclude the analysis of traffic flow and queuing theory.	**PO2 (3)**
CO3	Solve the critical problems for highway capacity and level of service designs with safety.	**PO3 (3), PO6 (2)**
CO3	Develop the knowledge on traffic signal theory and elements of traffic signal operations using tools.	**PO5 (3)**

Module I

Introduction to Traffic Engineering (10+2 Hours)

Basic characteristics of Traffic, Volume, Speed and Density; Definitions and their interrelationships; Traffic Volume studies - Objectives, Methods of Volume counts, Presentation of Volume Data; Speed studies- Types of Speeds, Objectives, Methods of speed studies, Statistical Methods for speed data Analysis, Presentation of speed data. Delay Studies; Head ways and Gap Studies - Headway and Gap acceptance, Origin and Destination Studies.

Module II

Parking and Accidental Study (8+1 Hours)

Parameters of parking, definitions, Parking inventory study, Parking survey by Patrolling method; Analysis of Parking Survey data; Accident studies- Causative factors of Road accidents, Accident data collection: Accident analysis and modelling; Road Safety Auditing, Measures to increase Road safety.

Module III

Signal Study and Design (10+2 Hours)

Fixed Time signals, Determination of Optimum Cycle length and Signal setting for Fixed Time signals, Warrants for Signals, Time Plan Design for Pre-Timed Control- Lane group analysis, Saturation flow rate, and Adjustment factors, Uniform and Incremental Delay, Vehicle Actuated Signals, Signal Coordination.

Module IV

LOS and Transportation System Management (10+2 Hours)

Introduction to Traffic capacity Analysis, Concepts of Level of Service, Basic definitions, Factors affecting Capacity and LOS, Capacity of Urban/Rural Highway, With or without access control, Basic freeway segments - Service flow rate of LOS, Lane width or Lateral clearance adjustment; Heavy vehicle adjustment; Driver population adjustment.

Transportation System Management - Measures for Improving vehicular flow – one way Streets, Signal Improvement, Transit Stop Relocation, Parking Management, Reversible lanes- Reducing Peak Period Traffic - Strategies for working hours, Congestion Pricing, Differential Toll Policies.

Text Books:

1. Transportation Engineering - An Introduction - C.Jotin Khisty, Prentice Hall Publication
2. Traffic Engineering and Transportation Planning – L.R. Kadiyali, Khanna Publishers

Reference Books:

1. Traffic Engineering - Theory & Practice - Louis J.Pignataro, Prentice Hall Publication.
2. Traffic Engineering by Roger P.Roess, William R. Mc. Shane, Elena S.Prassas, PrenticeHall, 1977.

Road Materials and Characterization

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

Course Outcomes:

COs	Course Outcomes	POs
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	**PO1 (3), PO7 (2)**
CO2	Demonstrate the utility of various bitumen products through analysis and design.	**PO2 (2), PO3 (3)**
CO3	Prioritize the sequential stages involved in the problem solving of flexible and rigid pavements	**PO4 (3)**
CO4	Test the quality of pavement layers in flexible and rigid pavements using modern tools.	**PO5 (3)**

Module I

Subgrade Soil Characterization **(7+2 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

Module II

Aggregate Characterization (10+2 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.

Module III

Bitumen & Bituminous Concrete Mixes (10+2 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.

Module IV

Cement and Concrete Mixes (10+2 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.

Text Book(s)

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

Reference(s)

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

Urban Transportation Planning

Subject Name	Code	T-P-PR	(Credit)
Urban Transportation Planning	CUTM2398	2-1-0	3

Course Objectives:

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

Course Outcomes:

COs	Course Outcomes	POs
CO1	Develop a basic knowledge of the fundamental in urban transportation systems.	**PO1 (3)**
CO2	Develop analysis skill on identify the study zone based on real problem case study and develop its solution.	**PO2 (3), PO3 (1)**
CO3	Able to define the critical problem-solving procedures for demand estimation and level of service analysis using available resources and investigations.	**PO4 (3), PO5 (2)**
CO4	Understand the supply demand planning and elements of traffic operations with safety and societal contexts.	**PO6 (3), PO7 (1)**

Module I

Introduction to UTP (10+2 Hours)

Introduction: Role of transportation in the economic development of nations, overview of transport modes, growth trends, National Transport Policy of India – Case studies, transportation planning in the developing world; and comparative international transportation policies; Fundamentals of transportation, Principles of planning, evaluation, selection, adoption, financing, and implementation of alternative urban transportation systems; formulation of community goals and

objectives, inventory of existing conditions; transportation modelling trip generation, distribution, modal choice, route assignment

Module-II

Data Collection and Inventories (7+2 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

Issues in Travel Demand (10+2 Hours)

Trends, Overall Planning process, Long term Vs Short term planning, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Detailed approach on 4 step travel demand estimation; Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques.

Module-IV

Demand and Supply Planning (10+2 Hours)

Planning for sustainable urban mobility, positive and negative externalities in urban transport, congestion pricing, parking policy, demand management , Urban travel and transportation system characteristics - a systems perspective, Data management and use in decision making , Demand analysis , Urban activity analysis, Supply analysis; Plan Preparation And Evaluation: Travel Forecasts to Evaluate Alternative Improvements, Impacts of New Development on Transportation Facilities.

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

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 Alignment of Roads
- To learn Geometric Design of Vertical Alignment of Roads.
- To learn transportation system management

Course Outcomes:

COs	Course Outcomes	POs
CO1	Able to get basic knowledge to fundamentals to design various elements of highway.	**PO1 (3), PO3 (2)**
CO2	Build knowledge on problems and its analysis of the intersection elements through interpretation of case study.	**PO2 (3), PO4 (1)**
CO3	Develop the skill to design the interchanges, and parking facilities using available tools.	**PO5 (3)**
CO4	Able to design and develop the facilities for bicyclists and pedestrians with environment and society friendly.	**PO6 (1) PO7 (2)**

Module I

Basic in Transportation Infrastructure Design (8+2 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.

Module II

Parameters in Transportation Infrastructure Design (9+2 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.

Module III

Alignment Design of Transportation Infrastructure (10+2 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

Module IV

Design of Intersections (10+2 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.

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

Subject Name	Code	T-P-PR	(Credit)
Traffic and Material Characterizations Lab for Road	CUTM2399	0-0-2	2

Course Objectives:

- To learn the various quality tests road construction aggregates.
- To understand various tests on 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:

COs	Course Outcomes	POs
CO1	Understand the various fundamentals on quality control tests done on aggregates.	**PO1 (3)**
CO2	Understand various aging tests skills on bitumen for performance of binder through conducting experiments.	**PO2 (3)**
CO3	Understand the various problem analysis and design on soil through field investigations.	**PO3 (3)** **PO4 (2)**
CO4	Knowledge on use of modern tools/ hands-on training to do traffic studies.	**PO5 (3)**

Aggregates

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

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

Soil: CBR Test, Cone penetration test.

Traffic studies

Traffic volume, speed, parking

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).

Pavement Analysis and Design

Subject Name	Code	T-P-PR	(Credit)
Pavement Analysis and Design	CUTM2401	2-1-0	3

Course Objectives:

- To learn about various factors affecting pavement design.
- To learn about stress analysis of the pavement.
- To learn about various methods of flexible pavement design.
- To learn about various methods of rigid pavement design.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Understand various the fundamental techniques adopted for pavement design.	**PO1 (3)** **PO3 (2)**
CO2	Analyze the stresses and strains in a flexible pavement design using multi-layered elastic theory.	**PO2 (3)**
CO3	Able to solve the complex layer thickness problem on the pavement using different codes.	**PO4 (3)**
CO4	Understand the use of tools to calculate the stress and strain of pavement.	**PO5 (3)**

Module I

Introduction to Pavement Engineering **(9+1 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 **(10+2 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 (11+2 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 (8+2 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.

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

Subject Name	Code	T-P-PR	(Credit)
Highway Project Formulation and Economics:	CUTM2446	2-1-0	3

Course Objectives:

- To learn the requirements in project formulation, Non-monetary and monetary components in Highway Planning.
- To understand the DPR components.
- To learn the fundamental knowledge on calculation of road user costs methodologies for economic evaluation.
- To learn the factors affecting environmental impact assessment for highway projects.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Able to fundamental classification of the requirements in project formulation, development of cash flow diagrams, Preparation of Project and components in Highway Planning	**PO1 (3)**
CO2	Gain analysis skill on DPR components and able to identify the problems in individual	**PO2 (3)** **PO9 (1)**
CO3	Fundamental knowledge calculation of road user costs methodologies and able to develop decision for economic evaluation of accidents.	**PO4 (3)** **PO3 (2)**
CO4	Develop the technical skill to identify the factors affecting to environmental impact assessment for highway projects concern to health of society.	**PO6 (2)** **PO7 (2)**

Module I

Project Formulation **(8+1 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 (12+3 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 (10+2 Hours)

A) 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 (7+2 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

Subject Name	Code	T-P-PR	(Credit)
Traffic Safety	CUTM2402	2-1-0	3

Course Objectives:

- To understand the driver characteristics, roadway characteristics, and climatic factors on highway safety.
- To understand the planning and design a road safety.
- To learn the analysis of accident data and suggest safety measures.
- To build knowledge on accident mitigation measures.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Build fundamental knowledge on accident mitigation measures through analyze data.	**PO1 (3)** **PO2 (2)**
CO2	Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety using modern tools.	**PO5 (3)**
CO3	Able to understand the accident data and ability of decision making for safety measures for the public health and safety.	**PO4 (3)** **PO3 (2)**
CO4	Design and develop a road safety improvement program based on societal and environmental contexts.	**PO6 (2)** **PO7 (1)**

Module I

Road Safety Management **(8+1 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 (10+2 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 (10+2 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 (10+2 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.

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

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

Course Objectives:

- To develop an appropriate framework for research studies
- 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.
- To Demonstrate enhanced Scientific writing skills
- Warn the common mistakes in the field of research methodology.
- To make expertise in academic writing, patenting

Course Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the research problem and research process.	PO1 (3), PO2(3),PO3(3),PO8(1)
CO2	Understand research ethics .	PO1 (3), PO2(3),PO3(1),PO8(2)
CO3	Prepare a well-structured research paper and scientific presentations.	PO1 (3), PO2(2),PO3(3),PO4(2)
CO4	Explore on various IPR components and process of filing.	PO1 (3), PO2(3),PO3(2)

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
3. Publishing. 270p.
4. Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
5. Neuman, W.L. (2008). Social research methods: Qualitative and quantitative approaches, Pearson Education

Practice on Application of Numerical Analysis

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 pavements through software.
- To learn the stress strain analysis of 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:

COs	Course Outcomes	POs
CO1	Gain knowledge on application of GIS for transportation engineering	**PO1 (3)**
CO2	Analyze and design the problems on stress strain function of flexible pavements	**PO2 (3)** **PO3 (2)**
CO3	Able solve the problems on stress strain analysis of rigid pavements by conducting design of experiments	**PO4 (3)**
CO4	Relate statistical IT tools for process and its application in traffic engineering	**PO5 (3)**

Flexible pavement:

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

Rigid pavement:

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

Remote Sensing and GIS:

1. Geo-referencing
2. Digitization
3. Spatial interpolation

4. Digital elevation model preparation

Statistical Techniques:

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

Remote Sensing and GIS for Transportation Engineering

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 of remotely sensed data.
- To learn about information extraction techniques.
- To learn basics and application of GPS in transportation engineering.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Interpret various knowledge on remotely sensed images with the help of acquired knowledge in remote sensing technology.	**PO1 (3)**
CO2	Able to develop skill on the GPS instrument in field for various applications identify data interpretation.	**PO2 (3)**
CO3	Build knowledge on global positioning system and able to solve problem of manual information collection problems focusing to engineer health and safety.	**PO3 (3)** **PO4 (1)**
CO4	Extend knowledge on use of modern tool usage to intelligent transportation systems in electronics engineering practice.	**PO5 (3)** **PO6 (2)**

Module I

Basic in Remote Sensing **(7+2 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 (10+2 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 (10+2 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 (10+2 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 & Sons, 1989.

Pavement Construction Management and Maintenance

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 pavement management systems.
- To learn on project appraisal and its elements.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Extend knowledge on fundamental issues in pavement management system.	**PO1 (3)**
CO2	Dissect skill in design strategies and economic evaluation on pavement maintenance problem analysis.	**PO2 (3)** **PO3 (1)**
CO3	Make use of expert systems in pavement management systems and decision making by synthesis of the available information through prediction and modeling.	**PO4 (2)** **PO5 (1)**
CO4	Develop the technical skill on project appraisal and its elements assess to societal and environmental contexts.	**PO6 (2)** **PO7 (1)**

Module I

Pavement management system: An Introduction (10+2 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

Module II

Pavement Inventories and Evaluation (10+2 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

Module-III

Construction and Management of Pavement (10+2 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.

Module-IV

Maintenance of Pavement (7+2 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

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

Subject Name	Code	T-P-PR	(Credit)
Intelligent Transport System	CUTM2404	2-1-0	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.
- To understand the role of sensors in ITS.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Knowledge to differentiate the ITS user services and its application in road user safety.	**PO1 (3)**
CO2	Able to analyze the interpret importance of AHS in ITS through electronics engineering problems to design.	**PO2 (2)** **PO3 (1)**
CO3	Gain knowledge and research methods on solving traffic problems using ITS applications	**PO4 (3)**
CO4	Understand the role of modern tools like sensors in ITS relevant to electronics engineering practice.	**PO5 (2)** **PO6 (1)**

Module I

Fundamentals of ITS **(7+2 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 **(10+2 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+2 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+2 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

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.
- To learn the analysis of different case studies/examples of EIA in practice.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Knowledge to identify the sources for pollution and control methods in transportation.	**PO1 (3)**
CO2	Able to analyze the different steps within environmental impact assessment through review the literatures.	**PO2 (2)** **PO3 (1)**
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	**PO4 (3)**
CO4	Develop technical skills on different case studies/examples of EIA in practice assess to societal and environmental contexts.	**PO6 (3)** **PO7 (2)**

Module-I:

Introduction **(7+2 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

Module II

Environmental Indicators (10+2 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.

Module III

Environmental Impact Assessment for Transportation Projects (10+2 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.

Module IV

Methodologies for Carrying Environmental Impact Assessment (10+2 Hours)

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

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

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

Course Objectives:

- To understand the methods of ground improvement to a given site condition.
- To learn the right technique to improve different difficult grounds to improvement.
- To understand the best suitable ground modification technique for different grounds.
- To learn the importance and application of gabion walls and crib walls.

Course Outcomes:

COs	Course Outcomes	POs
CO1	Build knowledge on importance and application of Gabion walls and crib walls.	**PO1 (3)**
CO2	Able to apply analytical skill on problems of ground improvement to a given site condition and the environmental considerations.	**PO2 (2)** **PO3 (1)**
CO3	Able to take the right decision and technique to improve different difficult grounds through research-based knowledge and research methods.	**PO4 (3)**
CO4	Able to design and develop the best suitable ground modification technique for different grounds based on societal and environmental contexts.	**PO6 (3)** **PO7 (2)**

Module I

Introduction to Soil Modification **(10+2 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.

Module II

Physical, Chemical Modification and Grouting **(7+2 Hours)**

Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting:

Categories of grouting, Grout materials, Grouting techniques and control.

Module III

Hydraulic Modification and Geo-textiles (10+2 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.

Module IV

Reinforced Earth and In-Situ Soil Treatment for Slopes (10+2 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.

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.