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**Elective – 1**
- 14CTE151 TRANSPORTATION SYSTEMS
- 14CTE152 REMOTE SENSING AND GIS IN TRANSPORT PLANNING
- 14CTE153 APPLIED STATISTICS IN TRANSPORTATION ENGINEERING
- 14CTE154 TRANSPORTATION STRUCTURES
### VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

**SCHEME OF TEACHING AND EXAMINATION FOR**

**M.Tech: Transportation Engineering [CTE]**

<table>
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<td>INTELLIGENT TRANSPORTATION SYSTEMS</td>
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<td>14CTE253</td>
<td>ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS</td>
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<td>14CTE254</td>
<td>TRANSPORTATION SYSTEM MANAGEMENT</td>
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**Between the II Semester and III Semester, after availing a vacation of 2 weeks.**
### III Semester: INTERNSHIP

#### Subject Details

<table>
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<th>Course Code</th>
<th>Subject</th>
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<th>Duration of the Exam in Hours</th>
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* The student shall make a midterm presentation of the activities undertaken during the first 8 weeks of internship to a panel comprising Internship Guide, a senior faculty from the department and Head of the Department.
# The College shall facilitate and monitor the student internship program.

The internship report of each student shall be submitted to the University.

**Between the III Semester and IV Semester after availing a vacation of 2 weeks.**
### VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
### SCHEME OF TEACHING AND EXAMINATION FOR
### M.Tech: Transportation Engineering [CTE]

#### Subject Code | Subject Code | Subject | No. of Hrs./Week | Duration of Exam in Hours | Marks for Total Marks | CREDITS |
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**Elective – 3**
- 14CTE421 RURAL ROADS
- 14CTE422 URBAN MASS TRANSPORT SYSTEMS
- 14CTE423 PAVEMENT EVALUATION AND MANAGEMENT
- 14CTE424 COMPUTER APPLICATIONS IN TRANSPORTATION ENGINEERING

Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carry out literature survey / visit to Industries to finalize the topic of dissertation.

2) Project Phase – II: 6 weeks duration during between III and IV Semesters. Evaluation shall be taken during the Second week of the IV Semester. Total Marks shall be 25.


Marks of Evaluation of Project:

- The I.A. Marks of Project Phase – I & II shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university. (Out of two external examiners at least one should be present).

Note: Please refer to the above point 2 wherein the Project Phase – II is mentioned as 16 weeks. Please get clarification regarding the same and then get it uploaded. The correction is marked as red in the second Note.
TRAFFIC ENGINEERING - 1

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OBJECTIVES:
- Provide an insight on traffic and its components, factors affecting road traffic and the design of intersection
- Explain sampling of data, analysis and interpretation of data in conducting various surveys
- Explain traffic movements, types of intersections, islands, crossings and their design.
- Illustrate the design of signals and explain the redesigning of existing signals
- Provide an insight on traffic regulations, pollution caused by traffic and the method of controlling pollution

OUTCOME:
After the completion of the course students should be
- Able to acquire and apply knowledge of traffic, its components, factors affecting road traffic in intersection design.
- Able to apply the knowledge of sampling data in conducting various surveys and analysis
- Capable of understanding traffic movements and designing islands, intersections and road lightings
- Capable of designing signals, redesigning the existing signals
- Able to remember traffic regulations, impact of noise pollution, air pollution and the method of controlling them

Module 1
Introduction: Objectives and scope of traffic engineering. Components of road traffic the vehicle, driver and road. Road user characteristics; human and vehicle characteristics, factors affecting road traffic; methods of measurement. Traffic manoeuvres and Stream Characteristics; application in intersection design.

Module 2
Traffic Engineering Studies and Analysis: Sampling in Traffic Studies, Adequacy of Sample Size; Objectives, methods of traffic study, equipment, data collection, analysis and interpretation (including case studies) of (i) Spot speed (ii) Speed and delay (iii) Volume (iv) Origin - Destination (v) Parking (vi) Accident studies.

Module 3
Design of Traffic Engineering Facilities: Control of Traffic Movements through Time Sharing and Space Sharing Concepts; Design of Channelizing Islands, T, Y, Skewed, Staggered, Roundabout, Mini-roundabout and other forms of at-Grade Crossings including provision for safe crossing of Pedestrians and Cyclists; Grade Separated Intersections, their Warrants and Design Features; Design of Road Lighting.

Module 4
Traffic Control Devices: Traffic signs, markings, islands and signals. Different methods of signal design, redesign of existing signal including case studies. Signal system and co-ordination.

Module 5
Traffic Regulations and Control: General regulations: Regulations on Vehicles, drivers and flow; Other regulations and control. Traffic management; noise and air pollution due to road traffic and method of control.

Note: Field and lab studies are to be carried out.

TEXT BOOKS:
REFERENCES

3. IRC and IS Publications

PAVEMENT MATERIALS

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OBJECTIVES:

• Explain the properties of aggregates and different test procedures and specifications
• Explain the origin, properties, constituents and preparation of bitumen and tar
• Explain about cut back bitumen and bitumen emulsions, test procedures and the uses
• Explain mechanism of stripping, adhesion failures and methods to improve adhesion
• Illustrate the bituminous mix design method.
• Explain in detail about HMA, WMA, CMA

OUTCOME:
After the completion of the course students should be

• Able to acquire and apply knowledge of properties of road aggregates in conducting various laboratory tests.
• Capable of remembering the properties and constitution of road binders
• Capable of remembering the constituents of bitumen emulsion, cut back bitumen and to conduct various tests on them
• Capable of analyzing adhesion failure and mechanism of stripping and the method to improve
• Qualified to design bituminous mix with Rothfuc’s method considering the required specifications

Module 1
Aggregates: Origin, classification, requirements, properties and tests on road aggregates, concepts of size and gradation - design gradation, maximum aggregate size, aggregate blending to meet specification

Module 2
Bitumen and Tar: Origin, preparation, properties and chemical constitution of bituminous road binders; requirements

Module 3
Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests

Module 4
Adhesion of Bituminous Binders to Road Aggregates: Adhesion failure, mechanism of stripping, tests and methods of improving adhesion

Module 5
Bituminous Mixes: Mechanical properties, dense and open textured mixes, flexibility and brittleness, (No Hveem Stabilometer & Hubbard-Field Tests) bituminous mix design methods using Rothfuc’s Method only and specification using different criteria - voids in mineral aggregates, voids in total mix, density, flow, stability, percentage voids filled with bitumen
TEXT BOOKS

1. RRL, D S I R , ‘Bituminous Materials in Road Construction’, HMSO Publication
2. RRL, D S I R , ‘Soil Mechanics for Road Engineers’, HMSO Publication

REFERENCES

3. Relevant IRC and MoRTH Publications.

APPLIED SOIL MECHANICS AND GROUND IMPROVEMENT TECHNIQUES

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OBJECTIVES:

- Explain the origin, formation, classification of soil, index properties and their determination, types of soil exploration programmes
- Provide information shear strength of soil and its measurement, elastic properties of soil
- Explain various ground improvement techniques and the types of compaction and its effect on soil properties
- Explain the types of drains and various stabilization techniques
- Inform about the types of reinforcement and design principles, grouting techniques

OUTCOME:

After the completion of the course students should be

- Able to remember the soil classification systems, various soil exploration methods
- Capable of testing the soil to know the shear strength of soil
- Capable of remembering various ground improvement techniques, compaction methods and to analyze the effect of compaction on soil properties
- Capable of selecting different drains depending on soil condition, remember stabilization process of soil using lime, fly ash etc
- Able to design steep reinforced soil slopes, remember soil nailing principles and grouting techniques

Module 1

Introduction: Soil Mechanics applications to Highway Engineering. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these.

Site Investigation: Introduction, Planning exploration programmes, Types of Exploration, Location and depth of Borings, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods

Module 2

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

Module 3

Ground improvements –Definition, Objectives of ground improvement, Classification of ground improvement techniques, Soil Compaction- Effect of grain size distribution on compaction for various soil types like lateritic soil, coarse-grained soil and micaceous soil. The Effects of compaction on engineering
behaviour like compressibility, swelling and shrinkage, permeability, relative density, liquefaction potential. Field compaction – static, dynamic, impact and vibratory type. Shallow and deep compaction, Dynamic Compaction, Vibrofrothation

Module 4

Module 5

TEXT BOOKS

REFERENCES
1. Geotechnical Engineering; Braja, M. Das (2002), Fifth Edition, Thomson Business Information India (P) Ltd., India
URBAN TRANSPORT PLANNING

Subject Code: 14 CTE 14  IAMarks: 50
No. of Lecture Hrs/Week: 04  ExamHrs: 03
Total no. of Lecture Hrs.: 50  ExamMarks: 100

OBJECTIVES
- Recall basic concepts and methods of urban transportation planning in the India.
- Summarize methods of designing, conducting and administering surveys to provide the data required for transportation planning.
- Examine and apply travel demand modelling, Mode Choice Modelling and Traffic Assignment Modelling.
- Formulate the need of land use modelling and illustrate land use models for urban transportation planning

OUTCOMES
After completion of the course the student will be able to
- Design and conduct surveys to provide the data required for transportation planning.
- Prepare zonal demand generation and attraction regression models.
- Prepare demand distribution models (gravity models) and modal split models for mode choice analysis.
- Develop and calibrate trip generation rates for specific types of land use developments.
- Compare among planning alternatives that best integrate multiple objectives such as technical feasibility and cost minimization.

MODULE 1
Introduction to transportation planning, various modes of transportation and comparisons, urban transportation system planning process, use and evaluation of various models.

MODULE 2
Transportation Planning Process: Introduction-Definition-Factors to be considered; Land use transportation planning, systems approach-Stages- Inventory of Existing Conditions-Difficulties in implementation.

MODULE 3
Transport Surveys: Basic Movements-Study Area-Zones-Surveys-Planning of different types of surveys and interpretation, Travel demand: Traffic surveys for mass transit system planning.

MODULE 4
Travel demand modeling: Trip generation, trip distribution, modal split analysis, trip assignment techniques, and various models, transportation compact study methodologies.

MODULE 5
Land Use Models- Lowry Model-Hansen’s Accessibility Model-Density- Saturation Gradient Model-Problems (Exception Lowry Model)

TEXT BOOKS
2. C. S. Papacostas, Fundamentals of Transportation System Analysis, PHI.

REFERENCES
TRANSPORTATION SYSTEMS

OBJECTIVES

- Explain the various modes of transportation with their relative merits and demerits
- List the various types of roads and road patterns, explain the importance of 20 year road development plans and current road projects in the country
- Explain the factors affecting development of harbours and ports and elements in harbour and port planning
- Categorize various the national waterways in the country with their important characteristics
- Explain the need of urban mass transportation in developing countries and compare the various modes of urban mass transportation systems

OUTCOMES

After completion of this course the student will be able to

- List, explain and compare the various modes of transportation with their relative merits and demerits
- Classify the various types of roads and road patterns, list the salient features of 20 year road development plans and discuss on current road projects in the country
- List and discuss on factors affecting development of harbours and ports and explain on elements in harbour and port planning
- List the various the national waterways in the country and explain their important characteristics
- Explain the need of urban mass transportation in developing countries and compare the various modes of urban mass transportation systems

Module 1
Introduction– Importance of transportation systems, Different modes, characteristics, their integration and comparison

Highway systems – Road type and classification, road patterns, phasing road development in India, salient features of 3rd and 4th twenty year road development plans, Present scenario of road development in India and in Karnataka.

Module 2
Railways systems– Role of railways in transportation, Advantages of railways, Indian railways, classification, present scenario of railway development in India, Modernization of railways, development of high and super high speed railways.

Module 3
Airports - Overview of air transportation, Role of FAA and ICAO, air transport in India, types of airports, Heliports, STOL ports, complexities in airport planning, elements of airport planning, airport master plan, environmental impact.

Module 4
Harbours and Ports –Development of harbours and ports in India, characteristics, factors constraining development, elements of harbour and port planning, role of harbours and ports in transportation, National waterways, characteristics.

Module 5
Urban transportation systems –Importance of collective transportation v/s individual transportation, freight transportation, Physical system components of urban transportation, Overview of Mass rapid transit, Light rail transit, Personal rapid transit, guided way systems, Para transit systems, Mono rail, bus rapid transit systems

TEXT BOOKS

REFERENCE BOOKS
1. Khanna, Arora and Jain, Airport planning and design, Nem Chand and Bros., Roorkee.

REMOTE SENSING AND GIS IN TRANSPORT PLANNING

Subject Code: 14 CTE 152
IAMarks :50
No. of Lecture Hrs/Week :04
ExamHrs :03
Total no.of Lecture Hrs. :50
ExamMarks :100

OBJECTIVES
• Explain the purpose of accurate mapping of all features under different spatial and temporal scales of all kinds of terrain and land under water bodies.
• Discuss on the advantages of remote sensing compared to traditional surveying techniques in terms of time, accuracy and output.
• Explain the purpose and methods of obtaining abstract data both spatial and temporally.
• Illustrate the application of GIS and remote sensing in solving real world transportation problems

OUTCOMES
After completion of the course the student should be able to
• Choose the remote sensing image from different sensors, resolutions, spatial and temporal scales.
• Explain and to comprehend large tracks of earth surface with less time and cost but more accuracy.
• Communicate to the common man his analysis of different problems developments, benefits by preparing different thematic maps.
• Apply GIS and remote sensing techniques in solving real world transportation problems

Module 1

Module 2
Introduction to GIS: Basic Concept and Components – Hardware, Software – Data Spatial and non-spatial – Geo-referencing – Map Projection – Types of Projection – Simple Analysis – Data retrieval and querying

Module 3
Data structures and analysis: Database – Raster and Vector data structures – Data storage – Run length, Chain and Block coding – Vector data storage – Topology – GIS Modeling - Raster and Vector data analysis – Buffering and overlaying techniques – Network Analysis – Spatial Analysis

Module 4
Basic applications in transportation: Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imagery

Module 5
Advanced applications: GIS as an integration technology – Integration of GIS, GPS and Remote Sensing Techniques – Advanced Traveller Information System (ATIS) – Automatic Vehicle Location System (AVLS)

TEXT BOOKS

REFERENCES
2. Jeffrey Star and John Ester, Geographical Information System – An Introduction, Prentice Hall Inc.,
APPLIED STATISTICS IN TRANSPORTATION ENGINEERING

Subject Code : 14 CTE 153  
IA Marks : 50

No. of Lecture Hrs/ Week : 04  
Exam Hrs : 03

Total no. of Lecture Hrs. : 50  
Exam Marks : 100

OBJECTIVES:

- Explain different statistical methods used in transportation engineering problems, measures of central tendency, correlations methods
- Illustrate the use of probability and discrete distributions in transportation engineering problems
- Explain significance testing to check goodness of fit
- Explain time series analysis
- Explain different graphical methods and statistical software packages useful in transportation engineering field

OUTCOME: After the completion of the course students should be

- Able to use appropriate statistical method in transportation engineering problems
- Capable of applying the rule of probability and discrete distributions in solving problems
- Capable of testing the goodness of fit by using statistical decision
- Able to apply the knowledge of optimization technique and use statistical software in analysis of transportation engineering problems

Module 1

Module 2

Module 3
Statistical decisions, hypothesis testing, significance levels – Tests concerning Mean, testing the equality of means of two populations, tests concerning the variance. Chi –square Test for goodness of fit. Confidence Interval.

Module 4
Time series analysis- introduction –moving average- Problems

Module 5
Optimization technique and applications: Graphical Method –Simplex Method-Big-M method-2 –Phase Simplex method- applications in transportation engineering problems. Use of mathematical and statistical software packages

TEXT BOOKS

REFERENCES
TRANSPORTATION STRUCTURES

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OBJECTIVES
- Classify the various transportation structures, explain the principles of design methods and list the steps involved in the design of various transportation structures
- Identify the input parameters required for design of transportation structures and design and evaluate a transportation structures based on the data given

OUTCOMES
After completion of the course the student should be able to
- Decide the selection of transportation structures, list the factors affecting design of various transportation structures and generate the input parameters required for design
- Summarize the design methodology and arrive at design values for various transportation structures

Module 1
**Introduction**: Principles of Planning of Elevated Rail Transit System, grade separation structures, pedestrian crossing and sub-ways.

Module 2
** Loads on Bridges**: Dead loads, live loads, dynamic effects of vehicles, longitudinal forces, centrifugal forces, wind loads, earth quake forces, stream flow pressure, load combinations, design examples

Module 3
**Design of Bridge Slabs**: Longitudinally reinforced deck slabs, transversely reinforced bridge slabs

Module 4
**Design of Reinforced Concrete Bridges**: Design procedures for T-beam, box girder bridges design examples
**Design of Pre-stressed Concrete Bridges**: Design code, design examples

Module 5
**Segmental Box bridges**: Precast sections, criteria, design examples
**Sub-Structure Design**: Foundation investigation, bearings, bridge pier design, and abutment design, Examples.

TEXT BOOKS

REFERENCES
PAVEMENT MATERIALS TESTING LAB

Subject Code : 14 CTE 16  
IA Marks : 25  
No. of Hrs/ Week : 04  
Exam Hrs : 03  
Total no. of sessions : 12  
Exam Marks : 50

OBJECTIVES:
• Explain the properties of aggregates and different test procedure of conduction and specifications
• Explain procedures of conducting tests on neat bitumen and modified bitumen
• Explain Rothfutch method of marshal mix design
• Explain CBR test to know the strength characteristics of soil
• Explain procedure for different tests on cement and mix design

OUTCOME:
After the completion of the course students should be
• Able to test the aggregates for different properties
• Able to test neat and modified bitumen
• Qualified to design bituminous mix Rothfutch method of marshal mix design
• Capable of analyzing the strength of soil by conducting CBR test
• Able to analyze the properties of cement and do concrete mix design

TESTS ON AGGREGATES
Basic tests such as crushing strength, abrasion value, impact value, combined index value, specific gravity and water absorption.

TEST ON NEAT AND MODIFIED BITUMEN
Basic tests on neat bitumen such as penetration, softening point, viscosity, ductility, flash and fire point and specific gravity.
Basic tests on modified bitumen such as penetration, softening point, viscosity, elastic recovery, flash and fire point, specific gravity and loss on heating.

TEST ON BITUMINOUS MIXES
Proportioning of materials by Rothfutch's method and Mix design by Marshall Method.

TEST ON SOILS
CBR test.

TEST ON CEMENT & CONCRETE
Basic tests on cement concrete such as workability test, soundness test, compressive strength, split tensile strength and flexural strength. Concrete mix design.

REFERENCES
1. Relevant IS and IRC codes
TRAFFIC ENGINEERING – 2

Subject Code : 14 CTE 21
IA Marks : 50
No. of Lecture Hrs/ Week : 04
Exam Hrs : 03
Total no. of Lecture Hrs. : 50
Exam Marks : 100

OBJECTIVES:
• Learn the relationships between the parameters of traffic flow and the types of flow theories.
• Learn the concept of design vehicle and design volume to be considered along with the concept of roadway capacity and level of service.
• Learn the probabilistic aspects of vehicle arrivals, gap acceptance and delays.
• Learn the principles of traffic forecasting and simulation in traffic engineering.

OUTCOME:
After the completion of the course students should be
• Able to apply the flow theories to field situations such as toll booths, diversion measures etc.
• Able to estimate the capacities of roadways and intersections and the prevailing level of service.
• Able to apply the concepts of vehicle arrivals to field situations such as exit ramps, entry ramps etc.
• Able to appreciate the process of traffic forecasting and simulation in traffic engineering.

Module 1
Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock Waves; Queuing theory and applications.

Module 2
Design Hourly Volume for Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, Price-volume relationships and demand functions. Determination of design hourly volume, critical hour concept.

Module 3
Highway Capacity: Factors affecting capacity, level of service; Capacity studies. Capacity of different highway facilities including un-signalized and signalized intersections. Problems in Mixed Traffic flow, Case studies.

Module 4
Probabilistic Aspects of Traffic Flow: Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models, applications.

Module 5
Traffic Forecast: General travel forecasting principles, different methods of traffic forecast-Mechanical and analytical methods, Demand relationships, methods for future projection. Simulation: Fundamental principle, application of simulation techniques in traffic engineering formulation of simulation models, Case studies. Formulation of system models.

TEXT BOOKS

REFERENCES
PAVEMENT ANALYSIS AND DESIGN

**OBJECTIVES**
- Identify and categorize the factors affecting design and performance of pavements
- Explain the basic modelling concepts used to analyse flexible and rigid pavements.
- Explain different design methods for flexible and rigid pavement design

**OUTCOMES**
After completion of the course the student will be able to
- List and explain the various factors affecting design and performance of pavements
- Calculate the stresses and deflection in flexible and rigid pavements
- Design flexible and rigid pavements

**Module 1**
Introduction: Factors Affecting Pavement Design, Variables Considered in Pavement Design, Types of Pavements, Functions of Individual Layers, Classification of Axle Types of Rigid Chassis and Articulated Commercial Vehicles, Legal Axle and Gross Weights on Single and Multiple Units, Tire Pressure, Contact Pressure, EAL and ESWL Concept, Lane Distributions & Vehicle Damage Factors, Effect of Transient & Moving Loads

**Module 2**
Stresses And Deflections In Flexible Pavements: Stresses and deflections in homogenous masses. Burmister’s two-layer theory, three layer and multilayer theories, Problems on above.

**Module 3**
Flexible Pavement Design Methods Principle, design steps, advantages and applications of different pavement design methods – Group Index, CBR, McLeod, Kansas triaxial test, IRC, AASHTO and Asphalt Institute methods

**Module 4**
Stresses In Rigid Pavements: Factors affecting design and performance of pavements. Types of stresses and causes, factors influencing the stresses, general considerations in rigid pavement analysis, EWL, wheel load stresses, warping stresses, frictional stresses, combined stresses. Problems on above.

**Module 5**
Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacing, design of CC pavement for roads and runways, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements. Problems on above

**TEXT BOOKS**

**REFERENCES**
3. Relevant IRC and AASHTO publications
OBJECTIVES:

- Learn the importance of geometric design elements and the cross sectional elements.
- Learn the importance of sight distances and the components of horizontal and vertical alignment.
- Learn about the various types of intersections and their suitability.
- Learn about the various types of facilities for pedestrians, cycles, buses and parking.

OUTCOME:

After the completion of the course students should be

- Able to design the cross sectional elements of different classes of highways.
- Able to design the components of horizontal and vertical alignment of different classes of highways.
- Able to appreciate the various types of intersections and suggest the required measures.
- Able to suggest the required facilities for pedestrians, bicycles, buses and parking.

Module 1

Introduction: Functional Classification of Highway systems, Objectives of highway geometric design, elements of geometric design, design controls and criteria. Cross Section Elements: Pavement surface characteristics – skid resistance, cross slope, unevenness, light reflecting characteristics. Width considerations for carriageway, formation, shoulders, kerbs, traffic barriers, medians, frontage roads, right of way. Facilities for pedestrians and bicycles.

Module 2

Sight Distances: Types, analysis, factors affecting and design of stopping sight distance, intermediate sight distance and overtaking distance. Horizontal Alignment: Design speed, stability at curves, analysis and design of super elevation, extra widening of pavements, design of transition curves, curve resistance and curvature at intersections.

Module 3

Vertical alignment: Classification of grades, change of gradients, design of summit curves for sight distance consideration, design of valley curves for comfort and sight distance considerations. Combination of vertical and horizontal alignment including design of hairpin bends, design standards for expressways and hill roads. IRC standards and guidelines.

Module 4

Design of Intersections: Types of intersections, characteristics and design considerations of at-grade intersections; different types of islands, channelization, median openings. Rotary intersections – warrants, design and suitability. Grade separated intersections - types, warrants and suitability. Interchanges and ramps.

Module 5


Note: Computer Lab using highway geometric design software for design of highways, intersections, interchanges and parking lots to be carried out.
TEXT BOOKS

REFERENCES
3. Relevant IRC publications

TRANSPORTATION ECONOMICS AND PROJECT EVALUATION

Subject Code : 14 CTE 24
IAMarks :50
No. of Lecture Hrs/Week :04
ExamHrs :03
Total no.of Lecture Hrs. :50
ExamMarks :100

OBJECTIVES
• Explain the basic terminology of economics and its application in transportation
• Define the concept and components involved in economic evaluation
• Explain the various methods of economic analysis and ranking of alternatives
• Illustrate the method of economic evaluation for transportation projects

OUTCOMES
After the course is completed the student should be able to
• Define the basic terminologies involved in economics
• Carry out economic analysis of transportation projects and rank the alternatives for evaluation

Module 1
Principles of Economics: Supply and demand models, Consumer’s surplus and social surplus criteria, framework for social accounting, accounting rate of interest, social opportunity cost, rate of interest, social time preference rate of interest, accounting prices of goods and services, measuring input costs, applications on social accounting frame work.

Module 2
Transport Costs and Benefits: Fixed and variable cost, cost of improvement, maintenance cost, cost estimating methods, accounting for inflation, external costs, Direct benefits: reduced vehicle operation costs, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost.

Module 3
Economic Analysis: Generation and screening of project alternatives, different methods of economic analysis: annual cost and benefit ratio methods, discounted cash flow methods, shadow pricing techniques, determination of IRR and NPV, examples of economic analysis, application economic theory in traffic assignment problem.
Module 4

Project Evaluation: Framework of evaluation, transport planning evaluation at urban and regional levels, other evaluation procedures – achievement matrices, factor profiles, plan ranking, environmental evaluation, safety evaluation, project financing.

Module 5


TEXT BOOKS
1. Ian G. Heggie, Transportation Engineering Economics, McGraw Hill

REFERENCES
1. Road User Cost Study, Central Road Research Institute, New Delhi.
2. Dickey J.W, Project Appraisal for Developing Countries, John Wiley

ROAD SAFETY MANAGEMENT
Subject Code : 14 CTE 251
IA Marks : 50
No. of Lecture Hrs/ Week : 04
Exam Hrs : 03
Total no. of Lecture Hrs. : 52
Exam Marks : 100

OBJECTIVES:
• Explain the causes of accidents, statistical measures of accident data analysis and computer application in data analysis
• Explain different parameters responsible for providing road safety in the construction of new roads
• Explain road reconstruction principle and improvement of road considering the different components of road and intersections
• Explain road safety and maintenance measures for road in operation considering pedestrian, cyclists and road furniture
• Explain road safety audit principle and procedure, various traffic management techniques and their effectiveness

OUTCOME: After the completion of the course students should be
• Able to acquire knowledge statistical methods and computer application of accident analysis
• Capable of analyzing the factors affecting the construction of new roads
• Capable of analyzing the factors affecting the reconstruction of existing roads
• Capable of analyzing the factors affecting the operation condition of road
• Able to remember the process of road safety audit and the measures of improving road safety. Qualified to evaluate the effectiveness of various management techniques adopted in reducing road accident.

Module 1

Road accidents, Causes, Scientific Investigations and Data Collection:- Analysis of Individual accidents to arrive at Real Causes, Statistical Methods of Analysis of Accident Data, Application of Computer Analysis of Accident Data.

Module 2

Ensuring Traffic Safety in Designing New Roads:-Ways of Ensuring Traffic Safety in Road Design considering the Features of Vehicle Fleet, Psychological Features of Drivers, Natural and
Meteorological Conditions, Structure of Traffic Streams, Orientation of a Driver on the Direction of a Road beyond the Limits of Actual Visibility and Roadway Cross Section & Objects on the Right-of-Way.

**Module 3**

**Ensuring Traffic Safety in Road Reconstruction**: Road Reconstruction and Traffic Safety, Reconstruction Principles, Plotting of Speed Diagram for Working out Reconstruction Projects, Use of Accident Data in Planning Reconstruction of Roads, Examples of Reconstruction of Selected Road Sections for Improving Traffic Safety, Improving Traffic Conditions on Grades, Sharp Curves, Redesign of Intersections, Channelized At-Grade Intersections, Bus Stops, Parking & Rest Areas and Effectiveness of Minor Road Improvements.

**Module 4**

**Ensuring Traffic Safety in Road Operation**: Ensuring Traffic Safety during Repair and Maintenance, Prevention of Slipperiness and Influence of Pavement Smoothness, Restriction speeds on Roads, Safety of Pedestrians, Cycle Paths, Informing Drivers on Road Conditions with Aid of Signs, Traffic Control Lines & Guide Posts, Guardrails & Barriers and Road Lighting.

**Module 5**


**TEXT BOOKS**


**REFERENCES**

INTELLIGENT TRANSPORTATION SYSTEMS

Subject Code : 14 CTE 252 IA Marks : 50
No. of Lecture Hrs/ Week : 04 Exam Hrs : 03
Total no. of Lecture Hrs. : 50 Exam Marks : 100

OBJECTIVES:
• Learn the objectives, benefits and the telecommunications in ITS.
• Learn about the functional areas, user needs and services in ITS.
• Learn the concepts of ITS operations and applications.

OUTCOME: After the completion of the course students should be
• Able to appreciate the advantages of ITS and suggest the appropriate technologies for field conditions.
• Able to suggest the appropriate system/s in various functional areas of transportation.
• Able to amalgamate the various systems, plan and implement the applications of ITS.

Module 1

Module 2
Telecommunications in ITS - Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts

Module 3


Module 4
ITS Operations – Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning

Module 5
ITS applications: 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 ; public transportation applications; Automated Highway
Systems- Vehicles in Platoons – ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries. [Case study]

TEXT BOOKS

REFERENCES

ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

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OBJECTIVES
- Explain the concepts of environmental impact assessment and apply in the projects.
- List and define various indicators such as terrestrial subsystems, Indicators aquatic subsystems, Socio-economic and able to Select various indicators for EIA studies.
- Explain the impacts of transportation related components on environment
- Explain and illustrate the methodologies for environmental impact assessment

OUTCOMES
After completion of the course the student will able to
- To describe the environmental imbalances, indicators and explain the concept of EIA
- To identify and describe elements to be affected by the proposed developments and/or likely to cause adverse impacts to the proposed project, including natural and man-made environment;
- To identify the negative impacts and propose the provision of infrastructure or mitigation measures
- To assess the impacts of various development on environment
- To summarise the methodologies for carrying out environmental impact assessment

Module 1
Introduction: 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 2
Environmental Indicators - 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 3

Module 4
Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development

Module 5
Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies, Adhoc Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria

TEXT BOOKS

REFERENCES
OBJECTIVES

- Explain the methods of data collection and analysis for traffic management
- Identify the various transportation problems and explain solutions for effective and efficient management
- Identify the problems associated with a site, conduct necessary surveys and arrive at feasible real world solutions

OUTCOMES

After completion of the course the student should be able to

- To list the various surveys required for traffic management
- To identify transportation problem at a given site, analyze the survey data and synthesize efficient traffic management measures

Module 1
Methodology & Data Collection: Methodological frame work, objectives and problems, conflicts resolution, strategic categories and action elements, travel behaviour impact and response time

Module 2
TSM actions combinations and interactions, impact assessment and evaluation, monitoring and surveillance, Area wide data collection methodology, corridor data collection methodology.

Module 3
Public transportation & HOV treatment - Toll discounts for car pools during peak periods, park and ride, carpooling, exclusive lanes, priority at ramp terminals, bus transfer stations, limited and skip-stop bus services, shared ride.

Module 4
Traffic Operations Improvement: On-street parking ban, freeway ramp control & closure, travel on shoulders, one-way streets, reversible lanes, traffic calming, right turn phase, right turn lanes, reroute turning traffic.

Module 5
Parking Management: Short term reserved parking, increased parking rates, time duration limits, expanded off-street parking, Non-Motorized Transport- pedestrian only streets, Dial-a-ride for elderly & handicapped.

TEXT BOOKS

2. C. S. Papacostas, Fundamentals of Transportation System Analysis, PHI.

REFERENCE BOOKS:

2. Transportation System Management, State of the Art, UMTA, USDOT, 2008
3. TRB Publications.
TRANSPORTATION ENGINEERING LAB

Subject Code : 14 CTE 26
IAMarks : 25
No. of Hrs/Week : 03
Exam Hrs : 03
Total no. of sessions : 12
Exam Marks : 50

OBJECTIVES
Illustrate application of soft computing techniques for solving transportation problems
- Illustrate the application of software for analyzing traffic survey data
- Explain and illustrate generation of models for transportation planning
- Explain the arrival of economic cost of road projects
- Introduce the methods of designing geometry of highways using computer software

OUTCOMES
The student should be able to
- Examine and arrive at required output from traffic surveys
- Analyse and generate models for transportation planning
- Compute the economic costs of road projects
- Design the geometry of highways

ANALYSIS OF TRAFFIC SURVEYS
1. Classified volume count survey
2. Moving car method
3. Parking studies
4. Origin-destination studies
5. LOS study

TRANSPORTATION PLANNING
1. Trip generation modeling
2. Mode choice/modal split problems
3. Trip assignment problems

TRANSPORTATION ECONOMICS
1. Vehicle operating costs
2. Toll pricing

HIGHWAY GEOMETRY
1. Design of horizontal alignment, vertical alignment, generating cross section and design of intersections

REFERENCES
1. Relevant IRC publications
2. C.S. Papacostas and P.D. Prevedouros “Transportation engineering & Planning”, PHI learning
OBJECTIVES:
- Explain concept of location surveys, procedure of preparing project report, documentation of contracts
- Explain features, functioning and uses of different types of equipments used in road construction and construction specification for different layers of road
- Provide information on specifications of construction of different types of granular subbase, base and surface course and construction of special pavement
- Provide information on application of CPM and PERT in construction planning
- Explain the maintenance activities for road and road furintures

OUTCOME: After the completion of the course students should be
- Able to acquire knowledge on location surveys, preparation of detailed project report, contract and its documentation
- Capable of remembering different types of equipments used for construction of roads, specification and construction steps for different layers of road
- Capable of designing the layer thickness and remembering the specifications for granular base course
- Capable of applying concept of PERT and CPM in construction planning
- Able to remember different kinds of road maintenance works

Module 1

Module 2
Road construction equipment – different types of excavators, graders, soil compactors / rollers, pavers and other equipment for construction of different pavement layers – their uses and choice Problem on equipment usage charges; Pre-construction surveys and marking on ground - Specifications and steps for the construction of road formation in embankment and cut, construction steps for granular sub-base, quality control tests.

Module 3
Different types of granular base course – WMM, CRM, WBM; specifications, construction method and quality control tests. Different types of bituminous layers for binder and surface courses; their specifications (as per IRC and MORTH); construction method and quality control tests.

Module 4
Different types of sub-base and base course for cement concrete (CC) pavement and construction method. Construction of cement concrete (PQC) pavements joints quality control during construction. Construction details of interlocking concrete block pavements

Module 5
Principle of construction planning, application of CPM and PERT, Problems, Road maintenance works – day to day and periodic maintenance works of various components of road works and road furniture

TEXT BOOKS
REFERENCES

2. Relevant IS, IRC, AASHTO and MoRTH Publications.

RURAL ROADS

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OBJECTIVES:

- Explain the concept and objective of providing low cost roads in developing country like India
- Explain problems involved in the design of rural roads, preparation of rural road development plans and economic viability
- Explain different types of surveys required for road alignment and road geometry with appropriate specifications
- Introducing different materials used for construction and different types of construction procedures and equipment required for construction
- Explain importance of road drainage, design of drainage and cross drainage structures with maintenance activities

OUTCOME:

After the completion of the course students should be

- Able to remember significance of low cost roads
- Capable of analyzing the problem associated with planning of low volume roads, preparing master plan of rural road network
- Capable of conducting surveys for rural road alignment and remembering specifications of various geometric features of road
- Capable of selecting and analyzing different materials and equipments required for rural road construction
- Able design various drainage structures and cross drainage works giving due importance to maintenance activities.

Module 1
Introduction: Concept Objective, Scope and coverage of low cost and rural roads. Explain significance of low cost roads for developing countries, with special reference to India.

Module 2

Module 3
Location Surveys and Geometrics Design: Location surveys, geometric design standards for rural roads, special considerations for rural roads in hilly areas

Module 4

Module 5
Road Drainage and Maintenance: Drainage of road surface, pavement layers and cross drainage works. Various low cost drainage alternatives. Short term routine maintenance, long term
maintenance, organizational and financial aspects of maintenance works.

REFERENCES:

### URBAN MASS TRANSPORT SYSTEMS

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**OBJECTIVES:**
- Explain different transit modes, routing management activities including demand analysis
- Provide information on functioning, designing and scheduling of transit terminal design, fleet management, cost benefit analysis and bus transit operation
- Provide information on loading and unloading transit platforms, traffic management techniques and IPT service improvements
- Explain demand management techniques, intersection management techniques, planning for pedestrian, bicycle and parking management

**OUTCOME:** After the completion of the course students should be
- Able to remember transit modes, management activities and demand analysis
- Capable of designing transit terminal units, fleet management and cost analysis
- Capable of planning and scheduling transit terminal platform for loading and unloading, selecting suitable traffic management techniques
- Capable of selecting different demand management techniques, intersection management techniques and small area management

**Module 1**
Transit Classifications: Classes of Transit Modes, Technologies, Service Types, and routing Management Activities: Service, Finance, Marketing, Maintenance, Demand Analysis, Transit Subsidies.

**Module 2**

**Module 3**
Planning, routing and scheduling, Location of loading and unloading platforms and transit terminals. Transport System Management Actions: Traffic management techniques for improving vehicular flows, preferential treatment for high occupancy modes, promoting non auto or high occupancy use, and transit and intermediate public transport service improvements.

**Module 4**
Demand management techniques for reduced traffic demand staggered hours, and vehicle restrictions; Intersection management techniques: signal progression, optimization and computer controls;

**Module 5**
Small area Management, Management of Bicycles, planning for pedestrians and planning for parking spaces
TEXT BOOKS

REFERENCE BOOKS:
1. Transportation Systems Management: State of the Art, UMTA, US Dept. of Transport

PAVEMENT EVALUATION AND MANAGEMENT

Subject Code : 14 CTE 423
IAMarks : 50
No. of Lecture Hrs/Week : 04
ExamHrs : 03
Total no. of Lecture Hrs. : 50
ExamMarks : 100

OBJECTIVES
1. Recall the importance of evaluation and strengthening of pavements
2. Introduce the various methods of structural and functional evaluation of rigid and flexible pavements
3. Discuss the need for pavement management and explain the techniques involved
4. Formulate the development and application of models for pavement management.

OUTCOMES
After completion of the course the student will be able to
1. Identify the factors causing deterioration of pavements and propose remedial measures
2. Carry out structural and functional evaluation of flexible and rigid pavements
3. Explain the use of models for pavement management
4. Develop a framework for efficient pavement management system

Module 1 Pavement Evaluation: Introduction - Structural and functional requirements of flexible and rigid pavements; pavement distress; different types of failures, causes and remedial measures.

Module 2 Functional evaluation of pavements: Evaluation of Surface Condition: Methods of evaluating pavement surface condition, PCI & PSI, measurement of skid resistance and unevenness by various methods, their applications

Module 3 Structural evaluation of pavements: Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design, Plate load test, wave propagation and other methods of load tests, evaluation by destructive test methods, and specimen testing.

Module 4 Pavement management: Historical Background - General nature and applicability of systems methodology, basic components of Pavement Management System, planning pavement investments. Design Strategies - Framework for pavement design – design objectives and constraints.

Module 5 Basic structural response models – characterization of physical design inputs – generating alternative pavement design – economic evaluation of alternative design – analysis of alternative design strategies – selection of optimal design strategy. Techniques for developing prediction models – AASHTO, CRRI and HDM models
TEXT BOOKS

REFERENCES

COMPUTER APPLICATIONS IN TRANSPORTATION ENGINEERING
Subject Code : 14 CTE 424
No. of Lecture Hrs/Week : 04
ExamHrs : 03
Total no.of Lecture Hrs. : 50
ExamMarks : 100

OBJECTIVES
1. List and define the fundamentals of simulation and modeling
2. Illustrate and generate different simulation and modeling techniques
3. Identify the parameters for simulation and modeling, analyze and prepare reports

OUTCOMES
After completion of the course the student should be able to
1. List and explain different modeling and simulation techniques used to solve transportation problems
2. Carrying out queuing and simulation problems, analyse and generate reports
3. Apply simulation and modeling techniques to solve real world problems

Module 1
Introduction to systems approach - Typical transportation systems - Mathematical models, Modelling Process Taxonomy of model types; Steps in model building; Simulation; Algorithms and Heuristics; Simulation Languages.

Module 2
Fundamentals of simulation - Monte Carlo method - Analog and digital simulation - Continuous and discrete models - Simulation languages - Introduction to CSMP.

Module 3
Probability concepts - Random numbers - Pseudo random generators - Arrival patterns - Service time distributions, Queue discipline - Manual simulation of simple queuing system

Module 4

Module 5
Applications of GPSS - Simple queuing problems - Inventory problems - Simulation of ports - Railway platforms and level crossings - Traffic signals. Analysis of simulation results - Model validation - Replication of random conditions - Time series analysis.

TEXT BOOKS

REFERENCE BOOKS