Syllabus for FirstSemesterM.Tech.in TransportationEngineering

(OUTCOMEBASEDEDUCATION(OBE) andCHOICEBASEDCREDITSYSTEM-2018-2019ONWARDS)

APPLIED STATISTICS

Subject Code	**:**	**18CTE11**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 oftransportationengineering problems.

Module 1:

Introduction: Statistical methods, scope and limitations, population and sample, frequencydistribution-measure of central tendency-measures of Dispersion- standard deviation, coefficient of variation, skewness. Variables - scatter diagram, Curve fitting methods, correlation linear regression, multiple linear regressions. Multivariate data analysis.

Module 2:

Probability: Review, Addition & Multiplication Rules, random Variables, Discrete distributions– Binomial & Poisson Distributions, Continuous Distribution – Uniform, Exponential, Gamma& normal Distributions, applications inHighway engineering problems.

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-Mmethod-2 –Phase Simplexmethod-applications in High way engineering problems

Use of mathematical and statistical software packages.

REFERENCE BOOKS:

1. **Gupta,S.C.andKapoorV.K.**FundamentalsofMathematicalstatistics,SultanChand andSons,1978.
2. **MedhiJ**(1982)Introductiontostatistics.Newagepublications,NewDelhi.
3. **WalpoleR.E.andR.H.Mayers(1982):**ProbabilityandstatisticsforEngineersandScientists.WileyIntl.2002.
4. **Johnson Rand G.Bhattacharya (1985):** Statistics– principlesand methods. JohnWiley,NY.
5. **Ross S. M.**ProbabilityandstatisticsforEngineers.WileyInt.Edition.
6. **KadiyaliL.R.**TrafficEngineeringand TransportPlanning,Khanna Publishers,2004

TRAFFIC ENGINEERING - I

Subject Code	**:**	**18CTE12**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Provideaninsightontrafficanditscomponents,factorsaffectingroadtrafficandthedesignofintersection.
- Explainsamplingofdata,analysis andinterpretationofdatainconductingvarious surveys.
- Explaintrafficmovements, types ofintersections,islands,crossings andtheirdesign.
- Illustratethedesignofsignals andexplainthe redesigningofexisting signals.
- Provide an insight ontraffic regulations, pollution caused by traffic and the method of controllingpollution.

OUTCOME:

Afterthecompletionofthecoursestudents shouldbe

- Abletoacquireandapplyknowledgeoftraffic,itscomponents,factorsaffectingroadtraffic inintersectiondesign.
- Abletoapplytheknowledgeofsamplingdatainconductingvarious surveysandanalysisCapableofunderstandingtrafficmovementsanddesigningislands,intersectionsan droad lightings.
- Capableofdesigning signals,redesigningtheexisting signals.
- Abletoremembertrafficregulations,impactofnoisepollution,airpollutionandthemethod ofcontrollingthem.

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. Concepts of passenger car units for mixed traffic flow.

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; 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.

Module 4:

Traffic Control Devices: Traffic signs, markings, islands and signals. Different methods of signal design; redesign of existing signal including case studies, VMS, Road Lighting.

Module 5:

Traffic safety and management: Road accidents, causes, effects and prevention, promotion and integration of public transport, promotion of non-motorized transport, area traffic management system, traffic system management(TSM), travel demand management(TDM), Congestion and parking pricing.

Note: Field Work/Laboratory

Surveys viz, Volume Count Survey, Pedestrian Survey Speed Survey, Axle Load Surveys, O-D Survey and Parking Survey are to be carried out.

REFERENCE BOOKS:

1. Kadiyali, L.R. `Traffic Engineering and Transport Planning', Khanna Publishers.
2. Drew, D.R. `Traffic Flow Theory and Control', McGraw Hill Book Co.
3. IRC and IS Publications.
4. Institute of Transportation Engineers, `Manual of Transportation Engineering Studies', Prentice Hall
5. Khanna and Justo, ‘Text book of Highway Engineering’, Nemchand Brothers, Roorkee,
6. 2000.
7. Papacostas, C.A., Fundamentals of Transportation Engineering', Prentice-Hall of India Private Limited, New Delhi.2000.
8. William R. McShane and Roger P. Roess, Traffic Engineering', Prentice hall, New Jersey, 2000

PAVEMENT MATERIALS

Subject Code	**:**	**18CTE13**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Explain the different types, properties and tests on soil subgrade
- Explain the properties of aggregates and different test procedures and specifications
- Explain the origin, properties, constituents and preparation of bitumen, tar, cutback bitumen and emulsions.
- Illustrate the bituminous mix design method.
- Explain in detail about HMA, WMA, CMA
- Explain types of cement, tests on cement, types of concrete, fillers and sealers

OUTCOMES:

After completion of the course the student will be able to

- Able to gain knowledge about soil, properties and its behavior.
- Able to gain knowledge about aggregates, properties and tests.
- Capable of doing mix design for different layers of pavement.
- Able to gain knowledge about cement, tests, joints.

Module 1:

Soil: Characterization: Properties of subgrade layers; different types of soils, Soil Classification; Index and other basic properties of soil; A critical look at the different laboratory and in - situ procedures for evaluating the mechanical properties of soils viz. SPT, CPT, CBR, Plate Load test, Field compaction and control.

Module 2:

Aggregates: Origin, classification, requirements, properties and tests on road aggregates, mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; concepts of size and gradation - design gradation, maximum aggregate size, aggregate blending to meet specification, Fuller and Thompson's Equation, 0.45 power maximum density graph, Sampling of aggregates.

Module 3:

Bitumen : Bitumen and Tar: Origin, preparation, properties and chemical constitution of bituminous road binders; requirements, bitumen structure, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, Bituminous Emulsions and Cutbacks, Preparation, characteristics, uses and tests, Adhesion of Bituminous Binders to Road Aggregates: Adhesion failure, mechanism of stripping, tests and methods of improving adhesion.

Module 4:

Bituminous Mixes: Resilient and Complex (Dynamic) Moduli of Bituminous Mixes, Permanent Deformation Parameters and other Properties. Modified bitumen: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Long term and short term ageing and its effect on bitumen performance, Tests to simulate ageing of bitumen viz. RTFOT and PAV. Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications, Hubbard Field method of mix design, Hveem's method of mix design; Introduction to super pave mix design procedure, Modified binders, HMA, WMA, CMA

Module 5:

Cement and Concrete : Types of cements and basic cement properties, Quality tests on cement; Tests on cement concrete including compressive strength, flexural strength, modulus of elasticity and fatigue properties; Introduction to advanced concretes like self-compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; Joint fillers and sealers for Jointed Plain Cement Concrete Pavements and their characterization.

REFERENCE BOOKS:

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan,A.,`HighwayEngineering',Nem Chand andBros,Roorkee, 2014.
2. ParthaChakrobortyand Animesh Das, 'Principles ofTransportation Engineering', Prentice Hall (India), NewDelhi, 2011.
3. Atkins, N. Harold, HighwayMaterials, Soils and Concretes,Fourth Edition, 2002, Prentice– Hall
4. FreddyLRoberts, Prithvi SKandhal et al, "HotMixAsphalt Materials,mixturedesignand construction"-(2^{nd}Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA.
5. RelevantIRCand MoRTH Publications

APPLIED SOIL MECHANICS AND GROUND IMPROVEMENT TECHNIQUES

Subject Code	**:**	**18CTE14**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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

- Able to gain knowledge of soil, origin, and exploration.
- Able to understand shear strength of soil and its measurement, elastic properties of soil
- About the types of reinforcement and design principles, grouting techniques

Module 1:

Introduction To Soil Mechanics And Site Investigation: 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 and Sand, Elastic properties of soil – Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus

Module 3:

Ground Improvement: Definition, Objectives of ground improvement, Classification of groundImprovement 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 behavior like compressibility, swelling and shrinkage, permeability, relative density, liquefaction potential. Field

compaction – static, dynamic, impact and vibratory type. Shallow and deep compaction, Dynamic Compaction, Vibrofloatation

Module 4:

Hydraulic Modification And Chemical Modification Hydraulic modification –Definition, gravity drain, lowering of water table, multistage well point, vacuum dewatering. Vertical drains, Sand drains,Drainage of slopes, Electro kinetic dewatering, Preloading. Chemical modification – Definition, cement stabilization, sandwich technique, admixtures. Hydration – effect of cement stabilization on permeability, Swelling and shrinkage and strength and deformation characteristics,. Stabilization using Fly ash. Lime stabilization – suitability, process, criteria for lime stabilization. Other chemicals like chlorides, hydroxides, lignin and hydrofluoric acid. Bitumen, tar or asphalt in stabilization.

Module 5:

Soil Reinforcement: Earth reinforcement – Principles and mechanism of reinforced earth-reinforced soil retaining structures, Synthetic and natural fibre based Geotextiles and their applications - Filtration, drainage, separation, and erosion control. Design Principles of steep reinforced soil slopes – pavements – Embankments on soft soils, introduction to soil nailing concepts

Miscellaneous Methods (Only Concepts & Uses):

Grouting: Introduction, Effect of grouting. Chemicals and materials used. Types of grouting, grouting procedure, Applications of grouting. Thermal methods, Crib walls, Gabions and Mattresses, Anchors, Rock bolts, Stone Column, Micropiles.

REFERENCE BOOKS:

1. Soil Mechanics and Foundation Engg. - Punmia B.C. (2005), 16th Edition Laxmi Publications Co., New Delhi.
2. Principles of Soil Mechanics and Foundation Engineering- Murthy V.N.S. (1996), 4th Edition, UBS Publishers and Distributors, New
3. Geotechnical Engineering; Braja, M. Das (2002), Fifth Edition, Thomson Business Information India (P) Ltd., India, Information India (P) Ltd., India
4. “Ground Improvement Techniques- Purushothama Raj P. (1999) Laxmi Publications, New Delhi

URBAN TRANSPORT PLANNING

Subject Code	**:**	**18CTE15**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 modeling, Mode Choice Modeling and Traffic Assignment Modeling.
- Formulate the need of land use modeling and illustrate land use models for urban transportation planning

OUTCOME:

After the completion of the course students should be

- Know about methods of urban transportation planning in the India.
- Able to apply knowledge of methods of designing apply travel demand modeling, Mode Choice Modeling and Traffic Assignment Modeling.
- Able to gain knowledge of land use modeling.

Module 1:

Introduction: Introduction to transportation planning, scope and objective of UTP, various modes of transportation and comparisons, urban transportation system planning process, transportation demand and forecast.

Module 2:

Transportation Planning Process & Surveys: System approach to urban planning, Stages in transportation planning, Basic Movements-Study Area-Zones-Surveys-Planning of different types of surveys-Inventory of transportation facilities

Module 3:

Trip generation & Trip distribution: Trip generation: Trip purpose- Factors governing trip generation and attraction- Category analysis-Problems on above

Trip distribution: Methods- Growth factors methods- Synthetic methods- Fratar and Furness method and problems on the above

Module 4:

Model Split & Trip Assignment: Model Split: Factors affecting- characteristics of split- Model split in urban transport planning- problems on above

Trip Assignment: Assignment techniques- problems on all techniques, minimum path tree problems.

Module 5:

Interdependency of Land Use & transport, characteristics of land use Models–Lowry Model-Hansen'sAccessibility Model-Density- Saturation Gradient Model-Problems(Exception Lowry Model & DSGM)- Difficulties in planning small & medium cities- Recent case studies

REFERENCE BOOKS:

1. Kadiyali L.R., Traffic Engineering and Transport Planning, Khanna Publishers
2. C. S. Papacostas, Fundamentals of Transportation System Analysis, PHI.
3. Khisty, C J., Transportation Engineering – An Introduction, Prentice-Hall, NJ
4. B.G.Hutchinson, Principles of urban transportation system planning- McGraw-Hill, New York, 1974
5. S.C. Saxena, Traffic Planning and Design, DhanpatRai Pub., New Delhi.

PAVEMENT MATERIALS LABORATORY I

Subject Code	**:**	**18CTE16**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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

Module 1:

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

Module 2:

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.

Module 3:

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

Module 4:

TEST ON SOILS: CBR test.

Module 5:

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. Highway Material Testing – S K Khanna- C.E.G. Justo , and Veeraraghavan A Nemchand Bros-Rookee, 2010
2. Relevant IS and IRC Publications
3. Relevant ASTM Standards

NOTE: 18RMI17– Research Methodologyand IPR Syllabus is sameforallstreams and henceit willbeprovided byJoint Boardof VTU.

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PAVEMENT DESIGN AND ANALYSIS

Subject Code	**:**	**18CTE21**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

Identify and categorize the factors affecting design and performance of pavements.

- Explain the basic methods and concepts used to analyse flexible and rigid pavements.
- Explain different design methods for flexible and rigid pavement design.
- Explain Structural and functional requirements of flexible and rigid pavements.

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, 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, advantagesand 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

REFERENCES:

1. Yoder, E.J., and Witczak, `Principles of Pavement Design', 2nd ed. John Wiley and Sons, 1975.
2. Yang, `Design of Functional Pavements', McGraw Hill Book Co.
3. Khanna and Justo, ‘Test Book of Highway Engineering ‘Nemchand brothers, Roorke-2004.
4. Huang, 'Pavement Analysis', Elsevier Publications
5. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers.
6. Pavement and Surfacing for Highway & Airports, Micheal Sargious, Applied SciencePublishers Limited.
7. Haas and Hudson `Pavement Management System', McGraw Hill Book Co., New York.
8. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements.
9. Relevant IRC Publications
10. CMA Hand Book

TRANSPORTATION ECONOMICS AND EVALUATION

Subject Code	**:**	**18CTE22**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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

OUTCOME:

After the completion of the course students should be

- Able to understand terminology of economics and its application in transportation
- Able to understand components involved in economic evaluation, and methods.

Module 1:

Principles of Economics: Supply and demand models, Consumer's surplus and social surplus criteria, and 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.

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:

Project Evaluation : Framework of evaluation, transport planning evaluation at urban and regional levels, other evaluation procedures, environmental evaluation, safety evaluation, project financing.

Module 4:

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 5:

Environmental impact assessment : 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

REFERENCES:

1. Ian G. Heggie, Transportation Engineering Economics, McGraw Hill
2. Winfrey R, Highway Economic Analysis, International Textbook Company
3. Road User Cost Study, Central Road Research Institute, New Delhi.
4. Dickey J.W, Project Appraisal for Developing Countries, John Wiley
5. L R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers.

GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES

Subject Code	**:**	**18CTE23**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 understand importance and design geometric elements.
- Able to understand sight distances and the components of horizontal and vertical alignment.

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

Module 5:

Miscellaneous Facilities: Pedestrian facilities especially on urban – types, IRC specification. Bicycle tracks -types, guidelines, and IRC design standards. Bus bays - types, guidelines and IRC design standards. Parking facilities - types, guidelines and IRC design standards.

REFERENCES:

1. AASHO, “A Policy on Geometric Design of Highways an d Streets', American Association of State Highway and Transportation Officials, Washington D.C.
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering’, Nem Chand and Bros, Roorkee, 2014.
3. DSIR`, Roads in Urban Areas', HMSO, London.
4. Jack E Leish and Associates, `Planning and Design Guide: At-Grade Intersections'. Illinois.Relevant IRC publications

THEORIES OF TRAFFIC FLOW

Subject Code	**:**	**18CTE241**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Learn the relationships and the types of flow theories.
- Learn the concept of Macroscopic and Microscopic traffic flow models.
- Learn the application of probabilistic aspects of vehicle arrivals, queuing theory.
- Learn the principles of application of GIS in traffic flow theory.

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 understand various car following theories
- Able to apply the concepts of vehicle arrivals to field situations such as exit ramps, entry ramps etc by queuing theory
- Able to appreciate the application of GIS techniques in traffic engineering.

Module 1:

Traffic Stream Parameters - Fundamental diagram of volume-speed-density surface. Discreteand continuous probability distributions. Merging manoeuvres - critical gaps and their distribution.

Module 2:

Macroscopic Models - Heat flow and fluid flow analogies - Shock waves and bottleneck controlapproach.

Module 3:

Microscopic Models - Application of queuing theory - regular, random and Erlang arrival and service time distributions - Queue discipline - Waiting time in single channel queues and extension to multiple channels.

Module 4:

Linear And Non-Linear Car Following Models - Determination of car following variables -Acceleration noise.

Module 5:

Geographical Information System – Global Positioning System – Intelligent TransportationSystems - Area Traffic Control – Automatic Toll Col lection – Smart Cards – Collision DetectionSystem.

REFERENCE BOOKS:

1. Drew, D.R., Traffic Flow Theory and Control, McGrawHill.,1978TRB,
2. Traffic Flow Theory - A Monograph, SR165, 1975.
3. Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004

RAILWAYS AND AIRWAYS

Subject Code	**:**	**18CTE242**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Provides the basic knowledge about the railways, components
- Provide the basic knowledge about the geometric design of points and crossings.
- Provides the basic knowledge about airports, runways, taxiways and its design.
- Provide basic knowledge about heliports, characteristics, design of heliports

OUTCOME:

After the completion of the course students should

- Describe about railways and its design.
- Analyze the points and crossings.
- Describe about airports design and runways.
- Analyze the design of heliports.

Module 1:

Permanent way and its requirements, Gauges and types, Typical cross sections, Coning of wheels and Tilting of rails, Components- Types, sections length- Defects- wear- creep- welding- joints. Track fitting and fastener, Calculation of quantity of materials, Tractive resistances and hauling capacity- Numerical examples

Module 2:

Geometric Design: Necessity, Safe speed on curves. Cant, cant deficiency, negative cant, safe speed, Transition curve, gradient, grade compensation Points and Crossings: Components of a turnout, design of turnouts, types of switches, crossings, track junctions. Stations and yards. Signaling: Objects and types of signals. Fouling mark, buffer stop, level crossing, track defects- Numerical examples

Module 3:

Railway sections and yards - Purpose, site selection, facilities, requirements, classification, platforms, building areas, types of yards, foot over bridges, subways, cranes, weigh bridge, loading gauge, end loading ramps, locomotive sheds, ash-pits, water columns, turntable, triangles, buffer stop, scotch block. Train accidents, derailments and its causes

Module 4:

Introduction: Layout of an airport with component parts and functions, Site selection for airport, Aircraft characteristics affecting the design and planning of airport, Airport classification, Runway orientation using wind rose- Numerical examples. Runway: Basic runway length-Corrections and examples.

Module 5:

Taxiway: Factors affecting the layout - geometrics of taxiway-Design of exit taxiway - Numerical examples. Visual aids- Airport marking – lighting-Instrumental Landing System. Heliports and their Design: Introduction, Helicopter characteristics, planning of heliports, Visual aids of heliports

.

REFERENCE BOOKS:

1. Saxena and Arora, “Railway Engineering” Dhanpat Rai and Sons, New Delhi
2. M M Agarwal,” Indian Railway Track”, Jaico Publications, Bombay
3. Khanna Arora and Jain, “Airport Planning and Design”, Nem Chand Bros, Roorkee
4. R Srinivasan, “Docks and Tunnel Engineering”, Charotar Publishing House
5. H P Oza and G H Oza, “Docks and Harbour Engineering”, Charotar Publishing House
6. B C Punmia, “Surveying”, Laxmi Publications
7. Mundrey, “Railway Engineering”, McGraw Hill Publications

TRANSPORTATION SYSTEMS

Subject Code	**:**	**18CTE243**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 o n 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, theirintegration and comparison

Highway systems – Road type and classification, road patterns, phasing road development inIndia, salient features of 3rd and 4th twenty year road development plans, Present scenario ofroad 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, typesof 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 individualtransportation, 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

REFERENCE BOOKS:

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', Nem ChandandBros, Roorkee
2. S.C.Saxena and S.P.Arora "A text book of Railway Engineering", Dhanpat Rai publications
3. Vukan R. Vuchic, Urban Transit Systems and Technology, Wiley and Son, New York, 2005
4. Alan Black, Urban Mass Transportation Planning, McGraw-Hill, 1995.

PAVEMENT MANAGEMENT SYSTEM

Subject Code	**:**	**18CTE251**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Discuss the need of PMS in planning and maintaining the flexible pavements.
- Discuss the performance of pavements, causes of failure, rating methods.
- Formulate the development and application of models for pavement management.
- Discuss the need of application of methods of prioritization and application of innovative methods
- Discuss the application of Road Asset Management

OUTCOMES:

After completion of the course the student will be able to

- Identify the factors influencing performance of pavement.
- Carry out structural and functional evaluation of pavements
- Explain the use of models for pavement management.
- Develop a framework for efficient pavement management system
- To apply Road Asset Management

Module 1:

Introduction: Definition -Components of Pavement Management Systems, Essential features.

Pavement Management Levels and functions: Ideal PMS- Network and Project levels of PMS- Influence Levels- PMS Functions- Function of Pavement evaluation.

Module 2:

Pavement Performance: Serviceability Concept- Development of Serviceability Index-PSI-RCI-Roughness- Roughness Components- Evaluation-Equipment- Universal Roughness standard-Techniques-IRI – Application of Roughness Data in Network level and Project Level.

Evaluation of Pavement Structural capacity:- Basics- NDT and Analysis—Condition Surveys- Distress-Destructive Structural Analysis- Application in Network and Project Levels-Methodsand Equipment-Combined Measures of Pavement Quality-Concept-Methods of developing a combined index-limitations.

Module 3:

Evaluation of Pavement Distress and Functional Aspects – Principles- Condition survey- Survey Methodology-Types of Distress-Examples-Equipment-Indexes-Applications of Distressdata- Pavement Safety-Components –Evaluation-Basic Concepts of Skid resistance-Methods of measuring skid resistance-

Effect of Time ,Traffic and Climate on Skid resistance.Establishing Criteria -Rehabilitation and Maintenance.

Module 4:

Expert Systems and Pavement Management - Implementation of Pavement ManagementSystems.

Module 5:

Road Asset Management: Management, Data and Modeling, Planning Application

REFERENCES:

1. Ralph Haas and Ronald W. Hudson, 'Pavement Management System', McGraw Hill Book Co.1978.
2. Ralph Haas, Ronald Hudson Zanieswki. 'Modern Pavement Management, KreigerPublications, New York, 1992.
3. PIARC Guidelines
4. Proceedings of North American Conference on Managing Pavement, USA, 2004.
5. Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports, USA, 2006.

TRANSPORTATION STRUCTURES

Subject Code	**:**	**18CTE252**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 separationstructures, 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.

Module 5:

Design of Pre-stressed Concrete Bridges: Design code, design examples.

Module 6:

Segmental Box bridges - precast sections, criteria, design examples

Module 7:

Sub-Structure Design: Foundation investigation, bearings, bridge pier design, and abutmentdesign, Examples.

REFERENCES:

1. Raina,R.K, 'Principles of Design of RCC Bridges, Tata McGraw Hill,1999.
2. Krishnaraju ‘Bridge Engineering‘, UPD Publishers, New Delhi,2000.
3. Conrad P. Heins and Richard A. Lawrie, `Design of Modern Concrete Highway Bridges, John Wiley and Sons, 1999.
4. Baider Bakhtand Leslie, G.Jaeger,` Bridge Analysis Simplified, McGrawHill Book Co,1998.
5. Johnson Victor, `Bridge Engineering', Oxford IBH, NewDelhi, 2000.

REMOTE SENSING AND GIS IN TRANSPORT PLANNING

Subject Code	**:**	**18CTE253**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 transportationproblems.

OUTCOME:

After the completion of the course students should be

- 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:

Introduction to remote sensing : Definition – Components of Remote Sensing – Energy, Sensor, Interacting Body –Active and Passive Remote Sensing – Platforms– Aerial and Space Platforms – Balloons, Helicopters, Aircraft and Satellites – Electromagnetic Radiation– EMR Spectrum.

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 – Datastorage – 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 Imageries

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)

REFERENCE BOOKS:

1. Anji Reddy, Remote Sensing and Image Interpretation, John Wiley and Sons Inc. New York, 1987.
2. M.G.Srinivas, Remote Sensing Applications, Narosa Publishing House, 2001
3. Burrough P.A, Principles of GIS for Land ResourcesAssessment, Oxford Publication, 1994.
4. Jeffrey Star and John Ester, Geographical Information System – An Introduction, Prentice Hall Inc., Englewood Cliffe, 1990.
5. Marble, D.F, Calkins, H.W and Penquest, Basic Readings in GIS, Speed System Ltd., New York, 1984

TRANSPORTATION ENGINEERING LAB

Subject Code	**:**	**18CTEL26**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

Illustrate application of soft computing techniques for solving transportation problems

- Illustrate the application of software for analyzing traffic survey data
- Evaluation of Pavement functional and structural condition
- Explain and illustrate generation of models for transportation planning
- 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
- Identify the adequacy of the pavement performance- functional and structural.
- Analyse and generate models for transportation planning.
- Design the geometry of highways.

PART - A: LAB Components

Module 1: ANALYSIS OF TRAFFIC SURVEYS

Classified volume count survey

Highway capacity Estimation.

Moving car method

LoS study

Origin and destination studies

Environmental impact – Noise studies and vehicular emission measurement

Lighting studies

Delay studies.

Headway and Gap-acceptance studies.

Pedestrian Survey.

Parking studies

Road Safety Audit.

Module 2: PAVMENT EVALUATION LAB

Road inventory

Pavement Condition Studies

Skid Resistance Studies

Stone Polishing Value Studies

Road Roughness Measurement

Benkelman Beam Deflection Studies

PART B: Demonstration and Assignment

Module 3: HIGHWAY GEOMETRY

Design of horizontal alignment, vertical alignment, generating cross section and design ofintersections.

Module 4: TRANSPORTATION PLANNING: (Data will be provided to compute the following)

Trip generation modeling

Mode choice/modal split problems

Trip assignment problems

Module 5: Introduction to Use of Software Related to Transportation Engineering

PAVEMENT EVALUATION & ECONOMIC ANALYSIS PACKAGES:

DAMA Package

Ken layer & Ken slab

Economic Analysis Package

HDM – IV

IIT PAVE

TRAFFIC ENGINEERING PACKAGES:

Signal Design

TRANSIT

SYNCRO

ACCIDENT ANALYSIS PACKAGE

TIME SERIES PACKAGE

REFERENCE BOOKS:

1. User Manuals of various packages
2. Relevant IRC publications
3. C.S.Papacostas and P.D.Prevedouros “Transportation engineering & Planning”, PHI learning
4. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering’, Nem Chandand Bros, Roorkee

Syllabus for
Third Semester M. Tech. in
TransportationEngineering
(OUTCOMEBASEDEDUCATION(OBE) andCHOICEBASEDCREDITSYSTEM-2018-2019ONWARDS)

PAVEMENT CONSTRUCTION TECHNOLOGY

Subject Code	**:**	**18CTE31**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Explain concept of location surveys, procedure of preparing project report, documentation of contract.
- 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 sub base, 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 furniture

OUTCOMES:

After the completion of the course students should be

- Able to gain knowledge of location surveys, procedure of preparing project report, documentation of contract.
- Able to understand functioning and uses of different types of equipments used in road construction.
- Gain knowledge of application of CPM and PERT in construction planning

Module 1:

Importance of surveys and investigations, Guidelines for alignmentand route location, Use of aerial photographs and remote sensing technology, Conventional ground survey techniques, Types of drawings, Estimates, Project reports, Project Cost Forecasting, Cost Optimization and Resources Planning, Tendering and Contracting, Laws of Contracts, Subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. ; Human Resource Management, Resource Management and Inventory: Basic concepts, labor requirements and productivity.

Module 2:

Road construction equipment – different types of ex cavators, 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

REFERENCE BOOKS:

1. Peurifoy.R.L., 'Construction Planning, Equipment and Methods', McGraw Hill Publishers, New York, 2000
2. S.C.Sharma, ' Construction Equipment and its Management', Khanna Publishers, New Delhi, 1988
3. Asphalt Technology and Construction Practices, The Asphalt Institute, Maryland, USA, 1997
4. Relevant IS, IRC, AASHTO and MoRTH Publications.

ROAD SAFETY AND MANAGEMENT

Subject Code	**:**	**18CTE321**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 newroads.
- 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: 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 onGrades, 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:

Road Safety Audit and Traffic Management Techniques: Principles- Procedures and Practice, Code of Good Practice and Checklists. Road safety issues and engineering, education, enforcement measures for improving road safety. Local area management, Various types of long term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, management and safety practices during road works.

REFERENCE BOOKS:

1. BABKOV, V.F. `Road conditions and Traffic Safety', MIR, publications,Mascow - 1975.
2. K.W. Ogden, `Safer Roads – A Guide to Road Safety Engg.' Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.
3. Kadiyali, L.R., `Traffic Engineering and Transport Planning', Khanna Publications, New Delhi, 2009.
4. C. Jotin Kishty& B. Kent Lall, "Transportation Engineering-An Introduction" , Thrid Edition, Prentice Hall of India Private Limited, New Delhi, 2006
5. Latest Editions of Relevant Indian Roads Congress (IRC) Publications for Design of Roads and Road Safety.
6. Khanna and Justo, 'Text book of Highway Engineering', Nemchand Brothers, Roorkee,2001.

INTELLIGENT TRANSPORTATION SYSTEMS

Subject Code	**:**	**18CTE322**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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:

Introduction to Intelligent Transportation Systems (ITS) – Definition, Objectives, Historical Background, Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

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 andspecification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts.

Module 3

ITS functional areas – Advanced Traffic Management Systems (ATMS) , Advanced Traveler.
Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehic le Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS). ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

Module 4:

ITS Operations – Regional and Project ITS architecture; Concept o f operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deploymentplanning 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, traveldemand 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]

REFERENCE BOOKS:

1. Choudury M A and Sadek A, “Fundamentals of Intelligent Transportation Systems Planning” Artech House.
2. Kan Paul Chen, John Miles, “Recommendations for Wor ld Road Association (PIARC)” ITS Hand Book 2000.
3. Sussman, J. M., “Perspective on ITS”, Artech House Publishers, 2005.
4. US Department of Transportation, “National ITS Architecture Documentation”, 2007 (CD- ROM).
5. Turban. E and Aronson. J. E, “Decision Support Sys tems and Intelligent Systems”, Prentice Hall

INFRASTRUCTURE MANAGEMENT

Subject Code	**:**	**18CTE323**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

- Discuss the need of Infrastructure Management in planning and maintaining the Infrastructures
- Discuss the performance of Infrastructures, causes of failure, rating methods
- Formulate the development and application of models for Infrastructure management
- Discuss the need of application of methods of prioritization and application of innovative methods.

OUTCOMES:

After completion of the course the student will be able to

- Identify the factors influencing performance of Infrastructure
- Carry out structural and functional evaluation of infrastructure
- Explain the use of models for Infrastructure management
- Develop a framework for efficient Infrastructure management system

Module 1:

The Challenge of Managing Infrastructure- Infrastructure and Society-Definition- Infrastructure Assets-Life cycle analysis-Infrastructure Crisis-Infrastructure Management- An integrated approach.

Module 2 :

Framework for Infrastructure Management: Background-Key issues-Application of systemMethodology-Development of IMS- Life cycle analysis Concept.

Planning, Needs, Assessment and Performance Indicators: Planning-Examples on planning- Life Cycle Management-Infrastructure Service life- Needs Assessments- Performance.

Module 3 :

Database Management: Information Management-Database Development and Management- Needs-Analysis and Modeling Techniques-Security-Quality Control and assurance Issues.

In-service Monitoring and Evaluation Data :-Needs- In service evaluation of Physical assets- Technologies for Evaluation- Methods- Issues- Examples-Road and Airport Pavements-Rail Road Tracks-Bridges-Buildings.

Module 4:

Performance Modeling and Failure Analysis: Performance evaluation-Modeling-FailureAnalysis.

Design and Construction for Infrastructure Service life:- Introduction-Design-Objectives and Constraints-Design Framework-Design Effectiveness- Construction-Construction as related to other phases of Management- Constructability-Quality Control and Quality assurance.

Module 5:

Maintenance, Rehabilitation, and Reconstruction (M,R & R) Strategies- Definition- Maintainability-Rehabilitation-Reliability-Maintenance management-Operation–IIMS-Exampleson IIMS.

REFERENCE BOOKS:

1. `Infrastructure Management: Design, Construction, Maintenance, Rehabilitation, Renovation', .W. Ronald Hudson, Ralph Haas and Waheed Uddin, McGraw Hill Co., 1997.
2. `Infrastructure Engineering and Management' Neil S. Grigg, John Wiley and Sons.
3. Modern Pavement Management',W. Ronald Hudson, Ralph Haas and Zeniswki, McGraw Hill and Co.

RURAL ROADS

Subject Code	**:**	**18CTE331**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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 equipment's 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:

Rural Road Planning and Investment : Problems associated with planning of low volume rural roads in India .Rural road network planning- principles and methods. Socio-economic aspects in planning, preparation of rural road master plans and their evaluation: stage construction, planning and utilization of successive investments.

Module 3:

Location Surveys and Geometrics Design : Location surveys, geometric design standards for rural roads, special considerations for rural roads in hilly area.

Module 4:

Materials: Stabilized soils, Design of soil-lime, soil-cement, soil-bitumen and soil-lime-fly ash mixes, Use of soft aggregates. Construction, Operation and Plants: Surveying and setting, excavation, hauling, Shaping and compaction, Stabilized soils-spreading, mixing and compaction. Appropriate technology, tools, plants and equipment for construction as per IRC practices.

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 BOOKS:

1. IRC SP 20, 'Rural Roads Manual, Indian Roads Congress', New Delhi, 2002.
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', Nem Chand and Bros, Roorkee.
3. HMSO, "Soil Mechanics for Road Engineers", Her Majesty's Stationary Office, London.
4. IRC, Manual for Rural Roads, Indian Road Congress, 2002.
5. Relevant IRC Codes & Publications.
6. PIARC, International Road Maintenance Hand Book –Maintenance of Paved Roads, France.
7. PIARC, International Road Maintenance hand Book –Maintenance of Unpaved Roads, France.

ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

Subject Code	**:**	**18CTE332**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

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:

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

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, Industrialeffluents and their impact on natural cycle, Environmental impact of Highways, Mining andEnergy 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.

REFERENCE 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
3. Canter, L.W., (1997), "Environmental Impact Assessment", McGraw Hill Pub. Co., NewYork
4. Grand Jean, E. Gilgen A., “Environmental Factors in Urban Planning”, Taylor and FrancisLimited, London, 1976.
5. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris

PAVEMENT EVALUATION AND MANAGEMENT

Subject Code	**:**	**18CTE333**	**CIE Marks**	**:**	**40**
No. of Lecture Hrs/Week	**:**	**04**	**Exam Hrs**	**:**	**03**
Total no. of Lecture Hrs	**:**	**50**	**SEE Marks**	**:**	**60**

OBJECTIVES:

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

OUTCOMES:

After completion of the course the student should be able to

- Understand importance of evaluation and strengthening of pavements.
- Gain knowedge of various methods of structural and functional evaluation of rigid and flexible pavements
- Formulate the development and application of models for pavement management

Module 1:

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

Module 2:

Functional evaluation of pavements : Evaluation of Surface Condition: Methods of evaluatiAng 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

REFERENCE BOOKS:

1. Yoder, E.J., and Witzack, 'Principles of Pavement Design', 2 nd Edition, John Wiley and Sons
2. Ralph Haas, W.Ronald Hudson and John Zaniewski, Modern Pavement Management, Kreigar Publishing Company, New York
3. M.Y.Stalin, Chapman and Hall Pavement Management for Airports, Roads and Parking Lots, New York
4. Michael Sargious, Pavements and surfacings for Highways and Airports, Applied Science Publishers Limited, London, 1975