Syllabus for
First Semester M. Tech. in
Transportation Engineering & Management

(OUTCOME BASED EDUCATION (OBE) and CHOICE BASED CREDIT SYSTEM - 2018-2019 ONWARDS)

APPLIED STATISTICS

Subject Code	**: 18CTM11**	**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 of transportation engineering problems.

Module 1:

Introduction: Statistical methods, scope and limitations, population and sample, frequency distribution-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 in Highway 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-M method-2 –Phase Simplex method-applications in High way engineering problems

Use of mathematical and statistical software packages.

REFERENCE BOOKS:

1. **Gupta, S.C. and Kapoor V.K.** Fundamentals of Mathematical statistics, Sultan Chand and Sons, 1978.
2. **Medhi J** (1982) Introduction to statistics. New age publications, New Delhi.
3. **Walpole R. E. and R. H. Mayers (1982):** Probability and statistics for Engineers and Scientists. Wiley Intl. 2002.
4. **Johnson R and G. Bhattacharya (1985):** Statistics – principles and methods. John Wiley, N Y.
5. **Ross S. M.** Probability and statistics for Engineers. Wiley Int. Edition.
6. **Kadiyali L.R.** Traffic Engineering and Transport Planning, Khanna Publishers, 2004

TRAFFIC ENGINEERING - I

Subject Code	**: 18CTM12**	**CIE Marks**	**: 40**
No. of Lecture Hrs/Week	**: 04**	**Exam Hrs**	**: 03**
Total no. of Lecture Hrs.	**: 50**	**SEE Marks**	**: 60**

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: Components of road traffic - the vehicle, driver and road. Objectives and scope of traffic engineering.

Module 2:

Traffic Engineering: Road user characteristics; human and vehicle characteristics, factors affecting road traffic; methods of measurement. Concepts of passenger car units for mixed traffic flow.

Module 3:

Traffic Engineering Studies and Analysis: Sampling in traffic studies; adequacy of sample size; application of sampling methods for traffic studies, 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. Traffic manoeuvres and Stream Characteristics; application in intersection design.

Module 4:

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.

Module 5:

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. Evaluation and design of road lighting.

Module 6:

ITS: Introduction to Intelligent Transport System- Application of ITS to Traffic Management System- Public Transportation Management System – ITS Case studies.

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, 2000.
6. Papacostas, C.A., Fundamentals of Transportation Engineering', Prentice-Hall of India Private Limited, New Delhi.2000.
7. William R. McShane and Roger P. Roess, Traffic Engineering', Prentice hall, New Jersey, 2000.

TRANSPORT PLANNING

Subject Code	**: 18CTM13**	**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 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:

Land use and Transportation System: Introduction-Urban system Components-Concepts and definitions-Criteria for measuring urban sprawl— Location theory-urban growth or decline

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:

Trip Generation and Distribution: Factors governing trip generation and attraction – Application of Regression Analysis- Methods of trip distribution; Growth and Synthetic Models-Calibration and Application of gravity model.-Category analysis. Problems

Module 5:

Modal Split and Assignment: Factors affecting modal split; Modal split in transport planning; Principles of traffic assignment; assignment techniques. Problems

Module 6:

Land Use Models – Lowry Model-Hansen's Accessibility Model-Density -Saturation Gradient Model-Problems (Except on Lowry Model)

Module 7:
Mass Transit Systems: Types- Capacity, Fleet planning and Scheduling.

REFERENCE BOOKS:

1. **Kadiyali, L. R**., `Traffic Engineering and Transportation Planning' - Khanna Publication, New Delhi, 2009
2. **JotinKhisty and B. Kent Lall "** Transportation Engineering –An Introduction- PHI, New Delhi, 3rd Indian Edition, 2006.
3. **Hutchinson**, B.G., `Principles of Urban Transport System Planning' - McGraw Hill Book Co., London, UK, 1982.
4. **Institute of Traffic Engineers** - An Introduction to Highway Transportation Engineering 'New York., 1982

PAVEMENT MATERIAL CHARACTERIZATION

Subject Code	**: 18CTM14**	**CIE Marks**	**: 40**
No. of Lecture Hrs/Week	**: 04**	**Exam Hrs**	**: 03**
Total no. of Lecture Hrs.	**: 50**	**SEE Marks**	**: 60**

OBJECTIVES:

- The main objective of this course is to provide students with a thorough understanding of the important factors in pavement design and analysis.
- The focus will be on practices of pavement design highway agencies.

OUTCOME:

After the completion of the course students should

- Determine the proportions of ingredients required for the mix design of both asphalt mixtures and cement concrete.
- Characterize the pavement materials including soil, aggregate, asphalt, cement, asphalt mixtures, cement concrete.
- Select appropriate asphalt binder for construction of a flexible pavement depending upon the traffic and climatic conditions.
- Choose appropriate stabilization technique for pavement.
- Understand the basic of cement & cement concrete Mix characterization.

Module 1:

Subgrade Soil Characterization: Various materials, source, functions, requirements, tests and specifications for use in various pavement layers. Index properties of soils, determination of strength properties of soil for flexible and rigid pavements, suitability of different types of soil for construction of embankment and other pavement layers, Laboratory and field compaction of soil, equipment for field compaction of soil, field compaction control, properties of compacted soils.

Module 2:

Introduction to Soil Stabilization: Introduction, types of stabilization – mechanical, cementing and chemical, proportioning of materials, grouting – principle, grouting materials, grouting plant and equipment, injection methods and applications of grouting. Geosynthetics – introduction, types and applications.

Module 3:

Aggregate Characterization: Origin, process of production of aggregates, sampling of aggregates, properties of aggregates, tests and specifications of aggregates for various layers of flexible and rigid pavements, Importance of aggregate gradation, proportioning and blending of aggregates (Rothfutch's method), Super pave gradation, use of locally available materials in lieu of aggregates.

Module 4:

Bituminous Binders and Mixes: Types of binders, properties and sues of bitumen, physical tests on bitumen, rheological and performance related properties of bitumen, grading of bitumen – penetration, viscosity and performance grading.

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Bituminous cutbacks and emulsions – preparation, types and uses, modified bitumen- CRMB, NRMB, PMB, Criteria for selection of bituminous binders, tests on ageing of bitumen – RTFOT and PAV.
Bituminous mixes – types, requirements, methods of mix design – Marshall, Hveem, Hubbard-field and super pave, tests on bituminous mixes.

Module 5:
Cement and Cement Concrete Mix Characterization: Introduction, ingredients of cement, manufacturing process, types of cement, tests on cement, IS specifications, mix proportioning of cement concrete for pavements, tests on cement concrete, IRC specifications, use of additives in cement concrete, introduction to self-compacted concrete and roller compacted concrete, joint filler and sealer – requirements and functioning.

REFERENCE BOOKS:

1. **R Srinivasa Kumar**, Highway Engineering, Universities Press
2. **Prithvi singh Kandhal**, Bituminous Road construction in India, PHI Publications
3. **Atkins, N. Harold,** Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice-Hall.
4. "Soil Mechanics for Road Engineers"- HMSO Publication
5. "Bituminous materials in Road Construction"- HMSO Publication.
6. MoRTH 'Specifications for Roads and Bridges Works'- Indian Roads Congress

APPLIED SOIL MECHANICS

Subject Code	**:**	**18CTM15**	**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 about 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 Engg. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these.

Module 2:

Soil Compaction: Introduction, Lab Tests, Factors affecting, Structure &Engg behavior of compacted cohesive soil, Field compaction specifications Filed compaction control, Different types of Equipments used for compaction, their choice.

Module 3:

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 4:

Stability of slopes: Introduction, Types, Different methods of analysis of slopes for Øu+0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.

Module 5:

Permeability of soil: Darcy's Law, Validity, Soil-water system, Types, Determination of permeability, problems.

Module 6:

Site Investigation: Introduction, Planning exploration programmes, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods.

Module 7:

Highway Drainage: Introduction, Importance, Surface drainage, Sub-surface drainage, methods, Design of subsurface drainage system, Road construction in water logged areas, Land slides – definition, classifies, factors producing.

Module 8:

Reinforced Earth Structures: Introduction, Components, Advantages, Types of stability – external, Internal, (No problems), Geo textiles – types, Functions, their uses in road embankments and railway works, other uses.

REFERENCE BOOKS:

1. **"Basic and Applied soil Mechanics", GopalRanjan, AS R Rao**, New Age International Publishers.
2. "Soil Mechanics & Foundation Engg**", Dr.B.C. Punmia, Ashok Kumar Jain, Arun**
3. **Kumar Jain**, Laxmi Publications (P) Ltd, 16th edition.
4. "Highway Engg", **S.K. Khanna, C.E.G. Justo,** 5th edit ion.
5. "Soil Mechanics & Foundation Engg" – **K.R. Arora** Standard Publishers Distributors.
6. "Soil Mechanics for road Engineers" – HMSO, London.
7. Relevant IRC – Codes.

PAVEMENT MATERIALS LABORATORY

Subject Code	**:**	**18CTML16**	**CIE Marks**	**:**	**40**
Practical/ Field work	**:**	**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:

Soil: Basic Tests-Gradation-dry and wet-Hydrometer Analysis- Attenberg Limits- Compaction Test- Sp. Gr Test-Density-Sand Replacement Method-Core Cutter method - CBR Test

Module 2:

Coarse Aggregate: Gradation- Routhfutch Method- Shape tests-Aggregate Impact Test- Los Angeles Abrasion Test – Compressive strength of Aggregates- Specific Gravity Test and Water Absorption Test

Module 3:

Cement Concrete: Normal Consistency Test- Sp. Gravity Test on Cement- Fineness test Cement-Compressive strength of Cement- Tests on Fresh Concrete- Tests on Fine Aggregates. Cement Concrete Mix Design

Module 4:

Bitumen: Penetration Test-Ductility Test- Softening point Test-Flash and Fire Point Test-Viscosity test

Module 5:

Bituminous mixes: Proportioning of materials by Rothfutch's method and Mix design by Marshall Method, Stripping Test- Bitumen Extraction Test

Module 6:

Preparation of Feasibility Report, DPR.

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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 Methodology and IPR Syllabus is same for all streams and hence it will be provided by Joint Board of VTU.

Syllabus for
Second Semester M. Tech. in
Transportation Engineering & Management

(OUTCOME BASED EDUCATION (OBE) and CHOICE BASED CREDIT SYSTEM - 2018-2019 ONWARDS)

PAVEMENT ANALYSIS AND DESIGN

Subject Code	**:**	**18CTM21**	**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:

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 Concepts, Traffic Analysis: ADT, AADT, Truck Factor, Growth Factor, Lane Distributions & Vehicle Damage Factors, Effect of Transient & Moving Loads.

Module 2:

Stresses In flexible Pavement: Vehicle-Pavement Interaction: Transient, Random & Damping Vibrations, Steady State of Vibration, Experiments on Vibration, Stress Inducing Factors in Flexible and Rigid pavements; Stress In Flexible Pavements: Visco-Elastic Theory and Assumptions, Layered Systems Concepts, Stress Solutions for One, Two and Three Layered Systems, Fundamental Design Concepts.

Module 3:

Stresses in Rigid Pavements: Westergaard's Theory and Assumptions, Stresses due to Curling, Stresses and Deflections due to Loading, Frictional Stresses, and Stresses in Dowel Bars & Tie Bars.

Module 4:

Design of Flexible Pavements: Factors effecting Design. Deflection studies in Flexible Pavements. Present Serviceability Index. IRC guidelines for Flexible Pavements. Pavement Performance and methods- AASHTO and Asphalt Institute Method.
Need for Overlays, Overlays design methods for Flexible and Rigid pavements.

Module 5:

Design of Rigid Pavements: Factors effecting Design - Wheel load & its repetition, subgrade strength & proportion, strength of concrete - modulus of elasticity. Reinforcement in slab. Design of joints. Design of Dowel bars. Design of Tie bars. IRC and AASHTO methods of Rigid Pavement design.

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 Science Publishers 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

TRAFFIC ENGINEERING –II

Subject Code	**:**	**18CTM22**	**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 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. 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 Forecast: General travel forecasting principles, different methods of traffic forecast - Mechanical and analytical methods, Demand relationships, methods for future projection.

Module 2:

Design Hourly Volume For Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, 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 unsignalised and signalised intersections. Problems in Mixed Traffic flow; Case studies.

Module 4:

Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions.

Module 5:

Traffic Flow Theory: Fundamental How relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications.

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

Simulation: Fundamental principle, application of simulation techniques in traffic engineering, formulation of simulation models, Case studies. Formulation of system models.

REFERENCES:

1. Kadiyali, L.R., 'Traffic Engineering and Transport Planning', Khanna Publications.
2. Drew, D.R., 'Traffic Flow Theory and Control', McGraw Hill Book Co.
3. Pignataro, Louis; 'Traffic Engineering - Theory and Practice', John Wiley.
4. IRC Third Highway Safety Workshop, Lecture Notes 1978 and other IRC publications.
5. Papacostas, C.A., "Fundamentals of Transportation E ngineering", Prentice-Hall of India Private Limited, New Delhi.2000.
6. William R. McShane and Roger P. Roess, Traffic Engineering', Prentice hall, New Jersey,2000.

PAVEMENT CONSTRUCTION AND EQUIPMENTS

Subject Code	**: 18CTM23**	**CIE Marks**	**: 40**
No. of Lecture Hrs/Week	**: 04**	**Exam Hrs**	**: 03**
Total no. of Lecture Hrs.	**: 50**	**SEE Marks**	**: 60**

OBJECTIVES:

- Understand the various equipment used for road construction
- Select suitable equipment for preparation of subgrade in cutting or filling and also the preparation steps for base and sub base layers.
- Able to recognize and use current pavement construction procedures.
- Understanding common construction features important to the performance of both asphalt and concrete pavements.

OUTCOME:

After the completion of the course students should be

- Gain the knowledge on the equipment used for road construction.
- Select suitable equipment for preparation of subgrade and preparation stages for base and sub base layers.
- Understand constructions of non bituminous, bituminous & cement concrete pavements for flexible & rigid pavements.

Module 1:

Components of road and pavement structure including subgrade, drainage system, functions, requirements and sequence of construction operations

Plants and equipment for production of materials - crushers, mixers, bituminous mixing plants, cement concrete mixers – various types, advantages and choice.

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.

Module 2:

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

Module 3:

Bituminous Construction: Preparation and Laying of Tack Coat; Bituminous Macadam ,Penetration Macadam, Built up Spray Grout, Open Graded Premix, Mix Seal, Semi-Dense Asphalt Concrete-Interface Treatments and Overlay Construction, IRC Specifications.

Module 4:

Cement Concrete pavement Construction: Cement Concrete Pavement Analysis - Construction of Cement Roads, Manual and Mechanical Methods, Joints in Concrete and Reinforced Concrete Pavement and Overlay Construction.

REFERENCES:

1. MORTH - Specifications.
2. Peurifoy, R.L., and Clifford,JS "Construction Planning Equipment and Method"- McGraw Hill Book Co. Inc
3. Sharma S.C., "Construction Equipment and its Management"- Khanna Publishers
4. Relevant IRC & ASTM Standards

TRANSPORTATION INFRASTRUCTURE DESIGN

Subject Code	**: 18CTM241**	**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 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:

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

Module 2:

Horizontal Alignment of Roads: Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance ; Objectives of horizontal curves; Super elevation; Extra- widening on Curves; Transition Curves – Objectives and Design. Transition Curve setting methods, Introduction to MX Roads software.

Module 3:

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

Module 4:

Geometric Design of Intersections : Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards.

Module 5:

Miscellaneous Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays –Types and Guide lines; Design of On-street and Off street Parking facilities – Guidelines for lay out Design, Traffic Signs and Markings.

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

REFERENCE BOOKS:

1. AASHO, "A Policy on Geometric Design of Highways an d Streets', American Association of State Highway and Transportation Officials, Washington D.C.
2. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna, 2007.
3. Khanna S.K. and Justo, C. E. G. `Highway Engineering', Nem Chand and Bros.,2000.
4. DSIR, `Roads in Urban Areas', HMSO, London.
5. Jack E Leish and Associates, `Planning and Design Guide: At-Grade Intersections'. Illinios.
6. Relevant IRC Codes & Publications.

THEORIES OF TRAFFIC FLOW

Subject Code	**:**	**18CTM242**	**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. Discrete and continuous probability distributions. Merging manoeuvres - critical gaps and their distribution.

Module 2:

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

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 Transportation Systems - Area Traffic Control – Automatic Toll Col lection – Smart Cards – Collision Detection System.

REFERENCE BOOKS:

1. Drew, D.R., Traffic Flow Theory and Control, McGraw Hill., 1978.
2. TRB, Traffic Flow Theory - A Monograph, SR165, 1975.
3. Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.
4. Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.

TRANSPORTATION SYSTEMS

Subject Code	**: 18CTM243**	**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 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

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	**: 18CTM251**	**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 pavements
- 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-Methods and 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 Distress data- 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 Management Systems.

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, Kreiger Publications, 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	**: 18CTM252**	**CIE Marks**	**: 40**
No. of Lecture Hrs/Week	**: 04**	**Exam Hrs**	**: 03**
Total no. of Lecture Hrs.	**: 50**	**SEEMarks**	**: 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 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.

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 abutment design, 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.

URBAN PUBLIC TRANSPORT

Subject Code	**: 18CTM253**	**CIE Marks**	**: 40**
No. of Lecture Hrs/Week	**: 04**	**Exam Hrs**	**: 03**
Total no. of Lecture Hrs.	**: 50**	**SEE Marks**	**: 60**

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 un loading, selecting suitable traffic management techniques.
- Capable of selecting different demand management techniques, intersection management techniques and small area management.

Module 1:

System and Technologies: Urban passenger transportation modes, transit classifications and definitions, theory of urban passenger transport modes, rail transit, bus transit, Para transit and ride sharing, designing for pedestrians, trends in transit rider ship and use of different modes.

Module 2:

Comparing Alternatives: Comparing costs, comparative analysis, operational and technological characteristics of different rapid transit modes, evaluating rapid transit

Planning: Transportation system management, system and service planning, financing public transportation, management of public transportation, public transportation marketing.

Module 3:

Transit System Evaluation: Definition of quantitative performance attributes, transit lane capacity, way capacity, station capacity, theoretical and practical capacities of major transit modes, quantification of performance

Module 4:

City Traffic: Classification of transportation systems, conventional transportation systems, unconventional transportation systems, prototypes and tomorrow's solutions, analysis and interpretation of information on transportation systems, perspectives of future transportation.

REFERENCE BOOKS:

1. **George E. Gray and Lester A. Hoel. "**Public Transportation", Prentice Hall, New Jersey.
2. **Vukan R Vuchic, "**Urban Public Transportation Systems and Technology", Prentice Hall Inc., New Jersey
3. **Horst R. Weigelt, Rainer E. Gotz, Helmut H. Weiss,'** City Traffic - A Systems Digest', Van Nostrand Reinhold Company, New York
4. **John W. Dickey,'** Metropolitan Transportation Planning', Tata McGraw-Hill Publishing Co. New Delhi.

TRANSPORTATION ENGINEERING LAB

Subject Code	**:**	**18CTML26**	**CIE Marks**	**:**	**40**
Practical/ Field work	**:**	**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 of intersections.

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
Transportation Engineering & Management

(OUTCOME BASED EDUCATION (OBE) and CHOICE BASED CREDIT SYSTEM - 2018-2019 ONWARDS)

TRANSPORTATION ECONOMICS

Subject Code	**:**	**18CTM31**	**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 highway economics, measurements of benefits due to improvements, Present concepts of operations.
- Learn the application of methods of economic evaluation to road way projects.
- Introduce the economic concepts of supply, demand, pricing and market structures.

OUTCOMES:

After the completion of the course students should be

- Able to apply the concepts and tool s of microeconomics.
- Able to understand basic concepts of economic analysis.
- Able to understand depreciation and its application.
- Able to appreciate the basic application of economics.

Module 1:

Introduction: Concepts and Principles of Engineering Economics, Identification and Measurements of Highway Benefits, Highway Transportation Costs, Road User Costs and Benefits- Introduction to PPP - Concepts of BOO, BOT, BOOT, Road User Cost Study in India, Highway Financing.

Module 2:

Methods of Economic Analysis: Basic formulas-Methods- BCR-NPV-IRR –Their Basic Characteristics, Illustrative applications on above Methods of Economic Analysis, Comparison of the Methods of Analysis-, Characteristics and Limitations of the Different Methods of Economic Analysis, Problems on above.

Module 3:

Break Even Analysis-Sensitivity Analysis. Case studies and problems.

Module 4:

Depreciation Concepts: Depreciation Cost, accounting Methods, Salvage Value Estimation, Depreciation, Problems.

Module 5:

Supply and Demand: Concept-Definition-Factors affecting Demand and Supply- Shift in Demand and Supply- Transportation demand Model- Equilibrium-Sensitivity of Travel Demand-Elasticities–determination of Elasticity from regre ssion analysis -Consumer Surplus- Marginal Cost- Average Cost- Pricing- Concept of Road Prising-Problems.

REFERENCE BOOKS:

1. R. PaneerSelvam "Engineering Economics"PHI Learning Pvt. Ltd., New Delhi 2009
2. JotinKhisty and Kent Lall, 'Introduction to Transportation Engineering' PHI, New Delhi,2001.
3. Kadiyali.L.R.' Traffic Engineering and Transport planning', Khanna Publications, New Delhi, 2000.
4. Relevant IRC Codes and Practices
5. James L Riggs, 'Engineering Economics' 4 th Edition, Tata McGrawhill, New Delhi, 2005.
6. Prasanna Chandra, 'Financial Management' 5 th Edition,Tata McGrawhill, New Delhi, 2005

ROAD SAFETY AND MANAGEMENT

Subject Code	**:**	**18CTM321**	**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 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.

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 4:

Road Safety Audit:- Principles- Procedures and Practice, Code of Good Practice and Checklists.Road Safety Issues and Various Measures through Engineering, education and enforcement measures for improving road safety.

Module 5:

Traffic Management Techniques:- Local area management. Transportation system management. Low cost measures, area traffic control. Various types of medium and 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. Economic evaluation of improvement measures by "before and after studies" - Case studies.

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	**:**	**18CTM322**	**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 and specification 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 Vehicle 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 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]

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	**:**	**18CTM323**	**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 system Methodology-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-Failure Analysis.

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-Examples on 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	**: 18CTM331**	**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 equipments required for rural road construction.
- Able design various drainage structures and cross drainage works giving due importance to maintenance activities.

Module 1:

Planning of Rural Roads: Problems associated with planning of low volume rural roads in India.Rural road network planning-principles and methods.

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

Module 2:

Pavement Materials: Soil Investigations ,Properties and Specifications of materials, utilization of locally available and waste ,materials in village road projects like fly ash , iron and steel slag ,recycled and other waste material etc., stabilized roads, road aggregates, materials for bituminous construction , cement and concrete , special pavements .

Module 3:

Pavement Design: Design factors, pavement thickness design as per IRC, internal drainage measures, design of Semi-rigid pavement, roller compacted cement concrete pavement, special pavements like inter locking- block paving, design of fly ash embankments.

Module 4:

Road Drainage: Types of drainage, surface and sub-surface drains for low volume roads.

Module 5:

Construction and Specifications : Earth, Sub-base, Base course and surface course – m aterials , specifications , and construction steps and use of different equipment , construction of special pavements , construction of fly ash embankments ,lime fly ash stabilized soil, lime fly ash bound macadam , lime fly ash concrete ,roller compacted concrete , dry lean fly ash concrete , cement stabilized fly ash , quality control in construction , Specifications and tests for quality control as per IRC .

Module 6:

Maintenance of Rural roads: Types of maintenance, maintenance of unpaved roads, maintenance of paved roads, maintenance of semi-rigid and roller compacted concrete pavements, maintenance of special pavements, Rehabilitation.

REFERENCES BOOKS:

1 HMSO, "Soil Mechanics for Road Engineers", Her Majesty's Stationary Office, London.
2 IRC, Manual for Rural Roads, Indian Road Congress, 2002.
3 Relevant IRC Codes & Publications.
4 PIARC, International Road Maintenance Hand Book –Maintenance of Paved Roads, France.
5 PIARC, International Road Maintenance hand Book –Maintenance of Unpaved Roads, France.

ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

Subject Code	**: 18CTM332**	**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 – Environmental Impact 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, 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.

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., New York
4. Grand Jean, E. Gilgen A., "Environmental Fact ors in Urban Planning", Taylor and Francis Limited, London, 1976.
5. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris

REMOTE SENSING AND GIS IN TRANSPORT PLANNING

Subject Code	**: 18CTM333**	**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 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:

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 – Typ es 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 sto rage – 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 G IS, 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 Resources Assessment, 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.