



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
(Established by an Act No.30 of 2008 of A.P. State Legislature)
 Kukatpally, Hyderabad – 500 085, Andhra Pradesh (India)

R13

M.TECH. (TRANSPORTATION ENGINEERING)
COURSE STRUCTURE AND SYLLABUS

I YEAR - I SEMESTER

| Code | Group | Subject | L | P | C |
|------|-------|--|---|---|----|
| | | Traffic Engineering and Management | 4 | 0 | 3 |
| | | Transportation Infrastructure Design | 4 | 0 | 3 |
| | | Urban Transportation Policy Planning for Sustainable Development | 4 | 0 | 3 |
| | | Pavement Material Characterization | 4 | 0 | 3 |
| | | Elective –I | 4 | 0 | 3 |
| | | Elective- II | 4 | 0 | 3 |
| | | Transportation Engineering Lab -1 | 0 | 4 | 2 |
| | | Seminar | 0 | 3 | 2 |
| | | Total credits (6 theory + Lab) | | | 22 |

I YEAR -II SEMESTER

| Code | Group | Subject | L | P | C |
|------|-------|---|---|---|----|
| | | Traffic Analysis | 4 | 0 | 3 |
| | | Land Use Transportation Modeling | 4 | 0 | 3 |
| | | Highway Project Formulation & Economics | 4 | 0 | 3 |
| | | Pavement Analysis and Design | 4 | 0 | 3 |
| | | Elective – III | 4 | 0 | 3 |
| | | Elective –IV | 4 | 0 | 3 |
| | | Transportation Engineering Lab - II | 0 | 4 | 2 |
| | | Seminar | 0 | 3 | 2 |
| | | Total credits (6 theory + Lab) | | | 22 |

II YEAR -I SEMESTER

| Code | Group | Subject | L | P | C |
|------|-------|-------------------------|---|---|----|
| | | Comprehensive Viva voce | - | - | 2 |
| | | Project Seminar | 0 | 3 | 2 |
| | | Project Work | - | - | 18 |
| | | Total credits | | | 22 |

II YEAR -II SEMESTER

| Code | Group | Subject | L | P | C |
|------|-------|--------------------------|---|---|----|
| | | Project Work and Seminar | - | - | 22 |
| | | Total | | | 22 |

Elective- I & II

Applied statistics
 Engineering of Ground.
 Project management
 Remote sensing and GPS for Transportation Engineering.
 Advanced Concrete Technology
 Transportation System Management

Elective- III & IV

Intelligent transportation systems
 Pavement Construction Maintenance and Management
 Optimization Techniques
 GIS Applications in transportation Engineering
 Environmental Impact assessment for Transportation Projects
 Rural Roads

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

TRAFFIC ENGINEERING AND MANAGEMENT

Unit I:

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

Unit II:

Traffic Studies (Part-II) : Parking Studies: parameters of parking, definitions, Parking inventory study, Parking survey by Patrolling method; Analysis of Parking Survey data; Accident studies- Causative factors of Road accidents, Accident data collection: Accident analysis and modeling;, Road Safety Auditing, Measures to increase Road safety.

Unit III:

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

Unit IV:

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

Unit V:

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

References:

1. Traffic Engineering and Transportation Planning – L.R. Kadiyali, Khanna Publishers
2. Principles of Highways Engineering and Traffic Analysis - Fred Mannering & Walter Kilareski, John Wiley & Sons Publication
3. Fundamentals of Transportation Engineering - C.S.Papacostas, Prentice Hall India.
4. IRC Codes
5. Traffic Engineering - Theory & Practice - Louis J.Pignataro, Prentice Hall Publication.
6. Traffic Engineering by Roger P.Roess, William R. Mc. Shane, Elena S.Prassas , Prentice Hall,1977.
7. Transportation Engineering - An Introduction - C.Jotin Khisty, Prentice Hall Publication
8. Fundamentals of Traffic Engineering – McShane & Rogers.
9. Highway Capacity Manual -2000.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

TRANSPORTATION INFRASTRUCTURE DESIGN

Unit I:

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.

Unit II:

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.

Unit III:

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

Unit IV:

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.

Unit V:

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.

References:

1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna, 2007.
2. Traffic Engineering and Transportation Planning, L.R.Kadiyali, Khanna Publications, 2007.
3. Highway Engineering, C.E.G.Justo and S.K.Khanna, Nem Chand and Brothers.
4. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.

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M. Tech – I year I Sem. (Transportation Engineering)

URBAN TRANSPORTATION POLICY AND PLANNING FOR SUSTAINABLE DEVELOPMENT

Unit I:

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

Unit II:

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

Unit III:

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

Unit IV:

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

Unit V:

Metropolitan cities: Design issues in urban mobility, integrating land use and transport planning; , Overview of urbanization process, city structure and urban activity and infrastructure systems, Economic and social significance of urban infrastructure systems; Transport's Role in tackling Social Inclusion, Economic Impacts of Transport Policy

References:

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

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M. Tech – I year I Sem. (Transportation Engineering)

PAVEMENT MATERIAL CHARACTERIZATION

Unit I:

Subgrade Soil Characterization: Properties of subgrade layers; different types of soils, Mechanical response of soil; 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, DCPT, CPT, CBR, Plate Load test & resilient modulus; Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control. Dynamic properties of soil: FWD test.

Unit II:

Introduction to Soil Stabilization : Physical and Chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control. Introduction to Ground improvement techniques; Introduction to Geo textiles and synthetics applications.

Unit III:

Aggregate Characterization: Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; Proportioning and Blending of aggregates: Super pave gradation, Fuller and Thompson's Equation, 0.45 power maximum density graph; Use of locally available materials in lieu of aggregates.

Unit IV:

Bitumen and Bituminous Concrete Mix Characterization: Bitumen sources and manufacturing, Chemistry of bitumen, bitumen structure, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, stiffness modulus of bitumen mixes using shell nomographs; Resilient, Diametral 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; Introduction to emulsified bitumen and its characterization; 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

Unit V:

Cement and Cement Concrete Mix Characterization:

Types of cements and basic cement properties, Special cements; 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; IS method of cement concrete mix design with case studies; Role of different admixtures in cement concrete performance; Joint fillers for Jointed Plain Cement Concrete Pavements and their characterization; Nano technology applications in cement concrete.

Reference Books:

1. Atkins, N. Harold, Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice-Hall.
2. Kerbs Robert D. and Richard D. Walker, Highway Materials, McGraw-Hill, 1971.
3. Relevant IRC and IS Codes of Practices (Separate List will be given).
4. Read, J. And Whiteoak, D., "*The Shell Bitumen Handbook*", Fifth edition, Shell Bitumen, Thomas Telford Publishing, London 2003
- 5 Relevant IRC and IS codes

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

**APPLIED STATISTICS
ELECTIVE- I & II**

UNIT-I

Introduction to Sampling Techniques and Statistical Distributions:

Frequency distribution; Mean; Standard deviation; Standard error, Skewness; Kurtosis; Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample Size determination; Applications in Traffic Engineering ; Statistical Distributions: Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Mean and variance; Chi-square test of goodness-of-fit; Chi-square distribution; Students T-distribution; Snedectors, F- Distribution. Applications in Traffic Engineering.

UNIT-II

Probability:

Laws of Probability; Conditional probability and Independent events; Laws of expectation. Theorem of total probability and Baye's theorem

UNIT-III

Regression and Correlation:

Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Curvilinear regression models; Applications in Transportation Engineering.

UNIT-IV

Multivariate data analysis:

Types of data; Basic vectors and matrices, Dispersion, Variance and covariance, Analysis of Variance; Correlation matrices; Principal component analysis, Time series analysis

UNIT-V

Tests of Significance & Confidence Interval:

Large sample and small sample tests; Tests for single mean, Means of two samples, Proportions, two variances, two observed correlation coefficients, Applications. Intervals for mean, variance and regression coefficients; Applications in Traffic Engineering problems.

References:

1. Basic Statistics - Simpson and Kafks; Oxford and IBH Calcutta, 1969.
2. Fundamentals of Mathematical Statistics – Gupta, S.C and Kapoor, K.V.Sultanchand.
3. Multivariate Data Analysis –Cootey W.W & Cohens P.R;John Wiley &Sons.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

**ENGINEERING OF GROUND
ELECTIVE- I & II**

UNIT-I

Introduction to Engineering Ground Modification: Need and objectives, Identification of soil types, In situ and laboratory tests to characterize problematic soils; Mechanical, Hydraulic, Physico-chemical, Electrical, Thermal methods, and their applications.

UNIT-II

Mechanical Modification – Deep Compaction Techniques- Blasting Vibrocompaction, Dynamic Tamping and Compaction piles.

UNIT-III

Hydraulic Modification – Objectives and techniques, traditional dewatering methods and their choice, Design of dewatering system, Electro-osmosis, Electro-kinetic dewatering. Filtration, Drainage and Seepage control with Geosynthetics, Preloading and vertical drains,

UNIT-IV

Physical and Chemical Modification – Modification by admixtures, Shotcreting and Guniting Technology, Modification at depth by grouting, Crack Grouting and compaction grouting, Jet grouting, Thermal Modification, Ground freezing.

UNIT-V

Modification by Inclusions and Confinement - Soil reinforcement, reinforcement with strip, and grid reinforced soil. In-situ ground reinforcement, ground anchors, rock bolting and soil nailing.

Text Books

1. Hausmann, M. R. (1990) – Engineering Principles of Ground Modifications, McGraw Hill publications
2. M. P. Moseley and K. Krisch (2006) – Ground Improvement, II Edition, Taylor and Francis

References:

1. Koerner, R. M (1994) – Designing with Geosynthetics – Prentice Hall, New Jersey
2. Jones C. J. F. P. (1985) – Earth Reinforcement and soil structures – Butterworths, London.
3. Xianthakos, Abreimson and Bruce - Ground Control and Improvement
4. K. Krisch & F. Krisch (2010) - Ground Improvement by Deep Vibratory Methods, Spon Press, Taylor and Francis
5. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012.

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M. Tech – I year I Sem. (Transportation Engineering)

**PROJECT MANAGEMENT
ELECTIVE- I & II**

UNIT-I

Introduction to Project Management: A systems Approach, Systems Theory and Concepts, Organisation, Management Functions, Overview of Management Objectives, Tools and Techniques, Project Management – Processes and Organisational Structures – Team Management – Project Manager as a Team Leader – Leadership Qualities, PMIS

UNIT-II

Construction Cost and Value Engineering: Types of Estimates, Implementation of Cost Controls, Project Cost Forecasting, Cost Optimisation and Resources Planning - Value Engineering, Techniques for Project Selection, Break-Even Analysis, Cost Modelling, Energy Modelling, Life Cycle Cost Approach.

UNIT-III

Contract Management: Tendering and Contracting, Laws of Contracts, subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. ; Human Resource Management: Man Power Planning – Training – Motivation – Industrial Relations – Welfare Measures – MIS – Components and Structure – Personal Management; Resource Management and Inventory: Basic concepts, labour requirements & productivity, non-productive activities, site productivity, equipment and material management, inventory control

UNIT-IV

Quality Management and Safety in Construction Industry: Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan – Compensation; Construction Management Practices: Implementation of Procedures and Practices – International Experiences – Case Studies – Examples

UNIT-V

Project Scheduling and Analysis Methods: **CPM, PERT, Linear programming, queuing concept, simulation, bidding models, game theory.**

References:

1. Herold Kerzner - Project Management - A systems approach to Planning, Scheduling and Controlling. CBS Publishers and Distributors.
2. K.Waker A Teraih and Jose M.Grevan; Fundamentals of Construction Management and Organisations.
3. Anghel Patterson - Construction Cost Engineering Handbook - Marcel Dekken Inc.
4. Dell Isola - Value Engineering in Construction Industry, Van Nostrand Reinhold Co.,
5. Choudhary, S. Project Management, Tata McGraw Hill Publishing Co., Ltd.,
6. Raina UK, Construction management Practices, Tata Mc Grawhill Publishing Company Ltd.
7. Sengupta B and Guha H, Construction Management and Planning, Tata McGraw-Hill Publishing Company Limited, New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

**REMOTE SENSING & G.P.S FOR TRANSPORTATION ENGINEERING
ELECTIVE- I & II**

UNIT-I

Remote Sensing:

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

UNIT-II

Pre-Processing Of Remotely Sensed Data:

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

UNIT-III

Enhancement Technique and Filtering Techniques:

Introduction, human visual system, contrast enhancement; Pseudo color enhancement. Thematic information extraction, classification and accuracy assessment and change detection. Hyper spectral and radar sensors

Filtering Technique Classification Low-pass (smoothing filters) High pass (sharpening) filters, edge detection, frequency domain filters, geometrical basis, classification, unsupervised and supervised classification, classification accuracy. Rectification of digital land satellite imagery. Image enhancement, spectral and spatial filtering

UNIT-IV

Global Positioning Systems:

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

UNIT-V

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

References:

1. GPS Satellite Surveys, Alfred Leick, Willey & Sons
2. Principles of Remote Sensing, Paul Jurnani, ELBS, 1985.
3. Computer processing of remotely sensed Images an Introduction – Paul M.Mather, John Wiley & Sons 1989.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

**ADVANCED CONCRETE TECHNOLOGY
ELECTIVE- I & II**

UNIT-I

Concrete Making Materials : Cement – Bogus Compounds – Hydration Process – Types of Cement – Aggregates – Gradation Charts – Combined Aggregate – Alkali Silica Reaction – Admixtures – Chemical and Mineral Admixtures.

UNIT-II

Fresh and Hardened Concrete: Fresh Concrete – workability tests on Concrete – Setting Times of Fresh Concrete – Segregation and bleeding.

Hardened Concrete: Abrams Law, Gel space ratios, Maturity concept – Stress strain behavior – Creep and Shrinkage – Durability Tests on Concrete – Non Destructive Testing of Concrete.

UNIT-III

High Strength Concrete – Microstructure – Manufacturing and Properties – Design of HSC Using Erintryo Shaklok method – Ultra High Strength Concrete.

High Performance Concrete – Requirements and Properties of High Performance Concrete – Design Considerations

UNIT-IV

Special Concretes: Self Compacting concrete, Polymer Concrete, Fibre Reinforced Concrete – Reactive Powder Concrete – Requirements and Guidelines – Advantages and Applications.

Concrete Mix Design: Quality Control – Quality Assurance – Quality Audit - Mix Design Method – BIS Method – DOE Method – Light Weight Concrete, Self Compacting Concrete.

UNIT-V

Form work – materials – structural requests – form work systems – connections – specifications – design of form work – shores – removal for forms - shores – reshoring – failure of form work.

REFERENCES:

1. Special Structural concretes by Rafat Siddique, Galgotia Publications 2000.
2. Design of Concrete Mixes by N.Krishna Raju, CBS Publications, 2000.
3. Concrete: Micro Structure by P.K.Mehta, ICI, Chennai.
4. Properties of Concrete by A.M.Neville, ELBS publications Oct 1996.
5. Concrete Technology by A.R. Santhakumar, Oxford University Press Oct 2006.
6. Concrete Technology by M.S.Shetty, S.Chand & Co 2009.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Transportation Engineering)

**TRANSPORTATION SYSTEM MANAGEMENT
ELECTIVE- I & II**

UNIT-I

TSM philosophy: System approach to Transportation Planning; Long Term Strategies and Short Term Measures; TSM actions- Objectives and Philosophy; Relevance of TSM actions Indian Urban context. Board Spectrum of TSM actions. Measures for Improving vehicular flow – one way Streets, Signal Improvement, Transit Stop Relocation, Parking Management, Reversible lanes- Reducing Peak Period Traffic - Strategies for working hours, Congestion Pricing, Differential Toll Policies.

UNIT-II

Measures to promote transit: Preferential Treatment to high Occupancy Vehicles; Car Pooling; Transit Service Improvement Measures; Transit Management Improvement Measure; Transit and Para transit integration; Para Transit Role in urban areas; Multi-Modal Coordination.

UNIT-III

Bus Route Network Planning and Management: Type of Bus Route Networks; Suitability for a given Urban Area; Types of routes – Corridor routes, activity routes and residential routes; issues in route networks evaluation – number of route, length of route; route alignment methods; service coverage and accessibility index.

UNIT-IV

Promotion of Non – Auto modes: Measures to promote non-auto modes; Pedestrianisation; Bicycle Transportation - advantages; Planning Bicycle Facilities - class I, Class II and Class III bikeways; Junction Treats for cycle tracks; LOS criteria for Pedestrian and bicycle Facilities.

UNIT-V

Advanced Transit Technologies: Conventional and Unconventional Systems; Rapid Transportation System; New technologies – LRT, monorail, Automated Highways- Hovercraft; System Characteristics and Suitability.

References:

1. Transportation System management Notes: S.R.Chari, REC Warangal
2. Metropolitan Transportation Planning, John W Dickey, Tata McGraw Hill
3. The Bicycle Planning, Mike Hudson , Open Books, UK

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M. Tech – I year I Sem. (Transportation Engineering)

TRANSPORTATION ENGINEERING LAB - I

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

Bitumen: Penetration Test- Ductility Test- Softening point Test- Flash and Fire Point test- Viscosity test- Stripping Test- Marshall Stability Mix Design – Analysis, Bitumen Extraction

Cement Concrete: Normal Consistency Test, Sp. Gravity Test on Cement, Fineness test, Compressive strength of Cement, Tests on Fresh concrete-Workability, Tests on Fine Aggregates- Bulking of sand.

Soil: Attenberg Limits – Compaction Test- Density – Sand Replacement Method –CBR Test.

Pavement Evaluation –BBD

Preparation of Feasibility Report, DPR.

References:

1. Highway Engineering – S.K. Khanna & C.E.G. Justo. New Chand & Brothers .
2. Highway material Testing - S.K. Khanna & C.E.G. Justo.
3. **IRC: SP: 19; 2001**, Manual For Survey, Investigation & Preparation of Road Projects.
4. **IRC:81-1997**, Guidelines for Strengthening of Flexible Road Pavement using Benkelman beam Deflection Technique.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year II Sem. (Transportation Engineering)

TRAFFIC ANALYSIS

UNIT-I

Traffic Flow Description: Traffic Stream Characteristics and Description Using Distributions: Measurement, Microscopic and Macroscopic Study of Traffic Stream Characteristics - Flow, Speed and Concentration; Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests.

UNIT-II

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalized Relationship, Fluid Flow Analogy Approach, Shock Wave Theory - Flow-Density diagram use in Shockwave analysis; Use of Time-space diagram for shockwave description; Bottleneck situations and shockwaves; traffic signal and shockwave theory; numerical Examples for application of shockwave theory; Car-Following Theory.

UNIT-III

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Analysis of M/M/1 system; Assumptions and Derivation of System State Equations; Application of M/M/1 analysis for parking Garages and Toll Plazas- numerical Examples; Analysis of D/D/1 system for delay characteristics; Traffic Signal analysis as D/D/1 system; Computation of delays and queue dissipation Time – Numerical Examples.

UNIT-IV

Pedestrian Delays And Gaps: Pedestrian Gap acceptance and delays; Concept of Blocks, Anti-blocks, Gaps and Non-Gaps; Underwood's analysis for Pedestrian Delays; Warrants for Pedestrian Crossing Facilities – Minimum Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant;

UNIT-V

Simulation of Traffic: Introduction, Advantages of Simulation techniques, Steps in Simulation, Scanning techniques, Example of Simulation.

References:

1. Traffic Flow Theory: A Monograph , TRB Special Report 165
2. Fundamentals of Transportation Engineering – C.S.Papacostas, Prentice Hall India Publication
3. Principles of Highway Engineering and Traffic Analysis – F.L.Mannering & W.P.Kilareski, John Wiley Publishers.
4. Traffic Flow Fundamentals – A.D.May, , Prentice Hall India Publication
5. Fundamentals of Traffic Engineering – McShane & Rogers,1977.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year II Sem. (Transportation Engineering)

LAND USE TRANSPORTATION MODELLING

UNIT-I

Land Use And Transportation Engineering:

Transportation modeling in Planning; Models and their role, Characteristics of Transport demand and supply, Equilibrium of supply and demand, Modeling and decision making, Issues in Transportation modeling and structure of the classic transport model.

UNIT-II

Land Use Transportation and Activity Models:

Introduction to Land Use Planning; Relation between Transportation and Land Use Planning; The economic base mechanism and allocation mechanism; Spatial allocation and employment interrelationship; Garin Lowry models.; Activity modeling

UNIT-III

General Travel Demand Models and Regional Transport Models:

Aggregate, Disaggregate models ; Behavioral models; Recursive and direct demand Models; Linear, Non-Linear models; Logit, discriminant and probit models; Mode split models - Abstract mode and mode specific models. Regional Transport Models: Factors affecting goods and passenger traffic; Prediction of traffic; Growth factor models; Time function iteration models; internal volume forecasting models.

UNIT-IV

Regional Network Planning: Problems in Developing Countries, Network Characteristics - Circuitry, Connectivity, Mobility, Accessibility and Level of Service Concepts - Network Structures and Indices – Network Planning – Evaluation - Graph Theory – Cut sets – Flows & Traversing – Optimum Network - Inter-modal Co-ordination. – Rural Road Network Planning.; User equilibrium concepts

UNIT-V

Advanced Spatial analysis Modelling: Applications of Artificial Neural networks, Cellular automata, Fuzzy logic systems, Genetic algorithms, artificial intelligence concepts to transportation Modelling

References:

1. Modelling Transport by Jhan De Dios Ortuzar. Luis E.Willumsen. John Wiley& Sons. 1970/1975.
2. Urban Development Models - Ed. By R.Baxter, M.Echenique and J.Owers; The Institute of Transportation Engineering, University of California.
3. Economic Models and Economic Forecast - Robert S, Pindyek, Daniel L.Rubin Field; McGraw Hill.
4. Land Use Transportation Planning Notes - S.R.Chari, REC Warangal.
5. Regional and Urban Models- A.G.Wilson; Pion, London.
6. Urban Modeling - Michael Batty.
7. Behavioral Travel Demand Models - Peter R. Stopher ARNIM.H.MEYBURG.
8. Introduction to Transportation Engineering and Planning, Morlok EK, McGraw Hill

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M. Tech – I year II Sem. (Transportation Engineering)

HIGHWAY PROJECT FORMULATION & ECONOMICS

UNIT-I

Project Formulation: Project Preparation – Flow Chart for Project preparation. Project Cycle- Project Formulation – Need and Scope of Project Formulation - Various Aspects and Approaches in Project Formulation. Stages in Project Formulation. Preparation of Feasibility Report and DPR – Guidelines.

UNIT-II

Economic Evaluation : Need for Economic Evaluation; Stages involved in Economic Analysis; Cost and Benefit components; Discounting Criteria; Welfare economics; Social costs; Rate of Return; Road User Cost study in India ; Value of Travel time Savings - Economic concept of evaluation of travel time savings; Issues connected with evaluation of travel time savings. Vehicle operating costs - Components of VOC, Accident costs; Methodologies for economic evaluation of an accident.

UNIT-III

Economic Analysis; Basic Concepts of Economic Analysis, Principles of Economic Analysis; Cash flow diagrams; Time value of Money; Development of cash flow Diagrams; Methods of Economic Evaluation -Equivalent Uniform Annual Cost Method; Present worth of cost method;- Equivalent uniform annual net return method; Net present value method; Benefit cost ratio method; Rate of Return Method. Applications of these methods to highway projects.

UNIT-IV

Project appraisal by shadow pricing with case studies; Toll system analysis , Financial analysis ; Budgeting.

UNIT-V

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. **Transportation Engineering Economics - Heggie. I. G.; Mc Graw Hill Publishers.**
2. **Economic Analysis for Highways - Winfrey.R; International TextBook Company.**
3. **Traffic Engineering and Transport Planning - L.R Kadiyali, Khanna Publishers.**
4. **Road User Cost Study, CRR**
5. **Road Project Appraisal, for Developing Countries, J.W.Dickey ,John Wiley & Sons.**
6. **IRC: SP: 19; 2001, Manual For Survey, Investigation & Preparation of Road Projects.**
7. **IRC:SP: 30, Manual on Economic Evaluation of Highway Projects in India.**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year II Sem. (Transportation Engineering)

PAVEMENT ANALYSIS AND DESIGN

UNIT-I

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.

UNIT-II

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;.

UNIT-III

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.

UNIT-IV

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.

UNIT-V

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. Design of Functional Pavements, Nai C. Yang, McGraw Hill Publications
2. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers
3. Principles of Pavement Design, Yoder.J. & Witzorac Mathew, W. John Wiley & Sons Inc
4. Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc.
5. Pavement and Surfacing for Highway & Airports, Micheal Sargious, Applied Science Publishers Limited.
6. IRC:37 & 58 Codes for Flexible and Rigid Pavements Design.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year II Sem. (Transportation Engineering)

**INTELLIGENT TRANSPORT SYSTEMS
ELECTIVES- III & IV**

UNIT-I

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

UNIT-II

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

UNIT-III

ITS User Needs and Services and Functional areas – Introduction, 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).

UNIT-IV

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

UNIT-V

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 and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

References:

1. Fundamentals of intelligent transportation systems planning By Mashrur A. Chowdhury, Adel Wadid Sadek
2. Lawrence A. Klein, Sensor technologies and Data requirements of ITS
3. ITS Hand Book 2000: *Recommendations for World Road Association (PIARC)* by Kan Paul Chen, John Miles.
4. Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.
5. National ITS Architecture Documentation, US Department of Transportation, 2007

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year II Sem. (Transportation Engineering)

**PAVEMENT CONSTRUCTION MAINTENANCE AND MANAGEMENT
ELECTIVES- III & IV**

UNIT-I

Pavement management system

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

UNIT-II

Pavement Inventories, Quality Control and Evaluation

Serviceability Concepts ;Visual Rating ;Pavement Serviceability Index; Roughness Measurements ;Distress Modes – Cracking Rutting Etc; Pavement Deflection – Different Methods and BBD, Skid Resistance, Roughness, Safety – Aspects; Inventory System. Causes of Deterioration, Traffic and Environmental Factors, Pavement Performance Modeling Approaches and Methods of Maintaining WBM, Bitumen and Cement Concrete Roads, Quality Assurance; Quality Control – ISO 9000 , Sampling Techniques – Tolerances and Controls related to Profile and Compaction

UNIT-III

Construction of Base, Subbase, Shoulders and Drain

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

UNIT-IV

Bituminous Construction and Maintenance:

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,

UNIT-V

Cement Concrete pavement Construction and Maintenance:

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

References:

1. Haas and Hudson , W. R. Pavement management systems –McGraw Hill publications
2. Sargious, M. A. – Pavements and surfacing for highways and airports – Applied Science Publishers Ltd
3. Bridge and Pavement maintenance- Transportation Research Record no.800, TRB
4. Shahin M.Y, 1994- Pavement management for airports, roads and parking lots
5. Bent Thagesan, 1996- Highway and Traffic engineering for developing countries
6. MORTH - Specifications

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M. Tech – I year II Sem. (Transportation Engineering)

**OPTIMIZATION TECHNIQUES
ELECTIVES- III & IV**

UNIT-I

Linear Programming:

Introduction and formulation of models; Convexity; simplex method; Two phase method; Degeneracy, non - existent and unbounded solutions; Duality in L.P. Dual simplex method, Sensitivity analysis; Revised simplex method; transportation and assignment problems.

UNIT-II

Non-Linear Programming:

Classical optimisation methods; Equality and inequality constraints; Lagrange multipliers; & Kuhn-Tucker conditions; Quadratic forms; Quadratic programming and seal's methods.

UNIT-III

Search Methods:

One dimensional optimisation; Fibonacci search; multi dimensional search methods; Univariate search; gradient methods; steepest descent/ascent methods; Conjugate Gradient method; Fletcher - Reeves method; Penalty function approach.

UNIT-IV

Dynamic Programming:

Principle of optimality; Recursive relations; solution of L.P.Problem; simple examples.

UNIT-V

Integer Linear Programming:

Gomory's cutting plane method; branch and bound algorithm; traveling salesman problem; Knapsack problem; Linear C-1 problem.

References:

1. Introduction to Optimisation - J.C.Pant; Jain Brothers; New Delhi.
2. Optimisation Theory and Applications - S.S.Rao; Wiley Eastern Ltd., New Delhi.
3. Optimisation Method - K.V.Mital; Wiley Eastern Ltd.. New Delhi.

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M. Tech – I year II Sem. (Transportation Engineering)

**GIS APPLICATIONS IN TRANSPORTATION ENGINEERING
ELECTIVES- III & IV**

UNIT-I

Introduction: Definitions of GIS – Components of GIS – Geographic data presentation: maps – mapping process – coordinate systems – transformations – map projections – geo referencing - data acquisition.

UNIT-II

Geographic Data Representation, Storage, Quality and Standards: Storage - Digital representation of data –Data structures and database management systems – Raster data representation – Vector data representation –Concepts and definitions of data quality – Components of data quality – Assessment of data quality –Managing data errors – Geographic data standards.

UNIT-III

GIS Data Processing, Analysis and Modeling: Raster based GIS data processing – Vector based GIS data processing – Queries – Spatial analysis – Descriptive statistics – Spatial autocorrelation – Quadrant counts and nearest neighbour analysis – Network analysis – Surface modeling – DTM; **Data Management:** The data base designs and approaches, 3 classic data models, Nature of geographic data, Spatial data models, Databases for GIS ; Implementation and Maintenance of GIS, Evaluation of alternative systems, System justification and Development of an implementation plan

UNIT-IV

Application of GIS in Transportation Engineering – I : Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning

UNIT-V

Application of GIS in Transportation Engineering – II: GIS applications in environment impact assessment and environment monitoring, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation, Utility management.

References:

1. Lo, C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2002.
2. Burrough, P.A., Principles of Geographical Information Systems, Oxford Publication, 1998.
3. Clarke, K., Getting Started with Geographic Information Systems, Prentice Hall, New Jersey, 2001.
4. DeMers, M.N., Fundamentals of Geographic Information Systems, John Wiley & Sons, New York, 2000.
5. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992
6. Jeffrey, S. & John E., Geographical Information System – An Introduction, Prentice-Hall, 1990
7. Marble, D.F., Galkhs HW & Pequest, Basic Readings in Geographic Information Systems, Sped System Ltd., New York, 1984.
8. GIS for Urban & Regional Planning, Scholten & Stillwen 1990, Kulwer Academie Publisher.
9. GIS A Management, Perspenfi Stan Aronoff, WDL Publisher.
10. GIS By Stonffer

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M. Tech – I year II Sem. (Transportation Engineering)

**ENVIRONMENTAL IMPACT ASSESSMENT FOR TRANSPORTATION PROJETS
ELECTIVES- III & IV**

UNIT-I

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

UNIT-II

Environmental Indicators Indicators for climate Indicators for terrestrial subsystems Indicators for aquatic subsystems Selection of indicators Socioeconomic indicators Basic information Indicators for economy Social indicators Indicators for health and nutrition Cultural indicators Selection of indicators.

UNIT-III

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

UNIT-IV

Environmental Issues in industrial Development: on-site and off-site impacts during various stages of industrial development, long term climate changes, green house effect, industrial effluents and their impact on natural cycle, Environmental impact of highways, mining and energy development

UNIT-V

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

References:

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

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M. Tech – I year II Sem. (Transportation Engineering)

**RURAL ROADS
ELECTIVES- III & IV**

UNIT-I

Planning and Alignment: Planning of Rural Roads, Concept of Network planning, rural roads planning, road alignment and surveys, governing factors on route selection, factors considered for alignment.

UNIT-II

Materials and Pavement Design: introduction, Soil ,material surveys, embankment and subgrade materials, stabilized Soils, Road aggregates, aggregate for base courses, new materials as stabilizers, materials for desert areas, materials for bituminous constructions and surfacing; materials for rigid pavements, special pavement, climatic suitability of concrete materials. Introduction, design procedure, pavement components, design of flexible and rigid pavements, special pavements design, types of drainage, and general criteria for road drainage, system of drainage, surface and subsurface systems.

UNIT-III

Construction and Specifications: introduction, selection of materials and Methodology, Embankment and subgrade, sub – base (granular), base (granular), shoulder, bituminous concrete, semi- rigid pavements, construction, concrete pavements, construction of special pavements, equipment required for different procedures.

UNIT-IV

Waste material for pavement construction: introduction, fly ash for road construction, design & construction, design & construction of fly ash embankment lime fly ash and stabilized soil, lime fly ash pavements, control of compaction, concrete stabilized fly ash with admixtures.

UNIT-V

Quality Control in Construction and Maintenance: Introduction, Pre-requirements, organizational setup, specification and code of practice, Laboratory equipment, Earth and granular layers, bituminous courses, semi- rigid and rigid pavements, special requirements, recovered of quality control data. Distresses/Defects in rigid and flexible pavements, Maintenance and evaluation, inventory roads and inspections, types of Maintenance Activities, Maintenance

References:

1. IRC manual for rural roads. Special publication – 20(2002)
2. HMSO, Soil Mechanics for rural Engineers in, London
3. IRC related code books
4. NRRDA – guidelines and code books

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M. Tech – I year II Sem. (Transportation Engineering)

TRANSPORTATION ENGINEERING LAB - II

Traffic Surveys:

1. Traffic surveys like traffic volume count, turning movements.
2. Origin and Destination Survey.
3. Parking studies.
4. Speed - Moving observer Method .
5. Delay studies.
6. Headway and Gap-acceptance studies.
7. Pedestrian Survey.
8. Road Safety Audit.
9. Traffic noise measurement.
10. User perception survey.
11. Highway capacity Estimation.
12. Videographic Survey
13. MX – Roads.

References:

1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna, 2007.
2. Traffic Engineering and Transportation Planning, L.R.Kadiyali, Khanna Publications, 2007.