ACADEMIC REGULATIONS
COURSE STRUCTURE AND
DETAILED SYLLABUS

CENTRE FOR TRANSPORTATION ENGINEERING

For

M. Tech. (Transportation Engineering)

(Two Year **Full Time** Programme)

JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)
Kukatpally, Hyderabad – 500 085, Telangana, India.

2015

JNTUH COLLEGE OF ENGINEERING HYDERABAD
M.Tech. (Transportation Engineering) – Full Time w.e.f. 2015-16

I YEAR **I – SEMESTER**

S.No.	Subject	L	T	P	Credits
1	Urban Transportation Policy and Planning	4	0	0	4
2	Pavement Material Characterization	4	0	0	4
3	Elective-I	4	0	0	4
4	Elective-II	4	0	0	4
5	Elective-III	4	0	0	4
6	Elective-IV	4	0	0	4
7	Transportation Engineering Lab – I	0	0	4	2
8	Soft Skills Lab	0	0	4	2
	Total Credits				**28**

I YEAR **II – SEMESTER**

S.No.	Subject	L	T	P	Credits
1	Pavement Analysis and Design	4	0	0	4
2	Land Use Transportation Modeling	4	0	0	4
3	Elective-V	4	0	0	4
4	Elective-VI	4	0	0	4
5	Elective-VII	4	0	0	4
6	Elective-VIII	4	0	0	4
7	Transportation Engineering Lab - II	0	0	4	2
8	Seminar	0	0	4	2
	Total Credits				**28**

II YEAR **I – SEMESTER**

S.No.	Subject	L	T	P	Credits
1	Comprehensive Viva Voce				4
2	Project Phase-I				12
	Total credits				**16**

II YEAR **II – SEMESTER**

S.No.	Subject	L	T	P	Credits
1	Project Phase-II & Dissertation				18
	Total credits				**18**

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Elective-I
1. Traffic Engineering
2. Advanced Concrete Technology

Elective-II
1. Transportation Infrastructure Design
2. Transportation System Management

Elective-III
1. Engineering of Ground
2. Road Safety Engineering

Elective-IV
1. GIS Applications in Transportation Engineering
2. Applied Statistics

Elective-V
1. Airport Engineering
2. Intelligent Transportation Systems

Elective-VI
1. Traffic Analysis
2. Rural Roads

Elective-VII
1. Highway Project Formulation and Economics
2. Optimization Techniques

Elective-VIII
1. Pavement Construction, Maintenance & Management
2. Environmental Impact Assessment

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M.Tech. I Year I-Sem (Transportation Engineering)

L	T	P	C
4	0	0	4

URBAN TRANSPORTATION POLICY AND PLANNING

Prerequisites:- Nil

Objectives:

- The course introduces students to the fundamentals of urban transportation planning.
- It familiarizes students with contemporary transportation planning issues and methods of analysis.
- Relationships between transportation and urban land use systems and new tools to address environmental and quality of life impacts of transportation are presented.
- Transportation investment decisions (or lack thereof) have been held accountable for increased economic prosperity or spiraling economic decline.

Course Outcomes:

At the end of the course, the student will be able to:

- Identify urban transportation problems.
- Estimate urban travel demand.
- Plan urban transport networks.
- Identify urban transport corridors.
- Prepare urban transportation plans.

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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L	T	P	C
4	0	0	4

PAVEMENT MATERIAL CHARACTERIZATION

Prerequisites:- Nil

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.

Course Outcomes:

At the end of the course, students will be able to:

- 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.

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.

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L	T	P	C
4	0	0	4

TRAFFIC ENGINEERING
(ELECTIVE-I)

Prerequisites:- Nil

Objectives:

- This module focuses on traffic**,** its properties, measurement, simulation and control. It deals with traffic flow variables and their measurement. Traffic flow and queuing theory is introduced. Survey methods and data analysis techniques required by traffic engineers are presented.
- Introduction to highway capacity & level of service is dealt.
- Parking analysis, traffic safety is discussed as well as traffic control regulation and signal design.
- The pollution due to traffic & its effect on environment are discussed.

Course Outcomes:

At the end of the course, students will be able to:

- Analyze design issues related to parking & traffic signal.
- To understand the detrimental effect of traffic on environment.
- Have good understanding of traffic engineering, know basic quantitative methods required by traffic engineers, understand how different road user groups interact and the consequences for traffic engineering.

UNIT-I:

Traffic Characteristics Measurement And Analysis: Basic traffic Characteristics - Speed, Volume and Concentration. Relationship between Flow, Speed and Concentration. Traffic Measurement and Analysis - Volume Studies - Objectives, Methods; Speed studies – Objectives, Definition of Spot Speed, time mean speed and space mean speed; Methods of conducting speed studies; Presentation of speed study data; Head ways and Gaps; Critical Gap; Gap acceptance studies.

UNIT-II:

Highway Capacity And Level Of Service: Basic definitions related to capacity; Level of service concept; Factors affecting capacity and level of service; Computation of capacity and level of service for two lane highways, Multilane highways and free ways.

UNIT-III:

Parking Analysis and Traffic Safety: Types of parking facilities – On-street parking and Off-street Parking facilities; Parking studies and analysis- Parking Inventory Study, Parking Usage Study By Patrolling, Questionnaire Survey, Cordon Surveys; Evaluation of parking parameters; Parking accumulation, Parking Load, Parking Turnover, Parking Index, Parking Volume. Traffic Safety -Accident studies and analysis; Causes of accidents - The Road, The vehicle, The road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents.

UNIT-IV:

Traffic Control, Regulation Signal Coordination: Traffic Signals –Types of Signals; Principles of Phasing; Timing Diagram; Design of Isolated Traffic Signal by Webster method, Warrants for signalization. Signal Coordination - Signal Co-ordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.

UNIT-V:

Traffic and Environment: Detrimental effects of Traffic on Environment, Air pollution; Noise Pollution; Measures to curtail environmental degradation due to traffic. Sustainable Transportation: Sustainable modes, Transit Oriented Development, ITS based benefits for Environment.

REFERENCES:

1. Traffic Engineering and Transportation Planning – L.R. Kadiyali, Khanna Publishers.
2. Traffic Engineering - Theory & Practice - Louis J.Pignataro, Prentice Hall Publication.
3. Principles of Highways Engineering and Traffic Analysis - Fred Mannering & Walter Kilareski, John Wiley & Sons Publication.
4. Transportation Engineering - An Introduction - C.Jotin Khisty, Prentice Hall Publication.
5. Fundamentals of Transportation Engineering - C.S.Papacostas, Prentice Hall India.
6. I.T.E. Traffic Engineering Hand Book.

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4	0	0	4

ADVANCED CONCRETE TECHNOLOGY (ELECTIVE-I)

Prerequisites:- Nil

Objectives:

- This course will provide the students with state-of-the art knowledge on durable and sustainable cement and concrete, on the various mineral additions and chemical admixtures to enhance the workability, strength, durability and sustainability of concrete, and will empower them in the decision making process regarding the various concrete products, construction procedures and performance test methods that will improve the durability and sustainability of concrete civil infrastructure.

- This course will empower students to become technical leaders in the concrete .The materials science aspects of concrete production will be explored in the context of various performance criteria with emphasis on durability and sustainability. The process of material selection, proportioning, mixing, transporting, placing and curing concrete will be the main focus, augmented with technology of admixtures use; green cements and concrete products.

- This comprehensive course is designed to provide students with an in-depth understanding of the fundamentals of concrete. Covered in detail is information about constituent materials, specification and production, concrete properties and performance as well as basic practical applications. The course is widely acknowledged by industry as the first step in obtaining a recognized qualification for candidates with some prior knowledge or experience in the field.

Course Outcomes:

At the end of the course, students will be able to:

- Identify Quality Control tests on concrete making materials.
- Understand the behavior of fresh and hardened concrete.
- Design concrete mixes as per IS and ACI codes.
- Understand the durability requirements of concrete.
- Understand the need for special concretes.
- Design form work.

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 Erintroy 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.

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L	T	P	C
4	0	0	4

TRANSPORTATION INFRASTRUCTURE DESIGN (ELECTIVE-II)

Prerequisites:- Nil

Objectives:

- Students will develop a good command of the concepts involved in geometric design of intersections, horizontal , vertical alignment of roads & pedestrian facilities.
- Describe the urban street hierarchy and functional classification system.
- Identify and define the elements of a roadway cross-section and discuss concepts related to the roadway design speed.
- Discuss alignment and grade elements including sight distance; horizontal and vertical curves; and terrain and acceptance grades for urban , local and collector streets.
- Define the functional area of an intersection. Identify key design elements for intersections.
- Identify pedestrian street crossing issues.

Course Outcomes:

At the end of the course, the student will be able to:

- Design the longitudinal and cross sectional elements of a highway.
- Design the horizontal and vertical alignment of roads.
- Design the intersections, interchanges, and parking facilities.
- Design the facilities for bicyclists and pedestrians.

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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L	T	P	C
4	0	0	4

TRANSPORTATION SYSTEM MANAGEMENT (ELECTIVE-II)

Prerequisites:- Nil

Objectives:

This courses will

- Discuss systems approach of transportation planning.
- Discuss various principles of transit vehicles, their differing operating environments and how they effect urban street design.
- Describe bus route networks and issues in route evaluation.
- Discuss measure to promote non auto modes.
- Study the characteristics of advanced transit technology.

Course Outcomes:

At the end of the course, students will be able to:

- Understand TSM, the need for TSM and the objectives of TSM.
- Understand the types of TSM strategies.
- Recommend methods to manage a transit system to improve its management efficiency.
- Understand the concepts of bus route networks and issues in route evaluation.
- Understand the importance of non auto modes and advanced transit technology.

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 Polling; 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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L	T	P	C
4	0	0	4

ENGINEERING OF GROUND
(ELECTIVE-III)

Prerequisites:- Nil

Objectives:
- This course will provide an introduction to the design and philosophy of geotechnical site investigations and a legislation element incorporating contaminated land.
- Students will learn about the range of exploration and testing techniques available.
- Students will also learn how investigations are planned and how the results of investigations relate to the design process.

Course Outcomes:
At the end of the course, students will be able to:
- Identify ground conditions and suggest method of improvement.
- Design and assess the degree of improvement.
- Understand the principles of soil reinforcement and confinement in engineering Constructions.
- Design reinforced soil structures.

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

- Hausmann, M. R. (1990) – Engineering Principles of Ground Modifications, McGraw Hill publications.
- 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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L	T	P	C
4	0	0	4

ROAD SAFETY ENGINEERING
(ELECTIVE III)

Prerequisites:- Nil

Objectives:
- This course discusses the fundamentals of traffic engineering & some of the statistical methods to analyze the traffic safety.
- The accident investigation and risk involved with measures to identify the causes are dealt.
- The various traffic management systems for safety & safety improvement strategies are dealt.

Course Outcomes:
At the end of the course, students will be able to:
- To understand fundamentals of Traffic Engineering.
- To investigate, determine the collective factors & remedies of accidents involved.
- To design & plan various road geometrics.
- To manage the traffic system from road safety point of view.

Unit I:
Fundamentals of Traffic Engineering - Basic Characteristics of Motor-Vehicle Traffic, Highway Capacity, Applications of Traffic Control Devices, Traffic Design of Parking Facilities, Traffic Engineering Studies; Statistical Methods in Traffic Safety Analysis – Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons.

Unit II:
Accident Investigations and Risk Management, Collection and Analysis of Accident Data, Condition and Collision Diagram, Causes and Remedies, Traffic Management Measures and Their Influence on Accident Prevention, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements, Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectiveness of Safety Design Features, Accident Reconstruction.

Unit III:
Road Safety in Planning And Geometric Design: Vehicle And Human Characteristics, Road Design and Road Equipments, Redesigning Junctions, Cross Section Improvements, Reconstruction and Rehabilitation of Roads, Road Maintenance, Traffic Control, Vehicle Design and Protective Devices, Post Accident Care.

Unit IV:
Role of Urban infrastructure design in safety: Geometric Design of Roads; Design of Horizontal and Vertical Elements, Junctions, At Grade and Grade Separated Intersections,Road Safety in Urban Transport, Sustainable Modes and their Safety.

Unit V:

Traffic Management Systems for Safety, Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Approach to Safety, Road Safety Improvement Strategies, ITS and Safety.

References:

1. Traffic Engineering and Transportation Planning – L.R. Kadiyali, Khanna Publishers.
2. Fundamentals of Transportation Engineering - C.S.Papacostas, Prentice Hall India.
3. Transportation Engineering – An Introduction, C.Jotin khisty, B. Kent Lall.
4. Fundamentals of Traffic Engineering, Richardo G Sigua.
5. Handbook of Road Safety measures, second Edition, Rune Elvik, Alena Hoye, Truls Vaa, Michael Sorenson.
6. Road Safety by NCHRP.

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4	0	0	4

GIS APPLICATIONS IN TRANSPORTATION ENGINEERING
(Elective – IV)

Prerequisites:- Nil

Objectives:
This course will focus on introducing students to the use of geographic information systems in the urban environment for transportation engineering.

The objectives of the course are to :
- Understand the purposes of GIS and the kinds of problems to which GIS is applied.
- Understand the fundamental types of GIS data, including raster and vector data.
- Explain and perform spatial data retrieval tasks.
- Use GIS operators to perform a number of kinds of analyses.
- Use GIS to support personal and professional decision making.
- Be aware of geographic information that is available on the World Wide Web.
- Understand the limitations of geographic information systems and of geographic data in general.

Course outcomes:
At the end of the course, students will be able to:
- Describe the functional basis of GIS.
- Appreciate the potential uses of GIS in transportation engineering.
- Consider the benefits and shortcomings of using GIS for transportation engineering.
- Outline the key data quality issues involved in using GIS for transportation engineering.
- Develop a strategy to implement an effective GIS for transportation engineering.

Unit 1 :
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 2 :
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 3 :
GIS introduction 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 neighbor 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; Definitions of GIS – Components of GIS – Geographic data presentation : maps – mapping process – Coordinate systems – Transformations- map projections – geo referencing – data acquisition.

Unit 4.

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 5.

Application of GIS in Transportation Engineering – II : GIS applicatios 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 Jersy, 2001.
4. DeMers, M.N., Foundamentals of Geographic Information Systems, John Wiley & Sons, New York, 2000.
5. Geo Information Systems – Applications of GIS and Related Spatial Information Technolgoes, 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.
9. GIS A management, Perspenfi Stan Aronoff, WDL Publisher.
10. GIS By Stonffer.

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APPLIED STATISTICS

(ELECTIVE IV)

Prerequisites:- NIL

Objectives:

The students of Transportation Engineering will acquire knowledge to

- Understand the qualitative and quantitative study of the frequency distributions.
- Identify the scientific methods of sampling and fitting the suitable distribution to the available data.
- Learn the basic concepts of Probability theory.
- Apply the concept of probability in testing the Hypothesis to accept or reject at a given level of significance.
- Learn the methods for analysing multivariate data by finding the relationship between the variables both qualitatively(Correlation) and quantitatively(Regression).
- Analyse the multivariable data through ANOVA.

Course outcomes :-

At the end of the course, students will be able to:

- Find the statistical constants of the frequency distributions which helps in understanding the distribution pattern of the given data points.
- Design sampling strategies depending on the objective of the study of the concerned real world problems.
- Find the probability of the events that arise in random experiments.
- Test the Null hypothesis against alternative Hypothesis in taking decisions to accept or reject the Null hypothesis with certain probability.
- Study the quality of relationship between two or more dependent variables.
- Find mathematical equation for the relationship between the variables.
- Analyse the variations of the data from their means and apply ANOVA.

Unit 1.

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 2.

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

Unit 3.

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

Unit 4.

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 5.

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.
Multivariate Data Analysis –Cootey W.W & Cohens P.R;John Wiley &Sons.

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TRANSPORTATION ENGINEERING LAB - I

Prerequisites:- Nil

Objectives:
The students will acquire knowledge about

- Objective material characterization of aggregate and bitumen.
- Cement and concrete preparations.
- Fundamental tests on soils.
- Preparation of DPR and BBD.

Course Outcomes:
At the end of the course, students will be able to:
- Characterize the pavement materials.
- Perform quality control tests on pavements and pavement materials.
- Conduct test on Aggregate & bitumen.

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.
   IRC:81-1997, Guidelines for Strengthening of Flexible Road Pavement using Benkelman beam Deflection Technique.

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SOFT SKILLS LAB
(Activity-based)

Course Objectives

- To improve the fluency of students in English.
- To facilitate learning through interaction.
- To illustrate the role of skills in real-life situations with case studies, role plays etc.
- To train students in group dynamics, body language and various other activities which boost their confidence levels and help in their overall personality development.
- To encourage students develop behavioral skills and personal management skills.
- To impart training for empowerment, thereby preparing students to become successful professionals.

Learning Outcomes

- Developed critical acumen and creative ability besides making them industry- ready.
- Appropriate use of English language while clearly articulating ideas.
- Developing insights into Language and enrich the professional competence of the students.
- Enable students to meet challenges in job and career advancement.

INTRODUCTION

Definition and Introduction to Soft Skills – Hard Skills vs Soft Skills – Significance of Soft/Life/Self Skills – Self and SWOT Analysis ***and***

1. **Exercises on Productivity Development**
   - Effective/ Assertive Communication Skills (Activity based)
   - Time Management (Case Study)
   - Creativity & Critical Thinking (Case Study)
   - Decision Making and Problem Solving (Case Study)
   - Stress Management (Case Study)
2. **Exercises on Personality Development Skills**
   - Self-esteem (Case Study)
   - Positive Thinking (Case Study)
   - Emotional Intelligence (Case Study)
   - Team building and Leadership Skills (Case Study)
   - Conflict Management (Case Study)
3. **Exercises on Presentation Skills**
   - Netiquette
   - Importance of Oral Presentation – Defining Purpose- Analyzing the audience- Planning Outline and Preparing the Presentation- Individual & Group Presentation- Graphical Organizers- Tools and Multi-media Visuals
   - One Minute Presentations (Warming up)
   - PPT on Project Work- Understanding the Nuances of Delivery- Body Language – Closing and Handling Questions – Rubrics for Individual Evaluation (Practice Sessions)
4. **Exercises on Professional Etiquette and Communication**
   - Role-Play and Simulation- Introducing oneself and others, Greetings, Apologies, Requests, Agreement & Disagreement….etc.

- Telephone Etiquette
- Active Listening
- Group Discussions (Case study)- Group Discussion as a part of Selection Procedure- Checklist of GDs
- Analysis of Selected Interviews (Objectives of Interview)
- Mock-Interviews (Practice Sessions)
- Job Application and Preparing Resume
- Process Writing (Technical Vocabulary) – Writing a Project Report- Assignments

5. Exercises on Ethics and Values

Introduction –– Types of Values - Personal, Social and Cultural Values - Importance of Values in Various Contexts

- Significance of Modern and Professional Etiquette – Etiquette (Formal and Informal Situations with Examples)
- Attitude, Good Manners and Work Culture (Live Examples)
- Social Skills - Dealing with the Challenged (Live Examples)
- Professional Responsibility – Adaptability (Live Examples)
- Corporate Expectations

☞ Note: Hand-outs are to be prepared and given to students.

☞ Training plan will be integrated in the syllabus.

☞ Topics mentioned in the syllabus are activity-based.

SUGGESTED SOFTWARE:

☞ The following software from **'train2success.com'**

- Preparing for being Interviewed
- Positive Thinking
- Interviewing Skills
- Telephone Skills
- Time Management
- Team Building
- Decision making

SUGGESTED READING:

1. Alex, K. 2012. *Soft Skills.* S. Chand Publishers.
2. *Management Shapers*. 2011. Collection of 28 Books by different Authors. Universities Press.
3. Sherfield, Robert M. *2005. et al Cornerstone: Developing Soft Skills*. Pearson.
4. Suresh Kumar,E; Sreehari, P. & Savithri, J. 2011. *Communication Skills and Soft Skills- An Integrated Approach.* New Delhi: Pearson.
5. The ACE of Soft Skills by Gopalaswamy Ramesh & Mahadevan Ramesh. 2013. Pearson Publishers. New Delhi.
6. Patnaik, P. 2011. *Group Discussion and Interview Skills.* New Delhi: Foundation.
7. Sudhir Andrews. 2009. *How to Succeed at Interviews.* New Delhi: Tata McGraw Hill.
8. Sasikumar, V & Dhamija, P.V. 1993. *Spoken English - A Self-Learning Guide to Conversation Practice.* New Delhi: Tata McGraw-Hill.
9. *Dixson, Richard J. Everyday Dialogues in English. Prentice Hall India Pvt Ltd.*
10. Mukhopadhyay. L *et al. 2012. Polyskills. New Delhi: CUP India Pvt Ltd.*
11. Rizvi, M. A. 2005. *Effective Technical Communication.* New Delhi: Tata McGraw Hill.
12. *The Hindu Speaks on Education* by the Hindu Newspaper.
13. Naterop, B. Jean and Revell, Rod. 2004. *Telephoning in English*. Cambridge: CUP.

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PAVEMENT ANALYSIS AND DESIGN

Prerequisites: - Nil

Objectives:

- Engineering analysis of stresses and strains in typical highway pavement structures due to loading from traffic and climate; characterization of paving materials; structural pavement design by IRC, and AASHTO for flexible and rigid pavement are discussed.
- Overlay design for Flexible and Rigid pavement is discussed.

Course Outcomes:

At the end of the course, students will be able to:

- Analyze the stresses and strains in a flexible pavement using multi-layered elastic theory.
- Analyze stresses and strains in a rigid pavement using Westergaard's theory.
- Design a Flexible pavement using IRC, Asphalt Institute, and AASHTO methods.
- Design a Rigid pavement using IRC, and AASHTO methods.
- Design of joints, dowel & tie bars.

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.

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LAND USE TRANSPORTATION MODELLING

Prerequisites:- Nil

Objectives:
- This course covers the fundamentals of land use theory.
- Various land use and travel demand models are discussed.
- Concepts of network planning and advanced spatial analysis are discussed.

Course Outcomes:
At the end of the course, students will be able to:
- Understand the fundamentals of land use theory.
- Apply land use theories for urban region development.
- Apply evolving understanding of development to provide a collaborative, interactive & applied environment for development.
- Develop travel demand models.

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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AIRPORT ENGINEERING
(ELECTIVE-V)

Prerequisites:- Nil

Objectives:
- The module introduces the Airport planning issues along with the designing of Runway.
- The visual aids required for Airport Traffic operation is dealt with the necessary inputs required for efficiency of drainage system in maintenance of the airport.

Course Outcomes:
At the end of the course, the student will be able to:
- Understand the region planning for an airport.
- Design the runway length after considering the correction required for basic runway length.
- Understand the visual aids required for safe landing and takeoff operation in an airport.
- Analyze and Design the Airport drainage.

UNIT-I:
Airport Planning: General- Regional Planning- Development of New Airport- Data Required Before Site Selection- Airport Site Selection- Surveys for Site Selection- Drawings to be prepared- Estimation of Future Air Traffic Needs.

UNIT-II:
Runway Design: Runway Orientation- Basic Runway Length- Corrections for Elevation, Temperature and Gradient- Airport Classification- Runway Geometric Design- Airport Capacity- Runway Configurations- Runway Intersection Design.

UNIT-III:
Structural Design Of Airport Pavements: Introduction- Various Design Factors- Design Methods for Flexible Pavement- Design Methods for Rigid Pavement- LCN System of Pavement Design- Joints in Cement Concrete Pavement- Airport Pavement Overlays- Design of an Overlay.

UNIT-IV:
Visual Aids: General- Airport Marking- Airport Lighting.

UNIT-V:
Airport Grading And Drainage: General- Computation of Earthwork- Airport Drainage- Special Characteristics and Requirements of Airport Drainage- Design Data- Surface Drainage Design- Subsurface Drainage Design.

REFERENCES:
1. Airport Planning And Designing by S.K. Khanna, M.G. Arora.
2. Highway Engineering including Expressways and Airport Engineering by Dr.L.R. Kadyali, Dr.N.B. Lal.
3. Highway Engineering including Airport Pavements by Dr.S.K. Sharma.
4. Transportation Engineering by S.P.Chandola.

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INTELLIGENT TRANSPORTATION SYSTEMS
(Elective- V)

Prerequisites:- Nil

Objectives:
Within the core module students will have been introduced to some of the basic concepts of Intelligent Transport Systems. The detailed objectives are:

- To develop an understanding of various sensor technology of ITS.
- To describe the of ITS architecture and user needs in functional areas of ITS.
- Understand the various applications of ITS.
- Understand how to evaluate technologies, applications and services of ITS.

Course Outcomes:
At the end of the course, students will be able to:
- Differentiate different ITS user services.
- Select appropriate ITS technology depending upon site specific conditions.
- Design and implement ITS components.

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.

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TRAFFIC ANALYSIS
(Elective- VI)

Prerequisites:- Nil

Objectives:
- This module focuses on traffic, its properties, measurement, simulation and control.
- Traffic flow variables and their measurement. Traffic flow and queuing theory is introduced. Survey methods and data analysis techniques required by traffic engineers are presented.
- Analysis of pedestrian delays and warrants.

Course Outcomes:
At the end of the course, students will be able to:
- Estimate basic characteristics of traffic stream.
- Conduct traffic studies and analyze traffic data.
- Understand traffic queue system.
- Understand the pedestrian delays & gaps.
- Understand simulation techniques.

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.

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RURAL ROADS
(Electives- VI)

Prerequisites:- Nil

Objectives:
1. This course focuses on planning of rural roads as well as design of pavements.
2. Various specifications for construction of rural roads is discussed.
3. The importance of quality control in construction and maintenance of rural roads is discussed.

Course Outcomes:
At the end of the course, students will be able to:
- Plan rural road network.
- Gain knowledge of the materials and pavement design for rural roads.
- Understand the construction and specifications for rural roads.
- Understand the importance of quality control in construction and maintenance of rural roads.

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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HIGHWAY PROJECT FORMULATION AND ECONOMICS
(Elective- VII)

Prerequisites:- Nil

Objectives:
The student needs to
- Understand the need & scope of project formulation.
- Learn evaluation of economics of highway projects.
- Understand the concepts of economic analysis and shadow pricing.
- Learn to deal with project analysis and environmental impact assessment.

Course Outcomes:
At the end of the course, students will be able to:
- Understand project formulations & project evaluation.
- Analysis the feasibility of highway projects.
- Demonstrate the need for environmental impact assessment.

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, CRRI.
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.

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OPTIMIZATION TECHNIQUES
(Elective – VII)

Prerequisites:- Nil

Objectives:

- To impart knowledge on different methods of optimization techniques, linear, non-linear, dynamic programming and use of network techniques.

Outcomes:

- The learner will be able to use effectively the different optimization techniques and apply to the appropriate engineering problems.

UNIT-I

Introduction to Optimization: Introduction - Historical developments - Engineering applications of Optimization - Statement of an Optimization problem - Classification of Optimization problems - Optimization Techniques. Optimization by calculus: Introduction - Unconstrained functions of a single variable - Problems involving simple constraints - Unconstrained functions of several variables – treatment of equality constraints - Extension to multiple equality constraints – Optimization with inequality constraints - The generalized Newton-Raphson method.

UNIT- II

Linear Programming: Introduction - Applications of linear programming - standard form of a linear programming problem - Geometry of linear programming problems - Definitions and theorems - Solution of a system of Linear simultaneous equations - Pivotal reduction of a general system of equations - Motivation of the Simplex Method - Simplex Algorithm - Two phases of the simplex method.

UNIT- III

Non-Linear Programming: Introduction - Unimodal Function - Unrestricted search - Exhaustive search - Dichotomous search - Interval Halving method - Fibonacci method - Golden section method - Comparison of elimination methods - Unconstrained optimization techniques - Direct search methods - Random search methos - grid search method - Univariate method - Powell's method - Simplex method - Indirect search methods - Gradient of a function - Steepest descent method - Conjugate gradient - Newton's method.

UNIT-IV

Dynamic Programming: Introduction - Multistage decision processes - concept of sub-optimization and the principle of optimality - computational procedure in dynamic programming - example illustrating the Calculus method of solution - example illustrating the Tabular of solution - conversion of a final value problem into an initial value problem - continuous dynamic programming - Additional applications.

UNIT- V

Network Analysis: Introduction - Elementary graph theory - Network variables and problem types - Minimum-cost route - Network capacity problems - Modification of the directional sense of the network.,Application of Optimization Techniques.

Text Books:

1. Optimization: Theory and Applications by S.S.Rao. New Age International (p) Ltd.
2. Numerical Optimization Techniques for Engineering Design with applications by G.N.Vanderplaats 2007.
3. Elements of Structural Optimization by R.T.Haftka and Z.Gurdal Kluwer academic publishers.
4. Optimum Structural Design by U.Kirsch. Tata Mc Graw Hill.
5. Optimum Design of Structures by K.I.Majid.
6. Introduction to Optimum Design by J.S.Arora. Academic press, 2012 ISBN : 978-0-12-381375-6.

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PAVEMENT CONSTRUCTION MAINTENANCE AND MANAGEMENT
(Elective- VIII)

Prerequisites: - Nil

Objectives:
- Being able to recognize and use current pavement design procedures.
- Understanding common design and construction features important to the performance of both asphalt and concrete pavements.
- The ability to design and recognize specification and construction activities that can improve the performance of pavements.
- Evaluating the condition of pavements through surface condition surveys, smoothness, friction, load/deflection and other evaluation techniques.
- Understanding the basic components of pavement management systems and how they can be used to optimize funding expenditures.

Course Outcomes:
At the end of the course, students will be able to:
- Prepare quality assurance and quality control plans in an attempt to construct better performing pavements.
- Evaluate the pavements based on the functional and structural characteristics.
- Understand constructions of non bituminous , bituminous & cement concrete pavements for flexible & rigid pavements.
- Understand the maintenance of bitumen and cement concrete pavement.
- Understand the construction of base, sub base and drains.

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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ENVIRONMENTAL IMPACT ASSESSMENT
(Elective- VIII)

Prerequisites:- Nil

Objectives:
The students will be able to
- The basic concepts of EIA and its methodologies.
- Impact and assessment of activity on environment.
- Understand environmental audit and legislations.

Course outcomes :
At the end of the course, students will be able to:
- The student will be able to assess the impact of development on environment and prepare a comprehensive plan for the various parameters.
- The student can assess and predict the significance of impact of deforestation**.**

UNIT-I
Basic concept of EIA and Methodologies: Initial environmental Examination, Elements of EIA, - factors affecting E I A Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters. E I A Methodologies: Introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/Benefit Analysis.
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UNIT-II
Impact of Developmental Activities and Land use. Introduction, Methodology for the assessment of soil and ground water, Delineation of study area, Identification of activities.

UNIT-III
Procurement of relevant soil: Quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures. E I A in surface water, Air and Biological environment: Methodology for the assessment of Impacts on surface water environment, Air pollution sources, Generalized approach for assessment of Air pollution Impact.

UNIT-IV
Assessment of Impact of development Activitie- On Vegetation and wildlife,environmental Impact of Deforestation – Causes and effects of deforestation.

UNIT-V
Environmental Audit & Environmental legislation: objectives of Environmental Audit, Types of environmental Audit, Audit protocel, stages of Environmental Audit, on-site activities, evaluation of Audit data and preparation of Audit report. Post Audit activities **:** The Environmental pollution Act, The water ;Act, The Air (Prevention & Control of pollution Act.), Mota Act. Wild life Act. Case studies and preparation : of Environmental Impact assessment statement for various Industries.

Text books:

1. Environmental Impact Assessment Methodologies, by Y. Anjaneyulu, B.S. Publication, Sultan Bazar, Hyderabad.
2. Environmental Science and Engineering, by J. Glynn and Gary W. Hein Ke – Prentice Hall Publishers.

Reference Books:

1. Environmental Science and Engineering, by Suresh K. Dhaneja – S.K., Katania &. Sons Publication., New Delhi.
2. Environmental Pollution and Control, by Dr H.S. Bhatia – Galgotia Publication (P) Ltd, Delhi.

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TRANSPORTATION ENGINEERING LAB - II

Prerequisites:- Nil

Objectives:

- Traffic studies on various surveys like volume, Origin and Destination Survey, speed ,parking studies.
- Issues related to road safety auditing and Highway capacity determinations.
- Demo of MX roads software.

Course Outcomes:

At the end of the course, students will be able to:

- Conduct traffic studies for estimating traffic flow characteristics.
- Determine the capacity and level of service of a highway element.
- Estimate parking requirements and inventory analysis.
- Design traffic signal systems.
- Determine causative analysis of delay.

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.

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SEMINAR

Prerequisites:- NIL

Objectives:

- The Student should be able to collect information on a specialized topic.
- The student shall be able to prepare a technical report.

Course Outcomes:

At the end of the course:

- The student will be able to acquire skills and prepare technical report.
- The student will be able to prepare a technical report on a specialized topic.

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COMPREHENSIVE VIVA VOCE

Prerequisites:- NIL

Objectives:
- The level of student's understanding of all courses is assessed by viva-voce.
- The student should be able to understand the various courses that are offered by the program.

Course Outcomes:
- The assessed students should have acquired the fundamentals of all the courses.

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PROJECT PHASE-I

Prerequisites:- NIL

Objectives:-
- The students are required to execute the P.G. Project after taking up a topic approved by the project review committee.

Course Outcomes:
- The PRC will monitor the progress of the project of the students.

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PROJECT PHASE-II & DISSERTATION

Prerequisites:- NIL

Objectives:-
- The students are required to present the progress of the project after Project Phase-I.

Course Outcomes:
- The PRC will monitor the progress of the project of the students.