**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech. in TRANSPORTATION ENGINEERING**
**Effective from Academic Year 2017- 18 admitted batch**

**COURSE STRUCTURE AND SYLLABUS**

**I Semester**

| Category | Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|---|
| PC-1 | Traffic Engineering and Management | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-2 | Urban Transportation Planning and Management | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-3 | Pavement Material Characterization | 25 | 75 | 4 | 0 | 0 | 4 |
| PE-1 | Engineering of Ground<br>Transportation System Management<br>Bridge Engineering | 25 | 75 | **3** | 0 | 0 | 3 |
| PE-2 | Highway Geometric Design<br>Advanced Concrete Technology<br>Road Safety Engineering | 25 | 75 | **3** | 0 | 0 | 3 |
| OE-1 | ***Open Elective – I** | 25 | 75 | 3 | 0 | 0 | 3 |
| Laboratory I | Transportation Engineering Lab -1 | 25 | 75 | 0 | 0 | 3 | 2 |
| Seminar I | Seminar-I | 100 | 0 | 0 | 0 | 3 | 2 |
| **Total** | | **275** | **525** | **21** | **0** | **6** | **25** |

**II Semester**

| Category | Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|---|
| PC-4 | Traffic Analysis | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-5 | Land Use and Transportation Modeling | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-6 | Pavement Analysis and Design | 25 | 75 | 4 | 0 | 0 | 4 |
| PE-3 | Highway Project Formulation and Economics<br>Environmental Impact assessment for Transportation Projects<br>Airport Engineering | 25 | 75 | **3** | 0 | 0 | 3 |
| PE4 | Pavement Construction Maintenance and Management<br>Intelligent transportation systems<br>Rural Roads | 25 | 75 | **3** | 0 | 0 | 3 |
| OE-2 | ***Open Elective - II** | 25 | 75 | 3 | 0 | 0 | 3 |
| Laboratory II | Transportation Engineering Lab - II | 25 | 75 | 0 | 0 | 3 | 2 |
| Seminar II | Seminar-II | 100 | 0 | 0 | 0 | 3 | 2 |
| **Total** | | **275** | **525** | **21** | **0** | **6** | **25** |

**III Semester**

| Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|
| Technical Paper Writing | 100 | 0 | 0 | 3 | 0 | 2 |
| Comprehensive Viva-Voce | 0 | 100 | 0 | 0 | 0 | 4 |
| Project work Review II | 100 | 0 | 0 | 0 | 22 | 8 |
| **Total** | **200** | **100** | 0 | **3** | 22 | **14** |

**IV Semester**

| Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|
| Project work Review III | 100 | 0 | 0 | 0 | 24 | 8 |
| Project Evaluation (Viva-Voce) | 0 | 100 | 0 | 0 | 0 | 16 |
| **Total** | **100** | **100** | **0** | **0** | **24** | **24** |

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

**# For Project review I, please refer 7.10 in R17 Academic Regulations.**

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**TRAFFIC ANALYSIS (PC - IV)**

**Course Objectives:**
This module focuses on *traffic*, its properties, measurement, simulation, and control. It starts 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. The theory and models behind traffic simulation are followed by an introduction to the VISSIM microscopic traffic simulator Attention is given to the management of different road user groups, including pedestrians of different abilities, buses, trams and cycles, leading to a critical examination of the arguments behind traffic segregation and integration. Methods for the assessment of traffic engineering schemes are presented.

**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 – Mc Shane & Rogers, 1977.

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**LAND USE AND TRANSPORTATION MODELLING (PC - V)**

**Course Objectives:**
This course covers the fundamentals of land use theory and invites students to apply these theories to a specific neighborhood design. The course surveys major historical and contemporary trends in land use, and introduces emerging theories on the future forces affecting the development and functioning of urban regions. We will discuss cities at multiple scales and will apply our evolving understanding to development at the neighborhood scale in locations in the Vancouver area. The course is designed to provide a collaborative, interactive, and applied and community based environment for the development of spatial thinking and basic land use modeling.
This is a required course for Urban Design students and is a foundation for anyone interested in gaining a basic literacy of Urban Design. The course is an entry point into the field from which students can build deeper knowledge and praxis with additional coursework and focused research.

**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, NIT 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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**PAVEMENT ANALYSIS AND DESIGN (PC - VI)**

**Course 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.

**Course Outcomes:**
- 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

**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, Michael Sargious, Applied Science Publishers Limited.
6. IRC: 37 & 58 Codes for Flexible and Rigid Pavements Design.

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**HIGHWAY PROJECT FORMULATION AND ECONOMICS (PE - III)**

**Course Objectives:**

- To understand the need & scope of project formulation.
- Evaluation the economics of highway project.
- The module deals with project analysis 7 environmental impact assessments.

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

- Understand project formulations & project evaluation.
- To analysis the feasibility of highway projects.
- To 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 ofReturn 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.; McGraw Hill Publishers.
2. Economic Analysis for Highways - Winfrey. R; International Text Book 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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**ENVIRONMENTAL IMPACT ASSESSMENT FOR TRANSPORTATION PROJECTS (PE - III)**

**Course Objectives:** To impart knowledge on the effect of various activities on the environment.

**Course Outcomes**: The learner will be able to assess and prepare a comprehensive plan for the various parameters effecting the environment.

**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.

**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 Activities:** 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 protocol, 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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**AIRPORT ENGINEERING (PE - III)**

**Course Objectives:** The module introduces the Airport planning issues along with the designing of Runway. The visual aids required from Airport Traffic operating are dealt with. The necessary inputs required for efficiency drainage system has significance in maintenance the airport.

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

- Introduced the region planning for an airport.
- Design the runway length after considering the correction required for basis runway length.
- Understand the visual aids required for safe landing and takeoff operating of airport.
- Analysis and Design the 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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**PAVEMENT CONSTRUCTION MAINTENANCE AND MANAGEMENT (PE - IV)**

**Course Objectives:**

- Being able to recognize and use current common 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.
- Communicating and promoting good road design and construction practices.

**Course Outcomes:**

- Select appropriate earth moving and compaction equipment depending upon the requirement
- 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
- Evaluate the safety aspects of the pavements specifically in terms of friction and other related distresses
- Select maintenance technique based on distresses intermits.

**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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**INTELLIGENT TRANSPORT SYSTEMS (PE - IV)**

**Course Objectives:**
Within the core module students will have been introduced to some of the basic concepts of Intelligent Transport Systems. The objective of this module is to explore ITS in more detail. The detailed objectives are:

- To develop an understanding of system engineering processes
- To describe the concepts of system architecture and their evolution
- Understand the capability of key technologies
- Understand impact of technology on different modes and movement
- Understand how to evaluate technologies, applications and services

**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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**RURAL ROADS (PE - IV)**

**Course Objectives:** By the end of the course students will be able to:

- Link issues of poverty with rural access and explain the approaches taken by the Rural Roads Project
- Identify key lessons from the case study and Contrast lessons from the case study with their own country context
- Analyse the links between rural access, economic development and poverty alleviation.

**Course Outcomes:**

- Plan rural road network
- Design highway geometrics
- Justify the geometric design standards adopted for low volume roads
- Plan surveys, and prepare survey forms
- Understand the procedure for conducting safety audit
- Design pavements for low volume 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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**TRANSPORTATION ENGINEERING LAB – II**

**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. Highway capacity Estimation.
11. Videographic Survey

**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.