HINDUSTAN UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING

M.Tech. HIGHWAY ENGINEERING
(CURRICULUM 2015-16)
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**SEMESTER – II**

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**ELECTIVES**

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**ELECTIVES**

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OBJECTIVES

To enable the students to

- Design various highway infrastructure projects effectively using computer aided tools.
- Analyze various accident prone zones, thereby reducing fatality rate.
- Evaluate the highway engineering projects considering various criteria.

OUTCOMES

After the completion of this course, the students will be able to

- Design various highway infrastructure projects effectively using computer aided tools.
- Apply the fundamental concepts in Traffic Engineering, Transport Planning, Highway Design and Construction, Sustainable Urban and Transport Development and will be efficient enough to take up field projects.
- Analyze various accident prone zones, thereby reducing fatality rate.
- Evaluate the highway engineering projects considering various criteria.
SEMESTER I

PMA103  PROBABILITY AND STATISTICS  LT P C 3 1 0 4

GOAL
The course will help the students to understand the concepts of probability and statistics and its applications in the field of Traffic and Highway Engineering.

OBJECTIVES
The course enables the students to understand the basic concepts of sampling distributions and the probability functions.

OUTCOMES
The students should be able to
1. Use the sampling principles in the field of Traffic and Highway Engineering.
2. Remember the significance of large samples by using hypothesis testing.
3. Implement the variance design principles in sampling.
4. Interpolate data’s by using probability theories.
5. Explain linear programming in the field of Traffic and Highway Engineering.

UNIT I SAMPLING DISTRIBUTIONS AND ESTIMATION 12
Sampling distributions - Point and interval estimates for population proportions, mean and variance - Maximum likelihood estimate method - Method of moments.

UNIT II TESTING OF HYPOTHESIS 12
Basic definitions of statistical hypothesis - Tests of significance for large samples - single proportion, Difference of proportion, single mean and difference of mean - Small samples - t, Chi-square and FDistributions.

UNIT III DESIGN OF EXPERIMENTS 12
Analysis of variance - One way and Two way Classifications. Completely randomized design - Randomized block design - Latin square design.
UNIT IV  PROBABILITY AND RANDOM VARIABLES

Discrete and Continuous random variables - Moments - Moment generating functions - Standard distributions - Binomial, Poisson, Geometric, Negative Binomial, Uniform, Normal, Exponential, Gamma and Weibull distributions - Two dimensional random variables - Joint, Marginal and Conditional distributions. Multiple and partial correlation and Regression.

UNIT V  LINEAR PROGRAMMING

Basic concepts - Graphical and Simplex method - Applications.

REFERENCES:

2) Dr.A.Singaravelu, Dr.S.Siva Subramanian and Dr.C.Ramachandran, "Probability and Queuing Theory", Meenakshi agency, 20th edition, January 2013.

TOTAL:60 PERIODS
OBJECTIVES

The course enables the students to analyse and design flexible & rigid pavements in roadways and airways.

OUTCOMES

The students would be able to

1. Understand the characteristics of pavement under various climatic conditions,
2. Analyze the Pavement behaviour under various stresses and strain conditions,
3. Design flexible and rigid pavements,

UNIT I PAVEMENT COMPONENTS AND ITS FUNCTION 12

Road Pavements and pavement layers - types, functions, choice Factors affecting design and performance of flexible and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL, VDF due to varying loads and CSA, Subgrade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation Pavement material Characteristics, climatic, drainage and environmental factors, their effects and evaluation.

UNIT II BEHAVIOUR OF FLEXIBLE PAVEMENT 12

Stresses and Deflection / strain in flexible pavements: Application of elastic theory, stresses, deflections / strains in single, two and three layer system, Applications in pavement design. Problems.

UNIT III DESIGN OF FLEXIBLE PAVEMENT 12

Flexible pavement design: Empirical, semi empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt Institute methods, Problems
UNIT IV    DESIGN OF RIGID PAVEMENT

Rigid pavement design: General design principle, Stresses in rigid pavements, stresses due to wheel loads and temperature variations, design of cement concrete pavements (joints and slab thickness) as per IRC guidelines. Design features of CRCP, SFRC and ICBP, Problems.

UNIT V    AIRPORT PLANNING AND DESIGN


TOTAL: 45 PERIODS

REFERENCES

2. Specifications for" Road and Bridge works", Fourth Revision, MoSRT&H(India), 2001
OBJECTIVES

The course enables the students to understand composition of soil and evaluate pavement conditions by conducting various tests.

OUTCOMES

The students would be able to

1. Understand the Soil Composition & its structure,
2. Remember the characteristics of Bitumen mixes,
3. Design Bituminous Mix and Cement Concrete Mix,
4. Evaluate Pavement conditions by conducting various tests.

UINT I       PROPERTIES OF SUBGRADE SOIL AND AGGREGATES         12

Subgrade soil – Soil composition and structure – Soil classification for engineering purposes - Origin, Classification, requirements, properties and tests on road aggregates.

UINT II      PROPERTIES OF BITUMEN                          12

Origin, preparation, properties and tests, constitution of bituminous road binders, requirements – Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests.

UINT III     CHARACTERISTIC OF BITUMINOUS MIXES           12

Bituminous Mixes: Mechanical properties – Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes.

UINT IV      DESIGN OF BITUMINOUS MIX                     12

Weathering and Durability of Bituminous Materials and Mixes – Performance based Bitumen Specifications – Superpave mix design method.
Cement Concrete for Pavement Construction: Requirements, design of mix for CC pavement, joint filler and sealer materials.

**THEORY: 45 PERIODS**

**LAB: 15 PERIODS**

**List of Experiments for Lab**

1. Tests on Bitumen
2. Tests on Aggregates
3. Tests on Soil Sub-Grade

**REFERENCES**

OBJECTIVES

The course enables the students to understand the components of bridge structures and design bridges based on various IRC specifications.

OUTCOMES

The students would be able to

1. Understand the components of bridge structures,
2. Remember the feature and design considerations of prestressed bridges,
3. Design variety of Foundation types based on loading standards,
4. Design Cantilever Bridge, Arch Bridge, Bowstring Girder Bridge etc,

UNIT I  INTRODUCTION


UNIT II  DESIGN OF SUBSTRUCTURE

UNIT III  DESIGN OF SUPERSTRUCTURE  12


UNIT IV  ELEMENTS OF PRESTRESSED CONCRETE BRIDGE DESIGN  12

Size, prestressed force, eccentricity, design of cables, end blocks. Features and Design Consideration Of Bridges: Suspension bridges, cable stayed bridges and their components; bearings – types – design of rocker and roller bearings.

UNIT V  CONSTRUCTION AND MAINTENANCE  12


TOTAL: 60 PERIODS

REFERENCES

OBJECTIVES

The course enables the students to understand the basic concepts of Traffic Engineering and design highway infrastructure considering safety aspects.

1. Remember Traffic volume studies, Origin Destination studies etc.,
2. Design Highway Cross sectional elements,
3. Design at grade Intersections, rotaries and Traffic signals,
4. Evaluating the Road safety Audit.

OUTCOMES

The students would be able to

1. Understand the basic concepts of Traffic Engineering
2. Remember Traffic volume studies, Origin Destination studies etc.,
3. Design Highway Cross sectional elements,
4. Design at grade Intersections, rotaries and Traffic signals,
5. Evaluating the Road safety Audit.

UNIT I BASIC CONCEPTS OF TRAFFIC ENGINEERING 12

UNIT II SURVEYS AND STUDIES IN TRAFFIC ENGINEERING 12
Traffic volume studies, origin destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies.

UNIT III GEOMETRIC DESIGN OF HIGHWAYS 12

UNIT IV DESIGN OF INTERSECTIONS 12

UNIT V HIGHWAY INFRASTRUCTURE AND SAFETY AUDIT 12


REFERENCES

3. AASHTO A Policy on Geometric Design of Highway and Streets

TOTAL: 45 PERIODS
OBJECTIVES

The course enables the students to understand traffic flow pattern and apply advanced techniques in Transportation system.

OUTCOMES

The students would be able to

1. Understand the fundamentals of Traffic Flow,
2. Analyse Macroscopic models of Traffic flow,
3. Apply queuing Theory in traffic flow pattern,
4. Apply Smart cards, Area Traffic Control in Transportation systems.

UNIT I    TRAFFIC FLOW FUNDAMENTALS  12


UNIT II    TRAFFIC FLOW CHARACTERISTICS  12

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

UNIT III    QUEUING THEORY  12

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

UNIT IV    CAR FOLLOWING MODELS  12

Linear and non-linear car following models - Determination of car following variables - Acceleration noise.

TOTAL: 45 PERIODS

REFERENCES

OBJECTIVES

The course enables the students to conduct traffic studies, Environmental impact analysis and design bituminous & concrete mixes.

OUTCOMES

The students would be able to

1. Understand studies on parking, spotspeed and delay,
2. Analyse Environmental impact data for Noise and Air pollution studies,
3. Design dense bituminous mix and pavement quality concrete mix.

LIST OF EXERCISE

Conduct of the following surveys and design related to Transportation Engineering
i) Volume count
ii) Spot speed
iii) Speed and delay studies
iv) Parking studies
v) Origin and destination studies
vi) Physical inventory using total station survey equipment
vii) Environmental impact – Noise studies and vehicular emission measurement
viii) Lighting studies
ix) Tests on bituminous mixture.
x) Design of dense bituminous mixes.
x) Design of pavement quality concrete mix.

TOTAL : 60 PERIODS
LABORATORY EQUIPMENT REQUIREMENTS (For a batch of 25 students)

1. Automatic traffic counter - 2 Nos.
2. Dopplar radar - 2 Nos.
3. Road measurement and data
   acquisition system - 1 No.
5. Five gas analyzer - 1 No.
7. Total station - 1 No.
8. Compression testing machine with
   Flexure test assembly - 1 No.

**Total number of equipments** - 12
OBJECTIVES

The course enables the students to understand Transit Oriented Land Use Development and apply the recent trends in Mass Transportation Planning and Management.

OUTCOMES

The students would be able to

1. Evaluate the performance of Public Transit Infrastructure Planning,
2. Analyse Operation and Management of Transit system,
3. Understand the need for Integrated Approach,
4. Apply the recent trends in Mass Transportation Planning and Management.

UNIT I TRANSIT SYSTEM AND ISSUES 12


UNIT II PUBLIC TRANSPORT SYSTEM 12


UNIT III BUS TRANSIT PLANNING AND SCHEDULING 12

UNIT IV RAIL TRANSIT TERMINALS AND PERFORMANCE EVALUATION 12


UNIT V IMPACT OF MASS TRANSPORT 12


TOTAL: 60 PERIODS

REFERENCES

1. Michael J.Bruton , An Introduction to Transportation Planning, Hutchinson.
3. F.D.Hobbs, Traffic Planning and Design, PoargamonOress
OBJECTIVES

The course enables the students to understand the components of pavement and apply various quality control tests as per specifications.

OUTCOMES

The students would be able to
1. Understand the road construction equipments, pre-construction surveys,
2. Apply various quality control tests as per specifications,
3. Design, Evaluate and Manage Pavement Systems,
4. Design drainage for urban roads.

UNIT I COMPONENTS OF PAVEMENT

Subgrade system, functions, requirements and sequence of construction operations. Plants and equipment for production of materials - crushers, mixers, bituminous mixing plants, cement concrete mixers – various types, advantages and choice.

UNIT II CONSTRUCTION OF DRAINAGE

Drainage – Assessment of drainage requirements for the road and design of various components, drainage materials, Construction of surface and subsurface drainage system and design of filter materials for roads. Drainage for urban roads.

UNIT III CONSTRUCTION EQUIPMENTS

Road construction equipment – different types of excavators, graders, soil compactors / rollers, pavers and other equipment for construction of different pavement layers – their uses and choice Problem on equipment usage charges; Pre-construction surveys and marking on
ground - Specifications and steps for the construction of road formation in embankment and cut, construction steps for granular sub-base, quality control tests.

UNIT IV PAVEMENT LAYERS AND SPECIFICATIONS

Different types of granular base course – WMM, CRM, WBM; specifications, construction method and quality control tests. Different types of bituminous layers for binder and surface courses; their specifications (as per IRC and MORTH); construction method and quality control tests. Different types of sub-base and base course for cement concrete (CC) pavement and construction method. Construction of cement concrete (PQC) pavements joints quality control during construction. Construction details of interlocking concrete block pavements.

UNIT V QUALITY CONTROL AND MAINTENANCE

Principle of construction planning, application of CPM and PERT( Problems not included) Road maintenance works – day to day and periodic maintenance works of various components of road works and road furniture. Preparation of existing pavement – patching, profile correction, Special measures to deal with reflection cracks in pavement layers, slipperiness of surface, etc. Special problems in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes.

REFERENCES

3. Freddy L Roberts, Prithvi S Kandhal et al, —Hot Mix Asphalt Materials, mixture design and construction- (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA.
5. “Hand Book on Cement Concrete Roads”- Cement Manufacturers Association, New Delhi
OBJECTIVES

The course enables the students to understand the principles of Transportation planning, Town planning concepts and evaluate Land Use Transport Models in Transportation projects.

OUTCOMES

Students would be able to

1. Understand the Concepts of four stage modeling,
2. Remember the classification of Trips based on generation and distribution,
3. Analysis of Network in modeling.
4. Evaluate Land Use Transport Models (LUT).

UNIT I PRINCIPLES OF URBAN TRANSPORT PLANNING 12

Urban Transportation Planning - Goals and objectives - Hierarchical levels of transportation planning - Forecast - Implementation - Constraints. UTP survey – Inventory of land use.

UNIT II FOUR STAGE MODELING PROCESS 12

Trip generation - Trip classification - productions and attractions - Multiple regression models - Category analysis - Trip production models - Trip distribution models – Linear programming approach.

UNIT III MODELING PROCESS AND ANALYSIS 12

UNIT IV  LANDUSE TRANSPORT MODEL


UNIT V  EVALUATION OF LUT

Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – Case studies.

REFERENCES


PHE204  TRANSPORT ECONOMICS AND MANAGEMENT  LTPC 3104

OBJECTIVES

The course enables the students to remember the ideas of vehicle scheduling, optimum fleet size etc. and design depots & terminals economically.

OUTCOMES

Students would be able to

1. Design Depots & Terminals
2. Analyze the projects economically,
3. Understand the importance of Vehicle Operating Cost,
4. Evaluate various transport projects economically.
UNIT I  TRANSPORT PLANNING AND SCHEDULING  12

Motor Vehicles Act - statutory provision for road transport and connected organisations. Route scheduling, Freight transport, Vehicle scheduling, Optimum fleet size, Headway control strategies, Crew scheduling.

UNIT II  DESIGN OF TRANSPORT INFRASTRUCTURE  12

Depots and Terminals - Principles and types of layout, Depot location, Twin depot concept, Crew facilities. Design of parking facilities – Bus terminal, bus stops and bus bays.

UNIT III  TRANSPORT DEMAND SUPPLY CONCEPT  12

Transportation costs - Supply and demand - elasticity of demand; Supply of transport services - Economics of traffic congestion - Pricing policy - Vehicle operating costs – Fuel costs - Maintenance and spares - Depreciation - Crew costs - Value of travel time savings - Accident costs.

UNIT IV  ECONOMIC EVALUATION  12

Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects.

UNIT V  HIGHWAY FINANCING  12

REFERENCES

3. CRRI, Road User Cost Study in India, New Delhi, 1982
OBJECTIVES

The course enables the students to have hands-on experience in ArcGIS and Mx Road Software to analyze geographic features and design L/S and C/S of highways.

OUTCOMES

The students would be able to

1. Analyze geographic features using ArcGIS
2. Design of Highway Alignment,
3. Design of Carriageway,
4. Design of L/S and C/S of highways using Mx Road Software.

ArcGIS

Exercise 1: Exploring your data
Exercise 2: Working with geographic features
Exercise 3: Working with tables
Exercise 4: Editing features
Exercise 5: Working with map elements

Mx Road

Exercise 6: Introduction to Mx Road
Exercise 7: Alignment design
Exercise 8: Carriageway design
Exercise 9: Earthworks calculation
Exercise 10: Visibility
Exercise 11: Sections and Volumes

Lab Requirements:

ArcGIS License for 10 systems
Mx Road license for 10 systems

Total 60 Periods
ELECTIVES
SEMESTER II

PHE701 ROAD SAFETY ENGINEERING LTPC 3 0 0 3

OBJECTIVES

The course enables the students to understand the fundamentals of traffic safety analysis and apply crash reduction techniques.

OUTCOMES

The students would be able to
1. Understand the fundamentals of traffic safety analysis,
2. Analyse Accident data,
3. Remember the concepts of road safety in urban transport,
4. Apply crash reduction techniques,
5. Design of urban Infrastructure considering safety aspects.

UNIT I TRAFFIC SAFETY ANALYSIS 9

UNIT II ACCIDENT ANALYSIS 9
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  URBAN INFRASTRUCTURE DESIGN  
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 SAFETY AUDIT  

REFERENCES
3. Transportation Engineering – An Introduction, C. Jotinkhisty, B. Kent Lall
4. Fundamentals of Traffic Engineering, Richardo G Sigua
OBJECTIVES

The course enables the students to understand the concepts of Remote Sensing and apply recent techniques of Remote Sensing and GIS.

OUTCOMES

The students would be able to

1. Understand the Components of Remote Sensing,
2. Analyse the Raster and Vector Datas,
3. Apply Buffering & Overlaying Techniques,

UNIT I BASIC CONCEPT OF REMOTE SENSING


UNIT II COMPONENTS OF REMOTE SENSING

Basic Concept and Components – Hardware, Software – Data Spatial and non-spatial – Georeferencing – Map Projection – Types of Projection – Simple Analysis – Data retrieval and querying

UNIT III DATA ANALYSIS


UNIT IV GIS IN TRANSPORTATION ENGINEERING

Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries
UNIT V INTEGRATION OF GIS

GIS as an integration technology – Integration of GIS, GPS and Remote Sensing Techniques – Advanced Traveler Information System (ATIS) – Automatic Vehicle Location System (AVLS)

TOTAL: 45 PERIODS

REFERENCES


PHE703 EVALUATION AND STRENGTHENING OF PAVEMENT LTPC 3003

OBJECTIVES

The course enables the students to understand the structural and functional requirements of pavements and evaluate the pavement by non-destructive methods.

OUTCOMES

The students would be able to

1. Understand the factors affecting pavement design,
2. Analyze the behaviour of pavements under various transient traffic loads,
3. Evaluate pavement conditions by destructive and non-destructive methods.

UNIT I TYPES OF PAVEMENT

Introduction- Highway and airport pavements, Types and component parts of pavements, their differences - Factors affecting design and performance of pavements.
UNIT II PAVEMENT BEHAVIOUR AND ITS PERFORMANCE

Stresses and Deflections in Flexible & Rigid Pavements-Stresses and deflections in homogeneous masses. Wheel load stresses, various factors in traffic wheel loads; ESWL and EWL factors. Pavement behaviour under transient traffic loads; Factors affecting design and performance of pavements. Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL, wheel load stresses, warping stresses, frictional stresses, combined stresses.

UNIT III PAVEMENT DISTRESS

Structural and functional requirements of flexible and rigid pavements; Pavement distress; different types of failures & its causes.

UNIT IV EVALUATION OF SURFACE CONDITION

Methods of measurement of skid resistance, unevenness, ruts and cracks.Pavement surface condition evaluation by physical measurements, by riding comfort and other methods; their applications.

UNIT V EVALUATION OF STRUCTURAL CONDITION

Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design, Plate load test, wave propagation and other methods of load tests; evaluation by destructive test methods, and specimen testing.

TOTAL: 45 PERIODS

REFERENCES

5. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements.
6. CMA Hand Book 30
OBJECTIVES

1. The course enables the students to understand the simulation concepts and apply simulation in transportation engineering projects.

OUTCOMES

The students would be able to

2. Understand the Simulation Concepts,
3. Simulate queuing system,
4. Schedule events using GPSS processor,
5. Prepare statistical reports,
6. Validate simulation models.

UNIT I  TRANSPORTATION SYSTEM APPROACH

Introduction to systems approach – Typical transportation systems – Mathematical models. Fundamentals of simulation – Monte Carlo method – Analog and digital simulation Continuous and discrete models – Simulation languages – Introduction to CSMP.

UNIT II CONCEPTS OF ARRIVAL PATTERN


UNIT III EVENT SCHEDULING

Creating and moving transactions – Queues and facilities – Event scheduling – Internal logic of GPSS processor – Program control statements.

UNIT IV STATISTICAL REPORT PREPARATION

UNIT V SIMULATION AND VALIDATION


TOTAL: 45 PERIODS

REFERENCES
2. GPSS/PC, User Manual, Minuteman Software, USA.

PHE705 HILL AND RURAL ROAD PLANNING AND CONSTRUCTION LTPC

OBJECTIVES
The course enables the students to understand the usage of waste materials in hilly and rural roads thereby applying go green concepts under all climatic conditions.

OUTCOMES
At the completion of this module, students would be able to:
1. Design elements such as sight distance, horizontal curvature, super elevation, grades, visibility on vertical curves etc.
2. Apply go green concepts for pavements.
3. Remember climate suitability for concrete materials,
4. Apply quality control tests at different stage of road construction.

UNIT I INTRODUCTION
Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads. Planning and Alignment: Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route
selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues.

UNIT II  GEOMETRIC DESIGN  9
Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, New materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials.

UNIT III  PAVEMENT DESIGN  9
Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, Drainage and Shoulders Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Construction of special pavements, Equipment required for different operations.

UNIT IV  GREEN ROAD CONCEPT AND USE OF WASTE MATERIALS  9

UNIT V  MAINTENANCE  9
General, Distresses/defects in pavements, Definitions of maintenance activities, Inventory of road and inspection, Types of maintenance, Classification of maintenance activities, Maintenance norms, maintenance cost.

TOTAL: 45 PERIODS

TEXT BOOKS
REFERENCES
2. Central Road Research Institute ‘Various Reports on Use of Waste Materials’.

PHE706 ENVIRONMENTAL IMPACT ASSESSMENT LTPC
FOR TRANSPORTATION PROJECTS 3003

OBJECTIVES

The course enables the students to remember Environmental laws and assess impact of traffic on environment.

OUTCOMES

At the completion of this module, students should be able to carryout
1. Understand Environmental Impact Assessment,
2. Apply Motor Vehicle Act & Town and Country Planning Act,
3. Remember Air & Noise Pollution measurements,
4. Apply energy efficiency strategies in variety of Highway projects.

UNIT I ENVIRONMENTAL LAWS
Laws concerned with protection of the environment such as Environmental Protection Act, Air and Noise Pollution Act, Motor Vehicle Act, Town and Country Planning Act, Development Control Regulation, Coastal Regulation Zone.

UNIT II ENVIRONMENTAL IMPACT ASSESSMENT

UNIT III POLLUTION MEASUREMENTS AND ITS IMPACT
Measurement of Air and Noise Pollution, Land Acquisition, Rehabilitation, Collection, Compilation and Presentation of Pollution and Impact Data, Measuring Impact before construction, at the time of construction and after construction, Prediction, Modeling and Validation
UNIT IV MITIGATING MEASURES
Mitigating Measures for Air and Noise Pollution Policies and Strategies, Involvement of Stakeholders, Public Participation, Institutional Arrangements

UNIT V TRAFFIC IMPACT

TOTAL: 45 PERIODS

REFERENCES

3. David Banister; Transport Policy and Environment E&FN Spain, 1999
OBJECTIVES

The course enables the students to understand factors influencing accidents and the need for safety audit.

OUTCOMES

The students would be able to
1. Understand the role of NGO
2. Analyse the causes of road accidents,
3. Apply Accident Prediction Models,
4. Evaluate road safety audit in existing roads.

UNIT I FACTORS INFLUENCING ACCIDENTS 9
Causes of accidents – Human factors – Vehicles – Road and its condition – Environmental Studies

UNIT II ACCIDENT ANALYSIS 9
Collision Diagram – Preparation, Spatial Analysis of Accidents – Methods - GIS in Accident Analysis - Black Spot, Black Route and Area Identification

UNIT III EVALUATION OF ACCIDENT PREDICTION MODELS 9

UNIT IV SAFETY AUDIT 9

UNIT V ACCIDENT INVESTIGATION 9

TOTAL : 45 PERIODS
REFERENCES

OBJECTIVES
The course enables the students to understand the time & resource planning and the contract laws in highway project.

OUTCOMES
The students would be able to
1. Understand various finance policies and programmes related to Urban Planning and Development,
2. Apply Indian and International practices for investment appraisal,
3. Analyze the methodology for planning highway projects,
4. Evaluate feasibility studies on urban projects.

UNIT I HIGHWAY PROJECT FORMULATION
Project formulation – detailed project report – agencies involved in projects – design consultants – supervision consultants – contractors for implementation – Govt agencies – linkages among organizations – environment and social issues – responsibilities of various agencies – discussion on various models

UNIT II TYPES OF FINANCING
Types of financing – financial institutions – internal generation of funds – international commercial borrowings – collaborator’s equity participation – share subscription by overseas investors – other sources

UNIT III INVESTMENT APPRAISAL
Motor vehicle operation cost – value of time of travel – accident cost – other cost – annual highway cost – economic analysis – Indian and International practices of investment appraisal – risk analysis and selection of a project

UNIT IV PROJECT PLANNING
Time and resources planning – project control methodology – resources productivity control – project cost control – project time control – codification of the planning system – network techniques.
UNIT V  CONTRACT FORMATION


TOTAL : 45 PERIODS

REFERENCES

OBJECTIVES

The course enables the students to understand the causes of accidents and apply the measures to mitigate it through accident reduction techniques.

OUTCOMES

The students would be able to design accident free roads and safe infrastructure for road users.

1. Black spot identification
2. Installation of Rumble Strips
3. Conflict points in two way roads – two lanes – four lanes – six lanes
4. Integrated System Approach
5. Land use planning and zoning
6. Efficient control measures and design of control systems
7. Intersection Design -Signal – rotaries – grade separators

REFERENCES

OBJECTIVES

The course enables the students to understand the data collection techniques of ITS and analyze ITS users in developing countries.

OUTCOMES

The students would be able to

1. Understand the historical background of ITS,
2. Apply the ITS Data collection Techniques,
3. Analyze ITS implementation in developing countries.

UNIT I  INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS (ITS) 9
Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques –
Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT II  TELECOMMUNICATIONS IN ITS 9
Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System

UNIT III  ITS FUNCTIONAL AREAS 9
UNIT III    ITS USER NEEDS AND SERVICES

UNIT V    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. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
OBJECTIVES

The course enables the students to understand the significance of Artificial Intelligence in Highway Engineering and apply its techniques for various Transportation Engineering problems.

OUTCOMES

Students who successfully complete this course would be able to

1. Remember surveys to provide the data required for transportation planning.
2. Analyse zonal demand generation and attraction regression models.
3. Evaluate trip generation rates for specific types of land use developments.
4. Evaluate final decisions among planning alternatives that best integrate multiple objectives such as technical feasibility and cost minimization.

UNIT I  INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Significance of AI in Transportation Engineering and uses of AI for solution of Transportation Engineering problems. Comparison between statistical methods and various AI techniques.

UNIT II  FIZZY LOGIC

Introduction to Fuzzy-logic, merits and limitations of Fuzzy-logic, crisp sets: types and properties of crisp sets, Partition and covering, Fuzzy sets: membership function, basic fuzzy set operations, Fuzzy Relations, Fuzzy Logic applications in Transportation Engineering.
UNIT III  ARTIFICIAL NEURAL NETWORKS


UNIT IV  GENETIC ALGORITHM

Basic concepts of Genetic Algorithms (GA), Working Principle, types of Encoding, cross-over, Fitness function, Methods of Reproduction (in brief) and Applications of GA in Transportation Engineering.

UNIT V  EXPERT SYSTEMS

Introduction to Expert Systems (ES), basic concepts of ES and their Applications in Transportation Engineering.

TEXT BOOKS

1. Neural Networks, Fuzzy Logic and genetic Algorithms, Synthesis and Applications, by S.

REFERENCES

2. Relevant IRC and TRB publications.
OBJECTIVES

The course enables the students to understand the requirements of ground improvements and apply soil stabilization techniques.

OUTCOMES

Students who successfully complete this course would be able to

1. Understand the Requirements of ground improvements,
2. Apply soil stabilization techniques,
3. Analyse the suitability of prefabricated vertical drains, dry powdered polymers etc.
4. Evaluate geo synthetics based on research and development.

UNIT I INTRODUCTION

Engineering properties of soft – weak and compressible deposits – problems associated with weak deposit – Requirements of ground improvements – introduction to engineering ground modification, need and objectives.

UNIT II SOIL STABILIZATION


UNIT III RECENT GROUND IMPROVEMENT TECHNIQUES

UNIT IV SOIL REINFORCEMENT

UNIT V GEO-SYNTHETICS

TOTAL: 45 PERIODS

REFERENCES
2. Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi
OBJECTIVES

The course enables the students to understand the relationship between Transportation and Land Use Planning and analysing the problems in developing countries.

OUTCOMES

Students who successfully complete this course would be able to

1. Understand the Problems in Developing Countries,
2. Analyse Transportation modeling in Planning,
3. Analyse Inter-modal Co-ordination and Rural Road Network Planning.

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 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.

UNIT III  GENERAL TRAVEL DEMAND 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.

UNIT IV  REGIONAL TRANSPORT MODELS
Factors affecting goods and passenger traffic; Prediction of traffic; Growth factor models; Time function iteration models; Internal volume forecasting models.

UNIT V REGIONAL NETWORK PLANNING


REFERENCES

1. Urban Modeling - Michael Batty.
2. Land Use Transportation Planning Notes - S.R. Chari, REC Warangal.
3. Introduction to Transportation Engineering and Planning, Morlok EK, McGraw Hill
5. Urban Development Models - Ed. By R. Baxter, M. Echenique and J. Owers; The Institute of
OBJECTIVES

To make the students to design highway using computer aided tools along with the usage of Google maps and GPS.

OUTCOMES

Students will be able to make use of software such as TRANSCAD, GIS and GPS for accurate design of highways and creating Digital Terrain Modeling, Digital Elevation Modeling and their design process & procedures in the field of Highway design considering safety aspects.

1. State of the art technologies in Surveying for Transportation Engineering
2. Use of Google maps/images and GPS for realtime planning,
3. Software applications on Highway Design,
4. Design of Highway elements in 3D,
5. DTM model concepts
6. Building transportation information and decision support systems using TRANSCAD
7. Project concepts, development and solutions,
8. Design standards, controls, step by step in the design of freeway, ramp, and tramp terminals intersection.
9. Reliable Infrastructure: Casestudies,
10. Recent trends in highway design.

REFERENCES

1. Vision: Road Transport in Europe 2025, FEHRL, April 2005
OBJECTIVES

The course enables the students to understand the effects of vehicle population in metropolitan cities and its emission measurement techniques & test procedures.

OUTCOMES

The students will be able to

1. Understand the effects on human health due to vehicular pollution,
2. Remember the construction and working of emission measuring instruments,
3. Apply the emission standards and test procedures,
4. Analyse US, Euro, Japan and Indian emission norms,
5. Evaluate in-cylinder emission control methods such as EGR, air injection, fuel modification etc.,

UNIT I INTRODUCTION

Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution.

UNIT II POLLUTANT FORMATION IN SI ENGINES

Pollutant Formation in SI Engines, mechanism of HC and CO Formation in four stroke and two stroke SI engines, NO\textsubscript{x} formation in SI engines, effects of design and operating variables on emission formation, control of evaporative emission, two stroke engine pollution.

UNIT III POLLUTANT FORMATION IN CI ENGINES

Pollutant Formation in CI Engines, Smoke and Particulate emissions in CI engines, effects of design and operating variables on CI engine emissions, NO\textsubscript{x} formation and control, noise pollution from automobiles, measurement and standards.

UNIT IV CONTROL OF EMISSIONS FROM CI AND SI ENGINES

Design of engines, Optimum selection of operating variables for control of emissions, EGR, Thermal reactors, secondary air injection, DPF, Lean NO\textsubscript{x}, SCR, Catalytic converters, catalysts, fuel modifications, fuel cells, Two stroke engine pollution control.
UNIT V MEASUREMENT TECHNIQUES AND TEST PROCEDURE

NDIR, FID, Chemiluminisent analysers, Gas Chromatograph, Smoke meters, emission standards, driving cycles-USA, Japan, Euro and India. Test procedures - ECE, FTP tests. SHED Test-chassis dynamometers, dilution tunnels.

TOTAL : 45 PERIODS

TEXTBOOKS


REFERENCES

1. SAE Transactions- “Vehicle Emission”-1982 (3 volumes)
OBJECTIVES

The course enables the students to remember the specifications for Road Markings and apply the concepts of sight distance for curves.

OUTCOMES

The students would be able to

1. Understand the specifications for Road Markings,
2. Design cross sectional elements of highways,
3. Design horizontal and vertical curve,
4. Apply the concepts of sight distance for curves.

UNIT I GEOMETRIC DESIGN OF HIGHWAYS


UNIT II HORIZONTAL AND VERTICAL ALIGNMENT

Objectives of horizontal curves; Super elevation — Need for Super elevation; Method of computing super elevation; Minimum Radius of Curve; Methods of attainment of super elevation; Extra widening on Curves; Transition Curves – Objectives and Design. Gradients – Types of Gradients, Design Standards; Vertical Curves – Summit Curves, Valley Curves and Design criteria for Vertical Curves; Combination of Vertical and Horizontal Curves – Grade Compensation; Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance; Importance of Sight Distances for Horizontal and Vertical Curves.
UNIT III

INTERSECTION DESIGN 9
Types of Intersections; Design Principles for Intersections; Design of Atgrade Intersections – Channelisation, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept and Design, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards.

UNIT IV

TRAFFIC SIGNS AND ROAD MARKINGS 9
Types of Road Signs; Guidelines for the provision of Road Signs; Cautionary Signs, Regulatory Signs, Information Signs – Design standards; Road markings – Objectives of Road Markings; Types of Road Markings; Role of Road markings in Road Safety and Traffic Regulation; Specification for Road Markings. Highway Appurtenances – Delineators, Traffic Impact Attenuators, Safety Barriers.

UNIT V

MISCELLANEOUS ELEMENTS 9
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.

TOTAL: 45 PERIODS

REFERENCES
1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna Publications
2. Traffic Engineering and Transportation Planning, L.R.Kadiyali, Khanna Publications
4. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.
OBJECTIVES

The course enables the students to understand the concepts of cement, admixtures, concrete mix design and special concrete issues.

OUTCOMES

The students would have gained knowledge on
1. Understand admixtures and its properties,
2. Remember the measurement of Workability by different tests,
3. Analyze the relation between compressive and tensile strength,
4. Evaluate the durability of concrete under various climatic conditions,

UNIT I CEMENT AND ADMIXTURES


UNIT II AGGREGATES AND ITS PROPERTIES

Classifications of aggregates - particle shape and texture - bond, strength and other mechanical properties of aggregate - specific gravity, bulk density, porosity, absorption and moisture content of aggregate - bulking of sand - deleterious substance in aggregate – soundness of aggregate - alkali-aggregate reaction - thermal properties - sieve analysis -
UNIT III  FRESH CONCRETE AND HARDENED CONCRETE  9


UNIT IV  ELASTICITY, SHRINKAGE AND CREEP  9


UNIT V CONCRETE MIX DESIGN AND SPECIAL CONCRETE ISSUES  9


**REFERENCES:**

1. Concrete Technology by M.S.Shetty, S.Chand& Co.
2. Properties of Concrete by A.M.Neville, ELBS publications.

**TOTAL: 45 PERIODS**