Curriculum and Syllabi

M.Tech Degree Programme

TRAFFIC AND TRANSPORTATION PLANNING

(with effect from Academic Year 2010-2011)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY
CALICUT

Programme Educational Objectives

1. Provide a strong foundation in mathematical, scientific and engineering fundamentals required to formulate, analyse and solve Transportation Engineering related problems.
2. Impart advanced knowledge in Transportation Engineering specialization, so that they can effectively compete with their contemporaries in the National / International level.
3. Motivate and prepare the students to pursue teaching and research, thus contributing to the ever - increasing academic and research demands of the country.
4. Enrich the students with strong communication, technical writing and interpersonal skills, thereby equipping them to work effectively in multidisciplinary teams both as team leaders and members.
5. Inculcate ethical practices in students through laboratory experiments, field work, live projects and interaction with industry.
6. Provide students with an academic environment which enables them to understand the significance of professionalism, safety, sustainability and societal commitment, along with life-long learning in a global perspective.

Programme Outcomes

1. Post-Graduates will be able to provide optimal and technical solutions for Transportation Engineering problems using knowledge of science, mathematics and engineering.
2. Post-Graduates will be able to identify, formulate and solve Transportation Engineering problems.
3. Post-Graduates will able to plan, analyse and design various components of transportation infrastructure system.
4. Post-Graduates will develop the ability to design and conduct tests/experiments in areas related to Transportation engineering and interpret the results.
5. Post-Graduates will be able to use latest tools, technologies, equipment and relevant software to solve various problems in Transportation Engineering domain.
6. Post-Graduates will be able to investigate complex problems in Transportation engineering using advanced knowledge and research methods, considering economy, safety, social and environmental aspects for sustainable development.
7. Post-Graduates will be able to apply ethical principles in discharge of their responsibilities related to Transportation Engineering practice.
8. Post-Graduates will be able to work independently or in a team as a member/ leader in multidisciplinary tasks.
9. Post-Graduates will be able to communicate effectively in both verbal and written forms.
10. Post graduates will be able to solve transportation problems at local, regional and national levels, by applying an understanding of engineering and management principles.
11. Post-Graduates will develop confidence to pursue research in Transportation Engineering and other related multi-disciplinary fields, and take up teaching as a profession.
12. Post-Graduates will develop ability for life-long learning of new and innovative technologies related to Transportation Engineering.

Department of Civil Engineering, NIT Calicut

Curriculum for M.Tech. Programme in
CIVIL - TRAFFIC AND TRANSPORTATION PLANNING

Semester 1

S.No	Code	Title	L	T	P/S	C
1	CE6201	Traffic Engineering	3	-	-	3
2	CE6202	Transportation Planning - I	3	-	-	3
3	CE6203	Pavement Materials, Design & Construction	3	-	-	3
4	MA6004	Applied Probability & Statistics	3	-	-	3
5	CE6291	Transportation Engineering Laboratory & Seminar	-	-	2	1
6	CE6292	Computational Laboratory	-	-	2	1
7	******	Elective	3	-	-	3
8	******	Elective	3	-	-	3

Total Credits – 14 (Core) + 3 or 6 (Electives)

Semester 2

S.No	Code	Title	L	T	P/S	C
1	CE6211	Theories of Traffic Flow	3	-	-	3
2	CE6212	Transportation Planning - II	3	-	-	3
3	CE6213	Pavement Evaluation & Management	3	-	-	3
4	CE6214	Transportation Data Analysis Methods	3	-	-	3
5	CE6293	Transportation Engineering Laboratory & Seminar	-	-	2	1
6	CE6294	Computer Aided Design in Transportation Engineering	-	-	2	1
7	******	Elective	3	-	-	3
8	******	Elective	3	-	-	3

Total Credits – 14 (Core) + 3 or 6 (Electives)

Semester 3

S.No	Code	Title	L	T	P/S	C
1	CE7297	Mini Project - **OPTIONAL**	-	-	6	3
2	CE7298	Project	-	-	-	8
3	******	Elective	3	-	-	3
4	******	Elective	3	-	-	3

Total Credits – 8 (Core) + 0 to 6 (Electives/Mini Project)

Semester 4

S.No	Code	Title	L	T	P/S	C
1	CE7299	Project	-	-	-	12

Total Credits – 12 (Core)

Stipulations:

1. A minimum of 60 credits have to be earned for the award of M.Tech. degree in this programme.
2. Students have to register for a minimum of four electives in three semesters. (One or two electives in the first two semesters and maximum of two courses, including Mini project, in the third semester). Fourth Semester is reserved for Project work only.
3. Industrial Training (1 credit) during the gap between 2nd and 3rd semesters is optional

LIST OF ELECTIVES

S.No.	Code	Title	Credit
1	CE6221	Geographic Information System & Its Applications	3
2	CE6222	Transportation Systems & Analysis	3
3	CE6223	Public Transport Planning & Design	3
4	CE6224	Transportation Infrastructure Design	3
5	CE6225	Transportation Economics & Appraisal	3
6	CE6226	Transportation System Management	3
7	CE6227	Transportation System Evaluation	3
8	CE6228	Pavement Management Systems	3
9	CE6229	Environmental Impact Assessment of Transportation Projects	3
10	CE6230	Database Management	3
11	CE6231	Soft Computing Tools	3
12	MA6005	Optimisation Techniques - I	3
13	MA6006	Optimisation Techniques - II	3
14	CE6232	Transportation and Land Use	3
15	CE 6233	Simulation Modelling of Transportation Systems	3
16	CE6234	Highway Capacity Analysis	3

**** Any other subject offered in the Institute with approval from the Programme Coordinator

COURSE ASSESSMENT METHODS:

Assessment is carried out as per the Rules & Regulations formulated by the Institute, the relevant portions of which are given below.

Lecture based courses

Continuous Assessment is based on:

- A minimum of two mandatory tests (of minimum one hour each).
- Assignments/tutorials/presentations/course projects/reports etc as decided by the course faculty.
- Weightage: Normally between 40-60%, as decided by the course faculty.

End Semester Assessment is based on:

- One end semester examination of minimum three hours duration.
- Weightage: Normally between 40-60%, as decided by the course faculty.

Laboratory/practical /drawing courses

- Assessment shall be based on tests and the performance of students in the regular laboratory/practical/ drawing classes and will be decided by the course faculty.
- End semester examination is not mandatory.
- If end semester examination is planned, it shall be conducted before the last instructional day and the weightage for it should not exceed 40%.

Continuous Assessment : 50 Marks
(Test 1: 15/20; Test 2: 25/20; Assignments/Tutorials etc: 10)
End Semester Examination : 50 Marks

COURSE OBJECTIVES & BRIEF SYLLABUS

CE6201 Traffic Engineering

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To introduce the elements of Traffic Engineering and the characteristics of road traffic components that influence road traffic.
- To introduce the traffic stream parameters and their inter - relationships.
- To explaint traffic engineering studies such as speed, speed and delay, volume, origin and destination, parking, accident and other studies, and analyse and present the collected data.
- To introduce the design of traffic engineering facilities such as uncontrolled and controlled intersections using space sharing and time sharing concepts, bus stop location and bus bay design and road lighting.
- To explain the traffic signs and markings and design and re-design an isolated signal, co-ordinate signals.

Objectives and Scope of Traffic Engineering - Components of Road Traffic - Study of Road User, Vehicle and Traffic Stream Characteristics - Sampling in Traffic Studies - Traffic Engineering Studies and Analysis - Design of At-grade and Grade Separated Intersections, Pedestrian and Cyclist facilities, Bus Stop Location and Bus Bay and Road Lighting - Traffic Signs, Markings and Signals - Principles of Signal Design - Webster's method of Signal Design - Signal System and Coordination.

CE6202 Transportation Planning – I

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To understand the transportation's interrelationship with the urban environment
- To familiarize with contemporary transportation planning issues
- To learn the basic concepts of urban transportation planning
- To find out the methods of travel demand estimation and forecasting
- To understand the interaction of land use and transportation

Role of Transportation - Transportation Problems and Problem Domain - Objectives and Constraints - Urban Transportation Planning Process - Planning in System Engineering Framework - Concept of Travel Demand - Methods of Travel Demand Estimation - Definition of Study Area - Zoning - Trip Generation Analysis - Trip Distribution Analysis - Mode Split Analysis and Route Split Analysis - Landuse-Transportation Models - Location models - Opportunity Models, Lowry based Landuse-Transportation Models – Urban form & Urban structure.

CE6203 Pavement Materials, Design and Construction

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives:

- To provide the knowledge about various types of materials used for pavement construction
- To understand uses of materials in each layer based on their properties
- To get familiarized with various tests on pavement materials
- To compare the physical, chemical and mechanical properties of pavement materials with respect traffic and environmental conditions
- To acquire knowledge about various types and components of pavements
- To understand the stresses and their distribution based on the crust properties
- To distinguish between highway and airfield pavements
- To familiarize with various methods of analysis of flexible and rigid pavements
- To design the pavement for typical environmental and design traffic conditions.

Types and Component parts of Pavements - Pavement Materials – Superpave - Bituminous mix design methods - Factors affecting Design and Performance of Pavements - Comparison between Highway and Airport pavements -

Subgrade functions, properties, assessment - Analysis of Stresses in Flexible Pavements - Empirical, Semi-empirical and Theoretical Methods of Flexible Pavement Design - Types, Causes and Analysis of Stresses in Rigid pavements - Types, Functions and Spacing of Joints in Cement Concrete Pavements - Design of Slab Thickness and Joint Details – Mechanistic empirical pavement design - Pavement Construction - Earthwork – roadway excavation, embankment construction; Drainage Subbase - Base - Bituminous pavements - Cement concrete pavements – joints in plain and reinforced cement concrete pavements - Study on Different Types of Failure of Pavements – Pavement recycling.

MA6004 Applied Probability and Statistics

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Discrete Random Variables and Standard Distributions - Continuous Random Variables and Standard Distributions - Sampling Distributions - Concept and Procedure of Statistical Hypothesis Tests - Analysis of Variance - Fundamental Assumptions of Analysis of Variance - Single Factor Experiments, Latin Square and Graeco-Latin Square Designs, Factorial Experiments, 2^k Factorial design - Regression and Correlation Analysis - Estimation and analysis of simple regression models - correlation coefficients - Hypothesis testing - Curvilinear regression models - Multiple regression models.

CE6211 Theories of Traffic Flow

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

This course provides knowledge of

- macroscopic and microscopic characteristics of traffic flow and their interrelationships
- empirical and analogy based models of traffic flow
- queuing theory and its applications to traffic systems
- concepts and analysis methods of capacity and level of service highway facilities
- simulation modelling of traffic systems

Measurement, Microscopic and Macroscoic Study of Traffic Stream Characteristics - Use of Counting, Interval and Translated Distributions - Empirical, Theoretical and Analogical approaches of Macroscopic Traffic Flow Modeling - Car-following theory - Queuing theory and its applications - Simulation Modelling of Traffic Systems - Capacity & Level-Of Service studies of different highway facilities, Passenger Car Units, Problems in Mixed Traffic Flow.

CE6212 Transportation Planning - II

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To introduce the models used for characteristics of the population such as demography and employment
- To explain the application of the concept of region in planning for transportation, while keeping in mind the theories proposed for regional planning.
- To explain the procedure to estimate the demand for freight transport in an area by applying the four stage transport planning process.
- To discuss the procedure to plan and evaluate an existing bus network.

Demographic and Employment Forecasting Models - Theories of Regional Development & Delineation of Transportation Planning Regions - Estimating and Forecasting of Passenger and Goods Demand - Models based on Behavioural Characteristic of Shippers, Demand Forecasting using Link Volume Modelling Philosophy - Urban Bus Transportation Planning and Evaluation - Accessibility Considerations - Marginal Ridership - Scheduling of Buses.

CE6213 Pavement Evaluation & Management

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives:

- To familiarize the various aspects of surface characteristics and their levels of influence in performance of pavement
- To get exposure on various techniques for pavement distress evaluation
- To assess the various pavement distresses in the field
- To acquire knowledge on cost analysis of pavement maintenance and management
- To analyse the various maintenance alternatives based on their suitability
- To design and suggest best alternatives for optimised pavement performance
- To familiarize the components and levels of pavement management system

Study on Different Types of Failure of Pavements - Evaluation of Pavement Surface Condition - Effect of Environment and Traffic on Structural Stability, Pavement Deterioration - Evaluation of Pavement Structural Condition by Non-Destructive and Destructive Methods - Pavement Overlays & their design - Pavement Management System - Structural condition deterioration models - Mechanistic & empirical models - Ranking and optimization methodologies.

CE6214 Transportation Data Analysis Methods

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To identify analyse multivariate data by finding the relationship between the variables both qualitatively and quantitatively
- To understand the theory of choice behaviour
- To understand components of time series, methods of time series analysis and forecasting.
- To gain skills on how to build ARIMA models.

Multivariate Data Analysis Techniques - Principle Component and Factor Analysis - Applications - Analysis and Modelling of Travel Choices: Deterministic and Stochastic Models - Value of Travel - Concept of Entropy and its Application in Travel Demand Modelling as applied to Trip Distribution, Mode and Route Splits - Forecasting using Time Series Analysis: Basic Components of Time Series – Smoothing and Decomposition Methods – Correlation and Line Spectral Diagrams –Box-Jenkins Forecasting Methodology.

CE6221 Geographic Information System and Its Applications

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To understand the various components of GIS and Coordinate systems for mapping, data acquisition and process.
- Familiarize the different data representation, storage and quality assessment methods
- To know analyse, process and modell the raster based and vector based GIS data
- To make spatial and descriptive analysis for modelling surfaces and develop DTM
- Application of the GIS tool for a specific area

Definitions & Components of GIS – Geographic Data Presentation – Geo Referencing - Data Acquisition - Storage & Digital Representation of Data – Data Structures and Database Management Systems – Raster Data Representation – Vector Data Representation - Data Quality and Errors - Geographic Data Standards - Processing, Analysis and Modeling of Raster based and Vector based GIS data – Application of GIS in one selected area.

CE6222 Transportation Systems and Analysis

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To introduce the functions and problems in the planning for a transportation system.
- To introduce the trends in traffic in the nation and to explain the salient features of the National Transport Policy
- To introduce the different transport technologies used with their relative advantages and disadvantages, power requirements and basic performance.
- To explain the factors influencing capacity and level of service of different transportation systems
- To introduce the concepts of operation controls of different transportation systems.

Functions and Problems in Transportation Planning - Factors in Planning of Transportation System - Historical Development of Transportation Systems in India - Classification and Study of technological characteristics of transportation systems - Study of Operational and Performance characteristics of Transportation Systems - Comfort and Environmental Effects of the different transportation systems - Operational Controls & Communications of Air, Water, Railway and Highway Transportation Systems.

CE6223 Public Transport Planning and Design

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To introduce the comparison between different public transport modes, with respect to their technology.
- To introduce the basic operating elements of a public transport system.
- To introduce the objectives and principles associated with planning of a transit network.
- To explain the characteristics of transit routes and predict the transit usage
- To introduce the components of the scheduling process by determining of service requirements.
- To introduce the design of bus stops, terminal facilities and depots

Public Transport - Modes of public transport and comparison - Public transport travel characteristics - Transit Network Planning - Objectives, principles, considerations, transit lines - Prediction of transit usage - Evaluation of network, accessibility considerations - Transit Scheduling - Scheduling procedure - Marginal ridership - Crew scheduling - Transit Agency Structure and Economics - Transit system statistics, performance and economic measures - Fare structure - Design of Facilities.

CE6224 Transportation Infrastructure Design

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To understand concepts involved in geometric design of intersections, horizontal & vertical alignment of roads & pedestrian facilities.
- To identify the elements of a terminal and design concepts and methods
- To know the hierarchy and functions of highways
- To understand plan and profile integration, geometric requirements, safety considerations, geometry evaluation methods

Design of Highways, At-Grade Intersections, Signalized Intersection, Coordinated Signals Grade Separated Intersection - Design of Facilities for Non-Motorised Transport - Functions, Analysis, Process Flow Charts and Design of Passenger & Goods Terminals - Hierarchy, Functions and Design Criteria of highways - Evaluation and Design of Existing Geometrics.

CE6225 Transportation Economics and Appraisal

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Objectives

- To understand the basic principles of economic analysis and various cost components in Transportation Projects
- To familiarize with the formulation of project alternatives and applying the economic analysis methods
- To acquire exposure in applying non-economic based appraisal methods for transportation related projects
- To understand the environment , energy and safety related issues in the transportation project appraisal
- To understand the principles and procedures of the road safety audit

Principles of Economics - Accounting prices of goods and services - Measuring input costs - Transport Costs and Benefits - Economic Analysis - Generation and screening of project alternatives - Different methods of economic analysis - examples of economic analysis – Multicriteria based project appraisal – environmental and safety evaluation of transportation projects.

CE6226 Transportation System Management

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Objectives

- To introduce the objectives and problems associated with TSM actions and their combinations and interactions.
- To explain the impact assessment and evaluation of various TSM measures by area wide data collection and corridor data collection methodologies.
- To explain the problems addressed, conditions for applications, categories and active elements of various TSM measures such as Public Transportation and HOV treatment, Park and ride, exclusive lanes, bus transfer stations and shared ride facilities.
- To introduce the different demand management measures
- To introduce the different traffic operations improvement measures.

To introduce the parking management measures in an urban areaMethodological Frame Work - Objectives and Problems - Strategic Categories and Action Elements - Travel Behaviour Impact and Response Time - Study of Various TSM Actions with Respect to Problems Addressed, Conditions for Applications, Potential Implementation Problems, Evaluation & Impact Analysis - Methods of Demand Management - Traffic Operations Improvement Techniques - Management of Parking and Non Motorized Transport.

CE6227 Transportation System Evaluation

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Objectives

- To explain the values, goals, objectives, criteria for evaluation of a transport system.
- To introduce the evaluation of alternatives with respect to economic, environmental and safety criteria using multi - criteria evaluation methods.
- To introduce the theoretical basis for different methods of economic evaluation.
- To explain the concepts of environmental evaluation of transport systems.
- To explain the concepts of evaluating transport systems with respect to safety.

Evaluation issues - Evaluation Process – Evaluation of Alternatives - Economic Evaluation -Discounted Cash Flow analysis - Average Cost vs Marginal Cost considerations - Allocation of Resources within Transportation Section - Financing of Transport Sections in India - Environmental Evaluation - Air and Noise Pollution Modeling, Control and Abatement Techniques - Energy related issues - Safety Evaluation - Highway Safety Improvement Program – Road safety Audit

CE6228 Pavement Management Systems

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Objectives:

- To understand the necessity of pavement management system
- To familiarize the components and levels of pavement management system
- To get exposure on various techniques for pavement distress evaluation
- To assess the various pavement distresses in the field
- To acquire knowledge on cost analysis of pavement maintenance and management
- To analyse the various maintenance alternatives based on their suitability

Pavement Management Process - Data Needs - Assessment of Pavement Performance - Evaluation of Pavement Structural Capacity, Distress & Safety - Combined Measures of Pavement Quality - Data Management - Pavement Deterioration Models – Future Needs – Rehabilitation and Maintenance Strategies – Project Level Design of Pavements – Variability, Reliability and Risk – Alternate Design Strategies – Rehabilitation Design Procedures – Economic Evaluation of Alternate Pavement Design Strategies – Selection of Optimal Design Strategy - Implementation of PMS.

CE6229 Environmental Impact Assessment of Transportation Projects

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To understand the concepts of environmental impact assessment and various policy framework and Acts enacted for the environmental protection
- To understand the conceptual approach to be adopted for conducting the environmental impact studies
- To familiarize the methodologies for the prediction and assessment of the impact on Air environment
- To familiarize the methodologies for the prediction and assessment of the impact on Noise environment
- To familiarize the methodologies for the prediction and assessment of the impact on Social environment
- To understand the decision making methods available for evaluation of alternatives
- To understand the need for public participation in the EIA process and familiarize the procedure to the followed

Concepts - National Environmental Policy Act - Screening, Utility and Scope of EIA - Conceptual Approach for Environmental Impact Studies - Planning and Management of Impact Studies - Methodologies for Impact Identification - Environmental Indices - Basic Information, Key Legislation and Guidelines, Conceptual Approach for Addressing, Impact Prediction Methods, Assessment of Significance of Impacts, Identification and Incorporation of Mitigation Measures of Air and Noise Environment - Prediction & Assessment of Impact on Social Environment - Decision Methods for Evaluation of Alternative - Public Participation in Environmental Decision Making.

CE6230 Data Base Management

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- introduce the fundamental concept of data structures
- emphasize the importance of data structures
- Define the terminology, features, classifications, and characteristics embodied in database systems.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models
- To understand and use data manipulation language to query, update, and manage a database

Data Types - Linear Data Structures & Operations - Non linear Structures& Operations - Characteristics of

database approach - Advantages of using DBMS - Database Concept and Architecture - Data models - Relationships - Object modeling - Secondary Storage Devices - RAID Technology - Operations in Files - Hashing techniques - Indices - Indexes on Multiple Keys - other types of indexes.

CE6231 Soft Computing Tools

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- Introduce a relatively new computing paradigm for solving complex real world problems.
- Provide insight into the tools that make up the soft computing technique: fuzzy logic, artificial neural networks, genetic algorithms and hybrid systems Techniques.
- Create awareness of the application areas of soft computing technique
- Provide alternative solutions to the conventional problem solving techniques in transportation systems analysis

Genetic Algorithms - Schemata - Data Structures – Operators - Coding fitness function – Algorithm – Applications - Fuzzy Logic - Concepts of uncertainity and imprecision – Concepts, properties and operations on Classical sets & Fuzzy Sets - Membership Functions - Fuzzy Logic – Fuzzification - Fuzzy Rule based Systems – Applications - Artificial Neural Networks - Models of a Neuron – Multi Layer Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), Recurring Neural Network (RNN) - Learning Processes - Back propagation algorithm Applications - Hybrid Systems - Fuzzy neural systems – Genetic Fuzzy Systems – Genetic Neural Systems.

MA6005 Optimisation Techniques I

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- understand different optimisation techniques such as linear programming, dynamic programming
- study network path models

Linear Programming, Simplex Method, Artificial Variables Techniques, Duality, Dual Simplex Method, Sensitivity Analysis, Parametric Programming, Transportation, Assignment & Routing Problems - Nature of Dynamic Programming problem – Bellmann's optimality principle. Cargo loading problem – Replacement problem – Multistage production planning and allocation problem – Rectangular Games – Two person – zero sum games – Pure and mixed strategies – 2 x n and mx 2 games. Relation between theory of games and linear programming - Network Path Models: Tree Networks – Network flow Algorithms.

MA6006 Optimisation Techniques II

Pre-requisite: First Course in Optimisation Techniques

Total Hours: 42

L	T	P	Cr
3	0	0	3

Mathematical Preliminaries – Mathematical Programing problems – Role of convexity in N. L. P. Unconstrained Optimization – Constrained nonlinear optimization – Optimization with inequality constraints – Quadratic Programming – Penalty and Barrier methods Integer linear programming – Introduction to Optimization tools and software.

CE6232 Transportation and Land Use

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To understand the urban travel patterns, urban transportation technologies, urban activity system, urban structure, urban forms
- To familiarize with the tools and techniques for forecasting socio-demographic characteristics

- To appreciate the interactions among land use and transportation
- To know the methods and procedures for evaluation of alternative land use and transportation policies

Urban Travel Patterns and Urban Transportation Technologies, Land use-Transportation Planning Process, Hierarchy of Urban Activity System, Hierarchy of Urban Transportation Network, Functions of Transportation Network, Urban Structure and its Characteristics, Study of Urban Forms, Demographic Forecasting Models, Employment Forecasting Models, Population and Employment Multiplier Models, Location, Opportunity and Lowry based Land use Transportation models, Dynamic and Disaggregated extensions, Evaluation of Land use – Transportation Plans

CE 6233 Simulation Modelling of Transportation Systems

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

System Concept, System Simulation, Concepts in Discrete Event Simulation, Random Number Generation, Random Variate Generation, Input Modelling for Simulation, Verification and Validation of Simulation Models, Output Analysis for a Single Model, Simulation Modelling and Analysis of midblocks, intersections, pedestrian facilities, simulation software.

CE 6234 Highway Capacity Analysis

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Course Educational Objectives

- To estimate the capacity and Level of Service of freeways
- To estimate the capacity and Level of Service of Two lane highways and multilane highways
- To estimate the capacity and Level of Service of uncontrolled and signalized intersections
- capacity and Level of Service of urban street segments'
- To take up a multimodal capacity analysis of an urban corridor

Highway capacity concepts, Capacity and Level of Service Analysis of Freeway, Freeway weaving sections, Two lane highways, Multilane highways, Sign Controlled Intersections, Roundabouts, Signalised Intersections, Urban street segments, Multimodal capacity analysis.

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CE6201 Traffic Engineering

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (9 Hours)

Scope of Traffic Engineering & Study of its elements: Introduction, Objectives and Scope of Traffic Engineering; Components of Road Traffic – Vehicle, Driver and Road; Road User and Vehicle Characteristics and their effect on Road Traffic; Traffic Manoeuvres. Traffic Stream Characteristics- Relationship between Speed, Flow and Density

Module II: (12 Hours)

Traffic Engineering Studies and Analysis: Sampling in Traffic Studies, Adequacy of Sample Size; Objectives, Methods of Study, Equipment, Data Collection, Analysis and Interpretation (including Case Studies) of (a) Speed (b) Speed and Delay (c) Volume (d) Origin and Destination (e) Parking (f) Accident & other Studies.

Module – 3 (11 Hours)

Design of Traffic Engineering Facilities: Control of Traffic Movements through Time Sharing and Space Sharing Concepts; Design of Channelising Islands, T, Y, Skewed, Staggered, Roundabout, Mini-roundabout and other forms of AT-Grade Crossings including provision for safe crossing of Pedestrians and Cyclists; Grade Separated Intersections, their Warrants and Design Features; Bus Stop Location and Bus Bay Design, Design of Road Lighting.

Module – 4 (10 Hours)

Traffic Control Devices: Traffic Signs, Markings and Signals; Principles of Signal Design, Webster's method of Signal Design, Redesign of Existing Signals including Case Studies; Signal System and Coordination.

Course Outcomes

1. Identify the influence of traffic stream components on traffic flow.
2. Establish the relationships between traffic stream parameters.
3. Conduct traffic engineering studies, analyse the data and present the results.
4. Design traffic and road facilities, and intersection control measures for smooth traffic movement.
5. Identify traffic signs and markings.
6. Design an isolated signal and co-ordinate signals in a corridor.

References

1. Pignataro, L., Traffic Engineering – Theory & Practice, John Wiley, 1973.
2. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers, 2007.
3. The Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall (1982) Chapters 8, 17, 21, 23 and 24.
4. O'Flaherty C A, Highways- Traffic Planning & Engineering, Edward Arnold, UK, 2002
5. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ, 2010
6. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas
7. Salter, R J., Highway Traffic Analysis and Design, ELBS, 1996.
8. Matson, Smith and Hurd, Traffic Engineering, Mc-Graw Hill Book Co, 1955.

CE6202 Transportation Planning – I

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Urban Transportation Planning Process & Concepts: Role of Transportation and Changing Concerns of Society in Transportation Planning; Transportation Problems and Problem Domain; Objectives and Constraints; Flow Chart for Transportation Planning Process- Inventory, Model Building, Forecasting and Evaluation Stages, Planning in System Engineering Framework; Concept of Travel Demand and its Modelling based on Consumer Behaviour of Travel Choices- Independent Variables, Travel Attributes.

Module II: (12 Hours)

Methods of Travel Demand Estimation: Assumptions in Demand Estimation- Sequential, Recursive and Simultaneous Process - Introduction to Transportation Planning Practices; Definition of Study Area, Zoning.

Trip Generation Analysis: Trip Generation Models- Zonal Models, Category analysis, Household Models, Trip Attractions of Work Centres & Commercial Trips

Trip Distribution Analysis**:** Trip End and Trip Interchange Models; Trip Distribution Models - Growth Factor Models, Gravity Models, Opportunity Models and their calibration; Estimation of Travel Demand based on link volume philosophy; Entropy based Trip Distribution models.

Module III: (10 Hours)

Mode Split and Route Split analysis: Mode Split Analysis- Mode Choice Behaviour, Competing Modes, Mode Split Curves, Probabilistic Models and Two Stage Mode Split Analysis; Route Split Analysis- Elements of Transportation Networks, Coding, Minimum Path Tress, Diversion Curves, All-or-Nothing Assignment, Capacity Restrained Assignment, Multipath Assignment

Module IV: (10 Hours)

Landuse-Transportation Models: Location models - Opportunity Models, Lowry based Landuse-Transportation Models – Allocation Function, Constraints, Travel Demand Estimation – Iterative Solutions, Matrix Formulation, Dynamic and Disaggregated extensions; Urban Forms & Urban Structures.

Course Outcomes

Students who successfully complete this course will be able to:

1. Design and administer surveys to provide the data required for transportation planning.
2. Estimate travel demand generation using category analysis and regression models at aggregate and disaggregate levels
3. Determine travel demand distribution using gravity models and growth factor methods.
4. Identify the factors of travel mode choice and develop modal split models.
5. Compute the shortest path and assign the travel demand
6. Estimate the traffic impact of new developments using the four-stage sequential models.
7. Develop land use integrated travel demand models.

References

1. Hutchinson, B.G., Principles of Urban Transportation System Planning, Mc-Graw Hill 1974.
2. Khisty, C J., Transportation Engineering – An Introduction, Prentice-Hall, NJ, 2007
3. Dickey, J.W., Metropolitan Transportation Planning, Tata Mc-Graw Hill, 1980
4. ITE (1982), 'Transportation and Traffic Engineering Hand Book', Chapters 10,12, and 17, Prentice Hall, New Jersey
5. Kanafani, A., Transportation Demand Analysis, McGraw-Hill, 1983.
6. Oppenheim, N., Applied Models in Urban and Regional Analysis, Prentice-Hall, NJ, 1995.
7. Bruton M.J., Introduction to Transportation Planning, Hutchinson of London, 1970.
8. Gallion A.B and Eisner S., The Urban Pattern, Affiliated East-West Press, New Delhi, 1993.
9. Wilson, A.G, Urban and Regional Models in Geography and Planning, John Wiley and Sons, 1974.
10. Meyer M.D. and Miller E.J., Urban Transportation Planning, McGraw-Hill International, 2001
11. Wilson, A.G., Entropy in Urban and Regional Modeling, Pion, London, 1970
12. Ortuzar J D & Willumsen L G, Modelling Transport, John Wiley & Sons Ltd, 2001.

CE6203 Pavement Materials, Design and Construction

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Pavement Materials: Types and Component parts of Pavements - A brief study on aggregates, bitumen and modified bitumen like cutback, emulsion, polymer modified bitumen - Bituminous mix design methods, specifications and testing - Superpave.

Factors affecting Design and Performance of Pavements**:** Comparison between Highway and Airport pavements - Functions and Significance of Subgrade properties, Various Methods of Assessment of Subgrade Soil Strength for Pavement Design - Causes and Effects of variation in Moisture Content and Temperature - Depth of Frost Penetration

Module II: (12 Hours)

Analysis & Design of Flexible Pavement: Stresses and Deflections in Homogeneous Masses - Burmister's 2- layer, 3- layer Theories - Wheel Load Stresses - ESWL of Multiple Wheels - Repeated Loads and EWL factors - Sustained Loads and Pavement behaviour under Traffic Loads - Empirical, Semi-empirical and Theoretical Approaches - Development, Principle, Design steps, Advantages and Applications of different Pavement Design Methods – Mechanistic Empirical Pavement Design

Module III: (10 Hours)

Analysis & Design of Rigid pavements: Types of Stresses and Causes, Factors influencing the Stresses; General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacings, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design - – Mechanistic Empirical Pavement Design.

Module IV: (10 Hours)

Pavement Construction: Earthwork – roadway excavation, embankment construction; Drainage - surface/subsurface, different types of drains; Subbase – Construction of gravel and stabilised bases; Base – WBM base, wet mix macadam; Bituminous pavements – preparation & laying of tack coat, bituminous macadam, mixed seal surfacing, bituminous concrete; Cement concrete pavements – construction methods of cement concrete roads, joints in plain and reinforced cement concrete pavements – Pavement Recycling.

Course Outcomes:

By the end of this course, the students will be able to

1. suggest suitable materials for different types of pavements
2. asses the properties of pavement materials with their suitability
3. interpret the material test results with respect to the field conditions
4. apply the material properties for analysis of pavements under traffic
5. understand the variation in specification for pavement materials used in other countries
6. identify the pavement types based on their behaviour under traffic
7. analyse the pavement components with respect to their material composition
8. estimate the stresses induced due to wheel load and temperature
9. design the pavement, flexible or rigid, for the conditions prevailing at site
10. provide feedback to update the design guidelines.

References:

1. Yoder and Witezak, Principles of Pavement Design, John Wiley and sons, 1975.
2. Yang, Design of functional pavements, McGraw-Hill, 1973.
3. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 2002.
4. Robert D. Krebs, Highway Materials, McGraw Hill Text, 1971
5. IRC: 37-2001, Guidelines for the Design of Flexible Pavements.
6. IRC: 58-2002, Guidelines for the Design of Rigid Pavements.
7. RRL, DSIR, Concrete Roads, HMSO, IRC Publications
8. Lavin P G, Asphalt Pavements, Spon Press, 2003.
9. MORTH Specifications for Road and Bridge Works, Indian roads Congress
10. Kett I, Asphalt Materials & Mix Design Manual, Noyes Publications, 1999.
11. Kim Y R, Modelling of asphalt Concrete, ASCE Press, 2008
12. Mechanistic Empirical Pavement Design Guide, NCHRP, TRB, 2008.

MA6004 Applied Probability and Statistics

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (11 Hours)

Probability distributions: Introduction to probability and random variables, Binomial distribution, Poisson distribution, Geometric distribution, Hyper Geometric distribution, Normal distribution, Log-Normal distribution, Uniform distribution, Exponential distribution, Gamma distribution, Beta distribution, and Weibull distribution.

Module II: (10 Hours)

Parameter Estimation and hypothesis Testing: Random samples, sampling distributions of mean and variance. Point estimators, the method of maximum likelihood, and the method of moments. Confidence interval estimation of – mean, and variance. Statistical hypothesis tests, Operations characteristic curve. Tests of hypothesis on the mean of a Normal Distribution, Tests of hypothesis on the means of two Normal distributions, The paired t-test, Tests of hypothesis on one variance, Tests of hypothesis for the equality of two variances, The testing of goodness of fit.

Module III: (10 Hours)

Design and Analysis of Experiments: Fundamental assumptions of analysis of variance, single factor experiments, Latin square and Graeco-Latin square designs, Design of experiments with several factors- Two factor factorial experiments.

Module IV: (11 Hours)

Regression and Correlation Analysis: Introduction, Bi-Variate Normal distribution and the associated marginal and conditional distributions, estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, Hypothesis tests associated with regression and correlation coefficients, curvilinear regression models, Multiple regression models, multiple and partial correlation coefficients.

Course Outcomes:

By the end of this course, the students will be able to

1. Formulate and differentiate between the different probability distributions and their corresponding distribution functions
2. Formulate the test hypothesis for mean and variance
3. Estimate the parameters of models using maximum likelihood method
4. Design the experiments using different methods
5. Identify the correlation between variables

References:

1. Hines, W. W. and Montgomery, D. C., et. al.; "Probability and Statistics in Engineering and Management Science", John Wiley and Sons, New York, (1990).
2. Freund, J. E.; "Mathematical Statistics", PHI, New Delhi, (1998)
3. Montgomery, D. C.; "Design and Analysis of Experiments", 5th edition, John Wiley and Sons, INC., New York. (2007).
4. Johnston, J. and Dinardo, J.; "Econometric Methods", 4th edition, McGraw-Hill International Editions, (1997).
5. Benjamin, J. R. and Cornell, C. A.; "Probability Statistics and Decision for Civil Engineers", McGraw-Hill, (1960).

CE6291 Transportation Engineering Laboratory and Seminar

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
0	0	2	1

Highway Materials Testing:

- Tests on Bitumen
- Tests on Emulsion

Design of Asphalt Concrete Mixes:

- Marshall Stability Test

Pavement Evaluation Tests:

- Benkleman Beam test
- Roughness Test

Course Outcomes

Students who successfully complete this course will be able to:

1. conduct tests on pavement materials
2. check the suitability of materials for pavement construction
3. carry out functional and structural evaluation of pavements
4. identify and select topic of relevance
5. assimilate literature on technical articles of a topic and develop comprehension
6. write technical report
7. design and develop presentation on a given technical topic
8. deliver technical presentation on a specified topic

Seminar on any chosen related topic

CE6292 Computational Laboratory

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
0	0	2	1

Development of Applications Programs using C/C++

Practice on use of

Transportation Planning software (TRIPS, EMME2)
GIS software (Geomedia, ArcGIS, AutoCADMap)
GIS Integrated Transportation Software , TRANSCAD
Highway Development Model (HDM)

Course Outcomes

Students who successfully complete this course will be able to:

1. write programs to analyse traffic data
2. write programs to estimate travel demand
3. write programs to do trip distribution analysis
4. carry out statistical analysis of data using AMTLAB, SPSS
5. estimate travel demand using EMME, TRANSCAD
6. develop spatial database using GIS software and carryout analysis

CE6211 Theories of Traffic Flow

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I (10 Hours)

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.

Module II: (11 Hours)

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalised Relationship, Fluid Flow Analogy Approach, Shock Wave Theory, Platoon Diffusion and Boltzman Like Behaviour of Traffic Flow, Car-Following Theory, Linear and Non-Linear Car-Following Models, Acceleration Noise

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Models of Delay at Intersections and Pedestrian Crossings.

Module III: (11 Hours)

Highway Capacity & Level-of-Service Studies: Concepts, Factors Affecting Capacity & Level-Of Service, Capacity Analysis of Different Highway Facilities, Passenger Car Units, Problems in Mixed Traffic Flow.

Module IV: (10 Hours)

Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data, Formulation of Simulation Problems in Traffic Engineering and Validation.

Course Outcomes

Students who successfully complete this course will be able to:

1. conduct measurements on traffic characteristics and analyse traffic flow data
2. model traffic flow on roadways and intersections using traffic flow theory
3. discuss the development of empirical and analogy based models of traffic flow.
4. apply the principles of queuing theory to analyse delay at signalized and unsignalized intersections.
5. apply shockwave theory to analyse bottleneck situations on freeways and at signalized intersections.
6. determine the capacity & level of service for highway facilities
7. build simulation model to simulate traffic flow at a midblock, intersection and pedestrian crossing.

References:

1. TRB - SR No.165 - Traffic Flow Theory, Transportation Research Board, Washington, 1976.
2. Gartner N.H, Rathi A.J. and Messer C.J., Traffic Flow Theory – A Revised Monograph, Transportation Research Board, Washington, 1997.
3. May, A D., Traffic Flow Fundamentals, Prentice-Hall, NJ, 1990.
4. Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York, 1968.
5. TRB: Highway Capacity Manual, Transportation Research Board, Washington DC, 2000.
6. Wohl M. and Martin, B V., Traffic System Analysis for Engineers and Planners, McGraw-Hill, New York, 1967.
7. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ, 2010.
8. Mannering, F.L. & Kilareski, W.P., Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons, 2008.
9. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley, 1966.

CE6212 Transportation Planning - II

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Demographic and Employment Forecasting Models: Demographic Models - Linear, Exponential and Logistic Models; Cohort Survival Models - Birth, Aging and Migration Models; Employment Forecasting Models - Economic base Mechanism; Population and Employment Multiplier Models- Input and Output Models - Dynamic Models of Population and Employment – Multiregional Extensions

Module II: (10 Hours)

Theories of Regional Development & Delineation of Transportation Planning Regions: Concept of Region and Space – Types of Regions – Classification of Regions – Christaller's and Perouxian Theories of Regional Development - Delineation of Regions for Transportation Planning of a Nation.

Module III: (11 Hours)

Estimating and Forecasting of Goods Demand: Growth Factor Models, Economic and Econometric Models, Gravity Models, Mode Specific and Mode Abstract models, Programming Model, Shift and Share Model, Excess Production, Consumption and Stock Piling Models, Models based on Behavioural Characteristic of Shippers, Demand Forecasting using Link Volume Modelling Philosophy

Module IV: (11 Hours)

Urban Bus Transportation Planning and Evaluation: Introduction to Bus Network Design, Classification of Routes and their Alignment, Prediction of Transit Usage, Evaluation of Network, Accessibility Consideration in Route Frequency Analysis, Marginal Ridership for Despatching Buses on Route, Scheduling of Buses and Minimum Wait Schedule.

Course Outcomes

1. Forecast the population and employment of an area using different models.
2. Incorporate the effects of input – output models in dynamic forecasting of population and employment.
3. Use the concept of region in planning for a transportation system for a nation.
4. Estimate and forecast the goods demand of an area using economic and econometric models.
5. Model the freight movement with reference to the four stage transport planning process.
6. Classify routes of an bus network and predict the transit usage in a network.
7. Schedule the bus operation in an urban bus route.

References:

1. Mishra, R.P. et al, Regional Development Planning in India, Vikas publishing house, New Delhi, 1975.
2. Heggie, I.G., Transportation Engineering Economics, Mc-Graw Hill Book Company, New York, 1972.
3. ISTE Summer School Notes on Rural and Regional Transportation Planning (1985) - Arranged by Dept. of Civil Engg. - R.E.C.Calicut - for Demand modelling.
4. Nagaraj, B.N., Chandrasekhar B.P. and Chari S.R. (1981), Delineation of Regions for Transportation Planning, IRC Journal 42-3 (1981).
5. Potts and Oliver, Flow Through Transportation Networks.
6. IRC Journals 42-4, 44-1, 44-3, for Rural Road Network Planning.
7. Hutchinson, B.G., Principles of Urban Transportation System Planning, McGraw-Hill, 1974.
8. Report of National Transport Policy Committee, by J. Carter, et al. Fort, 1951.

CE6213 Pavement Evaluation & Management

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (11 Hours)

Pavement Surface Condition & Its Evaluation: Various Aspects of Surface and their Importance; Causes, Factors Affecting, Deterioration and Measures to Reduce: i) Pavement Slipperiness ii) Unevenness iii) Ruts, Pot holes, and Cracks; 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.

Module II: (11 Hours)

Pavement Structure & Its Evaluation: Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Subgrade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration; Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propogation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing

Module III: (9 Hours)

Pavement Overlays & Design: Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection and other Methods, Flexible Overlays and Rigid Overlays over Rigid Pavements, Use of Geosynthetics in Pavement Overlays.

Module IV: (10 Hours)

Pavement Management System: Concepts of pavement management systems, pavement performance prediction – concepts, modeling techniques, structural conditional deterioration models, mechanistic & empirical models, functional condition deterioration models, unevenness deterioration models and other models, ranking and optimization methodologies.

Course Outcomes:

By the end of this course, the students will be able to

1. identify the causes of pavement surface distresses and suggest suitable remedial measures
2. suggest suitable remedial measures for various distresses to improve the pavement surface condition
3. interpret the field evaluation data and pavement design data with respect to present and future traffic condition
4. optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative
5. adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available
6. provide the feedback data for updating the pavement performance monitoring system

References

1. Yoder E.J. and Witezak, Principles of Pavement Design, II Ed., John Wiley and Sons, 1975.
2. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.
3. David Croney, The Design and Performance of Road Pavements, HMSO Publications, 2008.
4. Haas and Hudson, Pavement Management System, McGraw Hill Book Co., New York, 1982.
5. Per Ullidtz, Pavement Analysis, Elsevier, Amsterdam,1998.
6. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements, 1988.
7. SHAHIN, M Y, Pavement management for airport, roads and parking lots, Chapman and hall 2005.
8. Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003.

CE6214 Transportation Data Analysis Methods

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (13 Hours)

Multivariate Data Analysis Techniques: Types of Data, Basic Vectors and Matrices, Sample Estimate of Centroid, Standard Deviation, Dispersion, Variance and Covariance, Correlation Matrices, Principle Component, Factor Analysis, Manova and Cross Classification Procedure in Multivariate Data Analysis and Application to Problems in Traffic and Transportation Planning.

Module II: (13 Hours)

Analysis and Modelling of Travel Choices: Fundamentals of Micro-Economic Demand Theory – Choice Function – Direct and Cross Elasticities of Demand – Properties of some Empirically Derived Demand Functions – Market Demand; Theory of Behavioural Models, Deterministic and Stochastic Models, Random Utility Model, Probit, Logit and Descriminant Model Formulations for Mode and Route Choices, Implications; Value of Travel Time Studies.

Module III: (9 Hours)

Forecasting using Time Series Analysis: Basic Components of Time Series – Stationery and Non-Stationery Processes- - Smoothing and Decomposition Methods – Correlation and Line Spectral Diagrams – Auto Correlations and Moving Averages.

Module IV: (7 Hours)

Box-Jenkins Forecasting Methodology: Examining correlations – Examining stationarity – Backshift notation – Autoregressive models – Moving average models – ARMA & ARIMA models – Model Identification – Parameter estimation.

Course Outcomes

Students who successfully complete this course will be able to:

1. understand the key terms and concepts of multivariate data analysis
2. identify correlations and perform factor analysis, MANOVA
3. estimate direct and cross elasticities of travel demand
4. develop models for estimation of travel choice attributes
5. analyse time series data and forecast
6. build ARIMA model

References

1. Cooley, WW and Lohnes, RR, Multivariate Data Analysis, John Wiley, 1971.
2. Joseph F. Hair, Bill Black, Barry Babin, Rolph E. Anderson, Ronald L. Tatham, Multivariate Data Analysis, Prentice Hall; 2005.
3. Richard A. Johnson, Dean W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, 1992.
4. Simon P. Washington, Matthew G. Karlaftis & Fred L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC, 2003.
5. Kanafani, A., Transportation Demand Analysis, McGraw-Hill, 1983.
6. Meyer M.D. and Miller J.M, Urban Transportation Planning, McGraw-Hill Science/Engineering/ Math, 2000.
7. Pindyck, R.S and Roubinfeld, D.L, Econometric and Economic Forecasts, McGraw-Hill, Tokyo, 2000.
8. Makridakis S.G., Wheelwright S.C, Hyndman R.J, Forecasting : Methods and Applications, Wiley, 1997.

CE6293 Transportation Engineering Laboratory and Seminar

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
0	0	2	1

Traffic Engineering Studies (Field Studies):

- Volume Studies – Straight Roads and at Intersections
- Speed Studies - Spot Speed Studies by Stop Watch, Enosocpe and Radar Speed Meter
- Journey Time and Delay Studies - Floating Car Method
- Parking Surveys and Parking Turnover Studies
- Study of Gaps and Lags – Critical Gaps and Lags at Intersections
- Delay Measurement at Signalised and Unsignalised Intersections

Study of Driver Characteristics:

- Reaction Time
- Visual Acquity
- Glare Recovery.

Seminar

A Seminar on any of the topics in Traffic and Transportation Planning

Course Outcomes

Students who successfully complete this course will be able to:

- conduct traffic studies for estimating traffic flow characteristics
- estimate parking requirements and inventory analysis
- design traffic signal systems.
- carry out causative analysis of traffic congestions and delay
- determine the capacity and level of service highway facilities
- identify and select topic of relevance
- Assimilate literature on technical articles of a topic and develop comprehension
- Write technical report
- Design and develop presentation on a given technical topic
- Deliver technical presentation on a specified topic

CE6294 Computer Aided Design in Transportation Engineering

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
0	0	2	1

Design and Drawing Exercises

The following Detailed Drawings have to be prepared:

i) Design and Drawing of At-Grade Intersections such as Square, T, Y and Rotaries.
ii) Design and Drawing of Grade Separated Intersections: Cloverleaf, Trumpet and Multilevel Intersections
iii) Design of Alignment of Roads given L/S & C/S and Drawing Optical Presentation of Details.
iv) Design and Drawing of Isolated Signals: Drawing to include Phasing, Split and Citing of Posts.
v) Design and Drawing of Signal Coordination System
vi) Sketching of Parking Garages, On-Street and Off-Street facilities

Highway Geometric Design using CAD Software

Course Outcomes

Students who successfully complete this course will be able to:

- design and draw at grade intersections
- design and draw rotary and roundabouts
- design and draw grade separated intersections
- design and draw on-street and off-street parking facilities
- design and draw longitudinal and cross sections of road alignment

CE6221 Geographic Information System and Its Applications

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (9 Hours)

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

Module II: (11 Hours)

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

Module III: (12 Hours)

GIS Data Processing, Analysis and Modeling: Raster based GIS data processing – Vector based GIS data processing – Queries – Spatial analysis – Descriptive statistics – Spatial autocorrelation – Quadrant counts and nearest neighbour analysis – Network analysis – Surface modeling – DTM.

Module IV: (10 Hours)

GIS Applications: (in one of the following areas)
Applications of GIS in Environment monitoring – Natural hazard management – Natural resources management urban planning – utility management – Land information – Business development

Course Outcomes

- Understanding the GIS components and reference systems for mapping and data acquisition
- Selecting suitable data representation tools and methods for analysis
- Processing the data to derive meaningful inferences for decision making
- Applying the tools and techniques for the selected practical applications

References

1. Lo, C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2006.
2. Anji Reddy, M., Remote Sensing and Geographical Information Systems, B.S.Publications, Hyderabad, 2001.
3. Burrough, P.A., Principles of Geographical Information Systems, Oxford Publication, 1998.
4. Clarke, K., Getting Started with Geographic Information Systems, Prentice Hall, New Jersy, 2010.
5. DeMers, M.N., Fundamentals of Geographic Information Systems, John Wiley & Sons, New York, 2002.
6. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992
7. Jeffrey, S. & John E., Geographical Information System – An Introduction, Prentice-Hall, 1990
8. Marble, D.F., Galkhs HW & Pequest, Basic Readings in Geographic Information Systems, Sped System Ltd., New York, 1984.

CE6222 Transportation Systems and Analysis

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Transportation and Society-Factors in Transportation Development: Functions and Problems in Transportation Planning-Economic, Geographical, Political, Technological, Social and Cultural Factors in Planning of Transportation System. A Brief Historical Development of Transportation Systems in India: Growth of Transport - Trends in Traffic - Imbalances in Transport System - New Evidences on Traffic Flow-Optimum Inter Model Mix-Study on National Transport Policy. (Students are expected to be introduced to the report on National Transport Policy).

Module II: (11 Hours)

Transport Technology: System Classification and their Variation; Study of Conventional Systems such as Automobile Taxi, Bus, Street Cars, Rapid Transit, Moving Belts, Tricycles and Bicycles and other Slow Moving Systems. Automatic Rapid Transit; Dual Modes, Demand Buses and Variation in other Slow Moving Vehicle Technologies; Unconventional Systems such as Automatic Cabin Systems, PRT Networks etc. Individual Vehicle Motion; Resistance of Air, Water and Ground Modes; Propulsion Forces, Basic Performance Relationships; Acceleration and Velocity Profiles.

Module III: (11 Hours)

Factors in Operation-Levels of Service and Performance Criteria - Quality of Service: Capacity and Levels of Service of different Transportation Systems; Safety and Dependability-Flexibility-Speed, Acceleration, Deceleration-Comfort and Environmental Effects of the different Transportation System on the Performance Criteria.

Module IV: (10 Hours)

Operational Controls of Air, Water, Railway and Highway Transportation Systems: Functions of Control & Communications-Despatching Policies - Interval Control - Signals and Traffic Control Devices - Navigational Aids of the different Transportation Systems. Air Traffic Control; Navigational Control. Automatic Signaling Systems of Railway and Highway Movements are proposed to be covered in this.

Course Outcomes

1. Identify the functions and problems associated with transportation planning.
2. Appreciate the National Transport Policy and its salient proposals for various transport modes.
3. Suggest a suitable transport system for a given requirement, by computing the power requirement and other parameters.
4. Identify the various factors influencing capacity and level of service for different transportation systems.
5. Identify the performance criteria for different transportation systems.
6. Identify and design the operational controls of different transportation systems

References:

1) Willam, Hay, Introduction to Transportation Engineering, Johnwiley, New York, 1978.
2) Heggei, I.G., Transportation Engineering Economics, McGraw-Hill Book Company, New York, 1972.
3) Planning Commision (1980), Report of the National Transport Policy Committee, Govt. of India, 1980.
4) Edward K. Morlock, Introduction to Transportation Engineering & Planning, International Student Edition, McGraw-Hill Book Company, New York, 1978.
5) CRRI (1982), Road user Cost Study in India, Final report, Central Road Research Institute, New Delhi.
6) ITE (1982), Transportation and Traffic Engineering Handbook, Chapters 1,2,3,4,5,6,7 and 14, Prentice-Hall, NJ.
7) Grava S, Urban Transportation Systems, McGraw-Hill, 2002.

CE6223 Public Transport Planning and Design

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (9 Hours)

Public Transport: Definitions, modes of public transport and comparison, public transport travel characteristics, trip chaining, technology of bus, rail, rapid transit systems, basic operating elements.

Module II: (12 Hours)

Transit Network Planning: Planning Objectives, principles, considerations, transit lines – types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, evaluation of network, accessibility considerations,

Module III: (11 Hours)

Transit Scheduling: Components of scheduling process, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling.

Transit Agency and Economics: Organisational structure of transit agency, management and personnel, transit system statistics, performance and economic measures, operations, fare structure.

Module IV: (10 Hours)

Design of Facilities: Design of bus stops, design of terminals – principles of good layout, types of layout, depot location, twin depot concept, crew facilities and amenities.

Course Outcomes

1. Distinguish between different modes of public transport and suggest one with respect to their basic operating elements.
2. Classify the transit lines with respect to their types, geometry and characteristics.
3. Design a timed transfer network for a public transport system.
4. Suggest the organizational structure for a transit agency and evaluate a transport system with respect to their performance and economic criteria.
5. Decide the fare structure for a transit system.
6. Design a terminal facility and a depot, by incorporating the principles associated with a good layout and amenities.

References:

1. Vukan R. Vuchic, Urban Transit : Operations, Planning and Economics, Wiley, 2005.
2. Peter White, Public Transport, UCL Press, 2008.
3. Kadiyali L.R., Traffic Engineering and Transport Planning, Khanna Publishers,1987.
4. Khisty, C J., Transportation Engineering – An Introduction, Prentice-Hall, NJ, 2002.
5. TCRP Report 30, TCRP Report 95, TCRP Report 100
6. Ceder A, Public Transit Planning and Operation, Elsevier, 2007.

CE6224 Transportation Infrastructure Design

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Introduction: Design of highways, design of at-grade intersections, design of signalized intersections, design of grade separated intersection, terminal design, and design of facilities for non-motorised transport.

Module II: (11 Hours)

Terminal Planning & Design: Terminal functions, analysis of terminals, process flow charts of passenger & goods terminals, terminal processing time, waiting time, capacity & level of service concept, study of typical facilities of highway, transit, airport and waterway terminals, concept of inland port.

Module III: (11 Hours)

Design of Highways: Hierarchy of highway system, functions, design designations, concepts in horizontal & vertical alignment, integration, optical design, geometrical standards for mobility & accessibility components, landscaping and safety considerations, evaluation and design of existing geometrics.

Module IV: (10 Hours)

Design of Intersections: Review of design of at-grade intersections, signal coordination – graphic methods & computer techniques, grade separated intersections – warrants for selection, different types & geometric standards, spacing & space controls, ramps & gore area design.

Course Outcomes:

Students who successfully complete this course will be able to:

1. Design the longitudinal and cross sectional elements of a highway.
2. Design the horizontal and vertical alignment of roads.
3. Design the intersections, interchanges, and parking facilities.
4. Design the facilities for bicyclists and pedestrians
5. Estimate the requirements in a terminal
6. Plan and design the terminals
7. Evaluate the existing transportation infrastructure facilties

References:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers, 1987.
2. The Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall (1982) Chapters 8, 17, 21, 23 and 24.
3. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas
4. Salter, R J., Highway Traffic Analysis and Design, ELBS, 1996.
5. Edward K. Morlock, Introduction to Transportation Engineering & Planning, International Student Edition, McGraw-Hill Book Company, New York, 1992.
6. Joseph, De Chiara, Urban Planning and Design Criteria, Van Nostrand Reinhold, 1982.
7. Department of Transport, Junction and Access Note, UK.
8. Joseph De Chiara, Michael J. Crosbie, Mike Crosbie, Time-Saver Standards for Building Types, McGraw-Hill Professional, 2001.

CE6225 Transportation Economics & Appraisal

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (11 Hours)

Transport Costs and Benefits: Principles of economic analysis, Fixed and variable cost, cost of improvement, maintenance cost, cost estimating methods, accounting for inflation, external costs; Consequences of transport projects, road user consequences - reduced vehicle operation costs, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost, non-user consequences – travel time.

Module II: (10 Hours)

Economic Analysis Methods: Generation and screening of project alternatives, different methods of economic analysis: annual cost and benefit ratio methods, discounted cash flow methods, shadow pricing techniques, determination of IRR and NPV, examples of economic analysis, application economic theory in traffic assignment problem.

Module III: (10 Hours)

Non Economic based Project Appraisal: Multi-criteria analysis – Simple non-compensatory methods, Simple additive model – sensitive testing, probabilistic additive weighing, checklists, case study, Analytic Hierarchy Process – Hierarchies, Establishing priorities within hierarchies, establishing and calculating priorities, Relationship AHP and Simple additive weighing.

Module IV: (11 Hours)

Environmental & Safety Evaluation: Introduction, air pollutants, pollutant effects, air quality standards, factors influencing air pollution, air pollution dispersion & pollution models, air pollution reduction measures - Noise pollution: noise measurement, noise propagation, noise modeling, noise control and abatement techniques, Energy related issues, energy consumption of different modes, energy related transportation actions; Highway safety problem, accident categories, highway safety improvement program – planning, implementation & evaluation stages, steps in HSIP, counter measures for accidents and probable causes, road safety audit.

Course Outcomes

1. Exercise the economic principles and estimating the various cost components in transportation
2. Formulating the possible project alternatives for the economic analysis and applying the appropriate economic analysis method
3. Applying various non economic based economic analysis techniques for transportation projects
4. Quantifying the energy, environment and safety consequences of transportation in the economic analysis

References

1. Winfrey R, Highway Economic Analysis, International Textbook Company, 1969.
2. Kenneth J. Button, Transport Economics, Elgar, 2010.
3. David A. Hensher, Ann M. Brewer, Transport: An Economics and Management Perspective, Oxford University Press, 2001.
4. Emile Quinet, Roger Vickerman, Principles of Transport Economics, Edward Elgar Pub, 2005
5. Road User Cost Study, Central Road Research Institute
6. Dickey J.W, Project Appraisal for Developing Countries, John Wiley, 1984
7. Ian G. Heggie, Transportation Engineering Economics, McGraw-Hill, 1972.
8. Canter, L.W., Environmental impact assessment, McGraw-Hill, 1997
9. Betty Bowers Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional, 1997.
10. Peter Morris & Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 2001

CE6226 Transportation System Management

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Methodology & Data Collection: Methodological frame work, objectives and problems, conflicts resolution, strategic categories and action elements, travel behaviour impact and response time, TSM actions combinations and interactions, impact assessment and evaluation, monitoring and surveillance, Area wide data collection methodology, corridor data collection methodology.

Module II: (12 Hours)

TSM Actions: Study of following TSM actions with respect to problems addressed, conditions for applications, potential implementation problems, evaluation & impact analysis

Public transportation & HOV treatment - Toll discounts for car pools during peak periods, park and ride, car pooling, exclusive lanes, priority at ramp terminals, bus transfer stations, limited and skip-stop bus services, shared ride,

Module III: (12 Hours)

Demand Management: Staggered work hours, flexible work hours, high peak period tolls, shuttle services, circulation services, extended routes.

Traffic Operations Improvement: On-street parking ban, freeway ramp control & closure, travel on shoulders, one-way streets, reversible lanes, traffic calming, Right turn phase, right turn lanes, reroute turning traffic,

Module IV: (8 Hours)

Parking Management: Short term reserved parking, increased parking rates, time duration limits, expanded off-street parking

Non Motorized Transport: pedestrian only streets, Dial a ride for elderly & handicapped.

Course Outcomes

1. Identify the objectives and problems for various TSM actions.
2. Collect data in an area and a corridor for analysing the impacts and evaluate the different TSM measures.
3. Suggest a suitable TSM measure by considering the problems addressed, conditions for applications, potential implementation problems, evaluation and impact analysis of a public transport system and HOV treatment.
4. Suggest appropriate demand management measures and traffic operations improvement for a traffic problem.
5. Manage the parking demand in an area by suggesting and implementing a paring management measure.
6. Plan and design for non-motorised transport and differently - abled traffic system users.

References:

1) D, Arlington, Transportation System Management in 1980: State of the Art and Future Directions, Transportation Research Board, 1980.
2) Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall, 1982
3) TRB Publications.

CE6227 Transportation System Evaluation

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (9 Hours)

Introduction: Evaluation issues, Evaluation process, values, goals, objectives, criteria and standards frame work – Estimation of cost, impacts and performance levels – evaluation of alternatives, economic environmental and safety evaluations; multi criteria evaluation methods, techniques – scoring techniques – group consensuous.

Module II: (12 Hours)

Economic Evaluation: Review of Engineering Economics-Welfare Theories and Equilibrium-Theoretical Basis-Discounted Cash Flow Methods-Cost, Benefit Cost Effectiveness and Shadow Pricing Techniques-Criteria for Pricing Services-Average Cost Vs Marginal Cost - Allocation of Resources within Transportation Section-Financing of Transport Sections in India

Module III: (11 Hours)

Environmental Evaluation: Introduction, air pollutants, pollutant effects, air quality standards, factors influencing air pollution, air pollution dispersion & pollution models, air pollution reduction measures - Noise pollution: noise measurement, noise propagation, noise modeling, noise control and abatement techniques, Energy related issues, energy consumption of different modes, energy related transportation actions

Module IV: (10 Hours)

Safety Evaluation: Highway safety problem, accident categories, highway safety improvement program – planning, implementation & evaluation stages, steps in HSIP, counter measures for accidents and probable causes, road safety audit.

Course Outcomes

1. Identify the goals, objectives, criteria and standards frame work for evaluation of alternatives .
2. Evaluate the transport alternatives with respect to economic environmental and safety using multi-criteria evaluation methods.
3. Evaluate transport projects using the different methods of economic evaluation.
4. Evaluate the environmental impacts of a transport system.
5. Evaluate the safety aspects of highways and suggest suitable countermeasures.
6. Conduct a road safety audit for a road section.

References

1. Hutchinson B.G., Principle of Transportation Systems Planning, McGraw-Hill, 1987.
2. Dickey J.W., et. al., Metropolitan Transportation Planning, Tata McGraw-Hill, 1983.
3. ITE (1982), Transportation and Traffic Engineering Hand Book, Chapters 21 and 22', Prentice-Hall, New Jersy.
4. Heggei, I.G., Transportation Engineering Economics, McGraw-Hill Book Company, New York, 1972.
5. CANTER, L.W., Environmental impact assessment, McGraw-Hill, 1997
6. CRRI, Road user Cost Study in India, Central Road Research Institute, New Delhi, 1982
7. Robley Winfrey, Economic analysis for highways, International Textbook Co, 1969.
8. M. Wohl, B.J. Martin, Traffic System Analysis for Engineers and Planners, McGraw Hill Text,1967.
9. Babkov, V.F., Road Conditions and Traffic Safety, MIR Publishers, Moscow, 1975.

CE6228 Pavement Management Systems

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (12 Hours)

Pavement Management Process & Data Requirements: Application of system concepts to pavement management, pavement management levels & functions - Data needs, assessment of pavement performance, evaluation of pavement structural capacity, distress & safety, combined measures of pavement quality, data management

Module II: (10 Hours)

Determining Present and Future Needs: Establishing criteria – development of models for pavement deterioration – determining the future needs – rehabilitation and maintenance strategies – developing combined programmes for maintenance & rehabilitation

Module III: (10 Hours)

Project Level Design: Framework for pavement design, characterization of physical design inputs, basic structural response models – variability, reliability and risk – generating alternate design strategies – pavement analysis & design of AC & PC, - rehabilitation design procedures – economic evaluation of alternate pavement design strategies – selection of optimal design strategy.

Module IV: (10 Hours)

Implementation: Major steps in implementing PMS – pavement construction management & pavement maintenance management – information's, research needs – cost and benefit of pavement management – future directions and need for innovations in pavement management.

Course Outcomes:

By the end of this course, the students will be able to

1. identify the root cause of different pavement distresses
2. suggest suitable remedial measures for various distresses to improve the pavement surface condition
3. interpret the field evaluation data and pavement design data with respect to present and future traffic condition
4. optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative
5. adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available
6. provide the feedback data for updating the pavement performance monitoring system

References

1) Haas R. C. G., W. Ronald Hudson, John P. Zaniewski, Modern Pavement Management, Krieger Publishing Company, 1994
2) OECD, Pavement Management Systems, O E C D, 1987.
3) SHAHIN, M Y, Pavement management for airport, roads and parking lots, Chapman and hall, 1994
4) Susan Brown, Pavement Management Systems, Transportation Research Board, 1993.

CE6229 Environmental Impact Assessment of Transportation Projects

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (9 Hours)
Introduction: Concepts of environmental impact analysis, key features of National environmental policy act and its implementation, screening in the EIA process, utility and scope of EIA process, Environmental protection acts EIA at national level.
Conceptual approach for environmental impact studies, planning and management of impact studies, matrix and network methodologies for impact identification, description of the affected environmental – environmental indices.

Module II: (11 Hours)
Prediction and Assessment of Impact on Air Environment: Basic information on air quality, sources of air pollutants, effects of air pollutants, key legislations and regulations, conceptual approach for addressing air environment impacts, impact prediction approaches, assessment of significance of impacts, identification and incorporation of mitigation measures.

Module III: (11 Hours)
Prediction & Assessment of Impact on Noise & Social Environment: Basic information on noise, key legislation and guidelines, conceptual approach for addressing noise environment impacts, impact prediction methods, assessment of significance of impacts, identification and incorporation of mitigation measures Conceptual approach for addressing socio-economic impacts, traffic and transportation system impacts, visual impacts, scoring methodologies for visual impact analysis

Module IV: (11 Hours)
Decision Methods for Evaluation of Alternatives: Conceptual basis for trade-off analysis, weighting of decision factors, scaling, rating or ranking of alternatives, development of decision matrix.
Public participation in environmental decision making: Regulatory requirements, advantages and disadvantages, environmental impact assessment process, objectives of public participation, selection of public participation techniques, techniques for conflict management and dispute resolution, verbal communication in EIA studies.

Course Out comes

1. Understanding the concepts, prevailing policy frameworks and acts with regard to environmental protection
2. Developing suitable methodological framework for conduction EIA studies
3. Prediction and Assessment of the impact on Air, Noise and Social environment
4. Selection of the alternatives through systematic decision making methodologies
5. Conducting and recording public participation in the EIA process

References:

1. CANTER, L.W., Environmental impact assessment, McGraw-Hill, 1997
2. Betty Bowers Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional, 1997.
3. Peter Morris & Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 2001.
4. Denver Tolliver, Highway Impact Assessment, Greenwood Publishing Group, 1993.
5. R. K. Jain, L. V. Urban, G. S. Stacey, H. E. Balbach, Environmental Assessment, McGraw-Hill Professional, 2001.

CE6230 Data Base Management

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Review of Data Types: Scalar types – Primitive types, Enumerated types, Subranges Structures types – Character strings, arrays, records, sets, tiles. Data abstraction.

Linear Data Structures: Stacks, queues, lists. Stack and queue implementation using array, linked list. Linked list implementation using pointers.

Module II: (11 Hours)

Non linear Structures: Graphs, trees, sets. Graph and tree implementation using array linked list. Set implementation using bit string, linked list.

Module III: (11 Hours)

Introduction to Database Management: Characteristics of database approach - advantages of using DBMS - database concept and architecture - data models - schemes - instances - data independence - database languages and interfaces - database modeling using entity - relationship (ER) - entity sets attributes and keys - relationships - type role and structural constraints - weak entity types - enhanced entity-relationship (EER) and object modeling - sub classes - super classes and inheritance - specialization and generalization - modeling of union types

Module IV: (10 Hours)

File organization and Storage*:* Secondary storage devices - RAID technology - operations in files - heap files and sorted files - hashing techniques - types of single level ordered index, multi-level indexes - B - trees and B^+ trees - indexes on multiple keys - other types of indexes

Course Outcomes

Students who successfully complete this course will be able to:

1. Select and use appropriate data structure while problem solving and programming
2. Develop algorithms for manipulating stacks, queues, linked lists, trees, graphs.
3. Demonstrate different methods for traversing trees
4. Compare and contrast the benefits of dynamic and static data structures implementations
5. Demonstrate an understanding of the components of a computerized database system.
6. Formulate, using relational algebra, solutions to a broad range of query problems.
7. Formulate, using SQL, solutions to a broad range of query and data update problems.
8. Demonstrate a rudimentary understanding of programmatic interfaces to a database and be able to use the basic functions of one such interface.
9. Select appropriate methods for organizing data files and implement file-based data structures.

References

1. Aho A.V., Hopcroft J.E., and Ullman J.D., Data Structures and Algorithms, Addison Wesley, 1983.
2. Elmasri & Navathe, Fundamentals of Database Systems, 3rd Edition, Addison Wesley, 2010.
3. Sahni S., Data Structures, Algorithms, and Applications in C++, Mc Graw Hill, 1998.
4. Wirth N., Algorithms +Data Structures = Programs, Prentice Hall International, 1976.
5. Cormen T.H., Leiserson C.E, and Rivest R.L., Introduction to Algorithms, MIT Press, 1990.
6. Ramakrishnan R. & Gehrke J., Database Management Systems, 2/e, McGraw Hill, 2003.
7. O'neil P. & O'neil E., Database Principles, Programming, and Performance, 2/e, Harcourt Asia, Morgan Kaufman, 2000.
8. Silberschatz A., Korth H. F., & Sudarshan S., Database System Concepts, Tata McGraw Hill, 2010
9. Ullman J. D., Principles of Database Systems, Galgotia Publications, 1982.
10. Date C. J., An Introduction to Database Systems, Addison Wesley, 2002.

CE6231 Soft Computing Tools

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (11 Hours)

Genetic Algorithms: Goals of optimization - Comparison with traditional methods - Schemata - Terminology in GA – Strings, Structure, Parameter string - Data Structures – Operators - Coding fitness function – Algorithm - Applications.

Module II: (11 Hours)

Fuzzy Logic: Concepts of uncertainity and imprecision – Sets - Concepts, properties and operations on Classical sets & Fuzzy Sets - Classical & Fuzzy Relations - Membership Functions - Fuzzy Logic – Fuzzification - Fuzzy Rule based Systems – Fuzzy propositions - Applications.

Module III: (11 Hours)

Artificial Neural Networks: Basics of ANN; Models of a Neuron – Topology: Multi Layer Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), Recurring Neural Network (RNN) - Learning Processes: Supervised and unsupervised learning. Error-correction learning, Hebbian learning; Single layer perceptrons - Multilayer perceptrons - Least mean square algorithm, Back propagation algorithm Applications.

Module IV: (9 Hours)

Hybrid Systems: Fuzzy neural systems – Genetic Fuzzy Systems – Genetic Neural Systems.

Course Outcomes

Students who successfully complete this course will be able to:

1. use a new tool /tools to solve a wide variety of real world problems
2. find an alternate solution, which may offer more adaptability, resilience and optimization
3. tackle real world research problems
4. develop neural network models for pattern classification, function approximation, pattern association, prediction and control problems
5. apply fuzzy logic and fuzzy reasoning for decision making
6. formulate genetic algorithm for simple single objective optimization problems

References:

1. David E. Goldberg, Genetic Algorithms in Search, Optimisation and Machine Learning, Addison-Wesley, 1989.
2. Timothy J.Ross, Fuzzy Logic with Engineering Applicatios, McGraw-Hill, 1995
3. Simon Haykin, Neural Netwroks, PrenticeHall, 1999.
4. J.M. Zurada, .Introduction to artificial neural systems., Jaico Publishers, 2006
5. H.J. Zimmermann, .Fuzzy set theory and its applications., III Edition, Kluwer Academic Publishers, London, 1991.
6. Suran Goonatilake, Sukhdev Khebbal (Eds), .Intelligent hybrid systems., John Wiley & Sons, New York, 1995
7. Deb Kalyanmoy, Optimization for Engineering Design, Prentice Hall of India (P) Ltd, 2004.

MA6005 Optimisation Techniques I

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Elementary Linear Programming: Systems of linear equations & inequalities – Convex sets – Convex functions – Formulation of linear programming problems - Theory of Simplex method – Simplex Algorithm – Charne's M-Method – Two phase method – Duality in linear programming – Dual Simplex method

Module II: (11 Hours)

Advanced Linear Programming: Sensitivity analysis – Parametric programming – Bounded Variables problem – Transportaion problem – Integrality property – MODI method – Degeneracy – Unbalanced problem – Assignment Problem – Development of Hungarian method – Routing problem.

Module III: (11 Hours)

Dynamic Programming and Game Theory: Nature of Dynamic Programming problem – Bellmann's optimality principle. Cargo loading problem – Replacement problem – Multistage production planning and allocation problem – Rectangular Games – Two person – zero sum games – Pure and mixed strategies – 2 x n and mx 2 games. Relation between theory of games and linear programming

Module IV: (10 Hours)

Network Path Models: Tree Networks – Minimal Spanning Tree –Kruskal's Algorithm ,Prim's Algorithm-Shortest path problems – Solution methods – Dijkstra's Method – Floyd's Algorithm – Network flow Algorithms – Maximal flow algorithm – The method of Ford and Fulkerson

Course Outcomes

Students who successfully complete this course will be able to:

- formulate linear programming problems
- apply simplex method linear programming problem
- solve transportation and routing problems
- formulate and solve dynamic programming problems
- form the network and find the shortest path and minimal spanning tree,
- find optimal solution to transportation problems

References:

1. Bazarra M. S. Jarvis J. J, H. D. Sherali-Linear programming and Network flows – John Wiley, II edition, 1990.
2. Bazarra M. S. Sherali. H. D, & Shetty. C. M. Nonlinear Programming Theory and Algorithms – John Wiley, II edition, 1993.
3. Hadley. G. Linear Programming , Narosa Publishing House, 1990.
4. Hillier F. S & Liebermann G. T. Introduction to OR. Mc. Grand Hill, VII edition, 2010
5. Taha. H. A. Operations Research – An introduction, Prentice Hall, India, VI edition, 1999.
6. Foulds L.R. Graph Theory Applications , Springer (Narosa) , Delhi , 1992

MA6006 Optimisation Techniques II

Pre-requisite: First Course in Optimisation Techniques

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (10 Hours)

Mathematical Preliminaries – Maxima and Minima –Quadratic forms – Gradient and Hessian – Unimodal functions – Convex sets – Concave and Convex functions – Mathematical Programing problems – Varieties and characteristics – Difficulties caused by nonlinearity – Role of convexity in N. L. P. Unconstrained Optimization – Search methods – Fibonacci Search – Golden sections search

Module II: (10 Hours)

Hooke and Jeeve's method – Optimal Gradient method – Newton's method – Constrained nonlinear optimization constrained optimization with equality constraints. Lagrangian method – Sufficiency conditions – Optimization with inequality constraints – Kuhn – Tucker conditions – Sufficiency conditions.

Module III: (11 Hours)

Quadratic Programming – Separable convex programming – Frank & Wolfe's method – Kelley's cutting plane method – Rosen's gradient projection method – Fletcher – Reeve's method – Penalty and Barrier methods.

Module IV: (11 Hours)

Integer linear programming – Gomory's cutting plane method – Branch and Bound Algorithm – Travelling Salesman problem – Knapsack problem; Introduction to Optimization tools and software.

References:

1. Taha. H. A., Operations Research, An Introduction (Sixth edition PHI), 2006.
2. Simmons D. M, Nonlinear Programming for Operations Research (PHI), 1976
3. M. S. Bazaraa. H. D. Sherali, C. M. Shetty, Nonlinear programming theory and Algorithm, John Wiley, II edition, 2006.

CE6232 Transportation and Land Use

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

MODULE - 1 11 H

Travel Patterns, Transportation Technologies, Urban Forms and Urban Structure: Brief Study of Urban Travel Patterns and Urban Transportation Technologies; Landuse-Transportation Planning Process - Hierarchy of Urban Activity System, Hierarchy of Urban Transportation Network and Technology; Relationship between Movement and Accessibility Functions of Transportation Network; Urban Structure and its Characteristics such as Centripetal, Grid Iron, Linear and Directional Grid types, Study of Urban Forms such as Garden City, Precincts, Neighbourhoods, Linear City, MARS Plan, LeCorbusier Concept, Radburn Concept, Environmental Area Concept.

MODULE – 2 10 H

Demographic and Employment Forecasting Models: Demographic Models - Linear, Exponential and Logistic Models; Cohort Survival Models - Birth, Aging and Migration Models; Employment Forecasting Models - Economic base Mechanism; Population and Employment Multiplier Models- Input and Output Models - Dynamic Models of Population and Employment – Multiregional Extensions

MODULE – 3 10 H

Landuse-Transportation Models: Location models - Opportunity Models, Lowry based Landuse-Transportation Models – Allocation Function, Constraints, Travel Demand Estimation – Iterative Solutions, Matrix Formulation, Dynamic and Disaggregated extensions.

MODULE – 4 9 H

Evaluation of Landuse – Transportation Plans: Operational, Environmental and Economic Evaluation – Concept of Demand and Supply for Transportation Projects – Benefit and Cost – B/C and Cost Effective Approach for Economic Evaluation.

Course Outcomes

Students who successfully complete this course will be able to:

1. Identify the transportation technologies suitable for the urban area based on activity system and travel patterns in the given urban area.
2. Critically analyse the form and structure of an urban area.
3. Forecast population and employment in an area for horizon year.
4. Develop models of land use and transportation interactions.
5. Design alternative land use transportation scenarios
6. Estimate the impacts of land use on transportation and vice versa
7. Evaluate alternative land use transportation plans.

REFERENCES

1. Hutchinson B.G., Principle of Transportation Systems Planning, McGraw-Hill.
2. Oppenheim N., Applied Models in Urban and Regional Analysis, Prentice-Hall.
3. Dickey J.W., *et. al*., Metropolitan Transportation Planning, Tata McGraw-Hill.
4. Gallion A.B and Eisner S., The Urban Pattern, Affluated East-West Press, New Delhi.
5. ITE (1982), Transportation and Traffic Engineering Hand Book, Chapters 21 and 22, Prentice-Hall, New Jersy.
6. Wilson, A.G, Urban and Regional Models in Geography and Planning, John Wiley and Sons.
7. Heggei, I.G., Transportation Engineering Economics, Mc-Graw Hill Book Company, New York.

CE 6233 Simulation Modelling of Transportation Systems

Pre-requisite: Nil

Total Hours: 42

L	T	P	Cr
3	0	0	3

Module 1 (11 Hours)

System Concept: Systems and system environment, Components of a system, Discrete and continuous systems, Systems approach to problem solving, Types of system study, System analysis, system design and system postulation, System modelling, Types of models.

System Simulation: Technique of simulation, Comparison of simulation and analytical methods, Types of system simulation, Steps in simulation study, Monte Carlo simulation.

Concepts in Discrete Event Simulation: Event scheduling/Time advance algorithm, Modelling world views, Simulation programming tasks, Comparison and selection of simulation languages.

Module 2 (11 Hours)

Random Number Generation: Techniques for generating random numbers, Linear congruential method, Test for random numbers, Frequency tests, run tests, tests for autocorrelation, gap test, and Poker test.

Random Variate Generation: Inverse transformation technique, Exponential, Uniform, Weibull, Triangular, Empirical-Discrete and continuous distributions. Convolution method, Acceptance-Rejection technique.

Input Modelling for Simulation: Data collection, Identifying the distribution with data, Parameter estimation, Goodness of fit test, Chi square, Klomogrov and Smirnov tests, Selecting input model when data are not available.

Module 3 (10 Hours)

Verification and Validation of Simulation Models: Verification of simulation models, Calibration and validation of models, Face validity, Validation of model assumption, validating input-output transformation, Input-output validation using historical input data.

Output Analysis for a Single Model: Measures of performance and their estimation, Point estimation, Interval estimation, Output analysis for terminating simulations and Steady state simulations.

Module 4 (10 Hours)

Simulation Modelling and Analysis of Transportation Systems: Objectives, Performance measures, Issues in simulation of transportation systems, Simulation software for transportation engineering applications, Simulation of midblocks, intersections, pedestrian facilities, Cellular automata.

References

1. Banks, J., Carson, J.S., Nelson, B.L., and Nicol, D.M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001.
2. Deo, N., System Simulation with Digital Computer, Prentice Hall of India, 1997.
3. Jaume Barceló, Fundamentals of Traffic Simulation, Springer, 2010.
4. John A. Sokolowski and Catherine M. Banks, Principles of Modeling and Simulation - A Multidisciplinary Approach, JOHN WILEY & SONS, 2009
5. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley, 1966.
6. Stewart Robinson, Simulation: The Practice of Model Development and Use, John Wiley & Sons Ltd, 2004.
7. Sing VP, System Modelling and Simulation, New Age International, 2009

Course Outcomes

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

1. Identify different types of systems and components of systems
2. Distinguish between analytical methods and simulation approaches
3. Identify the different steps in simulation
4. Implement different techniques for random number generation
5. Fit different distributions to the observed data
6. Perform goodness-of-fit tests on the models
7. Calibrate and validate the models developed
8. Identify the issues pertaining to modeling of transportation systems
9. Simulate different transportation facilities

CE 6234 Highway Capacity Analysis

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module 1 (9 Hours)

Highway capacity concepts - Concept of Capacity and Level of Service (LoS), Road user perceptions in LoS, Service Flow rates and volumes, v/c ratio and its use in Capacity analysis,

Freeway capacity – Freeway capacity, Free flow speed, Flow characteristics, Speed flow density relationships, Factors affecting Free flow speed, Analysis methodologies for basic freeway sections, Calibration of passenger car equivalents, Driver population factor and Adjustment factors, Freeway weaving, Weaving configurations and their effects, Types of junctions, Ramps and Ramp Junctions – Capacity and LoS.

Module 2 (12 Hours)

Two lane highways – Design standards, Passing sight distance on two-lane highways, Capacity and Levels of Service, Determination of Free Flow speed, Determining of Demand Flow rate, Average travel speed, Percent time- spent – following, Determination of LoS.

Multilane highways – Weaving, merging and diverging movements on multilane highways, Characteristics and computational procedures of weaving segments, merge and diverge segments, Base conditions for multilane highways, Determination of Free flow speed, Determination of Capacity & LoS.

Sign controlled Intersections - Conflicting traffic in sign controlled intersections, Critical gap and follow-up time, Movement capacity, Impedance effects, Shared lane capacity, Two stage gap acceptance, Estimation of queue lengths, Level of service criteria, Capacity & LoS estimation.

Module 3 (12 Hours)

Roundabouts – Intersection control concepts, Capacity of roundabouts, Factors influencing capacity of roundabouts, Methods of estimating roundabout capacity, Models for estimation of roundabout capacity, LOS of roundabouts.

Signalised Intersections – Basic principles of intersection signalisation, discharge headways, saturation flow, LoS and Capacity, Left turn and right turn equivalencies, delay as a measure of effectiveness, Critical movement approach to signalised intersection analysis, Delay and LOS analysis.

Module 4 (9 Hours)

Urban Street segments - Flow characteristics at urban streets, Free flow speed, running speed, Time space trajectory, Level of Service, Data requirements for estimating LOS, Urban street classes.

Multimodal capacity analysis – Highway corridor facilities, Determination of segment capacity, Gate-tree-building capacity, Determination of segment free – flow and segment traverse times, Determination of queue delay, Performance measures, Transit and highway corridor analysis – Determination of bus stop capacity, Estimation of transit travel time and delay, Transit subsystem analysis.

Course Outcomes

Students who successfully complete this course will be able to:

1. Estimate the factors influencing capacity of a freeway segment and estimate the capacity of a freeway segment.
2. Estimate the capacity and level of service of a two lane highway.
3. Estimate the capacity and level of service of a multilane highway.
4. stimate the movement capacity of a sign controlled intersection considering the follow-up time and critical gap of vehicles.
5. Identify the factors influencing capacity and level fo service of a roundabout and estimate the same using various models.

References

1. Roess, R.P., Prassas E.S. and McShane, W.R. (2010), 'Traffic Engineering', 4th Edition, Prentice Hall.
2. Transportation Research Board, National Academics (2010), 'Highway Capacity Manual (HCM)'.
3. Transportation Research Board, National Academics (2000), 'Highway Capacity Manual (HCM)'.
4. IRC: SP41, Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas
5. IRC:64-1990, Guidelines for Capacity of Roads in Rural Areas
6. IRC:73-1980, Geometric Design Standards for Rural (Non-Urban) Highways
7. IRC:86-1983, Geometric Design Standards for Urban Roads in Plains
8. IRC:92-1985, Guidelines for the Design of Interchanges in Urban Areas
9. IRC:106-1990, Guidelines for Capacity of Urban Roads in Plain Areas.