Curriculum and Syllabi

M.Tech Degree Programme

TRAFFIC AND TRANSPORTATION PLANNING

(with effect from Academic Year 2018-2019)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

CALICUT

M.Tech Degree Programme

Traffic and Transportation Planning

Programme Educational Objectives

PEO 1: Provide a strong foundation in mathematical, scientific and engineering fundamentals required to formulate, analyse and solve Transportation Engineering related problems.

PEO 2: Impart advanced knowledge in Transportation Engineering specialization, so that they can effectively compete with their contemporaries in the National / International level.

PEO 3: Motivate and prepare the students to pursue teaching and research, thus contributing to the ever - increasing academic and research demands of the country.

PEO 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.

PEO 6: Inculcate ethical practices in students through laboratory experiments, field work, live projects and interaction with industry.

PEO 7: 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 (provided by NBA)

PO 1: Ability to independently carry out research / investigation and development work to solve practical problems

PO 2: Ability to write and present a substantial technical report / document

PO 3: Demonstrate a degree of mastery over the area as per the specialisation of the programme

Programme Specific Outcomes

PSO 1: Apply ethical principles in discharge of their responsibilities to solve transportation problems considering economy, safety, social and environmental aspects for sustainable development

PSO 2: 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	CE6201D	Traffic Engineering and Management	3	-	-	3
2	CE6202D	Transportation Planning	3	-	-	3
3	CE6203D	Pavement Materials and Design	3	-	-	3
4	CE6291D	Pavement Engineering Laboratory & Seminar	-	-	2	1
6	CE6292D	CAD in Transportation Engineering	-	-	2	1
7	*******	Elective	3	-	-	3
8	*******	Elective	3	-	-	3

Total Credits – 11 (Core) + 6 (Electives)

Semester 2

S.No	Code	Title	L	T	P/S	C
1	CE6211D	Theories of Traffic Flow	3	-	-	3
2	CE6212D	Analytical Transportation Planning	3	-	-	3
3	CE6213D	Pavement Evaluation & Management	3	-	-	3
4	CE6293D	Traffic Engineering Laboratory & Seminar	-	-	2	1
5	*******	Elective	3	-	-	3
6	*******	Elective	3	-	-	3
7	*******	Elective	3	-	-	3

Total Credits – 10 (Core) + 9 (Electives)

Semester 3

S.No	Code	Title	L	T	P/S	C
1	CE7297D	Mini Project - **OPTIONAL**	-	-	6	2
2	CE7298D	Project	-	-	-	10

Total Credits – 10 (Core) + 0 to 2 (Electives/Mini Project)

Semester 4

S.No	Code	Title	L	T	P/S	C
1	CE7299D	Project	-	-	-	14

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 five 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	Credits
1	CE6221D	Transportation Infrastructure Design	3
2	CE6222D	Transportation System Management	3
3	CE6223D	Public Transport Planning & Design	3
4	CE6224D	Transportation and Land Use	3
5	CE6225D	Pavement Construction & Maintenance	3
6	CE6226D	Transportation Systems & Analysis	3
7	CE6227D	Geographic Information System & Its Applications	3
8	CE6228D	Highway Design and Safety	3
9	CE6229D	Highway Capacity Analysis	3
10	CE6230D	Simulation Modelling of Transportation Systems	3
11	CE6231D	Advanced Travel Demand Modelling	3
12	CE6232D	Pavement Management Systems	3
13	CE6233D	Transportation Economics & Appraisal	3
14	CE6234D	Environmental Impact Assessment of Transportation Projects	3
15	CE6235D	Transportation System Evaluation	3
16	MA6004D	Applied Probability and Statistics	3
17	MA6005D	Optimisation Techniques - I	3
18	MA6006D	Optimisation Techniques - II	3

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

CE6201D TRAFFIC ENGINEERING AND MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify the influence of traffic stream components on traffic flow.
CO2: Establish the relationships between traffic stream parameters.
CO3: Conduct traffic engineering studies, analyse the data and present the results.
CO4: Design traffic and road facilities, and intersection control measures for smooth traffic movement.
CO5: Identify appropriate traffic control and management measures.

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: (10 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 (10 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 Regulation and Management: 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. Traffic Management measures: Speed, vehicle, parking, enforcement regulations, mixed traffic regulation, various management techniques

References:

1. Pignataro, L., Traffic Engineering – Theory & Practice, John Wiley, 1973.
2. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers, 2011.
3. The Institute of Transportation Engineers, Traffic Engineering Handbook, 7th edn, 2016.
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. F. D. Hobbs, Traffic Planning and Engineering, Pergamon Press, 1979
7. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas
8. Salter, R J., Highway Traffic Analysis and Design, ELBS, 1996.
9. Nicholas J. Garber & Lester A. Hoel, Traffic and Highway Engineering, Cengage Learning, 2009
1. Federal Highway Administration, Manual on Uniform Traffic Control Devices (MUTCD), 2009
2. Matson, Smith and Hurd, Traffic Engineering, Mc-Graw Hill Book Co, 1955.

CE6201D TRAFFIC ENGINEERING AND MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	H
PO2	M	M	M	M	M
PO3	H	H	H	M	H
PSO1	H	H	M	H	H
PSO2	H	H	M	H	H

CE6202D TRANSPORTATION PLANNING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Design and administer surveys to provide the data required for transportation planning.
CO2: Estimate travel demand generation at aggregate and disaggregate levels
CO3: Determine travel demand distribution using gravity models and growth factor methods.
CO4: Identify the factors of travel mode choice and develop modal split models.
CO5: Compute the shortest path and assign the travel demand
CO6: Estimate the traffic impact of new developments using the four-stage sequential models.
CO7: Develop land use integrated travel demand models.

Module I: (9 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: (10 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)

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

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. Meyer, Michael D, ITE Transportation Planning Handbook, John Wiley & Sons 2016
1. Kanafani, A., Transportation Demand Analysis, McGraw-Hill, 1983.
5. Oppenheim, N., Applied Models in Urban and Regional Analysis, Prentice-Hall, NJ, 1995.
6. Bruton M.J., Introduction to Transportation Planning, Hutchinson of London, 1970.
7. Gallion A.B and Eisner S., The Urban Pattern, Affiliated East-West Press, New Delhi, 1993.
8. Meyer M.D. and Miller E.J., Urban Transportation Planning, McGraw-Hill International, 2001
9. Ortuzar J D & Willumsen L G, Modelling Transport, John Wiley & Sons Ltd, 2001.
10. Ennio Cascetta, Transportation Systems Analysis, Springer, 2009

CE6202D TRANSPORTATION PLANNING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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 – Land use-Transportation Models - Location models - Opportunity Models, Lowry based Landuse-Transportation Models – Urban form & Urban structure.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	H	H	H	H	H	H	H
PO2	M	L				L	
PO3	H	H	H	H	M	M	M
PSO1	M	L	L	L	L	H	M
PSO2	M	M	M	M	M	M	H

CE6203D PAVEMENT MATERIALS AND DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: suggest suitable materials for different types of pavements
CO2: asses the properties of pavement materials with their suitability
CO3: interpret the material test results with respect to the field conditions
CO4: apply the material properties for analysis of pavements under traffic
CO5: understand the variation in specification for pavement materials used in other countries
CO6: identify the pavement types based on their behaviour under traffic
CO7: analyse the pavement components with respect to their material composition
CO8: estimate the stresses induced due to wheel load and temperature
CO9: design the pavement, flexible or rigid, for the conditions prevailing at site
CO10: provide feedback to update the design guidelines.

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 mix design and material testing.
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: (10 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 - ESAL – VDF - Repeated Loads and EWL factors - Sustained Loads and Pavement behaviour under Traffic Loads - Empirical, Semi-empirical, Analytical and Mechanistic-empirical approaches - Development, Principle, Design steps, Advantages and Applications of different Pavement Design Methods – Mechanistic Empirical Pavement Design – Guidelines and examples.

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 Spacing, 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: (9 Hours)

Alternate Materials for durable pavements: artificial aggregates – Industrial waste materials – fly ash, pond ash, marble dust, GGBS, Geo-polymer coated aggregates – waste plastics, fibres – recycled aggregate and RAP. Nanomaterials for pavements: Nano clay, Nano silica, Carbon Nano Tube (CNT) and other nanomaterials – warm mix technologies: additives and modifiers, design guidelines and practices – Cold mix technologies: materials, additives, guidelines and practices.

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: 37-2012, Guidelines for the Design of Flexible Pavements.
6. IRC: 58-2015, 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.

CE6203D PAVEMENT MATERIALS AND DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:
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 - artificial aggregates – Industrial waste materials waste plastics, fibres – recycled aggregate and RAP, Nano clay, Nano silica, Carbon Nano Tube (CNT), warm mix and Cold mix technologies.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
PO1	H	H	H	H	H	H	H	H	H	H
PO2	M	M	H	L	M	M	M	L	H	H
PO3	H	H	H	H	H	H	H	H	H	M
PSO1	M	L	H	M	H	H	H	M	H	M
PSO2	H	H	M	M	H	H	H	H	H	H

CE6291D PAVEMENT ENGINEERING LABORATORY & SEMINAR

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Course Outcomes:
CO1: conduct tests on pavement materials to check the suitability of materials for pavement construction
CO2: carry out functional and structural evaluation of pavements
CO3: identify and select topic of relevance
CO4: assimilate literature on technical articles of a topic and develop comprehension
CO5: write technical report
CO6: design and develop presentation on a given technical topic
CO7: deliver technical presentation on a specified topic

Highway Materials Testing:

- Tests on Bitumen
- Tests on Emulsion

Design of Asphalt Concrete Mixes:

- Marshall Stability Test
- Rut test
- Repeated load test
- Indirect tensile strength test
- Moisture sensitivity test

Pavement Evaluation Tests:

- Benkleman Beam test
- Roughness Test
- Skid resistance test

Seminar on any chosen related topic

References

1. Khanna, S.K.,Justo, C.E.G., Veeraragavan. A. Highway Engineering, Nemchandand Bros, 2015, Roorkee.
2. Khanna, S.K., Justo, C.E.G; Veeraragavan. A. Highway Materials and Pavement Testing. Nemchandand Bros, 2015, Roorkee
3. Relevant BIS Standards.
4. Relevant AASHTO Guidelines.
5. Relevant ASTM Testing and Methodologies.

CE6291D PAVEMENT ENGINEERING LABORATORY & SEMINAR

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Brief Syllabus:

Highway Materials Testing; Design of Asphalt Concrete Mixes; Pavement Evaluation Tests; Seminar on any chosen related topic

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	H	H	M	H	H	H	M
PO2	M	M	M	H	H	M	H
PO3	H	M	L	M	H	M	H
PSO1	H	H	M	M	H	H	H
PSO2	H	M	M	L	M	M	M

CE6292D COMPUTER AIDED DESIGN IN TRANSPORTSTION ENGINEERING

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Course Outcomes:

CO1: design and draw at grade intersections
CO2: design and draw rotary and roundabouts
CO3: design and draw grade separated intersections
CO4: design and draw on-street and off-street parking facilities
CO5: design and draw longitudinal and cross sections of road alignment

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

CE6292D COMPUTER AIDED DESIGN IN TRANSPORTSTION ENGINEERING

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Brief Syllabus:

Transportation Engineering Design and Drawing Practices

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H		
PO2	L	L	L		
PO3	H	H	H		
PSO1	H	H	H	M	
PSO2	M	M	M		

CE6211D THEORIES OF TRAFFIC FLOW

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: conduct measurements on traffic characteristics and analyse traffic flow data
CO2: model traffic flow on roadways and intersections using traffic flow theory
CO3: discuss the development of empirical and analogy based models of traffic flow.
CO4: apply the principles of queuing theory to analyse delay at signalized and unsignalized intersections.
CO5: apply shockwave theory to analyse bottleneck situations on freeways and at signalized intersections.
CO6: determine the capacity & level of service for highway facilities
CO7: build simulation model to simulate traffic flow at a midblock, intersection and pedestrian crossing.

Module I (9 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: (10 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: (10 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.

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. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ, 2010.
7. Mannering, F.L. & Kilareski, W.P., Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons, 2008.
8. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley, 1966.
9. Winnie Daamen, Christine Buisson, Serge P. Hoogendoorn, Traffic Simulation and Data Validation - Methods and Applications, CRC Press, 2015

CE6211D THEORIES OF TRAFFIC FLOW

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	H	H	H	H	H	H	H
PO2	L		M				L
PO3	H	M	H	H	M	M	M
PSO1	H	L	L	L	L	H	M
PSO2	M	M	M	M	M	M	H

CE6212D ANALYTICAL TRANSPORTATION PLANNING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: Predict employment and population of an area
CO2: Forecast time series data using Box-Jenkins forecasting approach
CO3: Apply multivariate data analysis techniques to problems in Traffic and Transportation Planning
CO4: Develop models for analysis of transport related choices

Module I: (9 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: (12 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. Box-Jenkins Forecasting Methodology: Examining correlations – Examining stationarity – Backshift notation – Autoregressive models – Moving average models – ARMA & ARIMA models – Model Identification – Parameter estimation.

Module III: (9 Hours)
Multivariate Data Analysis Techniques: Types of Data, Basic Vectors and Matrices, Cluster Analysis,

Exploratory and Confirmatory Factor Analysis, Multiple Discriminant Analysis, Logistic Regression, Overview of Structural Equation Modelling, MANOVA and Cross Classification Procedure in Multivariate Data Analysis and Application to Problems in Traffic and Transportation Planning.

Module IV: (9 Hours)
Analysis and Modelling of Travel Choices: Revealed Preference and Stated Preference Survey Instruments, Formulation of a Stated Preference Survey Instrument, Random Utility Model, Probit, Logit and Discriminant Model Formulations, Nested Logit Model, Mixed Logit Model, Discrete - Continuous choice modelling methods – Model formulation and error assumptions, Estimation of MDCEV model, Application of Choice models, including MDCEV in forecasting.

References:

1) David A. Hensher, John M. Rose and William H. Greene, Applied Choice Analysis A Primer, Cambridge University Press, 2005.
2) Frank S. Koppelman and Chandra Bhat, A Self Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models, USDOT, 2006.
3) Jordan J. Louviere, David A. Hensher and Joffre D. Swait, Stated Choice Methods Analysis and Applications, Cambridge University Press, 2000.
4) Joseph F. Hair, Bill Black, Barry Babin, Rolph E. Anderson, Ronald L. Tatham, Multivariate Data Analysis, Prentice Hall; 2005.
5) Juan de Dios Ortuzar and Luis G. Willumsen, Modelling Transport, John Wiley and Sons, 2011.
6) Makridakis S.G., Wheelwright S.C, Hyndman R.J, Forecasting: Methods and Applications, Wiley, 1997.
7) Moshe Ben-Akiva and Steven R. Lerman, Discrete Choice Analysis - Theory and Application to Travel Demand, MIT Press, 1997.
8) Nobert Oppenheim, Applied Models in Urban and Regional Analysis, Prentice Hall, 1980.
9) Richard A. Johnson, Dean W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, 1992.
10) Simon P. Washington, Matthew G. Karlaftis & Fred L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC, 2003.

CE6212D ANALYTICAL TRANSPORTATION PLANNING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

Demographic and Employment Forecasting Models, Economic base Mechanism, Dynamic Models of Population and Employment. Forecasting using Time Series Analysis - Basic Components, Auto Correlations and Moving Averages. Box-Jenkins Forecasting Methodology, ARMA & ARIMA models. Multivariate Data Analysis Techniques - Cluster Analysis, Exploratory and Confirmatory Factor Analysis, Multiple Discriminant Analysis, Logistic Regression, MANOVA and Cross Classification. Analysis and Modelling of Travel Choices, Stated Preference Survey Instrument, Random Utility Models, Discrete - Continuous choice modelling methods

Correlation between COs and POs

	CO1	CO2	CO3	CO4
PO1	H	H	H	H
PO2			M	M
PO3	H	H	H	H
PSO1	H	M	H	M
PSO2	M	M	H	H

CE6213D PAVEMENT EVALUATION & MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: identify the causes of pavement surface distresses and suggest suitable remedial measures
CO2: suggest suitable remedial measures for various distresses to improve the pavement surface condition
CO3: interpret the field evaluation data and pavement design data with respect to present and future traffic condition
CO4: optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative
CO5: adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available
CO6: provide the feedback data for updating the pavement performance monitoring system

Module I: (9 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: (10 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: (10 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.

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.

CE6213D PAVEMENT EVALUATION & MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H
PO2	M	L	H	H	M	H
PO3	H	H	H	H	L	M
PSO1	H	H	M	L	M	H
PSO2	H	H	H	M	H	H

CE6293D TRAFFIC ENGINEERING LABORATORY & SEMINAR

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Course Outcomes:

CO1: conduct traffic studies for estimating traffic flow characteristics
CO2: estimate parking requirements and inventory analysis
CO3: design traffic signal systems.
CO4: carry out causative analysis of traffic congestions and delay
CO5: determine the capacity and level of service highway facilities
CO6: identify and select topic of relevance
CO7: Assimilate literature on technical articles of a topic and develop comprehension
CO8: Write technical report
CO9: Design and develop presentation on a given technical topic
CO10: Deliver technical presentation on a specified topic

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

CE6293D TRAFFIC ENGINEERING LABORATORY & SEMINAR

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Brief Syllabus: Traffic Engineering Studies, Driver Characteristics Studies, Seminar

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
PO1	H	H	H	M	H	M	H	H	H	M
PO2	M	M	M	M	H	M	H	H	M	H
PO3	H	H	M	L	M	L	M	H	M	H
PSO1	H	M	H	M	M	M	M	H	H	H
PSO2	H	M	M	M	L	M	L	M	M	M

CE7298D PROJECT

L	T	P	C
-	-	-	10

The primary objective of the course 'Project' is to introduce the students to various sub-fields in Traffic and Transportation Engineering. It is aimed at exposing the students to current development and research activities in the above mentioned fields. The students are also trained to gather in-depth information on specified areas or topics. The students are made proficient to make proper technical documentation on the selected topic. Moreover, the course would also provide training to students to make effective technical presentations.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	
PO2	L	L	L	M	H
PO3	H	H	H	M	
PSO1	M	M	M	M	L
PSO2	H	M	H	H	M

CE7299D PROJECT

L	T	P	C
-	-	-	14

This course is a continuation of the work initiated in third semester and the student is expected to submit a consolidated report of the work undertaken in the third and fourth semester, at the end of the fourth semester.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	
PO2	L	L	L	M	H
PO3	H	H	H	M	
PSO1	M	M	M	M	L
PSO2	H	M	H	H	M

CE6221D TRANSPORTATION INFRASTRUCTURE DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: Design the longitudinal and cross sectional elements of a highway
CO2: Design the horizontal and vertical alignment of roads.
CO3: Design the intersections, interchanges, and parking facilities.
CO4: Design the facilities for bicyclists and pedestrians
CO5: Estimate the requirements in a terminal
CO6: Plan and design the terminals
CO7: Evaluate the existing transportation infrastructure facilities

Module I: (9 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: (10 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: (10 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.

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.

CE6221D TRANSPORTATION INFRASTRUCTURE DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	H	H	H	H	H	H	H
PO2	M	M	M	L	L	M	L
PO3	M	M	M	M	M	M	M
PSO1	H	H	H	H	H	H	H
PSO2	M	M	M	M	M	M	M

CE6222D TRANSPORTATION SYSTEM MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify the objectives and problems for various TSM actions.

CO2: Collect data in an area and a corridor for analysing the impacts and evaluate the different TSM

measures.

CO3: 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.

CO4: Suggest appropriate demand management measures and traffic operations improvement for a traffic problem.

CO5: Manage the parking demand in an area by suggesting and implementing a paring management measure.

CO6: Plan and design for non-motorised transport and differently - abled traffic system users.

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: (10 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: (10 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: (9 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.

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.

CE6222D TRANSPORTATION SYSTEM MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

To introduce the parking management measures in an urban area Methodological 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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H
PO2	M	M	M	M	M	M
PO3	H	H	H	M	M	M
PSO1	M	M	M	M	M	M
PSO2	M	H	H	M	M	M

CE6223D PUBLIC TRANSPORT PLANNING & DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: Determine the frequency and headway for load profiles
CO2: Forecast passenger demand
CO3: Identify measures of system and connectivity performance
CO4: Develop timetables for public transport systems
CO5: Develop schedules for the crew and vehicles for public transport systems

Module I: (9 Hours)

Introduction to Public Transport Planning – Operational Planning Decomposition Process. Service and Evaluation standards, Concept of Viability. Data requirements – Data collection techniques. Frequency and Headway Determination – Max load and Load profile methods. Route Design – Methodology for design of public transit routes.

Module II: (9 Hours)

Transit demand and Service Design – Factors influencing transit demand, Demand function and elasticity. Demand Forecasting. Passenger Waiting time and proportion of passengers boarding each route. Passenger assignment using route choice. Service design elements – standards and measures of system and connectivity performance. Optimum stop location.

Module III: (9 Hours)

Timetable Development – Objectives, Optional timetables and comparison measures. Anchoring the timetable to a single time point- Even headways with smooth transitions, Headways with average loads. Even maximum load on individual vehicles, minimum frequency standard, Optimisation problem. Minimum passenger-crowding timetables for a fixed vehicle fleet. Timetable for maximum synchronization – Formulation an O-R model.

Module IV: (12 Hours)

Vehicle Scheduling and Crew Scheduling: Estimation of fleet size required for a single route. Max-flow technique for fixed vehicle scheduling - Formulation and transformation of the max-flow problem. Deficit – function model with deadheading trip insertion. Fleet size lower bound for fixed schedules. Variable trip departure times – single route minimum fleet size, variable scheduling using deficit functions. Crew Scheduling: Vehicle chain construction using minimum crew – cost approach, arrival – departure joinings with hollows – Formulation of Objective function. Crew assignment procedures.

References:

1. Avishai Ceder, Public Transit Planning and Operation, Butterworth – Heinemann, 2007.
2. Partha Chakraborty and Animesh Das, Principles of Transportation Engineering, Prenctice-Hall of India Pvt Ltd, 2003.

3. Peter White, Public Transport, UCL Press, 2008.
4. Sigurd Grava, Urban Transportation Systems, Mc-Graw Hill,2003.
5. Vukan R. Vuchic, Urban Transit: Operations, Planning and Economics, Wiley, 2005.

CE6223D PUBLIC TRANSPORT PLANNING & DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

Introduction to Public Transport Planning - Operational Planning Decomposition Process, Data requirements, Frequency and Headway Determination, Methodology for design of public transit routes. Transit demand and Service Design, Demand Forecasting, Passenger assignment, Service design elements. Timetable Development - Objectives, Optional timetables and comparison measures, Minimum passenger-crowding timetables, Timetable for maximum synchronization. Vehicle Scheduling and Crew Scheduling - Estimation of fleet size required, Fleet size lower bound for fixed schedules, Vehicle chain construction using minimum crew – cost approach, Crew assignment procedures.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	H
PO2			H		
PO3		H		H	H
PSO1		H	H	H	H
PSO2		M	M	H	H

CE6224D TRANSPORTATION AND LANDUSE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify the transportation technologies suitable for the urban area based on activity system and travel patterns in the given urban area.
CO2: Critically analyse the form and structure of an urban area.
CO3: Forecast population and employment in an area for horizon year.
CO4: Develop models of land use and transportation interactions.
CO5: Design alternative land use transportation scenarios
CO6: Estimate the impacts of land use on transportation and vice versa
CO7: Evaluate alternative land use transportation plans.

Module – I (10 Hours)

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-II (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-III (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.

Module-IV (9 Hours)

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.

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.

CE6224D TRANSPORTATION AND LANDUSE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	H	H	H	H	H	H	H
PO2	L		M	M	L	M	M
PO3	H	H	M	H	H	H	M

PSO1	H	M	M	M	M	H	M
PSO2	H	H	H	H	H	H	H

CE6225D PAVEMENT CONSTRUCTION & MAINTENANCE

Pre-requisite: Nil
Total Hours: 39

L	T	P	Cr
3	0	0	3

Course Outcomes:

CO1: Carry out the construction of flexible and rigid pavements
CO2: Identify the structural and functional failure of the pavements
CO3: Evaluate the pavement distresses
CO4: Develop pavement maintenance strategies

Module I: (10 Hours)

Flexible Pavement Construction: components and layers – Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers and their choice.

Module II: (10 Hours)

Rigid Pavement construction: components and layers – Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints; Thin White Topping – Ultra Thin White Topping – Fibres in cement concrete pavement construction.

Module III: (10 Hours)

Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilisation methods. Use of additives pavement material stabilisation, numerical problems on mix design and applications. Geo Synthetics for stabilised pavements layers: types and functions – suitable locations and specifications – Guidelines and practices.

Module IV: (9 Hours)

Pavement Maintenance: flexible and rigid pavement – surface distresses: types, causes and redial measures – functional and structural quality of pavements – types of maintenance: time bound and condition responsive maintenance and rehabilitation, full depth reclamation, recycling methods and life cycle costing,

References:

1. Prithvi Singh Kandhal, Bituminous Road Construction in India, PHI Learning Pvt. Ltd., Delhi, 2016.
2. P. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications (P) Ltd., New Delhi, 2005.
3. Transport and Road Research Laboratory, Soil Mechanics for Road Engineers, HMSO, London, 1974.
4. W.Ronald Hudson, Ralph Haas and Zeniswki, Modern Pavement Management, Mc Graw Hill and Co
5. MoRTH, Specifications for Road and Bridge Works, Fifth Revision, IRC, New Delhi, 2013.
6. Relevant IRC codes and Ministry Specifications.

CE6225D PAVEMENT CONSTRUCTION & MAINTENANCE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

Flexible Pavement Construction - materials, construction methods and field control checks- Specifications- Construction of interlocking block pavements, Quality control tests; Construction of various types of joints. Soil Stabilized Pavement Layers: Design factors, mix design, construction control and quality control checks. Pavement Evaluation - Pavement Distress - life cycle costing,

Correlation between COs and POs

	CO1	CO2	CO3	CO4
PO1	M	H	H	M
PO2	L	M	M	M
PO3	H	H	H	H
PSO1	H	H	H	H
PSO2	H	M	H	H

CE6226D TRANSPORTATION SYSTEMS & ANALYSIS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify the functions and problems associated with transportation planning.
CO2: Appreciate the National Transport Policy and its salient proposals for various transport modes.
CO3: Suggest a suitable transport system for a given requirement, by computing the power requirement and other parameters.
CO4: Identify the various factors influencing capacity and level of service for different transportation systems.
CO5: Identify the performance criteria for different transportation systems.
CO6: Identify and design the operational controls of different transportation systems

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: (10 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: (10 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: (9 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.

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.

CE6226D TRANSPORTATION SYSTEMS & ANALYSIS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H
PO2	L	L	L	M	M	M
PO3	H	H	H	M	H	H
PSO1	H	H	H	M	M	M
PSO2	M	M	M	M	M	M

CE6227D GEOGRAPHIC INFORMATION SYSTEM & ITS APPLICATIONS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Understanding the GIS components and reference systems for mapping and data acquisition
CO2: Selecting suitable data representation tools and methods for analysis
CO3: Processing the data to derive meaningful inferences for decision making
CO4: Applying the tools and techniques for the selected practical applications

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: (10 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: (10 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

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.

CE6227D GEOGRAPHIC INFORMATION SYSTEM & ITS APPLICATIONS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4
PO1	H	H	H	H
PO2			L	M
PO3	H	H	M	M
PSO1	M	L	L	L
PSO2	M	M	M	M

CE6228D HIGHWAY DESIGN AND SAFETY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: Identify the factors influencing the traffic safety
CO2: Measure the safety level and effects of various geometric elements on safety
CO3: Develop safety performance functions and predict safety on different category of roadways
CO4: Identify and design the appropriate safety measures for road traffic
CO5: Identify and design the suitable safety measures for pedestrians

Module 1 (9 Hours)
Highway Functions; Driver and Vehicle Characteristics; Cross Sections Design; Design Speeds; Horizontal Alignment; Vertical Alignment; Sight Distance; At-Grade intersections; Grade Separated Intersections; Signing; Marking and Islands; Traffic Calming.

Module 2 (10 Hours)
Measurement of Road Safety; Human factors in road safety; Safety performance functions; Data needs and limitations; data analysis; road safety audit-applications, process, check lists, effectiveness; Accident Modification Factors; Safety Effects of Speed, Traffic volume and composition, Highway Design Elements, Traffic Control and Operational Elements, other Elements, Pedestrian and Bicycle Safety on Roadway Segments;
Safety Effects of Design Elements, Traffic Control, Operational Elements, and other Features; Pedestrian and Bicycle Safety at intersections; Safety Effects of Design, Traffic Control and Operations Elements at Interchange; Intersection manoeuvres; Star rating of roads

Module 3 (10 Hours)
Predictive methods for segments and intersections for Rural Two-Lane Roads, Rural Multilane Highways, urban and Suburban Arterials; Accident Modification Factors for Roadway Segments, Intersections, Interchanges, Special Facilities.

Module 4 (10 Hours)
Road Safety Measures- Road Design and Road Equipment, Road Maintenance, Traffic Control, Vehicle Design and Protective Devices, Driver Training and Regulation of Professional Drivers, Public Education and Information, Police Enforcement and Sanctions;
Pedestrian safety Measures- Pedestrian Facility Design, Roadway Design, Intersection Design, Traffic Calming, Traffic Management, Signals and Signs, Other Measures.

References:

1. AASHTO, A policy on Geometric Design of Highways and Streets, AASHTO, 2004.
2. Rune Elvik, Alena Hoye, Truls Vaa & Michael Sorensen, The Hand Book of Road Safety Measures, Emerald Group Publishing Limited, 2009.
3. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering, Avebury Technical Cambridge, 1996.
4. Babkov, V.F. Raod Conditions and Traffic Safety. Mir Publishers, Moscow, 1975.
5. ITE, Highway Safety Manual, ITE, 2010.
6. PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System, USDOT, 2004.
7. Ezra Haure, Observational Before-After Studies In Road Safety, Pergamon, 2002.
8. IRC-Sp 41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas.
9. IRC:73-1980-Geometric Design Standards for Rural (Non-Urban) Highways
10. IRC:86-1983- Geometric Design Standards for Urban Roads in Plains.
11. IRC:92-1985- Guidelines for Design of Interchanges in Urban Areas.

CE6228D HIGHWAY DESIGN AND SAFETY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

Highway Functions; Traffic elements and their characteristics; Horizontal Alignment; Vertical Alignment; Signing; Marking and Islands; Traffic Calming. Measurement of Road Safety; Safety performance functions; Accident Modification Factors; Safety Effects of Design Elements, Pedestrian and Bicycle Safety; Star rating of roads. Predictive methods for segments and intersections. Road Safety Measures- Design, Equipment, Maintenance, Traffic Control, Vehicle Design and Protective Devices, Driver Training and Regulation of Professional Drivers, Public Education and Information, Police Enforcement and Sanctions; Pedestrian safety Measures

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	H
PO2	L	M	M	M	M
PO3	M	M	H	H	H
PSO1	H	L		M	M
PSO2	M		M	M	M

CE6229D HIGHWAY CAPACITY ANALYSIS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Estimate the factors influencing capacity of a freeway segment and estimate the capacity of a freeway segment.
CO2: Estimate the capacity and level of service of a two lane highway.
CO3: Estimate the capacity and level of service of a multilane highway.
Co4: Estimate the movement capacity of a sign controlled intersection considering the follow-up time and critical gap of vehicles.
CO5: Identify the factors influencing capacity and level fo service of a roundabout and estimate the same using various models.

Module 1 (10 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 (10 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 (10 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.

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.

CE6229D HIGHWAY CAPACITY ANALYSIS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	H
PO2	M	M	M	M	M
PO3	M	M	M	M	M
PSO1	H	H	H	H	H
PSO2	M	M	M	M	M

CE6230D SIMULATION MODELLING OF TRANSPORTATION SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify different types of systems and components of systems
CO2: Distinguish between analytical methods and simulation approaches
CO3: Identify the different steps in simulation
CO4: Implement different techniques for random number generation
CO5: Fit different distributions to the observed data
CO6: Perform goodness-of-fit tests on the models

CO7: Calibrate and validate the models developed
CO8: Identify the issues pertaining to modeling of transportation systems
CO9: Simulate different transportation facilities

Module 1 (10 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 (10 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, Kolmogrov 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 (9 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

CE6230D SIMULATION MODELLING OF TRANSPORTATION SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:
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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9
PO1	H	H	H	H	H	H	H	H	H
PO2	L	L	H	L	H	M	M	L	M
PO3	H	H	H	H	H	H	H	M	M
PSO1		M	H					M	M
PSO2	M	M	M	M	M	M	M	H	H

CE6231D ADVANCED TRAVEL DEMAND MODELLING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: design the survey instrument and administer the travel survey
CO2: analyse and explore the travel survey data to identify the travel patterns
CO3: develop models to describe activity travel behaviour
CO4: synthesise household population and activity travel episodes
CO5: estimate travel demand incorporating policies and development strategies

Module 1: (10 Hours)

Introduction: Transport planning and modelling, Models and their role, Characteristics of transport problems, Characteristics of travel demand, Characteristics of transport supply, Equilibration of supply and demand, Issues in transport modelling, Classic travel demand model - trip generation, trip distribution, modal split, assignment, Limitations of trip based approach, Need for & introduction to activity based approach, comparative study of conventional and activity based approaches.

Module 2: (10 Hours)

Data Needs & Methods: Data requirements, Travel surveys and their role in transport planning, Survey methods- manual, automatic & electronic methods, Precision and accuracy in travel surveys, Sample design, Sampling procedures, Design and administration of travel and activity surveys, Stated and revealed preference survey, Survey data – correction, expansion and validation, data exploration.

Module 3: (10 Hours)

Activity based models: Theoretical background, Important features, Activities, Tours and trips, Linkage between trip, tour & activity performed, Individuals and representative individuals, Intra household interactions, Analysis of activity-travel behavior, Characteristics by socio-economic market segment, Activity frequency analysis using linear regression models, Count data models of activity frequency, Discrete choice models of activity-travel demand, Applications and worked out problems.

Module 4: (9 Hours)

Simulation models: Household synthesis, Personal synthesis, Activity travel synthesis, Monte Carlo and probabilistic processes, Study of activity based simulation models like DaySim, CEMDAP, FAMOS, CARLA, AMOS, ALBATROSS, TASHA, Applications of activity based models in travel demand forecasting

REFERENCES

1. Ben-Akiva, M. and S. Lerman, Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press, Cambridge, MA, 1985.
2. Ettema, D. and H. Timmermans, eds., Activity-Based Approaches to Travel Analysis, Elsevier Science Ltd, 1997.
3. Goulias, K.G., ed., Transportation Systems Planning: Methods and Applications, CRC Press, 2003.
4. Hensher, D.A., ed., Travel Behavior Research: The Leading Edge, Elsevier Science Ltd, 2001.
5. Meyer, M.D. and E.J. Miller, Urban Transportation Planning, Second Edition, McGraw Hill, 2001.
6. Ortuzar, J de D. and L. Willumsen, Modelling Transport, Third Edition, John Wiley & Sons, 2001.
7. Timmermans, H., ed., Progress in Activity-Based Analysis, Elsevier Science Ltd, 2005.
8. Washington, S.P., M.G. Karlaftis, and F.L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC, 2003.

CE6231D ADVANCED TRAVEL DEMAND MODELLING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

Transport planning and modelling, Characteristics of travel demand, conventional four stage process of travel demand forecasting, need for activity based travel analysis, Data requirements, Travel surveys, Survey methods, Sampling, Stated and revealed preference survey, Data exploration, Identification of activity travel patterns, Activity based models, Simulation of activity travel patterns, application of activity based travel demand models.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	M	H	M	H	H
PO2	M					
PO3	H	H	H	M	H	M
PSO1	M	M	H	M	H	M
PSO2	M	M	H		M	M

CE6232D PAVEMENT MANAGEMENT SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: identify the root cause of different pavement distresses
CO2: suggest suitable remedial measures for various distresses to improve the pavement surface condition
CO3: interpret the field evaluation data and pavement design data with respect to present and future traffic condition

CO4: optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative
CO5: adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available
CO6: provide the feedback data for updating the pavement performance monitoring system

Module I: (10 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: (9 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.

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.

CE6232D PAVEMENT MANAGEMENT SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H

PO2	M	L	H	H	M	H
PO3	H	H	H	H	L	M
PSO1	H	H	M	L	M	H
PSO2	H	H	H	M	H	H

CE6233D TRANSPORTATION ECONOMICS & APPRAISAL

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Exercise the economic principles and estimating the various cost components in transportation
CO2: Formulating the possible project alternatives for the economic analysis and applying the appropriate economic analysis method
CO3: Applying various non economic based economic analysis techniques for transportation projects
CO4: Quantifying the energy, environment and safety consequences of transportation in the economic analysis

Module I: (9 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: (10 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.

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. Martin Rogers, Engineering Project Appraisal, Balckwell Publishing, 2012.

CE6233D TRANSPORTATION ECONOMICS & APPRAISAL

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:
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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4
PO1	H	H	H	H
PO2	H	H	M	M
PO3	M	M	M	H
PSO1	H	H	H	M
PSO2	H	M	M	M

CE6234D ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: Understanding the concepts, prevailing policy frameworks and acts with regard to environmental protection
CO2: Developing suitable methodological framework for conduction EIA studies
CO3: Prediction and Assessment of the impact on Air, Noise and Social environment
CO4: Selection of the alternatives through systematic decision making methodologies
CO5: Conducting and recording public participation in the EIA process

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: (10 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: (10 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: (10 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.

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.

CE6234D ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	M	M	H
PO2	H	M	H	M	H

PO3	M	H	M	H	M
PSO1	H	H	L	M	H
PSO2	M	M	M	L	M

CE6235D TRANSPORTATION SYSTEM EVALUATION

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Identify the goals, objectives, criteria and standards frame work for evaluation of alternatives.
CO2: Evaluate the transport alternatives with respect to economic environmental and safety using multi-criteria evaluation methods.
CO3: Evaluate transport projects using the different methods of economic evaluation.
CO4: Evaluate the environmental impacts of a transport system.
CO5: Evaluate the safety aspects of highways and suggest suitable countermeasures.
CO6: Conduct a road safety audit for a road section.

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 consensus.

Module II: (10 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: (10 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.

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.

CE6235D TRANSPORTATION SYSTEM EVALUATION

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:
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

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H
PO2	H	L	L	L	L	L
PO3	M	M	H	M	H	M
PSO1	H	H	M	H	H	H
PSO2	M	M	M	M	M	M

MA6004D APPLIED PROBABILITY AND STATISTICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Formulate and differentiate between the different probability distributions and their corresponding distribution functions
CO2: Formulate the test hypothesis for mean and variance
CO3: Estimate the parameters of models using maximum likelihood method
CO4: Design the experiments using different methods
CO5: Identify the correlation between variables
CO6: Develop models using regression analysis

Module I: (9 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: (10 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.

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).

MA6004D APPLIED PROBABILITY AND STATISTICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H
PO2	L	L	L	L	L	L
PO3	H	H	M	M	M	H
PO4	M	H	M	L	M	M
PO5	L	L	M	M	L	M

MA6005D OPTIMIZATION TECHNIQUES- I

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
CO1: formulate linear programming problems
CO2: apply simplex method linear programming problem
CO3: solve transportation and routing problems
CO4: formulate and solve dynamic programming problems
CO5: form the network and find the shortest path and minimal spanning tree,
CO6: find optimal solution to transportation problems

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: (10 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: (10 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: (9 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

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

MA6005D OPTIMIZATION TECHNIQUES - I

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:
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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	H	H	H	H	H	H
PO2	L			L		
PO3	H	H	M	H	M	M
PSO1	H	H	H	L	L	H
PSO2	M	M	M	M	M	M

MA6006D OPTIMIZATION TECHNIQUES - II

Pre-requisites: First course in Optimization Techniques

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

CO1: Calculate the maxima and minima of functions
CO2: Formulate non-linear optimization problems
CO3: Solve constrained non-linear optimization problems
CO4: Formulate and solve Quadratic programming problems
CO5: Solve Quadratic programming problems

Module I: (9 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: (10 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: (10 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.

MA6006D OPTIMIZATION TECHNIQUES - II

Pre-requisites: First course in Optimization Techniques

L	T	P	C
3	0	0	3

Total hours: 39

Brief Syllabus:

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.

Correlation between COs and POs

	CO1	CO2	CO3	CO4	CO5
PO1	H	H	H	H	H
PO2					
PO3	M	M	M	M	H
PSO1	M	M	H	H	M
PSO2	H	H	M	M	H