Curriculum and Syllabi

M.Tech Degree Programme

TRAFFIC AND TRANSPORTATION PLANNING

(with effect from Academic Year 2006-2007)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

CALICUT

Department of Civil Engineering, NIT Calicut

Curriculum for M.Tech. Programme in

CIVIL - TRAFFIC AND TRANSPORTATION PLANNING

FIRST SEMESTER					SECOND SEMESTER				
Subject Code	Name of the Subject	L/T	P/S	Credits	Subject Code	Name of the Subject	L/T	P/S	Credits
MAG601	Applied Statistics & Probability	3	-	3	CEB611	Transportation Data Analysis Methods	4	-	4
CEB601	Traffic Engineering	3	-	3	CEB612	Theories of Traffic Flow	3	-	3
CEB602	Transportation Planning - I	3	-	3	CEB613	Transportation Planning - II	3	-	3
CEB603	Pavement Materials, Design & Construction	3	-	3	CEB614	Pavement Evaluation & Management	3	-	3
CEB691	Transportation Engineering Laboratory & Seminar	-	3	2	CEB693	Transportation Engineering Laboratory & Seminar	-	3	2
CEB692	Computational Laboratory	-	2	1	CEB694	Computer Aided Design in Transportation Engineering	-	2	1
*****	Elective	3	-	3	*****	Elective	3	-	3
*****	Elective	3	-	3	*****	Elective	3	-	3

Total Credits – 15 (Core) + 3 or 6 (Electives) Total Credits – 16 (Core) + 3 or 6 (Electives)

THIRD SEMESTER					FOURTH SEMESTER				
Subject Code	Name of the Subject	L/T	P/S	Credits	Subject Code	Name of the Subject	L/T	P/S	Credits
CEB797	Mini Project - **OPTIONAL**	-	-	1	CEB799	Project	-	-	12
CEB798	Project	-	-	8					
*****	Elective	3	-	3					
*****	Elective	3	-	3					
	Total (compulsory)			8		Total (compulsory)			12

Total Credits – 8 (Core) + 0 to 6 (Electives/Mini Project) Total Credits – 12 (Core)

Stipulations:

1. A minimum of 63 credits have to be earned for the award of M.Tech. degree in this programme.
2. Students have to register for a minimum of four electives in three semesters. (One or two electives in the first two semesters and maximum of two courses, including Mini project, in the third semester). Fourth Semester is reserved for Project work only.
3. Industrial Training (1 credit) during the gap between 2nd and 3rd semesters is optional

LIST OF ELECTIVES

MAG621	Optimisation Techniques - I
CEB621	Transportation Economics & Evaluation
CEB622	Transportation Systems & Analysis
CEB623	Public Transport Planning & Design
CEB624	Transportation Infrastructure Design
CEB625	Geographic Information System & Its Applications
CEA625	Bridge Engineering
MAG651	Optimisation Techniques - II
CEB651	Transportation System Management
CEB652	Transportation System Evaluation
CEB653	Pavement Management Systems
CEB654	Environmental Impact Assessment
CEB655	Database Management
CEB656	Soft Computing Tools
CEA611	Finite Element Method

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

MAG601 APPLIED STATISTICS AND PROBABILITY

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module – 1 (12 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 - 2 (11 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 - 3 (11 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 - 4 (11 Hours)

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

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, (1990)
3. Montgomery, D. C.; “Design and Analysis of Experiments”, 5th edition, John Wiley and Sons, INC., New York. (2001).
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, (1970).

CEB601 TRAFFIC ENGINEERING

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module – 1 (10 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 – 2 (13 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 (12 Hours)

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

Module – 4 (10 Hours)

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

References

1. Pignataro, L., Traffic Engineering – Theory & Practice, John Wiley.
2. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers.
3. The Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall (1982) Chapters 8,17,21.23 and 24.
4. O'Flaherty C A, Highways- Traffic Planning & Engineering, Edward Arnold, UK
5. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ
6. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas
7. Salter, R J., Highway Traffic Analysis and Design, ELBS.
8. Matson, Smith and Hurd, 'Traffic Engineering' Mc-Graw Hill Book Co.

CEB602 TRANSPORTATION PLANNING – I

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module – 1 (10 Hours)

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

Module – 2 (13 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.

Module – 3 (12 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 – 4 (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.

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
3. Dickey, J.W., Metropolitan Transportation Planning, Tata Mc-Graw Hill 1980
4. ITE (1982), 'Transportation and Traffic Engineering Hand Book', Chapters 10,12, and 17, Prentice Hall, New Jersey
5. Kanafani, A., Transportation Demand Analysis, McGraw-Hill.
6. Oppenheim, N., Applied Models in Urban and Regional Analysis, Prentice-Hall, NJ.
7. Bruton M.J., Introduction to Transportation Planning, Hutchinson of London.
8. Oppenheim N., Applied Models in Urban and Regional Analysis, Prentice-Hall.
9. Dickey J.W., *et. al*., Metropolitan Transportation Planning, Tata McGraw-Hill.
10. Gallion A.B and Eisner S., The Urban Pattern, Affluated East-West Press, New Delhi.
11. Wilson, A.G, Urban and Regional Models in Geography and Planning, John Wiley and Sons.

CEB603 PAVEMENT MATERIALS, DESIGN AND CONSTRUCTION

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module - 1 (12 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.

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 - 2 (12 Hours)

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

Module – 3 (10 Hours)

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

Module – 4 (11 Hours)

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

References:

1. Yoder and Witezak, Principles of Pavement Design, John Wiley and sons.
2. Yang, Design of functional pavements, McGraw-Hill.
3. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 1996.
4. Robert D. Krebs, Highway Materials, McGraw Hill Text, 1971
5. Asphalt Institute, The Asphalt Handbook, 1989
6. IRC: 37-2001, Guidelines for the Design of Flexible Pavements.
7. IRC: 58-2002, Guidelines for the Design of Rigid Pavements.
8. RRL, DSIR, Concrete Roads, HMSO, IRC Publications

MAG621 OPTIMISATION TECHNIQUES I

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module - 1 (11 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 - 2 (12 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 - 3 (12 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 - 4 (10 Hours)

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

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,
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

CEB621 TRANSPORTATION ECONOMICS AND EVALUATION

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module - 1 (10 Hours)

Principles of Economics: Supply and demand models, Consumer's surplus and social surplus criteria, framework for social accounting: accounting rate of interest, social opportunity cost, rate of interest, social time preference rate of interest, accounting prices of goods and services, measuring input costs, applications o social accounting frame work.

Module – 2 (12 Hours)

Transport Costs and Benefits: Fixed and variable cost, cost of improvement, maintenance cost, cost estimating methods, accounting for inflation, external costs, Direct benefits: reduced vehicle operation costs, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost.

Module – 3 (11 Hours)

Economic Analysis: 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 – 4 (12 Hours)

Project Evaluation: Framework of evaluation, transport planning evaluation at urban and regional levels, Other evaluation procedures – achievement matrices, factor profiles, plan ranking, environmental evaluation, safety evaluation, project financing.

References

1. Winfrey R, Highway Economic Analysis, International Textbook Company.
2. Kenneth J. Button, Transport Economics, Elgar
3. David A. Hensher, Ann M. Brewer, Transport : An Economics and Management Perspective, Oxford University Press
4. Emile Quinet, Roger Vickerman, Principles Of Transport Economics, Edward Elgar Pub
5. Road User Cost Study, Central Road Research Institute
6. Dickey J.W, Project Appraisal for Developing Countries, JohnWiley
7. Ian G. Heggie, Transportation Engineering Economics, McGraw Hill.

CEB622 TRANSPORTATION SYSTEMS AND ANALYSIS

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module - 1 (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 – 2 (12 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 – 3 (12 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 – 4 (11 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.
2) Heggei, I.G., Transportation Engineering Economics, Mc-Graw Hill Book Company, New York.
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, Mc-Graw Hill Book Company, New York.
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.

CEB623 PUBLIC TRANSPORT PLANNING AND DESIGN

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module - 1 (9 Hours)

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

Module – 2 (13 Hours)

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

Module – 3 (13 Hours)

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

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

Module – 4 (10 Hours)

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

References:

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

CEB624 TRANSPORTATION INFRASTRUCTRE DESIGN

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module – 1 (10 Hours)

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

Module – 2 (12 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 – 3 (12 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 – 4 (11 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.
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.
5. Edward K. Morlock, Introduction to Transportation Engineering & Planning, International Student Edition, Mc-Graw Hill Book Company, New York.
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.

CEB625 GEOGRAPHIC INFORMATION SYSTEM AND ITS APPLICATIONS

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module - 1 (10 Hours)

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

Module - 2 (12 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 – 3 (13 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 – 4 (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, 2002.
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, 2001.
5. DeMers, M.N., Fundamentals of Geographic Information Systems, John Wiley & Sons, New York, 2000.
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.

CEA625 BRIDGE ENGINEERING

Pre-requisite: Nil

L	T	P	Cr
3	0	0	3

Module 1 (12hrs)

Introduction–classification and components of bridges– layout and planning–

Structural forms of bridge decks – grillage analysis of slab decks, beam and slab decks, cellular decks.

Module 2 (15hrs)

Standard specifications for bridges – IRC loadings for road bridges – standards for railway bridges – design of RC slab, skew slab and box culverts. Design of T beam bridges – balanced cantilever bridges – rigid frame bridges – Arch bridges – bow string girder bridges.

Module 3 (12hrs)

Design of plate girder bridges – steel trussed bridges – Introduction to long span bridges: cable stayed bridges and suspension bridges –instability.

Module 4 (6hrs)

Forces on piers and abutments – Design of piers and abutments – types of wing walls – types of bearings – design of bearings.

References

1. E.C. Hambly, Bridge deck behaviour, Chapman and Hall, London
2. E.J. O'Brien and D.L. Keogh, Bridge deck analysis, E& FN Spon, New York
3. D.Johnson Victor, Essentials of bridge engineering, Oxford & IBH publishing Co. Ltd., New Delhi.
4. N.Krishna Raju, Design of bridges, Oxford & IBH publishing Co. Ltd., New Delhi.
5. Jaikrishna and O.P Jain, Plain and reinforced concrete-vol.II, Nem Chnand & Bros,Roorkee.
6. IRC: 5 -1970, Standard specifications and code of practice for road bridges, Sections I to V, Indian Roads Congress, New Delhi.
7. Indian railway standard code of practice for the design of steel or wrought iron bridge carrying rail, road or pedestrian traffic, Govt. of India, Ministry of Railways, 1962.

CEB691 TRANSPORTATION ENGINEERING LABORATORY AND SEMINAR

Pre-requisite: Nil

L	T	P	Cr
0	0	3	2

Highway Materials Testing:

- Tests on Bitumen
- Tests on Emulsion

Design of Asphalt Concrete Mixes:

- Marshall Stability Test

Pavement Evaluation Tests:

- Benkleman Beam test
- Roughness Test

Seminar on any chosen related topic

CEB692 COMPUTATIONAL LABORATORY

Pre-requisite: -Nil

L	T	P	Cr
0	0	2	1

Development of Applications Programs using C/C++

Practice on use of

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

CEB611 TRANSPORTATION DATA ANALYSIS METHODS

Pre-requisite: Nil

L	T	P	Cr
3	1	0	4

Module - 1 (14 Hours)

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

Module – 2 (14 Hours)

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

Module – 3 (14 Hours)

Concept of Entropy and its Application in Travel Demand Modelling: Definition of Entropy, its relations to Probability and Uncertainity, Entropy of Probability Distribution, Entropy and Bayesian Statistics, Application of Entropy Concepts in Transport Models: Theory of Trip Distribution, Mode Split and Route Split, Production, Attraction, Doubly Constrained Gravity Models and Derivation of Intervening Opportunity Model, Missing Information and Use of Entropy in Travel Demand Modelling: Entropy and Information Theory Approaches for Estimating the Travel Demand using Indirect Methods such as Use of Link Volume Counts, Turning Counts, etc.

Module – 4 (14 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; Introduction to Box-Jenkins Forecasting.

References

1) Cooley, WW and Lohnes, RR, Multi-variate Data Analysis, John Wiley, .
2) Joseph F. Hair, Bill Black, Barry Babin, Rolph E. Anderson, Ronald L. Tatham, Multivariate Data Analysis, Prentice Hall; 2005.
3) Richard A. Johnson, Dean W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall.
4) Simon P. Washington, Matthew G. Karlaftis & Fred L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC.
5) Kanafani, A., Transportation Demand Analysis, McGraw-Hill.
6) Michael Meyer, Eric J Miller, Urban Transportation Planning, McGraw-Hill Science/Engineering/Math.
7) Wilson, A.G., Entropy in Urban and Regional Modeling, Pion, London,
8) Pindyck, R.S and Roubinfeld, D.L, Econometric and Economic Forecasts, McGraw-Hill, Tokyo.
9) Spyros G. Makridakis, Steven C. Wheelwright, Rob J Hyndman, Forecasting : Methods and Applications, Wiley.

CEB612 THEORIES OF TRAFFIC FLOW

Pre-requisite: -Nil

L	T	P	Cr
2	1	0	3

Module - 1 (12 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 - 2 (11 Hours)

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

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

Module - 3 (12 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 - 4 (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 - D.C.
2. May, A D., Traffic Flow Fundamentals, Prentice-Hall, NJ
3. Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York.
4. TRB Special Report 209: Highway Capacity Manual, Transportation Research Board, Washington DC, 1985.
5. Wohl M. and Martin, B V., Traffic System Analysis for Engineers and Planners, McGraw-Hill, New York.
6. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ
7. Mannering, F.L. & Kilareski, W.P., Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons.
8. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley.

CEB613 TRANSPORTATION PLANNING - II

Pre-requisite: -Nil

L	T	P	Cr
2	1	0	3

Module - 1 (11 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 - 2 (11 Hours)

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

Module - 3 (12 Hours)

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

Module -4 (11 Hours)

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

References:

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

CEB614 PAVEMENT EVALUATION & MANAGEMENT

Pre-requisite: -Nil

L	T	P	Cr
2	1	0	3

Module - 1 (12 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 – 2 (12 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 – 3 (9 Hours)

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

Module – 4 (12 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.
2. Babkov, Road Conditions and Traffic Safety, Mir Publications.
3. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.
4. David Croney, The Design and Performance of Road Pavements, HMSO Publications.
5. Haas and Hudson, Pavement Management System, McGraw Hill Book Co., New York.
6. Per Ullitz, Pavement Analysis, Elsevier, Amsterdam
7. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements.
8. SHAHIN, M Y, Pavement management for airport, roads and parking lots, Chapman and hall 1994
9. Yang H. Huang, Pavement Analysis and Design, Prentice Hall.

MAG651 OPTIMISATION TECHNIQUES II

Pre-requisite: - First Course in Optimisation Techniques

L	T	P	Cr
2	1	0	3

Module –1 (11 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 – 2 (11 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 – 3 (12 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 – 4 (11 Hours)
Integer linear programming – Gomory's cutting plane method – Branch and Bound Algorithm – Travelling Salesman problem – Knapsack problem; Introduction to Optimization tools and software.

REFERENCES:

1. Taha. H. A., Operations Research, An Introduction (Sixth edition PHI)
2. Simmons D. M, Nonlinear Programming for Operations Research (PHI)
3. M. S. Bazaraa. H. D. Sherali, C. M. Shetty, Nonlinear programming theory and Algorithm, John Wiley, II edition, 1993.

CEB651 TRANSPORTATION SYSTEM MANAGEMENT

Pre-requisite: - Nil

L	T	P	Cr
2	1	0	3

Module –1 (12 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 – 2 (12 Hours)

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

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

MODULE – 3 (12 Hours)

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

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

Module – 4 (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.

CEB652 TRANSPORTATION SYSTEM EVALUATION

Pre-requisite: - Nil

L	T	P	Cr
2	1	0	3

Module – 1 (10 Hours)

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

Module – 2 (13 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 – 3 (12 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 – 4 (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.
2) Dickey J.W., et. al., Metropolitan Transportation Planning, Tata McGraw-Hill.
3) ITE (1982), Transportation and Traffic Engineering Hand Book, Chapters 21 and 22', Prentice-Hall, New Jersy.
4) Heggei, I.G., Transportation Engineering Economics, Mc-Graw Hill Book Company, New York.
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.
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

CEB653 PAVEMENT MANAGEMENT SYSTEMS

Pre-requisite: - Nil

L	T	P	Cr
2	1	0	3

Module – 1 (12 Hours)

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

Module – 2 (11 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 – 3 (11 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 – 4 (11 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) R. C. G. Haas, 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.

CEB654 ENVIRONMENTAL IMPACT ASSESSMENT

Pre-requisite: - Nil

L	T	P	Cr
2	1	0	3

Module - 1 (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 - 2 (12 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 - 3 (12 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 measuresConceptual approach for addressing socio-economic impacts, traffic and transportation system impacts, visual impacts, scoring methodologies for visual impact analysis

Module – 4 (12 Hours)

Decision Methods for Evaluation of Alternative: 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.

CEB655 DATA BASE MANAGEMENT

Pre-requisite: - Nil

L	T	P	Cr
2	1	0	3

Module - 1 (11 Hours)

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

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

Module - 2 (12 Hours)

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

Module – 3 (12 Hours)

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

Module – 4 (10 Hours)

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

References

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

CEB656 SOFT COMPUTING TOOLS

Pre-requisite: - Nil

L	T	P	Cr
2	1	0	3

Module – 1 (12 Hours)

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

Module – 2 (12 Hours)

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

Module – 3 (12 Hours)

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

Module – 4 (9 Hours)

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

References:

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

CEA611 FINITE ELEMENT METHOD

Pre-requisite: Nil

L	T	P	Cr
2	1	0	3

Module 1 (10hrs)

Introduction:- The Finite Element Method – The element characteristic matrix – Element assembly and solution for unknowns – Summary of finite element history.

Basic equations of elasticity – Strain-displacement relations – Theory of stress and deformation – Stress-strain-temperature relations.

The Direct Stiffness Method: - Structure stiffness equations – Properties of [K] – Solution of unknowns – Element stiffness equations – Assembly of elements – Node numbering to exploit matrix Sparsity – Displacement boundary conditions – Gauss elimination solution of equations – Conservation of computer storage – Computational efficiency – Stress computation – Support reactions – Summary of the finite element procedure.

Module 2 (12hrs)

Stationary Principles, Rayleigh-Ritz Method and Interpolation: - Principle of stationary potential energy – Problems having many d.o.f – Potential energy of an elastic body – The Rayleigh-Ritz method – Piecewise polynomial field – Finite element form of Rayleigh-Ritz method – Finite element formulations derived from a functional – Interpolation – Shape functions for C^0 and C^1 elements – Lagrangian and Hermitian interpolation functions for one dimensional elements – Lagrangian interpolation functions for two and three dimensional elements

Introduction to Weighted Residual Method: -Some weighted residual methods – Galerkin finite element method – Integration by parts – Axially loaded bar – Beam – Plane elasticity.

Module 3 (12hrs)

Displacement-based Elements for Structural Mechanics:- Formulas for element stiffness matrix and load vector – overview of element stiffness matrices – Consistent element nodal load vector – Equilibrium and compatibility in the solution – Convergence requirements – Patch test – Stress calculation – Other formulation methods.

Straight-sided Triangles and Tetrahedra:- Natural coordinates for lines, triangles and tetrahedra – Interpolation fields for plane triangles – linear and quadratic triangle – quadratic tetrahedron.

The Isoparametric Formulation:- Introduction – An isoparametric bar element – Plane bilinear element – Summary of Gauss quadrature – Quadratic plane elements – Direct construction of shape functions for transition elements – Hexahedral (solid) isoparametric elements – Triangular isoparametric elements – Consistent element nodal loads – Validity of isoparametric elements – Appropriate order of quadrature – element and mesh instabilities – Remarks on stress computation

Module 4 (11hrs)

Coordinate Transformation:- Transformation of vectors – transformation of stress, strain and material properties – Transformation of stiffness matrices – Transformation of Flexibility to Stiffness – Inclined support – Joining dissimilar elements to one another – Rigid links – Rigid elements.

Topics in Structural Mechanics: - D.o.f. within elements – Condensation – Condensation and recovery algorithm – Substructuring – Structural symmetry.

References

1. Cook, R.D., et al, Concepts and Applications of Finite Element Analysis, John Wiley.
2. Desai, C.S., Elementary Finite Element Method, Prentice Hall of India.
3. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India.
4. Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India.
5. Gallaghar, R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc.
6. Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Pub.
7. Krishnamoorthy, C.S., Finite Element Analysis – Theory and Programming, Tata Mc Graw Hill.
8. Zienkiewicz, O.C., and Taylor, R.L., The Finite Element Method, Vol. I and II, Mc Graw Hill.

CEB693 TRANSPORTATION ENGINEERING LABORATORY AND SEMINAR

Pre-requisite: - Nil

L	T	P	Cr
0	0	3	2

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

CEB694 COMPUTER AIDED DESIGN IN TRANSPORTATION ENGINEERING

Pre-requisite: - Nil

L	T	P	Cr
0	0	2	1

Design and Drawing Exercises

The following Detailed Drawings have to be prepared:

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

Highway Geometric Design using CAD Software

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