GUJARAT TECHNOLOGICAL UNIVERSITY

M.E

Civil in Transportation Engineering

Semester-1

1.Urban Transportation Systems Planning

Course Objectives:

1. To cover concepts of Transportation planning, various modes, transit systems and their suitability.
2. To give idea of modeling in planning, to develop the methodology of travel demand modeling for Urban Transportation Systems.
3. To provide knowledge of Land use planning and transportation interaction.

Course Contents:

1. Introduction to transportation systems planning, various modes of transportation and comparisons, urban transportation system planning process, use and evaluation of various models.
2. Planning methodologies, modeling techniques in planning, problem solving techniques.
3. Urban Mass transportation Systems: Urban transit problems, travel demand, types of transit systems, public, private, para-transit transport, mass and rapid transit systems, coordination, types of coordination.
4. Travel demand modeling: Trip generation, trip distribution, modal split analysis, trip assignment techniques, and various models, transportation compact study methodologies.
5. Network assignment methods, connectivity, strategies for the evaluation of ultimate transportation framework and case studies. Strategies for the evaluation of alternate transportation plans and plan implementation.
6. Land use planning models and their suitability. Transportation impacts study methodologies
7. Urban goods movement, framework and case studies.

Tutorials:

Problems based on:

1. Trip generation: Linear Regression and Cross Category analysis.
2. Trip distribution: Growth Factor Methods, Gravity Model.
3. Modal split analysis.
4. Trip assignment: Shortest path analysis and network-assignment, connectivity.
5. Land use planning model (Lowery and Garin Lowery model).
6. Computer application for solving the above mentioned problems.

Field work: Collection of Home – Interview data. Presentation with group discussion on its analysis and interpretations.

Field Visit: Visit to Urban Mass Transportation System Service - Depot, Terminals, Offices.

References :

1. B.G.Hutchinson, *Principles of urban transportation system planning*- McGraw-Hill, New York, 1974
2. Edward K.Morlok, *Transportation Engg. and Planning*
3. W.Dickey, *Metropolitan Transportation Planning* Tata McGraw-Hill, New Delhi, 1975
4. Blunder and Black, *Land useTtransportation System*
5. J.Ortuzer and L.G. Willumsen, *Modelling Transport,* Johan Wiley and Sons Chincester,1994
6. Vukan R. Vuchic, *Urban Transit : Operations, Planning and Economics*, Wiley Sons Publishers.
7. Peter White, *Public Transport*, UCL Press
8. Kadiyali L.R., *Traffic Engineering and Transport Planning*, Khanna Publishers
9. Khisty, C J., *Transportation Engineering – An Introduction*, Prentice-Hall, NJ
10. TCRP Report 30, TCRP Report 95, TCRP Report 100
11. S.C. Saxena, *Traffic Planning and Design,* Dhanpat Rai Pub., New Delhi.
12. Partho Chakraborty and Animesh Das, *Principles of Transportation Engineering*, PHI
13. C. S. Papacostas, *Fundamentals of Transportation System Analysis,* PHI.
14. James H. Banks, *Introduction to Transportation Engineering,* WCB-McGraw Hill, New York

2: Traffic Engineering -1

Course Objectives:

1. To give knowledge about basic elements of traffic and their characteristics, interactions, impacts.
2. To provide know-how of fundamental variables of traffic, techniques of measurements and analysis.
3. To make conversant with conducting different traffic surveys, analysis and interpretations.

Course Contents:

1. Introduction: Basic components of traffic and their characteristics.
2. Fundamental variables of traffic: volume, speed, delay, density, headway - measurement techniques and analysis, sampling, frequency distribution, statistics.
3. Transportation surveys- O-D survey, methodology and analysis.
4. Parking survey, characteristics and interpretation.
5. Road accidents and safety measures.
6. Traffic planning and design – for pedestrians, intersections, road markings, signs.

Practical work:

List of tests/ practical are given below:

Sr. No.	Test
1	Driver's ability test & Vehicular characteristics
2	Classified traffic volume study with use of hand count, tape, video recorder
3	Spot speeds study with radar meter, enoscope
4	Travel time and delay study
5	Parking survey
6	Road accident studies
7	Pedestrian flow survey
8	Intersection volume study
9	Analysis of traffic survey data, presentation and interpretations.

References:

1. L.J.Pingnataro, *Traffic Engineering; Theory and Practice*. Prentice Hall, Englewood Clitts, 1973.
2. M.Wohl and B.V.Martin, *Traffic System Analysis for Engineering and Planners*, McGraw-Hill. New York,1983.
3. D.R.Drew, *Traffic Flow Theory and Control*, McGraw Hill. New York 1968.
4. W.R.McShane, R.P.Roess and E.S.Prassas, *Traffic Engineering*, Prentice Hall, New Jersey, 1990.
5. R.J.Salter, *Highway Traffic Analysis and Design*, McMillan, Hampshire, 1989.
6. *Highway Capacity Manual*, Transportation Research Board, Washington D.C., 1997, 2000
7. Partho Chakraborty and Animesh Das, *Principles of Transportation Engineering*, PHI
8. S.C. Saxena, *Traffic Planning and Design,* Dhanpat Rai Pub., New Delhi.

3 : Highway Materials and Construction

Course Objectives:

1. To provide knowledge of different materials used for highway construction, their suitability, standard tests, field applications.
2. To make students familiar with highway construction procedure.
3. To give an idea regarding techniques of highway construction in problematic situations.

Course Contents:

1. Soil: Properties, Classification, Compaction, Consolidation, Application of Tests, Results and use of Geotextile materials.
2. Soil Stabilization – Methods, Principles, Test Significance, Design of Soil – Stabilized Mix, Control.
3. Aggregates Types, Tests, Desired Properties, Aggregate Blending Methods.
4. Bituminous Materials – Types, Tests, Properties, Blending.
5. Mix Designs – Bituminous Mixes, Admixtures, Tests, Results, Control. (Marshall Stability Test)
6. Highway Construction Methods: Embankment, Sub- Base, Base and Surface Courses, Flexible Pavements, Rigid Pavements. Materials for road construction, Specification and tests, Macadam construction, surfacing and surface treatment. Asphalt mix design.
7. Surface and Subsurface Drainage.
8. Road Work in Desert, Swampy, Hilly Area in Problematic Situation.

Practical work:

List of the tests are given below.

Tests on Soil

Sr. No.	Test
1	Soil Classification
2	Proctor test / Compaction test
3	California Bearing Ratio test
4	Soil-Cement stabilization test

Tests on Aggregate

5	Impact test
6	Crushing test
7	Los Angeles Abrasion test
8	Specific Gravity and Water absorption test
9	Shape test
10	Stripping Value test

Tests on Bitumen

11	Penetration test
12	Softening Point test
13	Ductility test
14	Flash and Fire Point test
15	Viscosity test
16	Bitumen Content test

Tests on Bituminous Mix

17	Marshall Stability test

Field Visit:

1. Hot – mix plant visit,
2. Road construction site visit: Earth work construction procedure and bituminous mix laying, spreading and rolling procedure.

References:

1. Walker and Martin. *Asphalt Pavement Engg*.
2. Kerbs and Walker, *Highway Materials*
3. HMSO, *Soil Mechanics For Road Engineers*
4. HMSO, *Bituminous Materials For Engineers*
5. MOST Standards for Highway constructions
6. Atkins Harold N., *Highway Materials, Soils, and Concrete*, Prentice Hall, 1996.
7. IRC: 37-2001, *Guidelines for the Design of Flexible Pavements*.
8. Kadiyali L.R.and Lal, N. B., *Principles & Practice of Highway Engineering*, Khanna Publishers, Delhi.
9. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee.
10. Various IRC codes for construction of Bituminous & Concrete Roads
11. Partho Chakraborty and Animesh Das, *Principles of Transportation Engineering*, PHI

Semester-2

1: Traffic Engineering – 2

Course Objectives:

1. To provide detailed knowledge of traffic flow characteristics, measurement techniques and analysis.
2. To train the students, how to find the highway capacity and level of service.
3. To make aware of traffic management techniques and impacts of traffic.
4. To impart the concepts of design of traffic control devices and traffic infrastructures.

Course Contents:

1. Basic Traffic Flow Characteristic, Speed-Flow, Speed-Density, Flow-Density Curves and relations.
2. Highway Capacity, Level of Service – Measurement Techniques.
3. Speed-Flow on Grades, HCM Methods. Design hourly volumes and speed; Highway capacity and performance characteristics
4. Merging – Diverging Flow, Weaving Flow, Length Calculations.
5. Traffic Control Devices, Rules, Signs, and Signals – Signal Cycle Time Calculations, Isolated and Co-Ordinated Signals.
6. Traffic Management: TSM Techniques.
7. Environmental Impact of Traffic – Air, Noise Pollution.
8. Principles of branching network systems for flexibility, Travel forecasting principles and techniques; Design of Parking;
9. Simulation in traffic engineering design.

Practical work:

List of tests/ practical are given below.

Sr. No.	Test/ Practical/Tutorials
1	Traffic speed-flow-density relationship by field observations and finding Capacity & Level of service of highway section.
2	Stopped delay & Travel time delay Study on Signalised Intersection.
3	Saturation flow measurement at Signalised Intersection.
4	Design of signal for Isolated Intersection.
5	Design of co-coordinated signals.
6	Design of summit vertical curve, Climbing lane & 'No overtaking zone' marking. Weaving length calculations.
7	Design of on Street Parking / Parking plot.
8	Tutorials on Travel forecasting techniques.

Field work: Identification of problematic spots for traffic flow and suggesting suitable remedial measures. Its presentation with group discussion.

Field visit: A visit to Full cloverleaf junction or any other important traffic infrastructure.

References:

1. L.J.Pingnataro, *Traffic Engineering; Theory and Practice*. Prentice Hall, Englewood Cliffs, 1973.
2. M.Wohl and B.V.Martin, *Traffic System Analysis for Engineering and Planners*, McGraw-Hill. New York,1983.
3. D.R.Drew, *Traffic Flow Theory and Control*, McGraw Hill. New York 1968.
4. W.R.McShane, R.P.Roess and E.S.Prassas, *Traffic Engineering*, Prentice Hall, New Jersey, 1990.

5. R.J.Salter, *Highway Traffic Analysis and Design*, McMillan, Hampshire, 1989.
6. *Highway Capacity Manual*, Transportation Research Board, Washington D.C.,1997, 2000.
7. James H. Banks, *Introduction to Transportation Engineering,* WCB-McGraw Hill, New York
8. S.C. Saxena, *Traffic Planning and Design,* Dhanpat Rai Pub., New Delhi.
9. Partho Chakraborty and Animesh Das, *Principles of Transportation Engineering*, PHI
10 Kadiyali L.R., *Traffic Engineering and Transport Planning*, Khanna Publishers.
11 Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee.
12 F. L. Mannering, W. P. Kilareski and S. S. Washburn, *Principles of Highway Engineering and Traffic Analysis.* Wiley India Pvt. Ltd., New Delhi.

2: Pavement Design and Evaluation

Course Objectives:

1. To make students aware of design procedure of different types of pavements.
2. To give knowledge of failures in pavements and their preventive measures.
3. To impart the concepts of evaluation techniques of pavements along with strengthening techniques.

Course Contents:

1. Types of Payments – Rigid, Flexible, Highway-Runway Comparison.
2. Types of Failures.
3. Stresses in Flexible Pavements – Theories, Analysis,
4. Stresses in Rigid Pavements – Theories, Analysis.
5. Design of Flexible Pavements –ESWL, Tyre Pressure, Other Factors, Various Methods for Highway and Runways Design.
6. Design of Rigid Pavements – EWLF, Other Factors Various Methods for Highways and Runways, Design of Joints, Temperature stresses. Pre-stressed Concrete Pavements.
7. Pavement evaluation and strengthening: Failures in flexible and rigid pavements, pavement evaluation, deflection survey, serviceability rating techniques, strengthening techniques, maintenance, overlays, replacements.

Practical work:

List of tests/ practical/ tutorials are given below:

Sr. No.	Test/ Practical/Tutorials
1	Plate Bearing Test.
2	Field CBR Test.
3	Pavement Evaluation by Benkelman Beam Method.
4	Road Unevenness Measurement by Bump-Integrator.
5	Valuation of Pavement Roughness by Roughometer / Profilometer.
6	Design of Flexible Pavements for Highway and Runway.
7	Design of Rigid Pavements For Highway and Runway.
8	Design of Overlays.

References:

1. E.J.Yoder and M.W.Witczak, *Principles of Pavement Design*, John Wiley and Sons, New York, 1975
2. Tang, *Pavement Design*
3. Sharma & Shrama, *Principles and Practice of Highway Engg*.
4. IRC– 37, 2001, IRC – 58-1998.
5. Y.H.Huang, *Pavement Analysis and Design*. Prentice Hall, Englewood Cliffs, New Jersey, USA, 1993, ISBN-0-13-655275-7
6. H.N.Atkins, *Highway Construction and Maintenance, Soils, and Concretes*, Reston Publishing Company, Reston VA, 1983.
7. J.P.Watson, *Highway Construction and Maintenance*, Longman Scientific and Technical, New York, 1989.
8. Relevant IRC, BIS, AASHTO and PCA Specifications and Guidelines.
9. Kadiyali L.R.and Lal, N. B., *Principles & Practice of Highway Engineering*, Khanna Publishers, Delhi.
10. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee.
11. Partho Chakraborty and Animesh Das, *Principles of Transportation Engineering*, PHI
12. F. L. Mannering, W. P. Kilareski and S. S. Washburn, *Principles of Highway Engineering and Traffic Analysis.* Wiley India Pvt. Ltd., New Delhi.

Major Elective – 1

(Group – 1)

Statistics and Optimization Techniques

Course Objectives:

1. To enhance the knowledge regarding statistics and its applications to transportation engineering.
2. To make students conversant with different optimization techniques and their applications in transportation engineering.

Course Contents:

1. Social Research Formulation: Design of research, scaling techniques, sampling techniques, design of questionnaire.
2. Statistics & Probability Base: Various probability distributions & their applications, parameter estimation, hypothesis testing, random variables, method of maximum likelihood, hypothesis testing to compare multiple population, statistical quality control.
3. Linear & Multi-linear Regression and Correlation Analysis: Estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, hypothesis tests associated with regression and correlation coefficients, multiple regression models.
4. Optimisation techniques: Linear programming, Simplex method, transportation model, Assignment problems.
5. Queuing theory, Queuing Models, Markov decision processes; Applications to inventory management and Replacement processes.

Tutorials:

1. Problems based on random sampling.
2. Problems based on probability distribution, hypothesis testing.
3. Problems based on linear regression analysis.
4. Problems based on linear programming, graphical method.
5. Problems based on Simplex method, its varieties.
6. Transportation and Assignment problem solution.
7. Problems based on Queuing theory.
8. Computer applications for solving the above mentioned problems.

References:

1. Benjamin J. R., Cornell C. A., *Probability Statistics and Decision for Civil Engineers*, McGraw-Hill, 1970.
2. Irwin R. Miller, Freund J. E. and Richard Johnson, Probability and Statistics for Engineers, PHI, New Delhi, 1990.
3. Hines W. W., Montgomery D. C., et. al., *Probability and Statistics in Engineering and Management Science*, John Wiley and Sons, New York, 1990.
4. Rao S.S., *Engineering Optimisation - Theory & Practice*, New Age International Publishers, Revised Edition III, 2006.
5. Sharma J.K., *Operation Research: Theory & Applications*, MacMillan India Ltd., 2000.
6. Bhandarkar P.L., Wilkinson T.S., *Methodology & Techniques of Social Research,* Himalaya Publishing House, 1991.
7. Gujarati Damodar, *Basic Econometrics*, Sheldor Ross Publications

Major Elective – 1

(Group – 2)
Decision Models in Management

Course Objectives:

1. To give the concepts of quantitative methods for management decision and subsequently their applications in transportation engineering.
2. To provide the basic understanding of simulation process and its applications in transportation engineering.
3. To make students conversant with shortest path method.

Course Contents:

1. Introduction: Quantitative methods for management decisions. Operation research. Decision environment, Decision making processes.
2. Linear programming problems, graphical solution, non linear programming. Heuristics, Simplex method, duality, post- optimality analysis; Primal and dual solution approaches; Sensitivity analysis, Unconstrained and constrained optimization, Kuhn- Tucker theory; Quadratic programming applications.
3. Transportation and transhipment problems.
4. Assignment problems.
5. Queuing theory, Queuing Models, Markov decision processes; Applications to inventory management and Replacement processes.
6. Discrete event simulation; Generation of random variables, simulation processes and languages.
7. Network models. Shortest path method, maximum flow. Minimum spanning tree problem.
8. Integer programming, goal programming, dynamic programming. Decision theory. Role of knowledge; Deterministic and probabilistic situation, Single and multiple person decision making.

Tutorials:

1. Problems based on linear programming, Simplex method and its varieties.
2. Problems based on Non-linear programming.
3. Solving Transportation, Transhipment and Assignment problems.
4. Problems based on simulation.
5. Problems based on shortest path method and minimum spanning tree.
6. Problems based on Integer, goal, dynamic programming.
7. Computer applications for solving above problems.

References :

1. Rao S.S., *Engineering Optimisation - Theory & Practice*, New Age International Publishers, Revised Edition III, 2006.
2. N.D.Vohra. *Quantititative techniques in management,* TMH, New Delhi, ISBN-0-07-451979-4
3. Deightler, philips, wilde (phi), *Foundations of optimization*
4. Ravindran, D.T.Philips and J.J.Solberg, *Operations Research; Principles and Practice,* John Wiley, 2nd Edition 1987
5. S.Bazzarra, J.J.Jarvis and H.D.Sherali, *Linear Programming and Network Flows*, 2nd Edition , John Wiley, 1990
6. L.Winston, *Operations Research; Application and Algorithms*, Kent P.W.S. 2nd Edition, 1991
7. A.Taha, *Operations Research; An Introduction*, MacMillan, 1982
8. Kapoor, *Computer Assisted Decision Models,* Tata McGrw-Hill, New Delhi, 1991

Major Elective – 1
(Group – 3)
Public Transportation Planning

Course Objectives:

1. To give detailed knowledge regarding public transportation systems, their operation, planning and economics.
2. To make the students familiar with problems of transit routing, scheduling, infrastructure facilities, fare structures and management.

Course Contents:

1. Development of Public Transit System: Historical Growth, Modes of public transport and comparison, public transport travel characteristics, technology of bus, rail, rapid transit systems, basic operating elements.
2. Transit Network Planning: Objectives, principles, Intercity and Regional transit system, considerations, transit lines – types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, network evaluation, accessibility considerations.
3. Transit Scheduling: Components, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling.
4. Transit Infrastructure Facilities: Design of bus stops, design of terminals – principles of good layout, types of layout, depot location, twin depot concept, crew facilities and amenities.
5. Transit Agency and Economics: Organisational structure of transit agency, management and personnel, transit system statistics, performance and economic measures, operations, fare structure.

Tutorials:

1. Problems based on routing, scheduling.
2. Problems based on fare structure, transit system statistics.
3. Design of bus stops, terminals, depot, goods terminal area.
4. Computer applications for solving the above.

Group work:

Collect the data for the problematic situations in the existing mass transit system. Analyze the collected data and suggest the steps for improvements. It should be presented with group discussion.

Field visit:

Visit to the City Bus Transport/any mass transit system Office, depot and terminal area. Review operation, management and its performance.

References:

1. Vukan R. Vuchic, *Urban Transit : Operations, Planning and Economics*, Wiley Sons Publishers.
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

Major Elective – 1
(Group – 4)
Highway Geometric Design

Course Objectives:

1. To give detailed knowledge of Highway Geometric elements, their importance in highway design.
2. To make the students conversant with techniques of designing highway geometric elements.
3. To make the students familiar with the procedure of fixing the designed geometric elements on the field.

Course Contents:

1. Highway Geometrics: Importance, highway system elements-road user and vehicular characteristics, mix traffic characteristics, classification of rural & urban roads, neighbourhood roads, roads in residential areas, geometric design factors-design speed, topography, traffic & environmental factors.
2. Cross-sectional Elements: Road surface characteristics- evenness, friction & skidding, camber values & implementation, lane width criteria for different modes, kerb, median, road margins, cross-sectional details for different categories of roads.
3. Sight distances: Sight distance factors & types, overtaking zones, grade impact, sight distances on head-light criteria.
4. Alignment: Alignment issues, factors, horizontal alignment, super-elevation design and implementation, pavement widening, transition curves, setting up of transition curves by surveying equipments, set back distances, vertical alignment, types of gradients and vertical curves, design of vertical curves & implementation.
5. Intersection Geometrics: Types of intersections, blind intersections, sight distances, island geometrics, geometrics for merging & diverging, geometrics for bus stop layouts, parking areas & fly-overs, rail-road level crossing.

Practical work:

1. Field surveys: Measurement of existing highway geometric elements.
2. Design of geometric elements: SSD, OSD, Horizontal curve, Set-back distance, Widening, Vertical curve.
2. Setting out Horizontal curves – Simple circular, compound, reverse and transition curve on the field.
3. Setting out of Vertical curve on the field.
4. Finding problematic spots on existing highway and suggesting remedies.
5. Fixing alignment on the ground.
6. Preparation of drawings, quantity estimation, use of computer and softwares.

References:

1. Kadiyali L.R., *Principles & Practice of Highway Engineering*, Khanna Publishers,2003
2. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee, 2001
3. F. L. Mannering, W. P. Kilareski and S. S. Washburn, *Principles of Highway Engineering and Traffic Analysis.* Wiley India Pvt. Ltd., New Delhi.
4. James H. Banks, *Introduction to Transportation Engineering,* WCB-McGraw Hill, New York
5. Relevant IRC codes: IRC:32-1969, IRC:38-1988, IRC:39-1986, IRC:64-1990, IRC:66-1976, IRC:73-1980, IRC:80-1981, IRC:86-1983, IRC:92-1985, IRC:103-1988, IRC:106-1990, IRC:SP:23-1983, IRC:SP:41-1994
6. Green, *Highway Geometric Design*.

Major Elective – 2
(Group – 1)
Regional and Mass Transportation Systems Planning

Course Objectives:

1. To enhance the idea of transportation planning at the regional level.
2. To impart the techniques of developing models for the regional transportation planning.
3. To make the students conversant with Urban Mass Transit Planning and Freight Transportation Planning procedure.

Course Contents:

1. 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; input and output models - dynamic models of population and employment, multiregional extensions.
2. Transport Modelling: Need & role of transport models, issues, transport models in practice, simplified transport demand models.
3. Regional Transportation Development - Delineation of Planning Regions: Concept of region and space – types of regions, rural road network development approach, regional freight transportation- issues & approach, demand assessment, various models.
4. Urban Mass Transit Planning & Modelling: Transit classification, transit network design, classification of routes, prediction of transit usage, evaluation of network, scheduling principles & methodology, urban freight transportation: freight demand, spatial distribution of goods, truck terminal planning,

Tutorials:

1. Problems based on population and employment forecasting by different methods.
2. Problems based on cohort analysis.
3. Problems based on regional and rural road network development concept.
4. Problems based on urban mass transit routing and scheduling procedure.
5. Problems based on freight demand and goods transportation.
6. Planning and design of truck terminal.

Field visit:

1. Visit to the urban mass transit system depot, terminal and management office.
2. Visit to the truck terminal area.

Review the existing urban mass transit system and freight transportation system. The suggestions for the improvements should be presented with group discussion.

References:

1. Hutchinson, B.G., *Principles of Urban Transportation System Planning*, Mc-Graw Hill 1974.

2. Oppenheim, N., *Applied Models in Urban and Regional Analysis*, Prentice-Hall, NJ.
3. Khisty C J., Lall B.Kent, *Transportation Engineering – An Introduction*, Prentice-Hall, NJ, 2005
4. Chand Mahesh, Puri U. K., *Regional in India*, Allied Publishers, New Delhi, 1983.
5. Glassion John, *Introduction to regional planning*, Hutchinson and MIT Press, Cambridge, 1996.
6. Ortuzar J. D., Willumsen L.G., *Modeling Transport*, John Wiley & Sons, 1994
7. Vukan R. Vuchic, *Urban Transit : Operations, Planning and Economics*, Wiley Sons Publishers.

Major Elective – 2
(Group – 2)
Railway and Airport Engineering

Course Objectives:

1. To enhance the knowledge of Railway and Airport Engineering in the context of regional mass transportation systems.
2. To provide techniques of planning, modeling and designing the transportation systems along with infrastructures required for Railways and Airports.
3. Also, to make the students aware of the environmental and other impacts impended due to Railway and Airport projects.

Course Contents:

1. Rail Transportation System: Importance of Railway for regional development, Railway Track system & sub-structures, Railway infrastructure, Modernization in track, safety in railways, under-ground railways.
2. Demand analysis and forecasting for passenger and freight traffic costing and pricing principles, project analysis and design; project interdependencies and programming techniques; systems analysis and systems planning; planning strategies for regional context, macroeconomic transportation simulator; case studies and implementation strategies. Environmental and other impacts.
3. Characteristics of Air Transportation, structure and organization, challenges and the issues, Airport Master Plan, Characteristics of the aircraft, Airport Requirements, site selection, layout plan and financial plan, Forecasting air travel demand, Air freight demand
4. Geometric Design of runway, taxiway, aprons, Design of Passenger Terminal, analysis of flow through terminals, Design of air cargo facilities, Airfield pavement and drainage design.
5. Environment impact of Airports. Air traffic control lighting and signing, Airport capacity and configuration, parking configurations and apron facilities

Tutorials:

1. Problems based on forecasting of passenger and freight traffic for railways and airways.
2. Problems based on costing and pricing strategy in railways as well as in airways.
3. Planning and design of railway and airway network, routes and schedules for the actual or hypothetical regional area development.
4. Planning and design of infrastructures required for railways and air ports.

Field Visit:

1. Visit to the Railway station, yards and management office.
2. Visit to the Airport terminal building, structures of terminal area and management office.

References:

1. Khanna S.K., Arora M.G., Jain S.S., *Airport Planning & Design*, Nemchand Bros., Roorkee
2. Horenjeff Robert, *The planning & Design of Airports*, McGraw Hill Book Co.
3. Saxena S.C., *Railway Engineering*, Dhanpat Rai & Sons, 1995.

Major Elective – 2
(Group – 3)
Docks and Harbour Engineering

Course Objectives:

1. To enhance the knowledge of Docks and Harbour Engineering for the water transportation in the context of regional and intercontinental transportation.
2. To provide techniques of planning and designing the infrastructures required for Harbour and Port area.
3. To impart the know-how regarding cargo and passenger demand forecasting, cargo handling capacity of ports and economic evaluation of port project.
4. Also, to make the students aware of the environmental and other impacts impended due to water transportation and port activities.

Course Contents:

1. Water Transportation: Scope, Merits, Developments of Water Transportation in India, Inland waterways, River, Canal, Inland water transportation, Development of ports & Harbours, Harbour classification, Site selection, Harbour dimensioning.
2. Natural Phenomena: Tides, Water waves, Wave decay & port, wave diffraction, breaking, reflection, Littoral drift, sediment transport.
3. Harbour Infrastructures: Types of breakwaters, jetty, dock fenders, piers, wharves, dolphin, mooring accessories, Repair facilities, wet docks, lift docks, dry docks, gates for graving docks, floating docks, slipways, locks and gates.
4. Port facility: transit shed, warehouses, cargo handling, container handling, Inland port facility, Navigational aids, types, requirements of signals, lighthouses, beacon light, buoys. Dredging & coastal protection: Types of dredgers, choices, usage of dredged material, sea wall protection-sea wall revetment, bulkhead.
5. Planning of ports for regional and intercontinental transportation development, forecasting cargo & passenger demand, regional connectivity, cargo handling capacity of port, economic evaluation of port project, impacts of port activities.

Tutorials:

1. Problems based on cargo and passenger demand forecasting for the ports.
2. Problems based on planning and design of harbour infrastructures.
3. Problems based on planning and design of port area infrastructure.
4. Problems based on cargo handling capacity of port.
5. Problems based on economic evaluation of port project.

Field Visit:

Visit to the major Port: Port area and Harbour area infrastructures.
Review the existing facilities and capacity of port. Arrange presentation with group discussion for the suggestions of improvement if any.

References:

1. Bindra S.P., *Docks & Harbour Engineering*, Dhanpat Rai Publications,
2. Srinivasan R., Harbours, *Docks & Tunnel Engineering*, Charotar Publishing House, Anand, 1999.

Major Elective – 2
(Group – 4)
Transportation Facility Design

Course Objectives:

1. To make the students conversant with the design aspects of transportation facilities required for the users.
2. To provide knowledge of design standards of transportation facilities along with aesthetic and safety aspects.

Course Contents:

1. 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.
2. 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.
3. 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.
4. 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.

Tutorials:

1. Problems based on design of at-grade intersections, signalized intersection.
2. Problems based on design of grade separated intersections.
3. Problems based on design of facilities required for non-motorised transport and pedestrians.
4. Problems based on design of terminals for passenger and goods on highway, railway, airport and waterway port.
5. Problems based on design of horizontal and vertical alignment of highways with landscaping and safety aspects.

Field Visit:

Visit to grade-separated intersections, full-cloverleaf junction.
Visit to bus, railway, airport, waterway port terminal area.

References:

1. Kadiyali, L.R., *Traffic Engineering and Transport Planning*, Khanna publishers.
2. IRC-SP41: *Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas*
3. Salter, R J., *Highway Traffic Analysis and Design*, ELBS.
4. Edward K. Morlock, *Introduction to Transportation Engineering & Planning, International Student Edition*, Mc-Graw Hill Book Company, New York.

5. Khanna S.K., Arora M.G., Jain S.S., *Airport Planning & Design*, Nemchand Bros., Roorkee
6. Horenjeff Robert, *The planning & Design of Airports*, McGraw Hill Book Co.
7. Saxena S.C., *Railway Engineering*, Dhanpat Rai & Sons, 1995.
8. Vukan R. Vuchic, *Urban Transit : Operations, Planning and Economics*, Wiley Sons Publishers.
9. Bindra S.P., *Docks & Harbour Engineering*, Dhanpat Rai Publications,
10. Srinivasan R., Harbours, *Docks & Tunnel Engineering*, Charotar Publishing House, Anand, 1999.

Major Elective – 3
(Group – 1)
Economic Evaluation of Transportation Projects

Course Objectives:

1. To give basic idea of economic analysis and related terms.
2. To make the students aware of using different methods for economic evaluation.
3. To make the students conversant with economic and financial analysis of transportation projects.

Course Contents:

1. Introductions – Demand and Utility.
2. Laws of Demand, Utility analysis, Ordinal analysis, Income effect, Price effect, Demand curves, Elasticity of supply.
3. National Income, GNP, GDP, Methods of Estimating National Income.
4. Project Appraisal – Total Cost, Principles of analysis, Road Users Cost – Factors, Benefits.
5. Economic Evaluation – Different Methods, Sensitivity analysis.
6. Maintenance Cost – Factors, Methods.
7. Traffic System Evaluation.
8. Financing Mechanism - Taxes, Tolls, Private Financing.
9. Transport Cost – Types, Factors, Cost analysis for Mass Transit System,
10. Pricing – Marginal Cost Pricing, National Policy, Fares, Subsidy.
11. Economic analysis of transportation projects ownership and financing of transport, economic function of transportation road user and transportation costs, highway finance and taxation, case studies of analysis and evaluation of transportation projects.

Tutorials:

1. Problems based on demand and supply, elasticity analysis.
2. Problems based on estimation of National Income.
3. Problems based on different methods for economic evaluation, like B/C ratio, NPV, IRR etc.
4. Problems based on deriving transport cost.
5. Cost analysis for mass transit system.
6. Problems based on toll fixation.
7. Computer applications for the above problems.

Group work:

Prepare brief report on any recent case study of economic evaluation of transportation project. Give presentation on it with group discussion.

References:

1. D.M.Mithani, *Economic Analysis* – (Himalaya)
2. IRC– 30, *Manual on Economic Evaluation of Highways In India*.
3. Fair and Williams, *Economics of Transportation*, Harper and Brothers, Publishers, New York, 1959.
4. R.Winfrey, *Economic Analysis for Highway* International Textbook Co., Pennsylvania. USA,1969
5. G.Harrl Clell, *A Manual for the Economic Appraisal of Transport Projects*, World Bank Report, Washington D.C.1980.

Major Elective – 3
(Group – 2)
Environmental Impact Assessment of Transportation Projects

Course Objectives:

1. To provide the basic understanding of environmental impact analysis.
2. To make the students conversant with techniques of prediction and assessment on air, noise and social environment due to transportation projects.
3. To give the concept of decision methods for evaluation of alternative proposals.

Course Contents:

1. 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.
2. 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.
3. 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
4. Decision Methods for Evaluation of Alternative: Development of decision matrix. Public participation in environmental decision making, Regulatory requirements, environmental impact assessment process, objectives of public participation, techniques for conflict management and dispute resolution, verbal communication in EIA studies.

Tutorials:

1. Problems based on matrix and network methodologies for impact identification.
2. Problems based on prediction and assessment of impact on air environment due to transportation.
3. Problems based on prediction and assessment of impact on noise level due to transportation.
4. Problems based on development of decision matrix.

Group work:

Collect the data for air quality (emission level) and noise level near the problematic spots on road network. Analyze and prepare a brief report with suggestions for improvement. Present the report with group discussion.

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.
6. Relevant IRC & CPCB codes.

Major Elective – 3
(Group – 3)
Transportation System Management

Course Objectives:

1. To make the students aware of low cost techniques for reducing problems of traffic and transportation system.
2. To give the concepts of data collection for TSM actions, its implementation and impact analysis.
3. To provide the know-how of demand management, traffic operation improvement and parking management.

Course Contents:

1. Methodology & Data Collection: Methodological frame work, objectives and problems, conflicts resolution, strategic categories and action elements, travel behaviour impact and response time.
2. TSM actions combinations and interactions, impact assessment and evaluation, monitoring and surveillance, Area wide data collection methodology, corridor data collection methodology.
   TSM Actions: Study of following TSM actions with respect to problems.
3. 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.
4. Demand Management: Staggered work hours, flexible work hours, high peak period tolls, shuttle services, circulation services, extended routes.
5. 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.
6. 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.

Practical work:

1. Traffic data collection on congested/problematic corridor for TSM action.
2. Traffic data collection on congested/problematic traffic network area for TSM action.
3. Analysis of data and suggestion of suitable TSM techniques, preparation of alternatives.
4. Prediction of impacts due to suggested TSM alternatives- either by computer simulation or by actual implementation.
5. Problem solving for the problematic transit operation and parking management.
6. Group discussion on the proposed TSM solutions.

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.

Major Elective – 3

(Group – 4)

Road Safety and Environment

Course Objectives:

1. To make the students aware of importance of road safety aspects and environmental impacts for commissioning the highway project.
2. The students should know about Road Safety Audit and EIA requirements/guidelines of World Bank and India for Highway projects.
3. To give the idea for mitigation measures for improving traffic safety and environment.

Course Contents:

1. Multidisciplinary approach to planning for traffic safety and injury control; pre crash and post crash models; Roles of vehicle, roadway traffic, driver, and environment, crash and injury causations; Accident analysis, Conflict points at intersections, Pedestrian safety.
2. Road safety Audit: Mixed traffic flow; Transport related pollution; Technology Vision-2020; Urban and non urban traffic noise sources, Noise pollution.
3. Energy related aspects of different transport technologies. Traffic Calming Measures. Road transport related air pollution, sources of air pollution, effects of weather conditions, Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; Imitative measures.
4. EIA requirements of Highways projects, Procedure; MOEF World Bank/RC/UK guidelines; EIA practices in India.

Practical work:

1. Collection of road accident data.
2. Accident analysis of collected data.
3. Collection of data regarding black spots on major highways including geometric details.
4. Analysis of black spots data and suggest mitigation measures.
5. Collection of air quality data (emission level) and noise level data on problematic spots of highway.
6. Analysis of collected data and suggest improvement measures.

References:

1. Evans S.K., *Traffic Engineering Handbook*, Institute of Traffic Engineers, USA
2. Wohl M., Martin B.V., *Traffic system analysis of Engineers & Planners*, McGraw Hill, New York.
3. Babkov V.F., *Road conditions & Traffic Safety*, MIR Publishers, Moscow, 1975
4. Kadiyali L.R., *Traffic Engineering & Transport Planning*, Khanna Publishers, 2003
5. Little A.D., *The state of art of Traffic Safety*, Paraeger Publishers, New York, 1970
6. Relevant IRC codes

Major Elective – 4
(Group – 1)
Soft Computing Techniques

Course Objectives:

1. To give basic idea of modern computing techniques which are useful for solving the non-linear and complex functions that may come across during dissertation work.
2. To make the students conversant with artificial intelligent techniques like GA, Fuzzy logic, Artificial Neural Network and their hybrid systems which are used for solving different transportation problems.

Course Contents:

1. 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.
2. Fuzzy Logic: Concepts of uncertainty 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.
3. 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.
4. Hybrid Systems: Fuzzy neural systems – Genetic Fuzzy Systems – Genetic Neural Systems.

Practical work:

(Work in Computation lab.)

1. Problems based on GA and its applications in transportation.
2. Problems based on Fuzzy logic and its applications in transportation.
3. Problems based on ANN and its applications in transportation.
4. Problems based on hybrid systems and its application in transportation.

References:

1. Timothy J.Ross, *Fuzzy Logic with Engineering Applicatios*, McGraw-Hill
2. Simon Haykin, *Neural Netwroks*, PrenticeHall
3. J.M. Zurada, *.Introduction to artificial neural systems*., Jaico Publishers
4. H.J. Zimmermann, *Fuzzy set theory and its applications., III Edition*, Kluwer Academic Publishers, London.
5. Suran Goonatilake, Sukhdev Khebbal (Eds), *.Intelligent hybrid systems*., John Wiley & Sons, New York, 1995
6. Goldberg, D. E, *Genetic algorithm in search, optimization and machine learning,*Addison-Wesley, Reading Mass.
7. Kalyanmoy Deb, *Optimization for Engineering Design – Algorithms and examples,* PHI, New Delhi, ISBN-81-203-0943-x.

Major Elective – 4
(Group – 2)
Traffic Flow Theories and Simulation

Course Objectives:

1. To provide the detailed knowledge of traffic flow theories and its simulation procedure.
2. To make the students familiar with analysis of traffic stream using different traffic flow models.
3. To make the students conversant with computer simulation for generating the traffic flow conditions, which may be useful for dissertation work and for evaluation of traffic improvement measures.

Course Contents:

1. Traffic Stream Characteristics: 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, gap acceptance.
2. 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
3. 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.
4. 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.
5. Traffic Simulation: System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments.

Practical work:

1. Classified traffic volume count along with spot speed data on congested urban road mid-block section (Preferably using video-graphy).
2. Generation of speed-flow-density relationship from the collected data.
3. Statistical analysis of the collected data for the parameters like - vehicle arrival pattern, headway, speed, gap, overtaking, queuing etc.
4. Intersection volume count and delay measurements.
5. Data collection for determining highway capacity and level of service.
6. Computer simulation of observed traffic data, using programme or software.
7. Simulation experiments for improving the traffic conditions.

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. Neylor, T.H. et al., *Computer Simulation Techniques*, John Wiley.

Major Elective – 4
(Group – 3)
Mode Choice Modelling and Trip Assignment Techniques

Course Objectives:

1. To give detailed knowledge of Mode Choice Modelling and Trip Assignment techniques, which are useful in travel demand modelling.
2. To make the students aware of latest techniques and models implemented for the Mode Choice analysis and Trip Assignment analysis.

Course Contents:

A. Mode Choice Modelling Techniques:

1. Mode choice behaviour: factors, Discrete Choice Model, Choice Set, Choice Probability, Identification of choices, Forecasting.
2. Methods of Data collection, preparation of format. RP and SP survey, analysis.
3. Binary, Logit Models, Generalised Extreme Value (GEV), NL, MNL, Probit, Mixed Logit and other types of models. Interpretation of results.
4. Estimation: Random Utility Theory, Probabilistic Choice Theory, Maximum Likely Hood, Aggregate and Disaggregate Demand Models, Statistics of Model Estimate, Methods of Estimate, Key Statistic test.
5. Concept of activity based analysis.

B. Trip Assignment Techniques:

1. Transportation Network: Nodes, links, characteristics, Link cost functions; Junction cost Functions, Shortest path algorithms.
2. Trip OD matrices, Route choice behaviour, Public transport trips and Private mode trips.
3. Methods for Static and Dynamic assignment, mathematical approaches, Simulation approach. Types of assignment procedure, Concepts of User equilibrium, System optimum and Stochastic user equilibrium condition.
4. Applications of trip assignment, network design problem, signal optimization, area traffic control, incident management, ITS applications.

Practical work:

1. Preparation of format for RP and SP survey for small segment.
2. Data collection for RP and SP survey.
3. Analysis of collected data, preparation of mode choice model and its statistical check.
4. Problems based on different types of mode choice models.
5. Developing computer programme for shortest path algorithm.
6. Data collection for congested / problematic road network for trip assignment exercise.
7. Analysis of collected data for static and dynamic trip assignment. Develop computer programme or use suitable software. Compare results with existing network conditions.

References:

1. J. Ortuzar and L. G. Willumsen, *Modelling Transport,* John Wiley & Sons, Chincester, 1994

2. Mosche Ben Akiva and Steven R Lerman, *Discrete Choice Modeling-Theory and Application to Travel Demand,* M.I.T. Press Cambridge.
3. Kennech E.Train, *Discrete Choice Method With Simulation.*
4. Roy Thomas, *Traffic Assignment Techniques,* Avebury Technical, Aldershot, England.
5. Y. Sheffi, *Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods,* Prentice Hall, Englewood Cliffs, New Jersey, USA.
6. Bell M. G. H. and Iida Y, *Transportation Network Analysis,*John Wiley and Sons Ltd., New York, USA.

Major Elective – 4
(Group – 4)
Pavement Management System

Course Objectives:

1. To make the students aware of importance of Pavement Management System for maintaining better riding quality on the roads for longer time at the reasonable cost.
2. To provide the techniques of assessment of pavement performance, data management, combined programming of maintenance and rehabilitation.
3. To enhance the knowledge regarding overlay design, optimal design strategy, implementation of PMS and related computer applications.

Course Contents:

1. Pavement Maintenance & Management Process: Application of system concepts to pavement management, pavement management levels-Network & Project level, functions - Data needs, Pavement life cycle, assessment of pavement performance, evaluation of pavement structural capacity, distress & safety, combined measures of pavement quality, data management.
2. 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.
3. Project Level Design: Framework for pavement design, characterization of physical design inputs, basic structural response models – variability, reliability and risk – generating alternate design strategies, rehabilitation design procedures, Overlay design, economic evaluation of alternate pavement design strategies – selection of optimal design strategy.
4. Implementation: Major steps in implementing PMS – pavement construction management & pavement maintenance management – informations, research needs – cost and benefit of pavement management – future directions and need for innovations in pavement management, HDM applications.

Practical work:

1. Benkelman beam deflection study.
2. Pavement unevenness measurement by Bump Integrator.
3. Traffic volume count for EWLF.
4. O-D survey on the highway.
5. Forecasting of traffic.
6. Design for overlay.
7. Economic evaluation of pavement management.
8. Computer applications for the above problems.

References:

1. Haas R. C. G., Hudson W. Ronald, Zaniewski John P., *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.

Inter Disciplinary - 1
Basics of Transportation Engineering

Couse Objectives:

1. To provide the basic understanding of Transportation Engineering and its main divisions.
2. To make the students aware of techniques used in transportation planning, traffic flow management, pavement – design, construction and its maintenance.

Course Contents:

1. Introduction: Importance of transportation, various modes and their suitability.
2. Urban transportation systems planning: Public, private, para-transit systems, coordination, routing, scheduling, fare structure.
3. Travel demand modeling: Land use planning, trip generation, trip distribution, modal split, trip assignment, their analysis.
4. Traffic Engineering: Basic elements-user, facility, vehicles, environment. Their characteristics and inter actions, traffic flow, classified volume, PCU concept, speed-flow-density relationship, headway, travel time and delay measurement techniques, O-D survey, accident analysis.
5. Traffic Infrastructures: Highway geometric elements, curves, intersections, rotary, grade-separated intersections, markings, signs, signals, parking, bus stops, terminal area, truck terminals.
6. Railway, Air port and Docks-Harbour: Their planning at the regional context, important characteristics, cargo and passenger demand forecasting, planning and design of terminal area facilities.
7. Pavements: Types, materials, tests, design criteria, ESWL, EWLF, CBR method, Marshall stability test, C.C. pavement design, joints, Construction methods for flexible and rigid pavements, failures, evaluation study, Benkelman beam deflection study, unevenness measurement, design of overlays, maintenance management.
8. Economic evaluation and Environmental Impact Assessment procedures for transportation projects.

References:

1. B.G.Hutchinson, *Principles of urban transportation system planning*- McGraw-Hill, New York, 1974
2. Edward K.Morlok, *Transportation Engg. and Planning*
3. W.Dickey, *Metropolitan Transportation Planning* Tata McGraw-Hill, New Delhi, 1975
4. Blunder and Black, *Land useTtransportation System*
5. J.Ortuzer and L.G. Willumsen, *Modelling Transport,* Johan Wiley and Sons Chincester,1994
6. Vukan R. Vuchic, *Urban Transit : Operations, Planning and Economics*, Wiley Sons Publishers.
7. Peter White, *Public Transport*, UCL Press
8. Kadiyali L.R., *Traffic Engineering and Transport Planning*, Khanna Publishers
9. Khisty, C J., *Transportation Engineering – An Introduction*, Prentice-Hall, NJ
10. TCRP Report 30, TCRP Report 95, TCRP Report 100
11. S.C. Saxena, *Traffic Planning and Design,* Dhanpat Rai Pub., New Delhi.
12. Partho Chakraborty and Animesh Das, *Principles of Transportation Engineering*, PHI

13. C. S. Papacostas, *Fundamentals of Transportation System Analysis,* PHI.
14. James H. Banks, *Introduction to Transportation Engineering,* WCB-McGraw Hill, New York
15. L.J.Pingnataro, *Traffic Engineering; Theory and Practice*. Prentice Hall, Englewood Clitts, 1973.
16. M.Wohl and B.V.Martin, *Traffic System Analysis for Engineering and Planners*, McGraw-Hill. New York,1983.
17. D.R.Drew, *Traffic Flow Theory and Control*, McGraw Hill. New York 1968.
18. W.R.McShane, R.P.Roess and E.S.Prassas, *Traffic Engineering*, Prentice Hall, New Jersey, 1990.
19. R.J.Salter, *Highway Traffic Analysis and Design*, McMillan, Hampshire, 1989.
20. *Highway Capacity Manual*, Transportation Research Board, Washington D.C., 1997, 2000
21. Kadiyali L.R.and Lal, N. B., *Principles & Practice of Highway Engineering*, Khanna Publishers, Delhi.
22. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee.
23. Khanna S.K., Arora M.G., Jain S.S., *Airport Planning & Design*, Nemchand Bros., Roorkee
24. Horenjeff Robert, *The planning & Design of Airports*, McGraw Hill Book Co.
25. Saxena S.C., *Railway Engineering*, Dhanpat Rai & Sons, 1995.
26. Bindra S.P., *Docks & Harbour Engineering*, Dhanpat Rai Publications,
27. Srinivasan R., Harbours, *Docks & Tunnel Engineering*, Charotar Publishing House, Anand, 1999.

Inter Disciplinary - 2
Geo-Spatial Techniques

Couse Objectives:

1. To provide the basic understanding of GIS and GPS.
2. To make the students conversant with geographic mapping process with data representation techniques in GIS.
3. To give the know-how of various applications of GIS in Civil Engineering.
4. To make the students familiar with GPS accessories and its applications.

Course Contents:

1. Geo-informatics: Remote Sensing-Principles, Concepts, air-photo interpretation, Data acquisition, Basic concepts of GIS & GPS.
2. Structure of GIS: Cartography, Geographic mapping process, transformations, map projections, Geographic Data Representation, Storage, Quality and Standards, database management systems, Raster data representation, Vector data representation, Assessment of data quality, Managing data errors, Geographic data standards.
3. 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. GIS Applications: Case studies.
4. GPS: Basic concepts, components, factors affecting, GPS setup, accessories, segments- satellites & receivers, GPS applications, Case studies

Practical work:

1. Map generation in GIS. Vectorization, Geo-referencing of map.
2. Creating point, line, polygon layers and removal of errors.
3. Attaching Raster based and Vector based data with map.
4. Queries and Spatial analysis.
5. Network analysis.
6. Surface modeling, generation of DTM, its applications.
7. Survey with GPS receivers, collection of data and its analysis.

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. Kennedy M., *The Global Positioning System & GIS: An Introduction*, Ann Arbor Press, 1996