

**M. Tech. Course Structure for Transportation Engineering**  
**(Modified for July 2011 Onwards)**

| <b>SEMESTER-1</b>                       |                                       |                      |
|---|---------------------------------------|----------------------|
| <b>Course No.</b>                       | <b>Course Name</b>                    | <b>L - T - P - C</b> |
| CE 581                                  | Urban Transportation Systems Planning | 3 - 0 - 0 - 6        |
| CE 582                                  | Pavements Materials                   | 3 - 0 - 2 - 8        |
| CE xxx                                  | Elective I                            | 3 - 0 - 0 - 6        |
| CE xxx                                  | Elective II                           | 3 - 0 - 0 - 6        |
| <b>Total Credits in First Semester</b>  |                                       | 12- 0 - 2 - 26       |
| <b>SEMESTER-2</b>                       |                                       |                      |
| CE 583                                  | Pavement Analysis and Design          | 3 - 0 - 0 - 6        |
| CE 584                                  | Traffic Engineering                   | 3 - 0 - 2 - 8        |
| CE 585                                  | Credit Seminar                        | 3 - 0 - 0 - 6        |
| CE xxx                                  | Elective III                          | 0 - 0 - 2 - 2        |
| CE xxx                                  | Elective IV                           | 3 - 0 - 0 - 6        |
| <b>Total Credits in Second Semester</b> |                                       | 12- 0 - 4 - 28       |
| <b>SEMESTER-3</b>                       |                                       |                      |
| CE 692                                  | Project and Thesis Phase I            | 0 - 0 - 24 - 24      |
| <b>SEMESTER-4</b>                       |                                       |                      |
| CE 693                                  | Project and Thesis Phase II           | 0 - 0 - 24 - 24      |
| <b>Total Credits</b>                    |                                       | 24- 0 - 54 - 102     |

## LIST OF ELECTIVES

### Elective- I

|        |  |         |
|--------|--|---------|
| CE 502 | Classical matrix methods for structural analysis and introduction to FEM | 3-0-0-6 |
| CE 601 | Numerical Methods  | 3-0-0-6 |
| CE 602 | Optimization Methods   | 3-0-0-6 |

### Elective-II, III, IV

|        |   |         |
|--------|---|---------|
| CE 517 | Design and construction of rural roads                      | 3-0-0-6 |
| CE 621 | Bridge Engineering  | 3-0-0-6 |
| CE 622 | Geometric Design of Transportation Facilities               | 3-0-0-6 |
| CE 623 | Pavement Evaluation, Rehabilitation and Maintenance         | 3-0-0-6 |
| CE 624 | Highway Construction Practice                               | 3-0-0-6 |
| CE 625 | Transportation System Management                            | 3-0-0-6 |
| CE 626 | Economic Evaluation and Analysis of Transportation Projects | 3-0-0-6 |
| CE 627 | GIS and RS in Transportation Engineering                    | 3-0-0-6 |
| CE 628 | Traffic Flow Modelling and Simulation                       | 3-0-0-6 |
| CE 629 | Public Transportation Systems Planning                      | 3-0-0-6 |
| CE 648 | Applied Soil Mechanics                                      | 3-0-0-6 |
| CE 649 | Ground Improvement Techniques                               | 3-0-0-6 |
| CE 651 | Road Safety Engineering                                     | 3-0-0-6 |

## DETAILS OF THE COURSE CURRICULUM

### **CE 581      Urban Transportation Systems Planning**

**(3 0 0 6)**

*Pre-requisites: Nil*

Introduction to transportation planning; systems approach to transportation planning; types of models; concept of travel demand and supply; socio-economic, land use, network, and transport system characteristics affecting transportation planning; study area definition, zoning principles, cordon and screen lines, data collection through primary and secondary sources, sampling techniques; four-stage sequential modeling approach; trip generation; trip distribution; modal split; trip assignment; land use-transport models; public transport planning, integration of different modes; travel demand management measures; case studies.

#### ***Texts:***

1. J. de D. Ortuzar and L.G. Willumsen, **Modelling Transport**, John Wiley and Sons, 2001.
2. C.J. Khisty and B.K. Lall, **Transportation Engineering – An Introduction**, Prentice Hall of India Pvt. Ltd., 2002.
3. C. S. Papacostas and P. D. Prevedouros, **Transportation Engineering and Planning**, Prentice Hall of India Pvt. Ltd., 2001.

#### ***References:***

1. P. Chakroborty and A. Das, **Principles of Transportation Engineering**, Prentice Hall of India Pvt. Ltd., 2003.
  2. B.G. Hutchinson, **Principles of Urban Transport Systems Planning**, McGraw-Hill Book Co., New York, 1974.
  3. L.R. Kadiyali, **Traffic Engineering and Transport Planning**, Khanna Publishers, New Delhi, 2000.
  4. G. E. Gray and L. A. Hoel, **Public Transportation**, Prentice Hall, New Jersey, 1992.
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### **CE 582      Pavements Materials**

**(3 0 2 8)**

*Pre-requisites: Nil*

Road making aggregates – classification, properties of aggregates, design of aggregate gradation; Bituminous road binders – penetration grade, emulsions, cut backs and modified binders; rheology of bituminous binders, modified binders; mix design – Marshall method and Superpave procedure; design of emulsified mixes, visco-elastic and fatigue properties of bituminous mixtures, resilient modulus of pavement materials; requirements of paving concrete, design of mixes for recycling of bituminous and concrete pavement surfaces; soil stabilization techniques.

**Texts:**

1. A. G. Correia, **Flexible Pavements**, A. A. Balkema Publishers, 1996.
2. P. H. Wright, **Highway Engineering**, John Wiley & Sons, 1996.
3. S. K. Khanna and C. E. G. Justo, **Highway Material Testing**, New Chand & Bros., 1999.

**References:**

1. G. N. Durhan, W. A. Marr, and W. L. DeGroff, **Resilient Modulus Testing for Pavement Components**, ASTM International, U.S.A., 2003.
  2. S. E. Zoorob, A. C. Collop, and S. F. Brown, **Performance of Bituminous and Hydraulic Materials in Pavements**, A. A. Balkema Publishers, 2002.
  3. R. N. Hunter, **Bituminous Mixtures in Road Construction**, Thomas Telford Services Ltd., 1995.
  4. ASTM, **Annual Book of ASTM Standards – Section IV**, Vol. 04.03, ASTM International, 2002.
  5. D. Croney, and P. Croney, **Design and Performance of Road Pavements**, McGraw- Hill, 1998.
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**CE 583      Pavement Analysis and Design**

**(3 0 0 6)**

*Pre-requisites: Nil*

Philosophy of design of flexible and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters – traffic loading and volume, material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods, comparison of different pavement design approaches, design of overlays and drainage system.

**Texts:**

1. Yang H. Huang, **Pavement Analysis and Design**, Pearson Prentice Hall, 2004.
2. Yoder and Witzech, **Pavement Design**, McGraw-Hill, 1982.

**References:**

1. Sharma and Sharma, **Principles and Practice of Highway Engg.**, Asia Publishing House, 1980.
  2. Teng, **Functional Designing of Pavements**, McGraw- Hill, 1980.
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**CE 584      Traffic Engineering**

**(3 0 2 8)**

*Pre-requisites: Nil*

Driver behaviour, traffic information and control systems, traffic studies- volume, speed and delay studies, elements of traffic flow theory, characteristics of uninterrupted traffic, capacity

and LOS of Uninterrupted facilities, characteristics of interrupted traffic, traffic characteristics at unsignalised intersections, design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination, design of parking, lighting and terminal facilities, simulation of traffic systems, statistics and probability in traffic engineering, trends in traffic engineering.

***Texts:***

1. Roger P. Roess, William R. McShane & Elena S. Prassas, **Traffic Engineering**, Prentice-Hall, 1990.
2. Pignataro L. J., **Traffic Engineering – Theory and Practice**, Prentice Hall, 1973.

***References:***

1. C. J. Khisty and B. K. Lall, **Transportation Engineering: An Introduction**, Prentice- Hall India, 2003.
  2. Wohl M. and Martin B. V., **Traffic System Analysis**, McGraw-Hill Book Company, 1967.
  3. P. Chakroborty and A. Das, **Principles of Transportation Engineering**, Prentice Hall of India Pvt. Ltd., 2003.
  4. L. R. Kadiyali, **Traffic Engineering**, Khanna Publishers, 2000.
  5. A. D. May, **Traffic Flow Fundamentals**, Prentice–Hall, 1990.
  6. C.S. Papacostas, **Transportation Engineering and Planning**, Prentice-Hall India, 2001.
  7. Highway Capacity Manual (HCM), **Transportation Research Board**, USA, 2000.
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**CE 502      Classical Matrix Methods for structural analysis and Introduction to FEM      (3 0 0 6)**

*Pre-requisites: Nil*

Basic approaches of structural analysis, stiffness and flexibility method, stiffness and flexibility coefficients, derivation of stiffness matrix of skeletal member under axial, bending and torsion; assembly of stiffness matrix, storage scheme, band width minimization, skyline storage; solution of algebraic equations, truss, plane frame, grid, space frame, treatment of boundary conditions- penalty function and Lagrange multiplier techniques, condensation and sub-structuring, flexible connection and finite size joints, symmetry and anti-symmetry, concepts of re-analysis, derivation of stiffness matrix for axial members of variable cross section; Rayleigh-Ritz principle, introduction to FDM and FEM; advantages of FEM, comparison between FEM and FDM, concept of discretization of structures and shape function, plane stress, plane strain problems, Lagrangian and serendipity elements, Isoparametric formulation, numerical integration and order of integration, criteria for convergence, computer implementations of algorithms.

***Texts:***

1. M.B. Kanchi, **Matrix Method of Structural Analysis**, Second and Enlarged Edition, Wiley Eastern Limited 1993.
2. W. McGuire, R.H. Gallagher and R.D. Ziemian, **Matrix Structural Analysis**, John Wiley & Sons Inc, 2000.

***References:***

3. C.S. Krishnamoorthy, **Finite Elements Analysis: Theory and Programming**, Second Edition, Tata McGraw Hill Publishing Company Limited 1994.
  4. R.D. Cook, D.S. Malkus and M.E. Plesha, **Concepts and Applications of Finite Element Analysis**, Third Edition, John Wiley & Sons 1989.
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**CE 517      Design and Construction of Rural Roads**

**(3 0 0 6)**

*Pre-requisites: Nil*

Rural Road Development; Introduction to Rural Road Construction Scheme in India and its Objectives; Classifications of Roads; Importance of Rural Road Connectivity; Planning of Rural Roads Core Network; Preparation of DPR; Specification of Rural Roads; Use of Alternate Materials in Rural Roads; Construction Methods and Techniques Used in Rural Roads; Quality Control in Rural Road Construction Projects; Maintenance of Rural Roads.

***Texts:***

1. Brown, J. Victor, and C. N. Conner, **Low cost roads and bridges**, Gillette Co. Publications, 1933.
2. K. N. Ramanujam, **Rural Transport in India**, Mittal Publications, 1993.
3. R. Lamm, A. Beck, and T. Ruscher, **How to Make Two-Lane Rural Roads Safer**, WIT Press, 2007.
4. L. Odier, **Low Cost Roads: Design, Construction and Maintenance**, Unesco, Butterworths, 1971.
5. G. R. Chatburn, and J. Wiley and Sons, **Highway Engineering, Rural Roads and Pavements**, Inc. Publication, 2010.
6. **Rural Development Study**, World Bank Publications, 1998
7. **Geometric Design Standards for Rural (Non-Urban) Highways**, IRC: 73-1980.
8. **Rural Roads Manual**, IRC: SP: 20-2002.
9. **Manual on Economic Evaluation of Highway Projects in India**, IRC: SP: 30-1993.
10. **Hill Road Manual**, IRC: SP: 48-1998.
11. **Guidelines for Quality Systems for Road Construction**, IRC: SP: 57-2000.
12. **Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads**, IRC: SP: 72-2007.
13. **Manual for Construction and Supervision of Bituminous Works**, MORT&H: 2001.



**Texts:**

1. K. Deb., **Optimization for Engineering Design: Algorithms and Examples**, PHI Pvt Ltd., 1998.
2. J. S. Arora, **Introduction to Optimum Design**, McGraw Hill International Edition, 1989.

**References:**

1. R. T. Hafta and Z. Gurdal., **Elements of Structural Optimization**, Third Revised and Expanded Edition. Kluwer Academic Publishers 1996.
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**CE 621      Bridge Engineering**

**(3 0 0 6)**

*Pre-requisites: Nil*

Investigation and site selection, hydraulic factors, alignment, traffic aspects, types of bridges; loading standard, IRC specification, impact factor, general design consideration, structural design of highway and railway bridges in masonry, reinforced, pre-stressed concrete and steel; superstructures: slab bridge, beam and slab bridge, plate girder and composite bridges, bearings and expansion joints, bridge foundation: types of foundation, design of well and pile foundation, bridge vibration: traffic loading, seismic and wind effect, construction techniques and maintenance.

**Texts:**

1. D. J. Victor, **Essentials of Bridge Engineering**, Oxford and IBH, 1980.
2. N. Kridhna Raju, **Design of Bridges**, Oxford and IBH, 1988.

**References:**

1. V. K. Raina, **Concrete Bridge Practice: Analysis, Design and Economics**, Tata McGraw Hill, 2002.
  2. L. Fryba, **Dynamics of Railway Bridges**, Thomas Telford, 1996.
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**CE 622      Geometric Design of Transportation Facilities**

**(3 0 0 6)**

*Pre-requisites: Nil*

Geometric design provisions for various transportation facilities as per AASHTO, IRC and other guidelines; discussion of controls governing geometric design, route layout and selection, elements of design – sight distances, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design for rural highways, urban streets and hill roads; at-grade inter-sections – sight distance consideration and principles of design, channelisation, mini

roundabouts, layout of roundabouts, Inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design.

***Texts:***

1. M. Rogers, **Highway Engineering**, Blackwell Publishing, 2003.
2. P. H. Wright, **Highway Engineering**, John Wiley & Sons, 1996.

***References:***

1. C. H. Oglesby, and R. G. Hicks, **Highway Engineering**, John Wiley & Sons, 1982.
  2. R. L. Brockenbrough, and K. J. Boedecker, **Highway Engineering**, McGraw-Hill, 1996.
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**CE 623      Pavement Evaluation, Rehabilitation and Maintenance      (3 0 0 6)**

*Pre-requisites: Nil*

Types of pavement distress, techniques for functional and structural evaluation of pavements, network and project survey and evaluation, pavement rehabilitation techniques, overlay design procedures, recycling of flexible and rigid pavements, maintenance of paved and unpaved roads, pavement management systems.

***Texts:***

1. R. Robinson, and B. Thagesan, **Road Engineering & Development**, Spon Press, 2004.
2. Yang H. Huang, **Pavement Analysis and Design**, Pearson Prentice Hall, 2004.
3. Yoder and Witzech, **Pavement Design**, McGraw-Hill, 1982.

***References:***

1. K. Atkinson, **Highway Maintenance Handbook**, Thomas Telford, 1997.
  2. C. A. O' Flaherty, **Highways – The Location, Design, Construction, & Maintenance of Pavements**, Butterworth Heinemann, 2002.
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**CE 624      Highway Construction Practice      (3 0 0 6)**

*Pre-requisites: Nil*

Embankment, formation cutting in soil and hard rock, sub grade; ground improvement; retaining walls on hill roads; granular & stabilized sub bases/bases; bituminous surfacing; recycled pavements; concrete roads; non conventional pavements; road construction equipments.

***Texts:***

1. MOST, **Specifications for Road and Bridge Work (4th Revision)**, Ministry of Road Transport and Highways, 2001.
2. C. A. O' Flaherty, **Highways – The Location, Design, Construction, & Maintenance of Pavements**, Butterworth Heinemann, 2002.
3. R. N. Hunter, **Bituminous Mixtures in Road Construction**, Thomas Telford Services Ltd., 1995.

***References:***

1. P. H. Wright, **Highway Engineering**, John Wiley & Sons, 1996.
  2. C. H. Oglesby, and R. G. Hicks, **Highway Engineering**, John Wiley & Sons, 1982.
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**CE 625      Transportation System Management**

**(3 0 0 6)**

*Pre-requisites: Nil*

Quick response travel evaluation procedure, TSM actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, bus priority measures, demand management techniques for reducing traffic demand, staggered hours, and vehicle restrictions; small area management: individual sites, residential neighborhoods, planning for pedestrians, parking planning, traffic calming; travel demand management and telemetries in travel planning.

***Texts:***

1. C. J. Khisty and B. K. Lall, **Transportation Engineering: An Introduction**, Prentice- Hall India, 2003.
2. **Transportation Demand Management (TDM) Encyclopedia**, Victoria Transport Policy Institute Canada, 2006.

***References:***

1. Roger P. Roess, William R. McShane & Elena S. Prassas, **Traffic Engineering**, Prentice-Hall, 1990.
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**CE 626      Economic Evaluation and Analysis of Transportation Projects**

**(3 0 0 6)**

*Pre-requisites: Nil*

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.



simulation methodologies and model design; simulation languages; application of macro and micro simulation packages.

***Texts:***

1. A. D. May, **Traffic Flow Fundamentals**, Prentice–Hall, 1990
2. Wohl M. and Martin B. V., **Traffic System Analysis**, McGraw-Hill Book Company, 1967.
3. Drew D. R., **Traffic Flow Theory and Control**, McGraw-Hill, 1968.

***References:***

1. P. Chakroborty and A. Das, **Principles of Transportation Engineering**, Prentice Hall of India Pvt. Ltd., 2003.
  2. Pignataro L. J., **Traffic Engineering – Theory and Practice**, Prentice Hall, 1973.
  2. Krishna Rao K. V. and Tom V. M., **Lecture Notes on Recent Developments in Urban Transportation Systems Planning**, IIT Bombay, 2003.
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**CE 629      Public Transportation Systems Planning**

**(3 0 0 6)**

*Pre-requisites: Nil*

Modes of public transportation and application of each to urban travel needs; comparison of transit modes and selection of technology for transit service; transit planning, estimating demand in transit planning studies, demand modeling, development of generalized cost, RP & SP data and analysis techniques; functional design and costing of transit routes, models for planning of transit routes, scheduling; management and operations of transit systems; integrated public transport planning; operational, institutional, and physical integration; models for integrated planning; case studies.

***Texts:***

1. Vuchic Vukan R., **Urban Transit: Operations, Planning and Economics**, Prentice Hall, 2005.
2. Gray G. E., and Hoel L. A., **Public Transportation**, Prentice Hall, 1992.

***References:***

1. Tyler N., **Accessibility and the Bus System – Concepts and Practice**, Thomas Telford, 2002.
  2. Tiwari G., **Urban Transport for Growing Cities – High Capacity Bus System**, MacMillan India Ltd., 2002.
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*Pre-requisites: Nil*

Earth pressures and design of retaining walls; theory of arching in soils and its applications in tunnel, conduits, silos; braced excavations and open cuts, Sheet piles and Anchored bulkheads, cofferdams and their design; diaphragm walls, bored pile walls and pre-stressed ground anchors; non-conventional retaining systems, stability analysis and design; earth dams and embankments.

***Texts:***

1. Kurian, N. P., **Design of Foundation Systems – Principles and Practices**, 2nd Edn., New Delhi, Narosa Publishing House, 1994.
2. Kurian, N. P., **Modern Foundations – Introduction to Advanced Techniques**, New Delhi, Tata McGraw-Hill Publishing Company Limited, 1984.

***References:***

1. Terzaghi, K., **Theoretical Soil Mechanics**, Wiley, New York, 1965.
  2. Terzaghi, K and Peck, R. B., **Soil Mechanics in Engineering Practice**, Asia Publishing House, Bombay, 1960.
  3. Teng, W. C., **Foundation Design**, Prentice-Hall of India Pvt. Ltd., New Delhi, 1965.
  4. Spangler, M. G and Handy, R. L., **Soil Engineering**, Harper & Row, New York, 1982.
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*Pre-requisites: Nil*

Engineering properties of soft, weak and compressible deposits; principles of treatment; methods of soil improvement-lime stabilization and injection; thermal, electrical and chemical methods; preloading; dynamic consolidation; vertical drains; granular piles; soil nailing; anchors; grouting; Electro-osmosis; soil freezing; vacuum consolidation, case histories.

***Texts:***

1. Bowels, J. E., **Foundation Analysis and Design**, McGraw-Hill International Edition, Singapore, 1997.
2. Moseley, M. P., **Ground Improvement**, Blackie Academic & Professional, Boca Raton, Florida, USA, 1993.
3. Raton, Florida, USA, 1993.

**References:**

1. Hausmann, M. R., **Engineering Principles of Ground Modification**, McGraw-Hill International Editions, 1990.
  2. Yonekura, R., Terashi, M. and Shibasaki, M. (Ed), **Grouting and Deep Mixing**, A.A. Balkema, Rotterdam, The Netherlands, 1966.
  3. Xanthakos, P. P., Abramson, L. W. and Bruce, D. A., **Ground Control and Improvement**, John Wiley & Sons, New York, USA, 1994.
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**CE 651      Road Safety Engineering**

**(3 0 0 6)**

*Pre-requisites: Nil*

Introduction to Road Safety Engineering: Road safety scenario, Road safety issues, Characteristics of road accidents, Factors contributing to road accidents; Accident data analysis and Management; Road safety measures: Road alignments, Road sign and pavements markings, Street lighting and traffic signal, Pedestrian facilities; Crash Investigation and analysis: Human/vehicular factor relating to crashes, Steps of crash investigation, Diagnosing the crash problem, Solutions/accident costing/economic appraisal; Road Safety Audit (RSA): Introduction to RSA, Feasibility stage audit, Design stage road safety audit, Construction stage audit, Pre and post opening stage audit, Audit report, Site visit to for road safety audit.

**Texts:**

1. Road Safety: Data Collection, Analysis, Monitoring, And Countermeasure Evaluations with Cases by M. Ohidul Haque, University Press of America, 2008.
2. The Handbook of Road Safety Measures by Rune Elvik, Alena Hoye, Truls Vaa, Emerald Group Publishing, 2nd Edition, Sept 2009.
3. Practical Road Safety Auditing by M. Belcher, Steve Proctor, P. Cook, Thomas Telford Publishing, 2008.
4. IRC: SP: 88-2019 Manual on Road Safety Audit.
5. Traffic Engineering by R. P. Roess, E. S. Prassa, W. R. Mcshane, Prentice Hall, 2011.
6. Transport Planning and Traffic Engineering by CA O'Flaherty, Elsevier, 2006.

**References:**

1. Highway Design and Traffic Safety Engineering Handbook by R. Lamm, McGraw-Hill Professional Publishing, Jan 1999.
2. The Handbook of Highway Engineering by T. F. Fwa, Taylor and Francis, 2006.
3. The Handbook of Highway Engineering by M. Kutz, McGraw-Hill, 2004.
4. Traffic Safety and Human Behaviour by David Shinar, Elsevier, 2007