CIVIL ENGINEERING DEPARTMENT
P.G. Section in Transportation Engineering & Planning

Curriculum
(*First Revision*)
For

M.TECH TRANSPORTATION ENGINEERING & PLANNING
(**APPROVED at 27th Meeting of Senate, 28,July, 2012**)

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY
SURAT-395 007

CIVIL ENGINEERING DEPARTMENT
S. V. National Institute of Technology, Surat – 395 007
M.Tech Transportation Engineering & Planning
(APPROVED at 27th Meeting of Senate, 28,July, 2012)

SEMESTER I

| Sr. No. | Subjects | L | T | P | Marks | | | Credit |
| | | | | | Theory | Practical / Tutorial | | |
						Continuous Assessment	End Semester Assessment	
CE 691	Research Analytical Methods	3	1	-	100	10	15	4
CE 693	Transport Economics	3	1	-	100	10	15	4
CE 695	Highway Materials & Construction	3	-	2	100	20	30	4
CE 697	Urban Transport System Planning	3	-	2	100	20	30	4
	Elective – I*	3*	-	-	100	-		3
Total		15	2	4	500	60	90	19
Semester Total		**21 hrs.**			650			**19**

*Can be 2-0-2 / 2-1-0

SEMESTER II

| Sr. No. | Subjects | L | T | P | Marks | | | Credit |
| | | | | | Theory | Practical / Tutorial | | |
						Continuous Assessment	End Semester Assessment	
CE 692	Operation & Maintenance Management of Pavements	3	0	2	100	20	30	4
CE 694	Pavement Analysis & Design	3	1	-	100	10	15	4
CE 696	Traffic Engineering & Road Safety	3	-	2	100	20	30	4
CE 698	Regional Transport System Planning	3	-	2	100	20	30	4
	Elective – II*	3	-	-	100	-	-	3
Total		15	1	6	500	70	105	19
Semester Total		**22 hrs.**			675			**19**

*Can be 2-0-2 / 2-1-0

L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER III

Sr. No.	Subjects	L	T	P	Marks			Credit
					Theory	Practical / Tutorial		
						Continuous Assessment	End Semester Assessment	
CE 861	Transportation Project	-	-	4	-	40	60	2
CE 863	Summer Training Report	-	-	-	-	40	60	2
CE 865	Dissertation Preliminaries	-	-	8	-	80	120	4
Total		-	-	12	-	160	240	08
Semester Total		**12 hrs**			400			**08**

SEMESTER – IV

Sr. No.	Subjects	L	T	P	Marks			Credit
					Theory	Practical / Tutorial		
						Continuous Assessment	End Semester Assessment	
CE 862	Seminar	-	-	2	-	20	30	1
CE 864	Dissertation	-	-	20	-	160	240	10
Total		-	-	22	-	180	270	11
Semester Total		**22 hrs**			450			**11**
Programme		**10 Theory Courses**		**Total Credit**				**57**

LIST OF ELECTIVES

Sr. No.	Subjects	L	T	P	Marks			Credit
					Theory	**Practical / Tutorial**		
						Continuous Assessment	End Semester Assessment	
Elective - I Group							
CE 701	Soft Computing Techniques	3	-	-	100	-	-	3
MG 601	Communication skills	2	1	-	100	10	15	3
MM 611	Decision Models in Management	3	-	-	100	-	-	3
CE 645	Geospatial Techniques	3	-	-	100	-	-	3
AM651	Ground Improvement & Reinforced Earth Techniques	3	-	-	100	-	-	3
CE703	Environmental Impact Assessment	3	-	-	100	-	-	3
CE705	Transportation System Analysis	3	-	-	100	-	-	3
CE707	Airport Planning and Design	3	-	-	100	-	-	3
EC/CE 709	Intelligent Transport System	3	-	-	100	-	-	3
CE 711	Water Transport System	3	-	-	100	-	-	3
Elective - II Group								
AM 702	Finite Element Method	3	-	-	100	-	-	3
MM 622	Human Resources Management	3	-	-	100	-	-	3
EE 652	Control Theory	3	-	-	100	-	-	3
CE 632	Urban Planning Techniques & Practice	2	-	2	100	20	30	3
CE 648	Planning Legislation	3	-	-	100	-	-	3
CE 636	Sustainable Environmental Planning	3	-	-	100	-	-	3
CE 702	Public Transport Planning	3	-	-	100	-	-	3
CE 704	Traffic Flow Theories	3	-	-	100	-	-	3
CE 706	Project Appraisal & Finance Management	2	-	2	100	20	30	3
CE 708	Transport Infrastructure Design	3	-	-	100	-	-	3

NOTE:

- Each Elective Group contains subjects of other departments, other P.G. area of the department and transportation area in order to make the system more flexible and to offer options to P.G. students of their interest area.

- One external examiner & concerned internal examiners shall conduct end semester examination in case of Practical/Studio and Project. Final examination for dissertation will be conducted as per Institute norms.

- Continuous assessment evaluation of project/seminar will be carried by a panel of 3 examiners including guide / supervisor.

- Two progress evaluations each of dissertation preliminary and dissertation at 3rd and 4th semester will be conducted by the panel of 3 internal examiners, including guide / supervisor.

- There will be 6-8 weeks of mandatory summer training for all the candidates. Assessment of summer training report will be carried out in the 3rd semester by panels of 3 internal examiners.

M. TECH. I (TEP) SEMESTER- I   **L T P C**

CE 691 RESEARCH ANALYTICAL METHODS   **3 1 0 4**

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- **SOCIAL RESEARCH FORMULATION**   **(08 Hours)**
  Design of research - Scaling techniques - Sampling design - Design of questionnaire - Data collection and statistical processing
- **STATISTICS & PROBABILITY BASE**   **(08 Hours)**
  Various probability distributions & their applications - Parameter estimation - Hypothesis testing - Random variables - Method of maximum likelihood - Hypothesis testing to compare multiple population - Statistical quality control
- **REGRESSION ANALYSIS**   **(06 Hours)**
  Estimation and analysis of simple regression models - Correlation coefficients - Analysis of correlation coefficients
- **HYPOTHESIS TESTING**   **(04 Hours)**
  Concepts - Hypothesis tests associated with regression and correlation coefficients
- **MULTIVARIATE ANALYSIS**   **(06 Hours)**
  Multiple regression models - Multivariate analysis – ANOVA - Rank coefficient - Application of statistical software
- **OPTIMIZATION TECHNIQUES**   **(10 Hours)**
  Linear programming - Simplex method - Transportation model - Concepts of non – Linear programming - Decision theories – Rules - Decision under uncertainty

(Total contact hours: 42)

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REFERENCES:

1. Benjamin J. R., Cornell C. A., *Probability Statistics and Decision for Civil Engineers*, McGraw-Hill, 1970.
2. Kothari, C.R., *Research Methodology: Method and Techniques*, New Age International Publication, 2004.
3. Hines W. W., Montgomery D. C., *Probability and Statistics in Engineering and Management Science*, John Wiley and Sons, New York, 1990.
4. Sharma J.K., *Operation Research: Theory & Applications*, MacMillan India Ltd., 2000.
5. Bhandarkar P.L., Wilkinson T.S., *Methodology & Techniques of Social Research*, Himalaya Publishing House, 1991.

M. TECH. I (TEP) SEMESTER- I   **L T P C**
CE 693 TRANSPORT ECONOMICS   **3 1 0 4**

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- **PRINCIPLES OF ENGINEERING ECONOMICS**   **(10 Hours)**
  Supply and demand models - Consumer's surplus and social surplus criteria - Framework for social accounting: Price – Demand - Supply loss - Elasticity applications - Growth demand nodal

- **TRANSPORT COSTS AND BENEFITS**   **(10 Hours)**
  Fixed and variable cost - Cost of improvement - Maintenance cost - Cost estimating methods - Pavement cost analysis - 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

- **ECONOMIC EVALUATION TECHNIQUES**   **(10 Hours)**
  Generation and screening of project alternatives - Different methods of economic analysis: - Discounting and Non discounting criteria methods – NPV - IRR, Benefit/Cost analysis - Analysis of public projects - replacement analysis - Application economic theory in traffic assignment problem - Break even analysis

- **DEPRECIATION AND INFLATION**   **(06 Hours)**
  Modified accelerated cost recovery system - Basic methods of computing depreciation charges - Evaluation of depreciation methods - Tax concepts - Corporate income taxes - Effects of inflation - Measuring inflation - Impact of inflation on economic evaluations.

- **RISK ANALYSIS**   **(06 Hours)**
  Probability concepts for economic analysis - Application of probability and simulation concepts in economic analysis - Decisions under uncertainty - Sensitivity analysis - Role of financial institutions

                                                      (Total contact hours: 42)

 REFERENCES:
1. Winfrey R., *Highway Economic Analysis*, International Textbook Company.
2. David A. Hensher, Ann M. Brewer., *Transport: An Economics and Management Perspective*, Oxford University Press
3. Emile Quinet, Roger Vickerman., *Principles of Transport Economics*, Edward Elgar Pub
4. Ian G. Heggie., *Transportation Engineering Economics*, McGraw Hill.
5. James L.Riggs, David D.Bedworth, and Sabah U. Randhawa., *Engineering Economics*, Tata McGraw Hill, Delhi,2009.
6. Sasmita Mishra., *Engineering Economics and Costing*, PHI, New Delhi.
7. IRC: SP: 30-1993., *Manual on Economic Evaluation of Highway Projects in India.*
8. Sarkar P K., Maitri V.,*Economics in Highway and Transportation Planning,* Standard Publisher, New Delhi, 2010.

M. TECH. I (TEP) SEMESTER- I   **L T P C**

CE 695 HIGHWAY MATERIALS AND CONSTRUCTION   **3 0 2 4**

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- **SOIL**   **(06 Hours)**
  Role of soil testing in pavement engineering - Subgrade requirements in road constructions - Basic concept of stress path and its representation in various spaces - Analysis of soil behavior - Evaluation of various elastic constants for practical use - Soil stabilization - Climatic Effects.
- **AGGREGATE**   **(04 Hours)**
  Road making aggregates classification - Mechanical Properties of aggregates - Design of aggregate gradation
- **BITUMEN**   **(10 Hours)**
  Bituminous road binders - Penetration and Viscosity Grade - Emulsion- properties – types - Cut backs and modified binders - Rheology of bitumen and Modified binders - Visco-elastic and fatigue properties of bituminous mixtures - Resilient modulus of pavement materials
- **BITUMINOUS MIX**   **(06 Hours)**
  Classification of mix design methods – Fillers - Theory of fillers and specifications - Marshall mix design procedure - Seal Design - Superpave and Micro surfacing procedures
- **FUTURISTIC PAVEMENT MATERIALS**   **(04 Hours)**
  Flyash (C&F) - Waste materials (Slags) - Geosynthetics - Chemicals etc.
- **ROAD CONSTRUCTION**   **(12 Hours)**
  Non-Bituminous and Bituminous road construction procedures and specifications - Quality control requirements - Concrete road construction - Construction methods - Quality control requirements - Joints in cement concrete pavements - Reinforced cement concrete road construction

(Total contact hours: 42)

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PRACTICALS
1. Identification tests on soils (atterburg limits)
2. Triaxial test of subgrade soil
3. Unconfined Compressive Strength of subgrade soil
4. Test for aggregate Durability and Soundness
5. GSB mix design
6. Bitumen viscosity test (rotational viscometer); retained stability test (Rolling Thin Film Oven Tester), Penetration, Ductility & Softening point test.
7. Marshall bituminous mix design, DBM and SDBC
8. Concrete mix design

REFERENCES:

1. Robert D Krebs Richard; *Highway Materials* McGraw-Hill Education.1971
2. Atkins Harold N., *Highway Materials, Soils, and Concrete*, Prentice Hall,1996
3. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee, 2001
4. Kadiyali L.R., *Principles & Practice of Highway Engineering*, Khanna Publishers,2001
5. Relevant IRC and IS Codes.
6. IRC: 37-2001, *Guidelines for the Design of Flexible Pavements*,2001,
   IRC: 58 -2011 IRC: SP: 62-2004

M. TECH. I (TEP) SEMESTER- I   **L   T   P   C**

CE 697 URBAN TRANSPORT SYSTEM PLANNING   **3   0   2   4**

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- **URBANISATION PROCESS**   **(04 Hours)**
  Urban growth mechanism – Urban morphology - Urbanisation & travel demand - Urban development planning policy – NUTP - Urban transport projects - Urban transport problems in India

- **URBAN TRANSPORT PLANNING PROCESS**   **(04 Hours)**
  Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system- Sustainable urban transport - Systems approach.

- **TRAVEL DEMAND ESTIMATE**   **(04 Hours)**
  Trip based and activity based approach - Four stage travel demand modeling - Data needs and outputs - Quick response techniques - Survey designs.

- **TRIP GENERATION**   **(04 Hours)**
  Productions & Attractions - Influential factors –Trip rate analysis-Category analysis- Simple & Multiple linear regression models – FHWA method

- **TRIP DISTRIBUTION**   **(06 Hours)**
  Interchange matrix – Growth factor methods – Synthetic methods – Calibration of Gravity model

- **MODAL SPLIT**   **(06 Hours)**
  Influential factors – FHWA Procedure – Diversion curves & surfaces- Discrete choice models, Concept, Types, BL,MNL & HL models

- **TRIP ASSIGNMENT**   **(06 Hours)**
  Trip Assignment procedure – Diversion curves- BPR model - All or Nothing assignment - Multipath assignment - Capacity restraint assignment – User equilibrium and system equilibrium approach - Stochastic assignment approach

- **LAND USE TRANSPORT SYSTEM**   **(04 Hours)**
  Urban system components - Urban spatial structure – Accessibility - Location theory - Land use models - Land use transport models, Lowry & Garin – Lowry models**.**

- **URBAN PUBLIC TRANSPORTATION**   **(04 Hours)**
  Urban growth and public transport needs - Transit mode classifications - Transit characteristics - Fleet size and capacity estimation

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PRACTICALS
1. Study area delineation & travel survey design
2. Home interview survey and data analysis
3. Use of TransCAD / CUBE in urban transport planning
4. Calibration of trip generation models
5. Calibration of singly / doubly constrained gravity models
6. Calibration of utility based mode choice models
7. Trip assignment by AoN / CRMethod / Multipath/ Equilibrium methods
8. Garin – Lowry model application: Case study

REFERENCES:

1. Bowmen, J. and M. ben-Akiva, *Activity based travel Forecasting; in Activity based travel forecasting*. Washington,DC: U.S. Department of Transportation, Report DOT-97-17.
2. Bruton M.J., *Introduction to Transportation Planning*, Hutchinson of London, 1988
3. Chakroborty P., Das N., *Principles of Transportation Engineering*, PHI,New Delhi,2003
4. Dickey J.W., *Metropolitan Transportation Planning*, Tata Mc-Graw Hill 1980
5. Hutchinson B.G., *Principles of Urban Transportation System Planning*, Mc-Graw Hill, 1974.
6. Khisty C J., Lall B.Kent, *Transportation Engineering – An Introduction, Prentice*-Hall, NJ, 2005
7. Ortuzar, J. D., Willumsen, L.G., *Modeling Transport*, John Wiley & Sons, 1994
8. Papacostas C.S. and Prevedouros, P.D., *Transportation Engineering & Planning*, PHI, New Delhi,2002

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 692 OPERATION AND MAINTENANCE MANAGEMENT OF   **3 0 2 4**
    PAVEMENTS
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- **INTRODUCTION**   **(06 Hours)**
  Operation and maintenance (O&M) of the Project Highway - Model Concession Agreement (MCA) for various types of PPP projects -Management and Organization - Project Cycle -Levels of Management - Administration and Logistics - Site Management - Road Maintenance – Approach – Organization - Management Activities
- **OPERATIONAL MANAGEMENT ACTIVITIES**   **(04 Hours)**
  Road Inventory - Assessment of Maintenance Requirements – Drainage - Running Surface – Structures - Setting Priorities - Planning Maintenance Works - Implementation - Work Activities and Task Rates - Tools for Maintenance Works - Reporting and Monitoring
- **PAVEMENT EVALUATION**   **(04 Hours)**
  General concept of pavement evaluation - Evaluation of pavement performance - Structural capacity – Distress – Safety
- **PAVEMENT DISTRESS**   **(06 Hours)**
  Structural and functional – serviceability - fatigue cracking - pavement deformation and low temperature shrinkage cracking - factors affecting performance - relation between performance and distress - Methods of performance surveys - Methods of measuring defects - Pavement – Life studies
- **DISTRESS MEASURING EQUIPMENTS**   **(04 Hours)**
  Functional and structural evaluation - Functions parameters such as roughness - Distress, rutting - Skid resistance etc. - structural parameters such as structural capacity - Benkelman beam - bump integrator - demonstration of equipments for dynamic testing of pavements (LWD) - pavement skid resistance measuring equipments - fatigue testing equipment
- **DESIGN OF OVERLAYS**   **(04 Hours)**
  Types of Overlays - Design Methodologies - Flexible overlays - Rigid overlays - design of overlay by Benkelman beam and falling weight Deflectometer - Asphalt Institute Method - Portland Cement Association Method, -AASHTO Method.

                                                      (Total contact hours: 28)
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 PRACTICALS
1. Pavement Distress Survey
2. Pavement Performance Analysis using V-Box (Demonstration)
3. Benkelman beam Deflectometer (BBD) and Falling weight Deflectometer (Demonstration)
4. Bump integrator (Demonstration)
5. Skid Resistance

REFERENCES:

1. Hass, R., Hudson, W.R. and Zaniewski, J., *Modern Pavement Management*, Krieger,1994
2. Hass, R. and Hudson, W.R., *Pavement Management System*, McGraw Hill Company, Inc,1978
3. Yang H. Huang, *Design of functional pavements*, Pearson Prentice Hall, 2004
4. Yoder, E.J. and Witczak, M.W., *Principles of Pavement Design*, John Wiley and sons, 1975
5. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee
6. Kadiyali L.R., *Principles & Practice of Highway Engineering,* Khanna Publishers, 2003
7. Relevant *IRC code* & Infrastructure development form Planning commission of India Publication, MORTHs Publications

M. TECH. I (TEP) SEMESTER- II   **L   T   P   C**

CE 694   PAVEMENT ANALYSIS AND DESIGN   **3   1   0   4**

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- **FUNDAMENTAL MATERIAL BEHAVIOUR**   **(06 Hours)**
  Elasticity – Plasticity and Viscosity of Granular or unbound materials - Cemented materials, Bituminous materials - Material characterization: **-** Resilient modulus of materials - Dynamic Modulus of Bituminous Mixtures - Fatigue Characteristics - Permanent Deformation Parameters

- **PAVEMENT BASICS**   **(06 Hours)**
  Types & comparison of vehicular loading pattern - Effect of Tire pressure and total load - Equivalent wheel and axle loads - Climatic and environmental factors - Modulus of resilience or California Bearing Ratio (CBR) for different layers - Loading pattern on airport pavement - factors affecting design and performance of pavements - Airport pavement - Environmental impact on pavements - Sub grade requirements - Functions of sub grade - Sub-base - Base course and wearing course

- **STRESSES AND STRAINS IN PAVEMENTS**   **(06 Hours)**
  Homogeneous Mass - Layered Systems - Viscoelastic Solutions - Material Characterization and creep-compliance curve - Stresses due to Curling/bending - Stresses and Deflections due to Loading - Stresses due to Friction

- **FLEXIBLE PAVEMENT DESIGN**   **(09 Hours)**
  CBR approach - IRC method - U.S. navy method - Boussinesq's and Burmister's analysis and design method - Triaxial & McLeod method - Calibrated Mechanistic Design Procedure - Asphalt Institute Method - AASHTO Method - Design of Shoulders.

- **DESIGN OF RIGID PAVEMENTS**   **(09 Hours)**
  Wheel load stresses - Liquid and elastic soil subgrade - Westergaard's analysis - Bradbury's approach - Arlington test - Pickett's corner load theory and related charts - Calibrated Mechanistic Design Procedure – IRC Method - Portland Cement Association

Method - AASHTO Method - Continuous Reinforced Concrete Pavements - Design of Shoulders - Design of joints - Dowel bar and tie bars

- **RELIABILITY IN DESIGN OF FLEXIBLE AND** **(06 Hours)**
  RIGID PAVEMENT
  Statistical Concepts - Probabilistic Methods – Variability - Rosenblueth Method

(Total contact hours: 42)

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REFERENCES:

1. Yoder, E.J. and Witczak, M.W., *Principles of Pavement Design*, John Wiley and sons,1975
2. Yang H. Huang, *Design of functional pavements*, Pearson Prentice Hall,2004
3. Gary N. Durham, W. Allen Marr, and Willard L. De Groff, *Resilient Modulus Testing for Pavement Components* ASTM Stock Number: STPl437, USA,2003
4. Andrew R. Dawson, *Pavements Unbound* Taylor & Francis Group plc, London, UK, 2004
5. Khanna S.K., Justo C.E.G., *Highway Engineering*, Nem Chand & Bros., Roorkee, 2001
6. Kadiyali L.R., *Principles & Practice of Highway Engineering*, Khanna Publishers, 2003
7. IRC: 37-2001, *Guidelines for the Design of Flexible Pavements*
8. IRC: 58-2011, *Guidelines for the Design of Plain Jointed Rigid Pavements*,2001

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 696   TRAFFIC ENGINEERING & ROAD SAFETY   **3 0 2 4**
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- **TRAFFIC STUDIES & ANALYSIS**   **(06 Hours)**
  Scope, traffic elements - Characteristics-vehicle, road user and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents - Sample size, study methodology - Data analysis & inferences.
- **TRAFFIC FLOW ANALYSIS**   **(08 Hours)**
  Macroscopic, Microscopic & Mesoscopic approach – Types of Flow- Traffic stream characteristics – Space – Time diagram – Relationship between speed, flow & density-Level of service & capacity analysis – Shockwave theory.
- **INTERSECTION DESIGN**   **(08 Hours)**
  Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries & at-grade intersections – Signal design - Grade separated intersections & their warrants
- **GEOMETRIC DESIGN**   **(08 Hours)**
  Cross sections – Sight distances – Super elevation – Horizontal & vertical alignments – Safety considerations
- **ROAD SAFETY AUDIT**   **(06 Hours)**
  Global & Local perspective – Road safety issues – Road safety programmes – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures
- **TRAFFIC REGULATION & T.S.M.**   **(06 Hours)**
  Speed, vehicle, parking, enforcement regulations - Mixed traffic regulation - Management techniques, one-way, tidal flow, turning restrictions etc. – Transportation System Management Process – TSM planning & Strategies

                                                                  (Total contact hours:42)
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PRACTICALS
1. Traffic Volume Count at Mid Block Section
2. Turning Movement Count at an Intersection
3. Registration Number Plate Survey
4. Spot Speed Survey
5. Speed and Delay Study by Moving Observer Method
6. Origin and Destination Study- Road Side Questionnaire Survey
7. Parking Inventory & Usage Survey by Patrol
8. Road safety audit: Construction & Operation stage

REFERENCES
1. Drew, D.R., *Traffic Flow Theory & Control*, McGraw Hill, New York, 1968.
2. Kadiyali, L.R., *Traffic Engineering and Transport Planning*, Khanna Publishers, New Delhi, 2002.
3. Khisty C J,Lall B.Kent; *Transportation Engineering-An Introduction*, Prentice-Hall,NJ, 2005
4. May, A.D., *Traffic Flow Fundamentals*, Prentice – Hall, Inc., New Jersey,1990.
5. O'Flaherty C A, *Highways- Traffic Planning & Engineering*, Edward Arnold, UK
6. Pignataro, L.J., *Traffic Engineering – Theory & Practice*, John Wiley, 1985.
7. Salter, R J., Hounsel, N.D., *Highway Traffic Analysis and Design*, Macmillan, London,1996.

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 698 REGIONAL TRANSPORT SYSTEM PLANNING   **3 0 2 4**

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- **REGIONAL PLANNING**   **(06 Hours)**
  Classification of regions - Transport systems functions - Regional delineation - Regional growth - Concepts of GDP and GNP - Regional economic analysis, factors of production, regional income, location quotient, multiplier effects

- **DEMOGRAPHIC AND EMPLOYMENT FORECASTING MODELS**   **(08 Hours)**
  Population forecast, Linear & Exponential models, Logistic models, Cohort – survival models – Employment classification, economic base mechanism, input and output analysis.

- **DIRECT DEMAND MODELS**   **(06 Hours)**
  Importance & Types – SARC model – Mc-Lynn model - Sketch planning methods – UMOT - Incremental demand models – Abstract models.

- **REGIONAL TRANSPORTATION**   **(06 Hours)**
  Regional passenger and goods travel demand – Aggregate freight demand modeling - Network planning and hierarchy - Multimodal transportation system - Intercity transport planning, various Traffic Forecasting Models.

- **RURAL ROAD NETWORK PLANNING**   **(06 Hours)**
  Principles – Methodology – Diversion analysis - Network development approach.

- **TRANSPORT TERMINAL PLANNING**   **(06 Hours)**
  Demand assessment – Location aspects -Passenger terminals, types, facilities, layout - Freight terminals, types, facilities, lay out - Logistics.

                                                          (Total contact hours: 42)

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PRACTICALS:
1. Delineation of planning region
2. Regional economic & demographic study
3. Use of TransCAD / CUBE in regional transport planning
4. Diversion analysis study
5. Intercity passenger demand forecast
6. Freight traffic growth modeling
7. Passenger / Goods terminal planning

REFERENCES:
1. Chand Mahesh, Puri U.K., _Regional Planning in India_, Allied Publishers, New Delhi,1983.
2. Glassion John, _Introduction to Regional Planning_, Hutchinson & MIT press, Cambridge, 1996
3. Kanafani, Adib, K., _Transportation demand Analysis_, Mc Graw Hill, New York,1983.
4. Morlok, K. E., _Introduction to Transportation Engineering_, McGraw-Hill,New York,1978.
5. Oppenheim, N., _Applied Models in Urban and Regional Analysis_, Prentice-Hall, NJ.,1980.
6. Ortuzar, J. D., Willumsen, L.G., _Modeling Transport_, John Wiley & Sons, 1998.

M. TECH. II (TEP) SEMESTER- III   **L T P C**

CE 861 TRANSPORTATION PROJECT   **0   0   4 2**

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A mini project on Transportation/Traffic Engineering is to be carried by group of students on the basis of field surveys and observations. The mini project site can be in cities/towns or rural areas.

Final project report is to be submitted & presented for examination after one mini project brief seminar.

(Total contact hours: 42)

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M. TECH. II (TEP) SEMESTER- III   **L T P C**

CE 863 SUMMER TRAINING REPORT   **0   0   0 2**

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Six/Eight week summer training on major Transportation or Traffic project, is to be carried at National/State/Local Government Project level after the Second Semester Examination and prior to opening of Third Semester and project report on the same is to be prepared & submitted duly certified by the Project Organization.

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M. TECH. II (TEP) SEMESTER- III   **L T P C**

CE 865 DISSERTATION PRELIMINARIES   **0   0   8 4**

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Dissertation preliminaries should clearly identify the goals & objectives and scope of the dissertation work taken up by the candidate. The focus is on data identification and proposed field surveys, questionnaire design, sample size decision. The study methodology and literature review on the dissertation topic is to be completed and a typed report is to be finalized in consultation with dissertation supervisor and submitted for the assessment at the end of the semester.

(Total contact hours: 42)

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M. TECH. II (TEP) SEMESTER- IV   **L T P C**

CE 862 SEMINAR   **0 0 2 1**

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Each student is required to prepare and submit a seminar paper in consultation with Dissertation Supervisor and seminar is to be presented on scheduled date decided by the P.G. Centre.

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M. TECH. II (TEP) SEMESTER- IV   **L T P C**

CE 864 DISSERTATION   **0 0 20 10**

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The preliminary dissertation work initiated in Third semester is further extended over fourth semester to cover up the field studies, data analysis, modeling , if any and research finding followed by conclusion etc.

The main objective of the dissertation work is to provide scope for original & independent research to express the ability of using analytical approach or technical investigation.

Thesis is to be prepared by each student under the guidance of faculty supervisor and finally submitted in six typed bound sets as per the specified time.

The assessment of the dissertation work will be carried out in two stages, first during the semester for 160 marks, and final viva-voce exam for 240 marks at the end of the semester.

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M. TECH. I (TEP) SEMESTER- I   **L T P C**

CE 701 SOFT COMPUTING TECHNIQUES   **3 0 0 3**

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- **GENETIC ALGORITHMS**   **(12 Hours)**
  Goals of optimization - Comparison with traditional methods - Schemata – Terminology in GA – Strings, Structure, Parameter string - Data Structures – Operators - Coding fitness function – Algorithm - Applications
- **FUZZY LOGIC**   **(12 Hours)**
  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
- **ARTIFICIAL NEURAL NETWORKS**   **(12 Hours)**
  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
- **HYBRID SYSTEMS**   **(06 Hours)**
  Fuzzy neural systems – Genetic Fuzzy Systems – Genetic Neural Systems.

(Total contact hours: 42)

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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

M. TECH. I (TEP) SEMESTER- I   **L T P C**
MG 601 COMMUNICATION SKILLS   **2 1 0 3**

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- **ENRICHING LANGUAGE SKILLS**   **(10 Hours)**
  Functional English Grammar – Parts of Speech - Uses of Articles – Prepositions – Tenses - Active and Passive Voice - Conditional Sentences - Punctuation - Common Errors and Vocabulary
- **WRITTEN COMMUNICATION**   **(10 Hours)**
  Paragraphs - Kinds and Construction – Letters - Seven C's of Letter Writing and Structure - Reports- Kinds and Structure - Research Paper - Characteristics and Components - E-mail etiquette
- **ORAL COMMUNICATION**   **(8 Hours)**
  Non-Verbal Communication- Body Language, Space and Personal Appearance; Job Interviews- Objectives and Preparation - Group Discussion- Speaking in a GD - Presentation – Planning - Structuring and Nuances of Delivery

(Total Contact Hour : 28)

REFERENCES:

1.   Bovee, Courtland L.; Thill, John V.& Chaturvedi, Mukesh. *Business Communication Today*. 9th Edition. New Delhi: Dorling Kindersley (India) Pvt. Ltd. Pearson. 2011.
2. Raymond V. Lesikar and Marie E. Flatley. *Basic Business Communication: Skills for Empowering the Internet Generation*. New Delhi: Tata McGraw Hill, 2008.
3. Farahthullah, T.M. *Communication Skills for Technical Students*. 5th Edition, Kolkatta: Orient Blackswan, 2009.
4. Quirk, Randolph & Greenbaum, Sidney. *A University Grammar of English*. 5th Edition, New Delhi: Pearson, 2009.
5. Raman, Meenakshi & Sharma Sangeeta**.** *Technical Communication Principles and Practice***.** 2nd Edition, New Delhi: Oxford University Press, 2011.
6. Rizvi, M. Ashrif**.** *Effective Technical Communication*. New Delhi: Tata McGraw Hill, 2005.

M. TECH.I (TEP)   SEMESTER- I   **L T P C**
MM 611: DECISION MODELS IN MANAGEMENT   **3 0 0 3**

- **DECISION THEORY AND MANAGEMENT**   **(03 Hours)**
  Concepts, Role of knowledge, Operations Research, Decision making processes, Deterministic and probabilistic situation, Single and multiple person decision making.
- **LINEAR PROGRAMMING**   **(07 Hours)**
  Advanced Methods- Heuristics, Simplex method, duality, Sensitivity analysis.
- **INTEGER PROGRAMMING**   **(03 Hours)**
  Gomory's cutting plane algorithm, Gomory's mixed integer problem algorithm,
  A branch and bound algorithm
- **GOAL PROGRAMMING**   **(02 Hours)**
  Introduction, Difference between LP and GP approach, Concept of Goal Programming,
  Graphical solution-method of Goal Programming.
- **DYNAMIC PROGRAMMING**   **(04 Hours)**
  Introduction, Nature of dynamic programming, Deterministic processes, Non-Sequential
  discrete optimization, Application of Dynamic Programming in production scheduling
  and routing problems.
- **NON LINEAR PROGRAMMING**   **(04 Hours)**
  Unconstrained and constrained optimization, Kuhn-Tucker theory,
  Quadratic programming applications.
- **TRANSPORTATION PROBLEMS**   **(04 Hours)**
  Mathematical Model for Transportation Problem, North-West Corner Method, Least Cost
  Method, Vogel's Approximation Method, Test for optimality, Degeneracy in Transportation
  Problem, Variations in Transportation Problem.
- **ASSIGNMENT PROBLEMS**   **(03 Hours)**
  Mathematical Model for Assignment Problem, Solution Method for Assignment Problem,
  Variations in Assignment Problem.
- **QUEUING THEORY**   **(05 Hours)**
  Basic Structures of queuing models, Poisson queues –M/M/1, M/M/C for finite and
  infinite queue length, Non-Poisson queue -M/G/1.
- **SIMULATION**   **(04 Hours)**
  Discrete event simulation; Generation of random variables, simulation processes and
  languages.
- **NETWORK MODELS**   **(03 Hours)**
  Shortest path method, maximum flow. Minimum spanning tree problem.

(Total Contact Hours : 42)

REFERENCES:
1. A. Ravindran, D.T.Philips and J.J.Solberg, *Operations Research: Principles and Practice*, John Wiley, 2nd Edition, 1987
2. W. L. Winston, *Operations Research: Application and Algorithms,* Brooks/Cole, 4th Ed., 1998.

3. H. A.Taha, *Operations Research: An Introduction,* MacMillan, 5th Ed.,1982.
4. Neylor, T.H., *Computer Simulation Techniques,* John Wiley, 1st Ed., 1966.
5. N.D.Vora, *Quantititative Techniques in management*, Tata McGrawhill, 1990.
6. P C Tulsian and V. Pandey, *Quantitative Techniques: Theory & Problems*, 1ST Ed., Pearson, 2002.

M. TECH. I (TEP) SEMESTER- I
CE 645 GEOSPATIAL TECHNIQUES

L T P C
3 0 0 3

- **INTRODUCTION TO REMOTE SENSING** (08 Hours)
  Concepts and fundamentals, energy sources, energy interactions, ideal and real remote sensing systems, fundamentals of aerial photo interpretation, keys, elements of air photo interpretation for terrain evaluation, Data acquisition, various remote sensing platforms, satellites, sensors, multi spectral scanners, microwave sensing.

- **DATA HANDLING IN RS** (04 Hours)
  Data acquisition, various remote sensing platforms, satellites, sensors, multi spectral scanners, microwave sensing

- **IMAGE PROCESSING** (04 Hours)
  Digital image processing, equipments used for remote sensing, other aspects of interpretation, ground truth.

- **GEOGRAPHICAL INFORMATION SYSTEM** (08 Hours)
  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.

- **DATA HANDLING IN GIS** (08 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. GIS Applications: Case studies.

- **GLOBAL POISONING SYSTEM** (06 Hours)
  GPS: Basic concepts, components, factors affecting, GPS setup, accessories, segments-satellites & receivers, GPS applications, Case studies.

- **APPLICATION** (04 Hours)
  Applications of remote sensing GIS and GPS, Engineering applications, land use/land cover mapping, applications to urban and regional planning, Water resources, environmental studies, transportation engineering, other civil engineering fields.

(Total contact hours:42)

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. De Mers, 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.

M. TECH. I (TEP) SEMESTER- I   **L T P C**

AM651 GROUND IMPROVEMENT &   **3 0 0 3**
       REINFORCED EARTH TECHNIQUES

- **SOIL CHARACTERISTICS**   **(14 Hours)**
  Subgarde, functions, Importance of Subgarde soil properties on pavement performance. Soil Survey- Soil survey procedure for highways and ground water investigation, Identification and significance of soil characteristics, Soil classification for highway engineering purpose, Effect of water in soils swelling/shrinkage, Cohesion and plasticity in soil.

- **SOIL**   **(14 Hours)**
  Moisture movement-ground water, Gravitational water, held water, soil suction. Drainage- General principles, Subsoil drainage. Frost Action Soil: Frost susceptible soils, Air and soil temperature, Heat flow through soils, Depth of frost penetration, Loss of strength during frost melting. Strength Evaluation of subgarde soil. Compaction of soils field and Laboratory methods and equipment.

- **STRESS IN SOILS**   **(14 Hours)**
  Theories of elastic and plastic behavior of soils. Function: Stability of embankment, Reinforcing embankment and fibers, Methods of reducing settlement due to consolidation in foundations of road embankment. Vertical Sand Drains: Design criteria, constriction and uses.

                                    (Total contact hours:42)

REFERENCES:
1. Terzaghi K., Peck R.B., *Soil Mechanics in Engineering Practice*, Asia Publishing House , New Delhi, 1962
2. Alam Singh, *Text Book of Soil Mechanics*, S.Chand Publication, New Delhi
3. Relevant ISS codes.

M. TECH. I (TEP) SEMESTER- I   **L   T   P   C**

CE 703   ENVIRONMENTAL IMPACT ASSESSMENT   **3   0   0   3**

- **INTRODUCTION**   **(12 Hours)**
  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

- **EIA AIR ENVIRONMENT**   **(10 Hours)**
  Prediction and Assessment of Impact on Air Environment: Basic information on air quality, sources of air pollutants, effects of air pollutants, key legislations and regulations, conceptual approach for addressing air environment impacts, impact prediction approaches, assessment of significance of impacts, identification and incorporation of mitigation measures.

- **EIA NOSIE AND SOCIAL ENVIRONMENT**   **(10 Hours)**
  Prediction & Assessment of Impact on Noise & Social Environment: Basic information on noise, key legislation and guidelines, conceptual approach for addressing noise environment impacts, impact prediction methods, assessment of significance of impacts, identification and incorporation of mitigation measures, Conceptual approach for addressing socio-economic impacts, traffic and transportation system impacts, visual impacts, scoring methodologies for visual impact analysis.

- **DECISION METHODS FOR EVALUATION OF ALTERNATIVE**   **(10 Hours)**
  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.

                                                                      (Total contact hours:42)

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.

M. TECH. I (TEP) SEMESTER- I   **L   T   P   C**
CE 705   TRANSPORTATION SYSTEMS ANALYSIS   **3   0   0   3**
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- **TRANSPORTATION AND SOCIETY-FACTORS IN TRANSPORTATION DEVELOPMENT** **(06 Hours)**
  Functions, Problems & factors in Transportation Planning, 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.

- **TRANSPORT TECHNOLOGY** **(14 Hours)**
  System Classification and their Variation; Study of Conventional Systems of slow & fast modes, 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.

- **LEVELS OF SERVICE** **(14 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.

- **OPERATIONAL CONTROLS OF AIR, WATER, RAILWAY AND HIGHWAY TRANSPORTATION SYSTEMS** **(08 Hours)**
  Functions of Control & Communications-Dispatching 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.

(Total contact hours: 42)
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REFERENCES:

1. Willam, Hay, _Introduction to Transportation Engineering,_ John Wiley, New York.
2. Edward K. Morlock, _Introduction to Transportation Engineering & Planning_, International Student Edition, Mc-Graw Hill Book Company, New York.

M. TECH. I (TEP) SEMESTER- I   **L   T   P   C**
CE 707   AIRPORT PLANNING AND DESIGN   **3   0   0   3**

- **AIRPORT PLANNING**   (06 Hours)
  Aviation Planning - Levels of Planning - Planning Airport Systems under different States - Effect of Airline Hubs and Deregulation on Indian Airport System - Air Transport Planning in the India and in Europe/USA.
- **AIRPORT MASTER PLANNING**   (06 Hours)
  Airport Master Plan: - Definition and Objectives - Hierarchy of Planning - Elements of Airport Master Plan: - FAA - ICAO Guidelines for Structure of Master Plan - Airport Layout Design - Structure of Master Plan Report - Airport Site Selection
- **AIRPORT CAPACITY**   (06 Hours)
  Capacity - Level of Service - Airside Capacity - Factors Affecting Airside Capacity and Delay - Determination of Runway Capacity and Delay - Annual Service Volume - Preliminary Capacity Analyses - Calculating Aircraft Delay - Taxiway and Gate Capacity - Airport Landside Capacity
- **AIRSIDE CONFIGURATION AND GEOMETRIC DESIGN OF THE AIRSIDE**
                                                                      (06 Hours)
  Principles of Airport Layout - Airfield Configuration - Runway Orientation - Obstructions to Airspace: - FAA and ICAO Standards - Runway Length - Separation of Parallel Runways - Runway and Taxiway Cross Section - Longitudinal-Grade Design for Runways and Stop-ways - Longitudinal-Grade Design for Taxiways -Taxiway Design - Holding Aprons - Terminal Aprons
- **FORECASTING AIR TRANSPORT DEMAND**   (06 Hours)
  Conventional Airport Forecast Methods - General Aviation Forecasts - Airport ground access mode choice modeling process - Use of airport ground access models in airport planning - Integration of airport ground access models in regional planning process
- **PASSENGER AND CARGO TERMINAL**   (06 Hours)
  Function of Airport Passenger and Cargo Terminal - Facilities Required at Passenger Terminal - Passenger and Baggage Flow - Elements to Be Considered in Design of Air Freight Terminals - Example of Design of Middle -Technology Freight Terminal
- **AIRPORT DRAINAGE AND PAVEMENT DESIGN**   (06 Hours)
   Estimation of Runoff - Collection and Disposal of Runoff - Subsurface Drainage - Wind Rose Analysis - Aircraft and Pavement Classification Numbers - Flexible-Pavement Design Methods (India Practice - McLeod Method - FAA Design Procedure - Corps of Engineers Designs) - Rigid-Pavement Design Methods (Indian Practice - Corps of Engineers Designs - FAA design - Joint and reinforcement requirements)

                                                      (Total contact hours: 42)

REFERENCES:

1. Geoffrey D. Gosling; *Airport ground access mode choice models,* Transportation Research Board, Washington, D.C., 2008
2. Norman J. Ashford, Saleh Mumayiz, Paul h. Wright; *Airport Engineering Planning, Design, and Development of 21st century Airports,* John Wiley & Sons, Inc.,2011

3. Horenjeff Robert; *The planning & Design of Airports*, McGraw Hill Book Co., 2007
4. Yang H. Huang; *Design of functional pavements,* Pearson Prentice Hall, 2004
5. Yoder, E.J. and Witczak, M.W; *Principles of Pavement Design*, John Wiley and sons,1975
6. Robert G. Packard, *Design of Concrete Airport Pavement,* Portland Cement Association, USA,1995

M. TECH. I (TEP) SEMESTER- I   **L T P C**

EC/CE 709   INTELLIGENT TRANSPORTATION SYSTEMS   **3 0 0 3**

- **INTRODUCTION TO ITS**   **(03 Hours)**
  Definition Objectives, Historical Background, Benefits of ITS – Introduction to Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Traffic control and monitoring aspects.
- **INTELLIGENT SUPPORTING TECHNOLOGIES**   **(18 Hours)**
  Wireless communications, Standards and Cellular Technology, ITS Data acquisition and processing, Hardware and Software--Micro-Controllers, PLC, Embedded systems, Ubiquitous Computing, Sensing Technologies, Detectors/Detection Techniques—Triangulation Technique, Inductive loop detection, Video vehicle detection, Microwave detection etc. Global Positioning System (GPS)
- **COMPONENTS OF ITS**   **(02 Hours)**
  Theories of elastic and plastic behavior of soils. Function: Stability of embankment, Reinforcing embankment and fibers, Methods of reducing settlement due to consolidation in foundations of road embankment. Vertical Sand Drains: Design criteria, constriction and uses.
- **ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS)**   **(02 Hours)**
  Traffic density, Variable message signs, Parking guidance, Weather information.
- **ADVANCE VEHICLE MONITORING SYSTEMS**   **(04 Hours)**
  Security CCTV systems, Wireless Sensor Network and RFID
- **COMMERCIAL VEHICLE OPERATIONS (CVO)**   **(04 Hours)**
  Emergency vehicle notification systems, Automatic road enforcement, Variable speed limits, Collision avoidance systems, Dynamic Traffic Light Sequence, Cooperative systems on the road, Automatic number plate recognition by Image processing.
- **ITS APPLICATIONS**   **(05 Hours)**
  Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems
- **ITS PROGRAMS IN THE WORLD**   **(04 Hours)**
  Overview of ITS implementations in developed countries, ITS in developing countries.

(Total contact hours:42)

REFERENCES:
1. Sumit Ghos and Tony Lee, *Intelligent Transportation Systems*, CRC Press, ISBN: 0849300673.
2. Chris Drane andC. R. Drane, *Positioning Systems in Intelligent Transportation Systems*, Artech House Publishers, ISBN: 0890065365.
3. Judy Mc Queen and Bob Mc Queen, *Intelligent Transportation System and Architecture*, Artech House Publishers, ISBN: 089006525X
4. Asad J. Khattak **,** *Intelligent Transportation Systems: Planning, Operations, and Evaluation*, CRC Press

M. TECH. I (TEP) SEMESTER- I   **L T P C**
CE 711 WATER TRANSPORTATION SYSTEM   **3 0   0 3**

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- **WATER TRANSPORTATION**   **(06 Hours)**
  Scope – Merits - Developments of Water Transportation in India - Inland waterways – River – Canal - Inland water transportation - Development of ports & harbours – Site selection & planning - Harbour classification - Harbour dimensioning.
- **NATURAL PHENOMENA**   **(04 Hours)**
  Tides - Water waves – Wave action - Wave decay & port - wave defraction – breaking – Reflection - Littoral drift - Sediment transport -
- **HARBOUR INFRASTRUCTURES**   **(06 Hours)**
  Types of brakewaters – Access channels - 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.
- **PORT FACILITY**   **(06 Hours)**
  Transit shed – Warehouses - Cargo handling - Container handling - Inland port facility - Navigational aids – Types - Requirements of signals – Lighthouses - Beacon light - Buoys
- **DREDGING & COASTAL PROTECTION**   **(04 Hours)**
  Types of dredgers – Choices - Usage of dredged material - Sea wall protection - Sea wall revetment – Bulkhead
- **OPERATION AND MANAGEMENT**   **(06 Hours)**
  Organization management and operation - function of port authorities - O and M- MIS, basic operational principles - Ship characteristics - Its influence on ports management & operations – Concern about Ship & Ship building
- **WATER TRANSPORTATION TECHNOLOGY**   **(04 Hours)**
  Simulation modeling -Analytical solutions- Cargo handling systems
- **ECONOMIC ANALYSIS**   **(06 Hours)**
  Economic feasibility- evaluation- Economic costs and benefits- least cost solutions
                                                              (Total contact hours: 42)

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REFERENCES:

1. Bindra S.P., _Docks & Harbour Engineering_, Dhanpat Rai Publications,
2. Srinivasan R., _Harbours, Docks & Tunnel Engineering_, Charotar Publishing House, Anand, 1999.
3. Aegerschou, Lundgren et. al., _Planning, Designing of Port and Marine Terminals_, John Wiley and Sons, 1983.
4. Port Engineering and Operations: Proc. Conference of British Ports, New Castle upo Tynes, March, 1985, Thomas Telford, London, 1985.
5. Hennes and Eske, _Fundamentals of Transportation Engineering_, McGraw-Hill Book Co., 1955.

M. TECH. I (TEP) SEMESTER- II   **L T P C**

AM 702 FINITE ELEMENT METHOD   **3 0 0 3**
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- **INTRODUCTION**   **(14 Hours)**
  Concept of FEM, and solution procedure for finite element displacement approach, Principles of discretization , Lagrangian & Hermitian interpolation functions, Shape functions and numerical integration techniques

- **ELEMENT PROPERTIES**   **(14 Hours)**
  Element properties for 1-D (bar & beam) elements and 2-D (rectangular, triangular & isoparametric) elements using natural and area coordinate system

- **ELEMENTS**   **(14 Hours)**

  Introduction to plate elements, shell elements, dynamics & vibration, buckling, and Galerkin method, Pre & post processors, solution techniques and software packages.

(Total contact hours: 42)

REFERENCES:

1. Logan, D L, 2007. *A First Course in the Finite Element Method* 4th edition, Thomson Asia Pvt. Ltd., New Delhi

2. Manika Selvam, V K, 1993.*Finite Element Primer,*Dhanpat Rai Publications Pvt. Ltd, New Delhi

M. TECH. I (TEP) SEMESTER- II   **L T P C**

MH 622 HUMAN RESOURCE MANAGEMENT   **3 0 0 3**

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- **NATURE AND SCOPE OF HUMAN RESOURCE MANAGEMENT**   **(05 Hours)**
  Introduction to Human Resource Management, Definitions, Scope, Functions, Objectives, Model of HRM, Qualities of a good personnel manager, Role of HRM.
- **LEADERSHIP, MOTIVATION AND JOB SATISFACTION & MORALE (05 Hours)**
  Definitions, Difference between a leader and a manager, Different approach of leadership, Theories of motivation, Job satisfaction, Morale, Job Enlargement, Enrichment, Job Rotation, QWL.
- **PROCUREMENT OF PERSONNEL**   **(08 Hours)**
  Man power planning, Determination of Manpower need, Job Analysis, Recruitment and Selection Process, Orientation and Placement.
- **TRAINING AND DEVELOPMENT**   **(06Hours)**
  Training, Education and development, Responsibility of Training and Development, Policy, Need and Objectives of training, Types and methods of training, Evaluation of training and development, Organization Development (OD).
- **PERFORMANCE APPRAISAL**   **(02 Hours)**
  Purposes of appraisal, Factors affecting appraisal, Criteria for Performance Appraisal, Methods.
- **JOB CHANGE**   **(02 Hours)**
  Resistance to change, Job change plans, Career planning, Promotion , Transfer, Demotions, Separations.
- **EMPLOYEE COMMUNICATION, CONTROL AND AUDIT**   **(03 Hours)**
  Communication, Process of communication, Directions of communication, Steps in control process, Personnel audit
- **EMPLOYEE REMUNERATION**   **(03 Hours)**
  Components of Remuneration, Concepts of wages, Determination of wages, Factors, Incentives, Employee benefits
- **EMPLOYEE WELFARE, SOCIAL SECURITY, SAFETY AND HEALTH (02 Hours)**
  Employee welfare, Principles, Labor welfare officer, Social security, Safety, Health, International, Labor Organization (ILO)
- **EMPLOYEE DISCIPLINE, GRIEVANCE, TRADE UNIONS & INDUSTRIAL RELATIONS**   **(04 Hours)**
  Meaning, Causes of indiscipline, Types of discipline, Rules, Causes of grievances, Model grievances procedure, Definition of Trade union, Nature and scope of Trade union, Functions of Trade Union, Collective bargaining, Industrial relations, Industrial disputes, Methods to solve disputes, Workers' participations in management
- **RECORDS AND RESEARCH**   **(02 Hours)**
  Records, Personnel research

                                      (**Total Contact Hours: 42**)

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REFERENCES:

1. Ashwathappa K., *Human Resource and Personnel Management*, Tata McGraw Hill, New Delhi, 4th Edition, 2005
2. Monappa A., *Personnel Management*, Tata Mcgraw Hill, New Delhi, 2nd Edition, 2004
3. Tripathi P.C., *Personnel Management and Industrial Relations*, Sultan Chand and Sons, New Delhi, 16th Edition, 2002
4. Zweig Mark C., *Human Resources Management*, John Wiley and Sons, 1991

M. TECH. I (TEP) SEMESTER- II　　　　　　　　　　　　　　　　**L　T　P　C**

EE 652: CONTROL THEORY　　　　　　　　　　　　　　　　　　**3　0　0　3**

- **INTRODUCTION TO CONTROL SYSTEMS:**　　　　　　　　　**(02 Hours)**
  Open loop control and close loop control - Illustrative examples of control systems
- **MATHEMATICAL MODELS OF PHYSICAL SYSTEMS:**　　　　**(10 Hours)**
  Linear and non-linear systems - equations and transfer functions for linear mechanical translational systems and linear electrical network - Force-Voltage and Force-Current analogy - Block diagram representation of control systems - Block diagram reduction - Transfer functions of armature-controlled and field - Controlled DC servomotors and 2-phase AC servomotors - Signal flow graph and Mason's gain formula
- **TIME DOMAIN ANALYSIS OF CONTROL SYSTEMS:**　　　　**(06 Hours)**
  Typical test signals - Response of first-order systems - Transient response of a second order system due to step input - Time domain specifications of a second order system - Impulse and ramp response of second order system - Steady-state errors - Static error coefficients - Error series and dynamic error coefficients
- **ROOT LOCUS TECHNIQUES:**　　　　　　　　　　　　　　**(06 Hours)**
  Basic Properties of Root Loci - Construction of Root Loci - Effects of Adding Poles and Zeros
- **CONCEPTS OF STABILITY:**　　　　　　　　　　　　　　**(02 Hours)**
  Introduction to stability - definition through impulse response function - asymptotic stability and relative stability - Routh-Hurwitz stability criterion
- **FREQUENCY DOMAIN ANALYSIS OF CONTROL SYSTEMS:**　**(08 Hours)**
  Steady state response of a system due to sinusoidal input - Frequency response - Logarithmic plots or Bode diagrams - Log-magnitude versus phase plots - Resonant peak and resonant frequency of a second order system - Polar plots - conformal mapping - principal of argument　　　- Nyquist stability criterion - Stability analysis - Relative stability - Gain margin and phase margin - Closed loop frequency response
- **DESIGN OF CONTROL SYSTEMS:**　　　　　　　　　　　**(08 Hours)**
  Introduction to phase lag, phase lead and phase lag-lead networks and their applications. P, PI, PID Controllers.

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REFERENCES:

1. Nagrath & Gopal, *Control system engineering*, New Age International Publishers, 3rd Edition, 2001.
2. K. Oggata, *Modern control system engineering*, Pearson Education Asia, 4th Edition, 2002.
3. B.C.Kuo, *Automatic control system*, Prentice Hall of India, 7th Edition, 1995.
4. Richard C Dorf & Robert H Bishop, *Modern control system*, Pearson Education Asia. 8th Edition, 2004.
5. Nise N. S. John willey & sons, *Control System Engineering*, 4th Edition, 2004

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 632 URBAN PLANNING TECHNIQUES AND PRACTICE   **2 0 2 3**

- **LAND USE ACTIVITIES**   **(04 Hours)**
  Population forecasting methods, Planning practices in India, Analysis, and prediction of important land use activities.
- **SPATIAL STANDRADS**   **(04 Hours)**
  UDPFI and TCPO guide lines for residential, industrial, commercial and recreational areas, standards for urban amenities, Provisions of Town Planning Act, zoning, subdivision practice, and metro region concept. Land use and urban form.
- **PLANNING TECHNIQUES**   **(06 Hours)**
  Linear programming, threshold analysis, simulation approach.
- **TOWN DEVELOPMENT PLAN /TOWN PLANNING SCHEMES**   **(06 Hours)**
  Scope, contents and preparation. Land value and density pattern. A case study of development plan, preparation of Town Planning Schemes, activity areas, plan implementation – organizational legal and financial aspects, public participation in plan formulation and implementation, planning for urban poor, national renewal schemes and policies.
- **URBAN RENEWAL AND CONSERVATION**   **(04 Hours)**
  Urban Decay causes and impacts, Urban renewal, Meaning, significance, scope and limitations, identification of renewal areas, renewal strategies. Urban conservation: Meaning, heritage, significance and techniques.
- **CONCEPT OF NEW TOWNS**   **(02 Hours)**
  Meaning, role and functions: Special planning and development considerations, scope and limitations of new town development, Indian, Asian and British experience of planning and development of new towns.
- **GLOBAL TRENDS**   **(02 Hours)**
  Concept of International cities, issues and planning approaches. Recent trends in international planning.

(Total contact hours:28)

PRACTICAL: (Any One)
- **DEVELOPMENT OF GROWTH CENTERS**
  Field Studies, Site Visit, Inventor and Field Data Collection, Preparation of planning Proposals.
- **DESIGNING A SPECIAL RESIDENTIAL ZONE**
  As per Government of Gujarat Guidelines SRZ development proposals.
- **SATELLITE TOWN DEVELOPMENT**
  Identification of site, Field Visit, Socio- eco Survey, Planning Desiging and cost estimation of Proposals.
- **URBAN RENEWAL PROPOSALS**
  Analyzing urban central space allocation, urban parametric relations and planning solutions.

REFERENCES:

1. MARGARET ROBERTS, *Town Planning Techniques*, Hutchinson Educational Publication.
2. N.V. MODAK AND V.N. AMBDEKAR, *Town and Country Planning and Housing*, Orient Longman Limited.
3. R.G. GUPTA, *Planning and Development of Towns*, New Delhi.
4. K.S. RAMEGAUDA, *Urban and Regional Planning,* Mysore University Publication.

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 648 PLANNING LEGISLATION   **3 0 0 3**

- **INTRODUCTION**   (08 Hours)
  Significance and Objectives of Legislation for Planners and Environmental Engineers. Constitutional Basis and Provisions. Evolution of Planning Legislation and Legislation in Environmental Engineering in India.
- **URBAN PLANNING LEGISLATION -1**   (15 Hours)
  Legal Framework in Town and Country Planning. Preparation and Implementation of Regional Plan/Development plan, T.P. Scheme in Light of The Gujarat Town Planning Act, 1976.
- **URBAN PLANNING LEGISLATION -2**   (05 Hours)
  Provisions of Land Acquisition Act, Urban Land Ceiling Act and Conservation Act.
- **ENVIRONMENTAL LEGISLATION**   (14 Hours)
  Legislative Framework for Pollution Monitoring and Control. Pollution Control Boards. Industrial Policy, License and Environmental Protection and Environmental Clearance, N.O.C. from Pollution Board.

(Total contact hours:42)

REFERENCES:
1. *The Gujarat Town Planning and Urban Development Act*, Vora Prakashan, Ahmedabad.
2. R.B. Das, *Urban Planning and Local Authority*, Oxford and IBH   Publication, Calcutta.
3. *Handbook of Environmental Laws, Vol. I and II*, Enviro-media Publication, Karad, Maharashtra

M. TECH. I (TEP) SEMESTER- II   **L   T   P   C**

CE 636 SUSTAINABLE ENVIRONMENTAL PLANNING   **3   0   0   3**

- **ECOLOGY AND ECO – SYSTEM**   **(06 Hours)**
  Basic concepts and components of ecology and ecosystem; Air water, noise, land pollution – causes, effects and control.
- **ENVIRONMENT AND POLLUTION**   **(06 Hours)**
  Concept, Source, Impact, Remedial Measures of various pollution
- **SUSTAINABLE DEVELOPMENT AND PLANNING TECHNIQUES**   **(16 Hours)**
  Definition, sustainability check lists multi-dimension concept, principles. Creation of green spaces, concepts of Green building, concept of green residential clusters, provision of green belt, Eco-friendly industrial location and planning, development of existing water bodies, water conservation techniques, Air-pollution abatement measures due to automobiles..
- **ENVIRONMENTAL MANAGEMENT AND LEGISLATION**   **(14 Hours)**
  Multi Disciplinary Environmental Strategies Decision Making – Concepts of Environmental Audit, Life Cycle Analysis (LCA) ISO 14001, Clean Development Mechanism (CDM), Carbon Credits, EIS(data meaning) Environmental standards in India, Role, legal provision and functions of MoEF, CPCB, DoEF, GPCB, Environmental acts. EIA rules.

(Total contact hours:42)

REFERENCES:

1. Dr. Suresh K. Dhameja; *Environmental Engineering and Management*,   S. K. Kataria & Sons, New Delhi, 2007
2. G. N. Pandey; *Environmental Management*”, Vikas Publishing House Pvt. Ltd., New Delhi, 2005.
3. Rehana Tariq; *Sustainable Urbanization and urban Development*, New Academic Publishers, New Delhi, 2008.
4.   Rachel Cooper; *Designing Sustainable Cities*, Wiley-Blackwell Publisher, New Delhi, 2009

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 702   PUBLIC TRANSPORT PLANNING   **3 0 0 3**
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- **DEVELOPMENT OF PUBLIC TRANSIT SYSTEM**   **(06 Hours)**
  Growth history – Urban growth & transit evolution - Modes of public transport and comparison - Public transport travel characteristics - Technology of bus, rail, rapid transit systems, basic operating elements.
- **PARA TRANSIT**   **(04 Hours)**
  Definition & Classification – Operational characteristics – Role in multi modal transport system – Evaluation of para transit systems
- **TRANSIT NETWORK PLANNING**   **(08 Hours)**
  Objectives & principles – Network configurations - 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.
- **TRANSIT DESIGN**   **(08 Hours)**
  Passenger demand assessment – Design data requirements & collection – Frequency & headway determination – Rail operation design – Bus operation design – Uninterrupted flow – Way capacity & Station capacity –Transit level of service
- **TRANSIT SCHEDULING**   **(08 Hours)**
  Components - Determination of service requirements – Time table development - Scheduling procedure - Marginal ridership – Vehicle & Crew scheduling.
- **TRANSIT INFRASTRUCTURE FACILITIES**   **(04 Hours)**
  Location of bus stops - Design of terminals, principles of good layout - Types of layout - Depot location - Twin depot concept - Crew facilities and amenities.
- **TRANSIT AGENCY AND ECONOMICS**   **(04 Hours)**
  Organisational structure of transit agency - Management and personnel - Transit system statistics - Performance and economic measures – Operations & fare structures - Alternative analysis.

                                                            (Total contact hours: 42)

REFERENCES

1. Black, Alan, *Urban Mass Transportation Planning*, McGraw- Hill,Inc., New York,1995.
2. Ceder, A.,*Public Transit Planning and Operation: Theory, Modeling and Practice*, B-H Elsevier Ltd., MA, 2007.
3. Khisty C J., Lall B.Kent, *Transportation Engineering – An Introduction*, Prentice-Hall, NJ, 2005
4. Papacostas C.S. and Prevedouros, P.D., *Transportation Engineering & Planning*, PHI, New Delhi,2002
5. Vukan, R. Vuchic, *Urban Public Transportation: Systems & Technology*, John –Wiley & Sons, New Jersey, 2007.
6. Vukan, R. Vuchic, *Urban Transit: Operations, Planning and Economics*, John –Wiley & Sons, New Jersey, 2005.
7. Vukan,R. Vuchic et. al, *Timed Transfer System Planning, Design and Operation: Final Report*, The Program,1983.

M. TECH. I (TEP) SEMESTER- II   **L T P C**

CE 704 TRAFFIC FLOW THEORY   **3 0 0 3**

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- **TRAFFIC STREAM CHARACTERISTICS**   **(08 Hours)**
  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.

- **TRAFFIC STREAM MODELS**   **(12 Hours)**
  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**   **(10 Hours)**
  Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Models of Delay at Intersections and Pedestrian Crossings.

- **HIGHWAY CAPACITY & LEVEL-OF-SERVICE STUDIES**   **(06 Hours)**
  Concepts, Factors Affecting Capacity & Level-Of Service, Capacity Analysis of Different Highway Facilities, Passenger Car Units, and Problems in Mixed Traffic Flow.

- **TRAFFIC SIMULATION**   **(06 Hours)**
  System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments.

                                                        (Total contact hours: 28)

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,
5. Washington DC, 1985.
6. Wohl M. and Martin, B V., _Traffic System Analysis for Engineers and Planners_, McGraw-Hill, New York.
7. McShane W R & Roess R P, _Traffic Engineering_, Prentice-Hall, NJ
8. Neylor, T.H. et al., _Computer Simulation Techniques_, John Wiley.

M. TECH. I (TEP) SEMESTER- II   **L   T   P   C**

CE 706   PROEJCT APPRAISALS AND FINANCE MANAGEMENT   2   0   2   3

- **FEASIBILITY STUDIES, APPRAISALS AND PROJECT**   **(06 Hours)**
  CLEARANCES
  Project identification - Pre feasibility report and its clearance - Estimates and techno economic feasibility report - Detailed project report - Clearances from various authorities

- **CONTRACT MANAGEMENT**   **(10 Hours)**
  Contract documents - Classification of engineering contracts - Bidding process - CPWD contract conditions - FIDIC form of contract agreement – Tendering - Team and condition – Arbitration - Public Private Partnership (P3) projects

- **PROJECT PLANNING AND ORGANIZING**   **(06 Hours)**
  Project team - Organizational structure for projects - Planning and scheduling techniques and methods - Computer application in scheduling - Resource leveling - Monitoring and reporting using Primavera - MS project, BIMS

- **PROJECT FINANCING**   **(10 Hours)**
  Finance resources and generation - Estimate and projection - Financial feasibility - Debt equity ratio - Lease financing - Public sector bonds and debentures - Long term rupee loan - Cost of capital - Collaborator's equity participation

- **PROJECT CONTROL**   **(04 Hours)**
  Time and cost control tools and techniques - Trending and predicting change control - Project quality and safety control - Information reporting system - Project audit

- **EQUIPMENT MANAGEMENT**   **(04 Hours)**
  Classification of highway construction equipment and its costing - Operating and investment cost of equipment

- **PROJECT CLOSE OUT**   **(02 Hours)**
  Commissioning - Start up - Stabilization, close out.

                                                   (Total contact hours: 42)

REFERENCES:
1. P K Joy., *Total Project Managemen*t; Mcmillian India Limited, New Delhi, 2007.
2. Uddesh Kohli and K. K.Chitkara; *Project Management Handbook*, Tata McGraw Hill, New Delhi, 2008.
3. Kumar Neeraj Jha; *Construction Project Management Theory and Practice*, Pearson, New Delhi, 2011.
4. R.Paneerselvam and P.Senthilkumar; *Project Management*, PHI, New Delhi, 2009.
5. R.L.Peurifoy, C.J. Schexnayder, and A. Shapira., *Construction Planning, Equipment and Methods*, Tata McGraw Hill, New Delhi, 2010.
6. Prasanna Chandra; *Projects Planning, Analysis, Financing, Implementation and Review*, Tata McGraw Hill, New Delhi, 2002.
7. Dr.V.K.Raina; *Construction & Contract Management Practices*, Shroff Publishers & Distributors Pvt.Ltd., 2099

M. TECH. I (TEP) SEMESTER- II   **L T P C**
CE 708   TRANSPORTATION INFRASTRUCTURE DESIGN   **3 0 0 3**

- **INTRODUCTION**   **(06 Hours)**
  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

- **TERMINAL PLANNING & DESIGN**   **(06 Hours)**
  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

- **DESIGN OF HIGHWAYS**   **(06 Hours)**
  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.

- **HISTORY OF BRIDGE DEVELOPMENT**   **(08 Hours)**
  Classification of bridges - Selection of bridge sites - Bridge alignment - Sub-surface investigations - Bridge Hydrology - Flood discharge – Waterways - Scour depth - Depth of foundation - Standards of loadings - Types of loads - Impact effect - Wind loads - Seismic forces – Buoyancy - Earth pressure - Loadings on various bridges - Traffic requirements - Types of low cost bridges – Settlements - Allowable soil pressures - Types of foundations - Foundation failures -Foundation setting - Cofferdams

- **BRIDGE SUPER STRUCTURE**   **(06 Hours)**
  Superstructure elements - Bridge flooring - Bridge bearings - Joins in bridges - Bridge superstructures – Piers – Abutments - Wing walls and approaches

- **BRIDGE CONSTRUCTION**   **(06 Hours)**
  Erection of steel girder bridge - Truss bridges - Suspension bridges - Maintenance of bridges - Bridge testing for safe carrying capacity - Strengthening of bridges - Aesthetical treatments.

(Total contact hours: 42)

REFERENCES:
1. Kadiyali, L.R., *Traffic Engineering and Transport Planning*, Khanna publishers, 2003
2. IRC-SP41: *Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas*, 1994
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. Bindra S.P., *Bridge Engineering*, Dhanpat Rai & Sons
6. Relevant IRC codes,
7. MORT&H Specifications & standards for Roads & Bridges, 2001