Department of Civil Engineering

**SCHEME OF INSTRUCTION & SYLLABUS
FOR**

M.Tech. (TRANSPORTATION ENGINEERING)
(with effect from 2019-20 Admitted Batch)

Department of Civil Engineering
A.U. College of Engineering (A)
Visakhapatnam

Department of Civil Engineering
M. Tech. (TRANSPORTATION ENGINEERING)
Scheme of Instruction and Examination
(With effect from 2019 – 20 Admitted Batch)

I – SEMESTER

Code No.	Course Title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam (hrs)	Ext.	Sess.		
TE1.1	Urban Transportation Planning	4	--	4	3	70	30	100	3
TE1.2	Analysis and Design of Pavements	4	--	4	3	70	30	100	3
TE1.3	Traffic Engineering and Management	4	--	4	3	70	30	100	3
Program Elective –I TE1.4	(a) Advanced Foundation Engineering (b) Analysis of Transportation Systems (c) Pavement Management Systems	4	--	4	3	70	30	100	3
Program Elective –II TE1.5	(a) Probability and Statistics (b) Bridge Engineering	4	--	4	3	70	30	100	3
TE1.6	Computational Transportation Engineering Laboratory	-	3	3	Viva	50	50	100	1.5
TE1.7	Traffic Engineering Laboratory	-	3	3	Viva	50	50	100	1.5
Total		**20**	**6**	**26**		**450**	**250**	**700**	**18**

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam. (hrs)	Ext.	Sess.		
TE2.1	Geometric Design of Highways	4	--	4	3	70	30	100	3
TE2.2	Traffic Flow Theory	4	--	4	3	70	30	100	3
TE2.3	Transportation Economics and Project Appraisal	4	--	4	3	70	30	100	3
Program Elective –III TE2.4	(a) Ground Improvement Techniques (b) Environmental Impact Assessment (c) Project Planning and Management	4	--	4	3	70	30	100	3
Program Elective –IV TE2.5	(a) Design and Maintenance of Rural Roads (b) Finite Element Method of Analysis	4	--	4	3	70	30	100	3
TE2.6	Pavement Material and Evaluation Lab.	--	3	3	Viva	50	50	100	1.5
TE2.7	Highway Construction Practice	--	3	3	Viva	50	50	100	1.5
TE2.8	Seminar	--	3	3	Viva	50	50	100	2
Total		**20**	**9**	**29**		**500**	**300**	**800**	**20**

III SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
Program Elective –V TE3.1	(a) Disaster Management (b) Operations Research	4	--	4	3	70	30	100	3
Program Elective–VI TE3.2	(a) GIS Applications in Transportation Engineering (b) Geoenvironmental Engineering	4	--	4	3	70	30	100	3
TE3.3	Dissertation (Preliminary)	--	--	--	Viva	--	100	100	8
Total		**8**	**--**	**8**		**140**	**160**	**300**	**14**

IV SEMESTER

Code No.	Course title	Scheme of Examination			Total	Credits
		Exam. (hrs)	Ext.	Sess.		
TE4.1	Dissertation (Final)	Viva	100	--	100	16
Total						**16**

I–SEMESTER

TE1.1   URBAN TRANSPORTATION PLANNING

Transport Planning: Introduction, Systems approach, Stages in transport planning, survey and analysis of existing conditions, forecast analysis of future conditions and plan synthesis and Evaluation.
Transportation Survey: Definition of study area, Zoning and types of survey – Home interviews, taxi surveys etc., Inventory of transport facilities, expansion of data from samples.
Trip generation: Trip purpose, Multiple Linear Regression Analysis, Category analysis.

Trip Distribution: Uniform factor method, Average factor method, Fratar method, Furness method, Gravity model, Trannar's model, Opportunity model.

Traffic Assignment: All or Nothing Assignment, Multiple Route Assignment, Capacity Restraint Assignment, Design Curves.

Modal Spilt: General Considerations, Modal spilt in Transport planning process

Economic Evaluation: Need, Basic principles, Costs and Benefits of Transport projects – Cost categories, Benefits –Types of benefits, Methods of economic evaluation – Benefit – Cost Ratio method, First Year Rate of Return method, Net present Value method, Internal Rate of Return method – Comparison between methods of economic evaluation.

Text Books:

1. *Introduction to Transportation Planning - M.J.Bruton; Hutchinson of LondonLtd.*
2. *Introduction to Urban System Planning - B.G. Hutchinson,Mc Graw Hill.*
3. *Traffic Engineering and Transport Planning - Kadiyali L.R. KhannaPublishers*

Reference Books:

1. *Urban Transportation Planning Guide - Roads &Transportation Association of Canada; University of TorontoPress.*
2. *Lecture notes on UTP - Prof. S.Raghavachari, R.E.C.Warangal*
3. *Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, PHI Learning.*

TE1.2 ANALYSIS AND DESIGN OF PAVEMENTS

Pavement Types, Design Factors: Definition, Comparison of pavements. Types of

pavements based on structural behavior – Flexible and Rigid Pavements, Comparison, components and their functions, Soil subgrade, sub-base, Base course and wearing course. Design wheel loads – Equivalent Single Wheel Load (ESWL), Repetitions of loads. Strength characteristics of pavement materials – subgrade modulus, Elastic moduli of base course and sub-base materials, Traffic and Loading, Environment, Materials, Failure criteria. Climatic Variations

Stresses in Flexible Pavements: Layered System Concepts: One Layer System - Boussinesq Theory. Two Layer Theory - Burmister's Theory. Three Layer System.

Stresses in Rigid Pavements: Relative Stiffness of Slabs, Modulus of Subgrade Reaction, Stresses due to Warping, Stresses due to Friction, Stresses due to Wheel Load, Stresses due to temperature variation (temperature differential).

Pavement Design:
Design of Flexible pavements – Group-Index method, California Bearing Ratio(CBR) method, Mc leod method, Burmister Method, IRC Method of Flexible Pavement Design as per IRC 37 –2001, AASHTO Method of Flexible Pavement. Design of Air field Pavements – Corps of Engineers method

Design of Rigid pavements – Design of Joints, Expansion Joints, Contraction Joints, Design of Dowel and Tie bars. IRC recommendations for Rigid pavements as per IRC 58-1988. Design of Airfield Rigid pavements– LCN System of Pavement design.

Pavement Failures: Flexible pavements – Alligator cracking, Longitudinal cracking, Frost heaving, lack of binder to lower course, formation of waveson corrugation, Reflection cracking.

Pavement Inventories: Serviceability Concepts, pavement serviceability index, Roughness for measuring unevenness, Profilograph, profilometer, road roughometer, Benkelman beam deflection method, Skid resistance measurement.

Pavement Evaluation: Structural Evaluation of Benkelman beam. Evaluationof Pavement surface measurement condition using instruments (Profilograph, bump Integrator)

Overlays: Types of overlays – Flexible overlay over Flexible Pavements, Rigid overlay over Flexible Pavements, Flexible overlay over Rigid Pavements, Rigid overlay over Rigid Pavements. Design of overlay using Benkelman beam using IRC 81-1997.

Concrete Block Pavements – Types and shapes, Construction and maintenance.

Text Books:

1. *PrinciplesofPavementDesign by Yoder and Witzorack,, John Willey and Sons.*
2. *Highway Engineering, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.*
3. *Airport Planning and Design by S.K. Khanna and S. Arora, Nemchand and brothers publications.*

Reference Books:

1. *Yang, H. Huang, "Pavement Analysis and Design", Prentice Hall Publication, Englewood Cliffs, NewJersy.*
2. *Sargious, M.A. Pavements and Surfacings for Highways andAirports– Applied science Publishers limited*
3. *Ralps Hass and Hudson, W.R. "Pavement Management System" Mc-Graw Hill Book Company.*
4. *Guidelines for the use of Interlocking concrete block Pavement, IRC:SP:63-2004*
5. *IRC codes ofpractice.*
6. *Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, PHI Learning.*

TE1.3   TRAFFIC ENGINEERING AND MANAGEMENT

Traffic Characteristics: Basic traffic characteristics - Speed, volume and concentration – Relationship between Flow, Speed and Concentration

Traffic Measurement and Analysis: Volume Studies - Objectives, Methods, Speed studies - Objectives: Definition of Spot Speed, time mean speed and space mean speed, Methods of conducting speed studies.

Speed Studies: Methods of conducting speed studies, Presentation of speed study data; Headwaysand Gaps, Critical Gap, Gap acceptance studies.

Highway Capacity And Level Of Service: Basic definitions related to capacity, Level of service concept, Factors affecting capacity and level of service, Computation of capacity and level of service for two lane highways Multilane highways and freeways.

Parking Studies and Analysis: Types of parking facilities - on street parking and off street Parking facilities, Parking studies and analysis.

Traffic Safety: Accident studies and analysis, Causes of accidents - The Road, The vehicle, The road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents.

Traffic Control And Regulation: Traffic Signals - Design of Isolated Traffic Signal by Webster method, Warrants for signalisation, Signal Co-ordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.

At–grade intersections, sight distance considerations and principles of design, channelization, mini round-abouts, layout of round-abouts. Advantages and limitations of round-abouts.

Rotary Intersections: Definitions – Diverging, Merging, Weaving, Weaving Length, Advantages and Disadvantages. Rotary Design Elements – Design Speed, Radius at Entry, Radius at Exit, Width of Rotary Carriage way, Entry and Exit angles, External kerb line, Super elevation and camber- Capacity of rotary.

Interchanges – Advantages and Disadvantages, Major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design.

Traffic And Environment: Detrimental effects of Traffic on Environment; Air pollution; Noise Pollution; Measures to curtail environmental degradation due to traffic.

Traffic Management – Transportation System Management – Travel Demand management – Traffic Management measures – Purpose, Measures – Types of traffic management measures – Restriction of Turning Movements – One - way streets – Tidal Flow operations – Closing Side Streets – Exclusive Bus Lanes.

Text Books

1. *Traffic Engineering and Transportation Planning - L.R. Kadiyali, KhannaPublishers.*
2. *Highway Engineering, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.*
3. *Transportation Engineering - An introduction - C. Jotin Khistry, Prentice HallPublication.*
4. *Fundamentals of Transportation Engineering - C.S.Papacostas, Prentice HallIndia*

Reference Books

1. *Traffic Engineering - Theory &Practice - Louis J. Pignataro, Prentice HallPublication.*
2. *Principles of Highways Engineering and Traffic Analysis - Fred Mannering &Walter P. Kilareski, John Wiley & SonsPublication.*
3. *Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, PHI Learning.*

TE1.4(a) ADVANCED FOUNDATION ENGINEERING

Common Syllabus for SMFE1.2, CTPM1.4(a), TE1.4(a) and ST1.4(a)

Introduction
Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity.
Shallow Foundations
Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.
Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesionless soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.
Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing.
Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade

reaction.

Deep Foundations

Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests-Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis

Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.

Foundations of Transmission Line Towers

Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Text Books
  1. *Analysis and Design of Substructures by Swami Saran, Oxford & IBH Publishing Co. Pvt. Ltd.*
  2. *Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications*

Reference Books
  1. *Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.*
  2. *Foundation Design by W.C. Teng, John Wiley, New York.*
  3. *Analysis and Design of Substructures by Swami Saran, Oxford &IBH Publishing Co.*
  4. *Foundation Engineering by P.C. Vargheese, Prentice Hall of India*

TE1.4 (b) ANALYSIS OF TRANSPORTATION SYSTEMS

Traffic Regulations**:** Purpose and Scope, One way streets; reversible lanes and road ways; Turn regulations, Transit and Carpool lanes, Bicycle lanes and Bikeways, Pedestrian only streets, Speed Regulations, Passing and No Passing Regulations; Stop and yield controls.

Traffic Management**:** Need for Traffic Management, Basic Traffic Management Activities, Traffic Management Strategies and their Coordination; Access Management, Congestion Management, Traffic Calming, Evaluation of Traffic Management Systems.

Transportation System Management: Objectives, Need for TSM Long – Range vs. TSM Planning; TSM Actions, Traffic Management Techniques for improving Vehicular Flows, Preferential Treatment for High Occupancy Modes; Promoting Non- Auto and High Occupancy Vehicles; Transit and Intermediate public Transport service improvements, Demand Management Techniques for Reduced Intermediate Public Transport service improvements, Demand Management Techniques for Reduced Traffic Demand, Staggered Working Hours, Vehicular Restrictions, Intersection management techniques- Signal Progression –Optimization.

Local Area Traffic Management: Pedestrian Facilities; Bicycle Facilities; Traffic Planning and Management at Local Level; Individual Sites, Residential Neighborhoods and local interests, Traffic Effects of Land Use Developments.

Traffic Administration: Legislative Authority; Functional Responsibilities; Organization- UMTA- State Highway Department; Traffic Records; Research Bodies; Citizen Participation; Asset Management.

Text Book

1. *Khisty CJ and BK Lall, Transportation Engineering: An Introduction Prentice Hall International, Inc*

Reference Books

1. *Institution of Transportation Engineers. Traffic Engineering Hand Book, 4th ed., Prentice Hall*
2. *Transportation System Management, State of theArt, UMTA, USDOT*
3. *Local Area Traffic Management, TRB SpecialPublications*

TE1.4 (c) PAVEMENT MANAGEMENT SYSTEMS

Pavement Management System: Components of PMS and their Activities, Major Steps in Implementing PMS, Inputs, Design, Construction and Maintenance, Rehabilitation and Feedback Systems, Examples of HDM and RTIM Packages, Highway Financing, Fund Generation, Evaluating Alternate Strategies and Decision Criteria.

Pavement Inventories and Evaluation: Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Distress Modes - Cracking, Rutting etc, Pavement Deflection – Different Methods, Skid Resistance, Roughness, Safety Aspects. Inventory System - Assessment of Deficiencies.

Pavement Maintenance And Quality Control: Causes of Deterioration, Traffic and Environmental Factors, Pavement Performance Modelling Approaches and Methods, Methods of Maintaining WBM, Bitumen and Cement Concrete Roads, Quality Assurance / Quality Control - ISO 9000; Sampling Techniques Tolerances and Controls Related to Profile and Compaction.

Pavement Life Cycle Cost Analysis: Cost Components, Methods of LCA - Brief Description - Items Considered – Case Studies

Pavement Maintenance Management: Components of Maintenance Management and Related Activities - Network and Project Level Analysis - Budgeting - Prioritisation Techniques and Formulation of Maintenance Strategies.

Text Books

1. *Sargious, M.A. - Pavements and Surfacing for Highways and Airports -Applied Science Publishers Ltd.*

Reference Books

1. *Haas and Hudson, W.R. Pavement Management Systems - McGrawHill*
2. *Bridge and Pavement Maintenance - Transportation Research Record No.BOO,TRB*
3. *Shahin MY,1994 - Pavement Management for Airports, Roads and parkingLots.*
4. *BentThagesan,1996-HighwayandTrafficEngineeringforDevelopingCountries.*
5. *Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, PHI Learning.*

TE1.5(a) PROBABILITY AND STATISTICS

Fundamental concepts and role of probability and statistics in civil engineering, collection and presentation of data – design of experiment.

Elementary probability theory: random variables, conditional probability, theorem of total probability and Baye's theorem.

Probability distributions: Gaussian and log normal, Binomial geometric, Poisson exponential, Gamma uniform, triangular, Hyper geometric, Beta, Student's 'T' , ψ square, Fischer's 'F'.

Extreme – value: Gamble distributions, Central limit theorem, Moments and Expectations, Covariance matrix and Covariance propagation, weights. Estimation of parameters: Method of least squares – observation equations, normal equations, linear and nonlinear models.

Confidence interval estimation and statistical testing: Tests of hypothesis and significance for mean, variance and ratio of variances, statistical inference, multi variety analysis, error analysis, error elapses derived probability distributions, goodness–of–fit tests.

Regression: Linear, Non-linear and Multiple–linear Correlation analysis, Applications in Civil engineering.

Reference Books

1. *Ang, H.S. and Tang, W.H., Probability Concepts in Engineering Planning and Design, Wiley, New York,1975.*
2. *Benjamin, J.R. and Cornell, C.A., Probability Statistics and Decision for Civil Engineers, McGraw Hill, New York,1975.*
3. *Statistical Techniques for Transportation Engineering by Kumar Molugarm and Shanker Rao, BSP Books PVTLtd*

TE1.5(b)   BRIDGE ENGINEERING

Introduction to bridge engineering. Historical background of bridges and types. Bridge aesthetics and proportioning. Design process. Review of applicable design codes. Loads on bridges and force distribution. Bridge geometry.

Analysis and design of Slab Bridge, Skew slab bridge.

Analysis and design of T-beam bridge: Deck slab considering IRC loads, longitudinal girders(Interior, Exterior), Cross girder.

Analysis and design of prestressed concrete girder and box girder bridges considering only primary torsion, Design of end block.

Bridge Bearing: Types of bearings, Rocker bearing, Elastomeric bearing.

Text book
> 1. *Essentials of Bridge Engineering, D. Jhonson Victor, Oxford University Press.*

Reference Books
> 1. *Design of Bridges, N.Krishna Raju, Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi*

TE1.6   COMPUTATIONAL TRANSPORTATION ENGINEERING LABORATORY

1. Programming in C language – functions, arrays, strings, structures, fileoperations
2. Data structures.
3. Applications in Transportation Engineering.

TE1.7 TRAFFIC ENGINEERING LABORATORY

1. Traffic surveys like traffic volume count, speed study, parking study, intersection-turning movements, speed & delay study.
2. Moving observer survey.
3. Origin–destination surveys.
4. Road side and house hold interviews.
5. Road lighting.
6. Traffic noise measurement.
7. Measurement of road user characteristics.
8. Use of automatic traffic recording equipment

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TE2.1   GEOMETRIC DESIGN OF HIGHWAYS

Objects of Geometric design: Design controls
Elements of design:Cross sectional Elementspavement surface Characteristics, Camber, Width of pavements – carriage-way, kerbs, road margins, Formation width, Right of way, Building line, control line. Sight distances – Stopping Sight Distance (SSD), Intermediate Sight Distance (ISD), Headlight Sight Distance (HSD), Overtaking Sight Distance (OSD). ("Geometric Design Standards for Rural (Non – Urban) Highways" – IRC: 73 -1980) ("Geometric Design Standards for Rural (Urban) Highways" – IRC: 86 - 1983)

Horizontal alignment– Super Elevation analysis and design, Extra widening and side friction. Transition curves – types, Calculation of length. ("Guidelines for Design of Horizontal Curves for Highways and design tables" – IRC: 38 – 1988)

Vertical alignment – Gradient, Types – Ruling, Limiting, Exceptional and Minimum gradient. Grade compensation. Vertical curves – Types- Summit and valley curve – Lengths. ("Vertical Curves for Highways", IRC SP 23: 1993)

At-grade intersections – sight distance considerations and principles of design, channelization, mini round-abouts, layout of round-abouts. Advantages and limitations of round-abouts. (Guidelines for the design of at-grade Intersections in Rural and Urban Areas", IRC SP41: 1994)

Rotary Intersections: Definitions – Diverging, Merging, Weaving, Weaving Length, Advantages and Disadvantages. Rotary Design Elements – Design Speed, Radius at Entry, Radius at Exit, Width of Rotary Carriage way, Entry and Exit angles, External kerb line, Super elevation and camber. Capacity of rotary ("Recommended practice for Traffic Rotaries", IRC: 65 – 1976).

Interchanges – Advantages and Disadvantages, Major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design. ("Guidelines for the design of Interchanges in Urban area", IRC 92:1985)

Parking layout and design. Terminal layout and design. ("Tentative Recommendation on the Provision of Parking Space for Urban Areas", IRC SP 12: 1973)

Text Books

1. *Highway Engineering, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.*

2. *Khisty, C. J., and Lall, B. K., Transportation Engineering: An Introduction, Prentice Hall International, Inc.,2002.*

Reference Books

1. *AASHTO Design Guide, A Policy on Geometric Design of Highways and Streets,2001.*
2. *Fruin, Pedestrian Planning and Design, McGraw Hill Publication,2003.*
3. *Institution of Transportation Engineers, Traffic Engineering Hand Book, 4th Edition, Prentice Hall,1999.*
4. *Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, PHI Learning.*

TE2.2   TRAFFIC FLOW THEORY

Traffic Flow Description: Traffic Stream Characteristics and Description Using Distributions: Measurement, Microscopic and Macroscopic Study of Traffic Stream Characteristics - Flow, Speed and Concentration; Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests.

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalised Relationship, Fluid Flow Analogy Approach, Shock Wave Theory - Flow-Density diagram use in Shockwave analysis; Use of Time-space diagram for shockwave description; Bottleneck situations and shockwaves; traffic signal and shockwave theory; numerical Examples for application of shockwave theory;, Platoon Diffusion and Boltzman Like Behavior of Traffic Flow, Car-Following Theory, Linear and Non-Linear Car-Following Models, Acceleration Noise, Fuel consumption models

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Analysis of M/M/1 system; Assumptions and Derivation of System State Equations; Application of M/M/1 analysis for parking Garages and Toll Plazas- numerical Examples; Analysis of D/D/1 system for delay characteristics; Traffic Signal analysis as D/D/1 system; Computation of delays and queue dissipation Time – NumericalExamples.

Pedestrian Delays And Gaps: Pedestrian Gap acceptance and delays; Concept of Blocks, Anti-blocks, Gaps and Non-Gaps; Underwood's analysis for Pedestrian Delays; Warrants for Pedestrian Crossing Facilities – Minimum Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant.

Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data,
Formulation of Simulation Problems in Traffic Engineering and Validation; Basic concepts of simulation modelling application for Signalised Intersections, Pedestrian Crossings and Transit scheduling.

Text Book

1. *Fundamentals of Transportation Engineering – C.S.Papacostas,Prentice Hall IndiaPublication*

Reference Books

1. *Traffic Flow Theory: A Monograph , TRB Special Report165*
2. *Principles of Highway Engineering and Traffic Analysis –F.L.Mannering& W.P.Kilareski, John WileyPublishers.*
3. *Traffic Flow Fundamentals – A.D. May, Prentice Hall IndiaPublication*
4. *Fundamentals of Traffic Engineering – McShane &Rogers*

TE2.3 TRANSPORTATION ECONOMICS AND PROJECT APPRAISAL

Transport Economics and Analysis: Review of Engineering Economics and Microeconomics, Welfare Theory and Equilibrium Conditions, Goals and Objectives, Principles of Economic Analysis. Discounted Cash Flows: Analysis of User Costs and Benefits, RUCS Models for Costs and Benefits, Methods of Economic Analysis; Suitability, Analysis for Null Alternative

Investment Policies and Pricing: Average Cost, Marginal Cost, Allocation of Resources within Transport Sectors, Financing of Transport Sectors, Transport Investment Policies - Pricing Policies. Issues in transport policy: Budgeting, Non-user Impact Analysis, Analysis of Related Endeavour, Monitoring and Continuous Evaluation Strategies, Case Studies.

System Selection, Evaluation And Cost Analysis: Framework of Evaluation, Transport Planning Evaluation at Urban andRegional levels, Other Evaluation Procedures - Traditional Economic Analysis, Achievement Matrices, Factor Profiles, Plan Ranking, Introduction to Mathematical Programming, Case Studies.

Life cycle cost analysis: Factors consider for Life Cycle Cost Analysis; Data requirements for highway project feasibility analysis, establishment of Technical/ Economic/ Financial feasibility of a highway project, Social Benefits, Role of HDM in feasibility studies.

Project Appraisal - Private Sector Participation**:** BOT, BOOT, BOLT Projects - Case history - Project Planning - Project System Management - Project Implementation - Funds Planning – Budgetary and Control - Tendering and Contract - Value Analysis, Information System - Impact assessment, Project Report Preparation.

TQM in Highway Projects: Need for TQM, TQM Principles, Phases in TQM - Conceptual stage to Operations stage, TQM in Traffic & Transportation projects, Case Studies.

Text Book

1. *Lan Heggie, Transport Engineering Economics, McGrawHill*

Reference Books

1. *Highway investment in Developing countries - Thomas Telford Ltd.,Institute of CivilEngineers*
2. *Winfrey R, Economic Analysis for Highways - International Text Book Co.,Pennsylvania*
3. *Road User Cost Study - Final Report - Central Road Research Institute, NewDelhi*

4. *Dickey, J.W. - Road Project Appraisal for Developing countries, JohnWiley andSons.*

TE2.4(a)   GROUND IMPROVEMENT TECHNIQUES

Common Syllabus for SMFE2.4(b), CTPM2.4(b), ST2.4(b) and TE2.4(a)

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction: Methods – Vibro floatation, Terra probe method, Pounding, Blasting, Compaction piles; Compaction Control.

Vertical Drains: Sand drains, Sand wicks, Rope drains, Design of vertical drains, Stone columns, application of the techniques to Marine clays.

Stabilization: Introduction, objectives, Methods of stabilization – Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods – Soil lime Columns and Cement Lime Columns, applications

Dewatering: Definition, necessity, Methods of dewatering – Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro-osmosis. Permanent drainage by Foundation drains and Blanket drains.

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Ascending, Descending and Stage Grouting in Soils, Hydro fracture, Grouting Equipment, Post grouting tests.

In-situ Reinforcement: Ground Anchors, Tiebacks and Soil Nailing, Micropiles.

Text Book
1. *Ground Improvement Techniques by P. Purushothama Raj, Laksmi Publications, New Delhi.*

Reference Books
1. *Engineering Principles of Ground Modification by Monfred R Hausmann, Mc Graw Hill Publishing Co.*
2. *Reinforced Soil and Its Engineering Applications by Swami Saran, I.K. International Pvt. Ltd.*

TE2.4(b)   ENVIRONMENTAL IMPACT ASSESSMENT

Concept of Environment – Definition of EIA and EIS – Elements of EIA – Guidelines for the preparation of EIS – Governmental policies for environmental protection.

Environmental setting – Environmental attributes – air, water, soil, noise, ecological, social, economical, cultural, human and aesthetic aspects – Environmental indices.

Methodology for the identification of Impacts – Criteria for the selection of methods –

Methodologies- Adhoc, checklist, Overlaying, Matrix and Network methods.

Prediction and Assessment of Impacts on – air, water, soil, noise, ecological, social, economical, cultural, human environments and aesthetic aspects.

Review of Environmental Impact Statement – Cost benefit analysis – Measures for environmental impact mitigation and control – Case Studies.

Reference Books
1. *Environmental Impact Analysis by Urban and Jain.*
2. *Environmental Impact Analysis by Canter.*
3. *Environmental Impact Assessment Methodologies by Y Anjaneyulu, and Valli Manikkam, BSP Books PVT Ltd*
4. *Environmental Impact Assessment by Anji Reddy, BSP Books PVT Ltd*

TE2.4(c)   PROJECT PLANNING AND MANAGEMENT

Introduction to Project Management: Systems Approach, Systems Theory and Concepts, Organization, Management Functions, Overview of Management Objectives, Tools and Techniques, Project Management - Processes and organizational Structures – Team Management - Project Manager as a Team Leader - Leadership Qualities, PMIS

Construction Cost and Value Engineering: Types of Estimates, Implementation of Cost Controls, Project Cost Forecasting, Cost Optimization and Resources Planning - Value Engineering, Techniques for Project Selection, Break-Even Analysis, Cost Modeling, Energy Modeling, Life Cycle Cost Approach.

Contract Management: Tendering and Contracting, Laws of Contracts, subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts.

Quality Management and Safety in Construction Industry: Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan – Compensation.

Human Resource Management: Man Power Planning - Training - Motivation – Industrial Relations– Welfare Measures - MIS - Components and Structure - Personal Management.

Resource Management and Inventory: Basic concepts, labour requirements and productivity, non-productive activities, site productivity, equipment and material management, inventory control.

Construction Management Practices: Implementation of Procedures and Practices - International Experiences - Case Studies - Examples.

Text Books

1. *Herold Kerzner - Project Management - A systems approach to Planning, Scheduling and Controlling., CBS Publishers andDistributors.*
2. *Sengupta Band Guha H, Construction Management and Planning, Tata Mc Graw-Hil*

Publishing Company Limited, NewDelhi

Reference Books

1. *K.Waker A Teraih and Jose M.Grevarn; Fundamentals of Construction Management and Organizations.*
2. *Anghel Patterson - Construction Cost Engineering Handbook - Marcel DekkenInc.*
3. *Dell Isola - Value Engineering in Construction Industry, Van Nostrand ReinholdCo.,*
4. *Choudhary, S. Project Management, Tata McGraw Hill Publishing Co. Ltd.,*
5. *Raina UK, Construction management Practices, Tata Mc Graw hill Publishing Company Ltd.*
6. *A Guide to the Project Management Body of knowledge (PMBOK), Draft Copy, 1994. A Publication of the Project management Institute,USA.*

TE2.5(a)   DESIGN AND MAINTENANCE OF RURAL ROADS

Introduction: Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads.

Planning and Alignment: Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues

Geometric Design: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances

Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, New materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials

Pavement Design: Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, Drainage and Shoulders

Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Construction of special pavements, Equipment required for different operations.

Green Road Concept and Use of Waste Materials: Introduction, Significance of green roads, Fly ash for road construction, Iron & steel and copper slags, Lime-rice husk ash concrete, Recycled concrete aggregate, Other waste materials.

Quality Control in Construction: General, Pre-requisite, Specifications and codes of practice, Quality control tests during construction.

Maintenance: General, Distresses/defects in pavements, Definitions of maintenance activities, Inventory of road and inspection, Types of maintenance, Classification of maintenance activities, Maintenance norms of maintenance cost.

Text Books

1. *Highway Engineering, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.*

Reference Books

1. *IRC: SP 20-2002 ''Rural Roads Manual'*
2. *IRC: SP 72-2007 'Guidelines for the Design of Flexible Pavements for Low*
3. *Volume Rural Roads'*
4. *IRC: SP 62-2004 'Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads'*
5. *IRC 'Specifications for Rural Roads', MoRD, 2004*
6. *CRRI 'Various Reports on Use of Waste Materials'*

TE2.5(b)   FINITE ELEMENT METHOD OF ANALYSIS

Common Syllabus for ST2.2, SMFE2.5(b), WRE2.5(b), HCH2.5(b) and TE2.5(b)

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM**:** Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoparametric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

Text Books
1. *Finite Element Analysis by C.S.Krishnamoorthy, (2002), Tata McGraw Hill Publishing Co. Ltd.*
2. *Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.*

Reference Books

1. *Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu*
2. *The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.*

TE2.6   PAVEMENT MATERIALS AND EVALUATION LABORATORY

1. Tests on aggregates – Specific gravity , Sieve Analysis , Shape test , Flakiness Index – Elongation Index –Angularity Number , Aggregate Crushing value, Impact value , Abrasion value, Attrition value, C.B.R Test
2. Tests on bitumen – Specific gravity, Penetration value, Viscosity value, Softening point, Ductility value, Flash and Fire point.
3. Tests on sub grade soil – C.B.R. test (IS 2720 – Part-XVI), N.D.C. Penetration test (IS 2720 Part-XXXII), Group Index.
4. Bitumen Extraction Test, Marshal Stability Test
5. Pavement Evaluation – Benkelman Beam Test
6. Marshal Mix design of bitumen and aggregates for different constructiontechniques.

TE2.7   HIGHWAY CONSTRUCTION PRACTICE

Embankment Construction: Formation cutting in Soil and hard rock, Preparation of Sub grade, Ground improvement – Methods – Rocks: Prefabricated vertical drain with surcharge, Rammed stone column using non-displacement method, Stone column using vibro-replacement (vibroflot) method. Soil: Lime treated soil for improved Subgrade/ Sub base, Cement treated soil and cement - fly ash subgrade/ sub base, Granular and Stabilized, Sub - bases / bases, Water Bound Macadam (WBM), Wet Mix Macadam (WMM), Cement treated bases, Dry Lean Concrete (DLC).

Bituminous Constructions: Types of Bituminous Constructions - Interface Treatments,Prime Coat and Tack Coat, Bituminous Surface dressing, Seal coat, Penetration Macadam, Built up. Spray Grout, Premix methods , Bituminous macadam, Bituminous Premix carpet, Bituminous concrete or Asphalt Concrete ¬ Sheet Asphalt, Mastic Asphalt, Bituminous Surfacing and wearing Courses for roads, Selection of wearing Course under different Climatic and Traffic conditions, IRCspecifications, Construction methods – Surface dressing, penetration (grouted) macadam, Built up spray grout, premixed bituminous carpet and Quality Control.
Concrete Road Construction: Test on Concrete mixes – Workability Tests – Slump cone, Vee-bee Consistometer test, Split - Tensile Strength test. Construction equipment, Method of construction of joints in concrete pavements, Quality Control in Construction of Concrete pavements, Construction of Pre-stressed, IRC, MORT&H, ACI Specifications, AASHTO Specifications, Recycled pavements, Non - Conventional Pavement materials.

Hill Roads Construction: Retaining walls, Breast walls, Type of pavements for hill roads – reason for avoiding rigid pavements. Hill Road Drainage – Surface water flowing, side drains, Cross drainage, sub surface drainage. Maintenance of drainage structures.Slope Stability and Erosion Control – Causes for slope movements, and Control of Erosion of hill slopes. Landslides – types and preventions, Snow clearance, control of Avalanches.

("Hill Roads Manual" – IRC: SP – 48)

Overlays: Types of overlays – Flexible overlay over Flexible Pavements, Rigid overlay over Flexible Pavements, Flexible overlay over Rigid Pavements, Rigid overlay over Rigid Pavements.Design of overlay using Benkelman beam using IRC 81-1997.

Text Book

1. *Highway engineering by S.K Khanna,C.E.G. Justo and A. Veeraragavan, Nemchand brothers Publications*

Reference Books

1. *IRC and MORT&H ACIspecifications,*
2. *AASHTO specifications*
3. *Specifications for Road and Bridge Works, MORTH, 5th Edition.*

TE2.8   SEMINAR

The student has to do a mini project in the area of Transportation Engineering either from Experimental analysis or Fieldwork. He/she should present the work in the form of a report along with a power-point presentation.

III –SEMESTER

TE3.1(a)   DISASTER MANAGEMENT

Types of Disasters-Disaster - concept and definitions of disaster, causes of disasters, types – natural disasters – floods, droughts, cyclones, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold wave, global warming, sea level rise, ozone depletion. Man-made disasters: Sociological – political – industrial and human disasters.

Risk Assessment and Analysis-Concept and elements of Hazards, Risks and Vulnerability – Policies of Disaster Management, Identification of Crisis Situation, strategic developments, roles and responsibilities of recovery team, importance of team building in disaster management.

Disaster Preparedness-Prevention and Preparedness – Plan, Action and Accountability, Concept and Nature of Disaster Preparedness, Plan of Disaster Preparedness for People with Special Needs/Vulnerable Groups, with Relevance to Housing, Infrastructure and Livestock, Community Based Disaster Preparedness Plan, Role of Information technology, Education, Communication and training. Medical and health preparedness plan.

Disaster Damage Assessment and Response-Needs and Damage Assessment– Control process and measurement – modern and traditional methods of response, Disaster Response Plan – roles of response teams and forces. Epidemiological Study of Disasters - Medical and Health Response to Different Disasters - Role of Information and Communication Technology in Health Response

Disaster Mitigation and Recovery-Disaster Mitigation – meaning and concept – structural mitigation and non-structural mitigation – mitigation strategies and emerging trends. Reconstruction and rehabilitation for development, Medium and long-term recovery aspects, Participative Rehabilitation Process: Community involvement and development of infrastructure.

Reference Books

1. *Disaster Management by Dr. Mrinalini Pandey, Wiley India Pvt. Ltd.*
2. *Natural Hazards & Disaster Management by R.B.Singh*
3. *Disaster Management: Future Challenges and opportunities by Jagbir Singh4*
4. *Natural Disaster Management ,Jon Ingleton*
5. *Disaster Management, Rajib Shaw and RR Krishnamurthy, Universities Press, Hyderabad.*

TE3.1(b)   OPERATIONS RESEARCH

Common Syllabus for CTPM3.1(b) and TE3.1(b)

Linear Programming – Problem Formation, graphical Solution methods

The Simplex Method – Two–Phase Simplex method, Formulation of L.P.P and its solutions by SIMPLEX Method.

Duality in Linear Programming – Fundamental properties of Duality, Duality and Simplex method, Bounded variable simplex algorithm.

The Transportation Problem – The North–West Corner rule, The Row minimum Method, The Column minima method, The Matrix minima method, Vogel's Approximation method, The Transportation Algorithm, Unbalanced Transportation Problems.

Assignment and Routing Problems –The Assignment Problem, Unbalanced Assignment Problem, Travelling Salesman Problem.

Queuing Theory – Characteristics of Queuing systems, Queue discipline, service channels, Poisson process and Exponential distribution, Distribution of Inter-travel times, Classification of Queues, The M/1/1 Queuing system (Model I to IV), The M/M/C Queuing System (Model I to IV), Non – Poisson Queuing Systems.

Text Books

1. *Operation research by Kanti Swarup, Gupta and Manmohan.*
2. *Operation research and statistical analysis by S.D.Sharma*

Reference Books

1. *Operations Research by Ranganath, Yes Dee publishing Pvt Ltd*
2. *Introduction to Optimization: Operation Research by J.C. Pant, Jain Brothers. Delhi.*
3. *Operation Research by Pannerselvam, Prentice Hall of India*
4. *Operation Research by Iyer, TMH*

TE3.2(a)   GIS APPLICATIONS IN TRANSPORTATION ENGINEERING

Introduction to GIS: Introduction, GIS over view, use of GIS in decision-making, Data processing, Components of GIS, The GIS and the organization. Data input - Key board entry, Manual digitizing, Scanning, Remotely and sensed data, existing digital data, census related data sets, Data output - Hard copy and soft, copy devices.

Data Quality: Components of data quality-Microlevel, Macrolevel components, Sources of error, A note about data accuracy. Data Management .The data base approach, 3 classic data models, Nature of geographic data, Spatial data models, Databases for GIS.

GIS Analysis and Functions: Organizing geographic data for analysis, Maintenance and analysis of thespatialdataandnon-spatialattributedataanditsintegrationoutputformatting. Implementing a GIS Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start up, Operation of the system.

Application of GIS in Transportation Engineering - I : Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning

Application of GIS in Transportation Engineering - II: GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation.

Text Books
1. *GIS A Management, Perspenfi Stan Aronoff, WDLPublisher.*
2. *Remote Sensing and GIS, S.K. Ghosh and A.M Chandra, Narosa Publications House*

Reference Books

1. *GIS by Lo Yeng, PHIPublications*
2. *Basics of Remote Sensing and GIS, S Kumar, University Sc. Press*

TE3.2(b)   GEO-ENVIRONMENTAL ENGINEERING

Common Syllabus for SMFE3.2(b) and TE3.2(b)

Wastes: source, production and classification of wastes, soil pollution processes, waste characterization.

Waste disposal facilities: Landfills and impoundments, Slurry walls, Types of landfills, Landfill planning and design; Barrier systems – Basic concepts, Design and construction; Stability, compatibility and performance contaminant transformation and transport in subsurface, Monitoring surface contamination, Stabilization and modification of wastes. Reuse of waste materials, contaminated site remediation, Case studies in waste handling.

Soil erosion and conservation: Causes of soil erosions, Factors contributing to erosion – climatic factors, Topographical factors, Vegetation factors. Erosion control – Cropping systems, Gullies, Check dams, Contouring, Wind striping, Ridging, Bank protection, Erosion control with vegetation mats and Silt fences.

Note:
1. Student is expected to give at least one seminar on the subject from journal.
2. Preparation of paper involving case studies where the topics covered were incorporated in practice.

Text Book

1. *Geoenvironmental Engineering – principles and applications by L.N. Reddiand H.F. Inyang, Marcel Dekker, 2000*

Reference books

1. *Geotechnical practice for waste disposal by D.E. Daniel, Chapman and Hall, London 1993*
2. *Clay barrier systems for waste disposal facilities by R.K. Rowe, R.M. Quigleyand J.R. Booker,E & FN Spon, London, 1995*
3. *Design, construction and monitoring of landfillsby Bagchi, A, John Wiley & Sons, New York 1994*
4. *Waste containment systems, Waste stabilization and landfillsDesign and evaluation by H.D. Sharma, H. D. and S.P. Lewis, John Wiley & Sons, New York 1994*

TE3.3   THESIS (PRELIMINARY)

The student shall submit a brief report on the selected topic of his/her thesis work and attend for a formal viva-voce examination before a committee comprising the Chairman, BOS, Head of the Department and the Guide.

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IV – SEMESTER

TE4.1 THESIS (FINAL)

The student shall submit his/her thesis work and attend for a formal viva-voce examination before a Committee comprising the Chairman, BOS, Head of the Department, the Guide and the External Examiner.