**Department of Civil Engineering**
**M TECH IN TRANSPORTATION SYSTEMS ENGINEERING**
**Teaching Scheme (2011 onwards)**

**1. FIRST SEMESTER**

| S.No. | Couse No. | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | CE-630 | Traffic Engineering | 3 | 0 | 0 | 3 |
| 2 | CE-631 | Highway Construction and Maintenance | 3 | 0 | 0 | 3 |
| 3 | CE-632 | Pavement Design | 3 | 0 | 0 | 3 |
| 4 | | Programme Elective-1 | 3 | 0 | 0 | 3 |
| 5 | | Programme Elective-2 | 3 | 0 | 0 | 3 |
| 6 | CE-633 | Highway Engineering Lab | 0 | 0 | 3 | 2 |
| Sub Total | | | 15 | 0 | 3 | **17** |

**2. SECOND SEMESTER**

| S.No. | Couse No. | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | CE-634 | Statistical Analysis in Transportation Systems | 3 | 0 | 0 | 3 |
| 2 | CE-635 | Urban Transportation System Planning | 3 | 0 | 0 | 3 |
| 3 | CE-636 | Highway Project Management | 3 | 0 | 0 | 3 |
| 4 | | Programme Elective-3 | 3 | 0 | 0 | 3 |
| 5 | | Open Elective-1(from other Dept) | 3 | 0 | 0 | 3 |
| 6 | CE-637 | Computational Lab | 0 | 0 | 3 | 2 |
| Sub Total | | | 15 | 0 | 3 | **17** |

**3. THIRD SEMESTER**

| S.No. | Course No. | Course Title | L | T | P | Hours | C |
|---|---|---|---|---|---|---|---|
| 1. | CE-799 | Self Study | 0 | 0 | 0 | 3 | 2 |
| 1. | CE-800 | Seminar | 0 | 0 | 0 | 3 | 2 |
| 2. | CE-801 | Dissertation | 0 | 0 | 0 | 24 | 12 |
| | | **Sub Total** | | | | | **16** |

**4. FOURTH SEMESTER**

| S.No. | Course No. | Course Title | L | T | P | Hours | C |
|---|---|---|---|---|---|---|---|
| 1. | CE-801 | Dissertation (Con. from 3rd Sem) | 0 | 0 | 0 | 40 | 20 |
| Sub Total | | | | | | | 20 |
| **Total** | | | | | | | **70** |

**PROGRAMME ELECTIVE COURSES**

| | Course No | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| **Common for all stream** | CE-701 | Fuzzy logic, artificial intelligence and neural network | 3 | 0 | 0 | 3 |
| | CE-702 | Optimization Methods | 3 | 0 | 0 | 3 |
| | CE-703 | Construction planning and scheduling | 3 | 0 | 0 | 3 |
| | CE-704 | GIS and its application in civil engineering | 3 | 0 | 0 | 3 |
| | CE-705 | Finite Element Method | 3 | 0 | 0 | 3 |
| **TRANSPORTATION SYSTEMS ENGINEERING** | CE-731 | Economic Evaluation of Transportation Project | 3 | 0 | 0 | 3 |
| | CE-732 | Ground Improvement Engineering | 3 | 0 | 0 | 3 |
| | CE-733 | Transportation Environment Interaction | 3 | 0 | 0 | 3 |
| | CE-734 | Quality Control in Pavement Construction | 3 | 0 | 0 | 3 |
| | CE-735 | Design of Airports and Waterways | 3 | 0 | 0 | 3 |
| | CE-736 | Hill Road, Earth Dams and Stability of Slope | 3 | 0 | 0 | 3 |
| | CE-737 | Earth Pressure and Retaining Structures | 3 | 0 | 0 | 3 |
| | CE-738 | Geotechnical Investigations | 3 | 0 | 0 | 3 |

**Detailed syllabus**

**CE-630 Traffic Engineering 3+0+0**

Traffic flow characteristics, Design Hourly volumes and speed Composite distributions, Highway capacity and performance characteristics Travel forecasting principles and techniques; Traffic flow modeling and Simulation; Parking studies, O-D studies and other traffic data collection methods, Gap Acceptance methods. Traffic signs and marking; Miscellaneous Traffic control devices. Road Lighting, Un-signalized and Signalized traffic interaction design, Signal co-ordination.

**Text/References**

- Khisty, Lall, Transportation Engineering An Introduction
- G.J. Pingnataro, Principles of Traffic Engineering, Mc Graw-Hill, 1970.
- Wohl and Martin, Traffic System Analysis for Engineering and Planners, Mc Graw Hill, 1983.
- Ronald D. Drew, Traffic Flow Theory, Mc Graw Hill, 1964.
- Drew, D.R., Traffic Flow Theory.
- Matson, Smith and Hurd, Traffic Engineering

**CE-631 Highway Construction and Maintenance 3+0+0**

Materials for road construction, Construction of Earth road, Construction of Gravel road, Construction of WBM roads, Flexible Pavement Construction, Construction of rigid pavements

Pavement Failures, Pavement maintenance, Evaluation of pavement, Strengthening of existing pavements

**Text/References**

- S K Khanna, C E G Justo, Highway Engineering
- Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
- Teng, Functional Designing of Pavements, Mc Graw - Hill, 1980.

**CE-632 Pavement Design 3+0+0**

Design Factors, Mix Design, Stresses in Flexible and Rigid Pavements, Subgrade Evaluation, Design of Flexible Pavement, Design of Rigid Pavement, Temperature Stresses, Design of Joints in Cement concrete Pavements.

**Text/References**

- S K Khanna, C E G Justo, Highway Engineering
- Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
- Teng, Functional Designing of Pavements, Mc Graw - Hill, 1980.

**CE 634 Statistical Analyses in Transportation Systems 3+0+0**

Elements of Probability Theory, Linear and Non-linear Regression, Experimental Data and Model Parameters, Transportation and Assignment problems. Dynamic programming, Queuing theory, Decision theory, Hypothesis Testing and Model Evaluation, Computer Simulation.

**References:**

- Sheffi, Y. (1984), Urban transportation networks: Equilibrium analysis with mathematical programming methods, New Jersey.
- Benjamin J.R. & Comell G.A., "Probability, statistics, & decision for Civil Engineers".
- H.S. Ang and W. H. Tang, Probability Concepts in Engineering, Planning and Design, John Wiley, 1975
- Erwin Kreyszig, Introductory Mathematical Statistics, John Wiley, 1970.

**CE-635 Urban Transportation System Planning 3+0+0**

Fundamentals of transportation planning. Components of transportation system and their interaction. Historical development and current status of techniques used in travel demand forecasting; Economic theory of travel demand forecasting; Trip generation, trip distribution , mode choice, traffic assignment, Transport system models, Transportation impact study, Data Collection, Passenger and freight movement in urban and regional contexts.

**References:**

- Dickey, J.W.,Metropolitan transportation planning, McGraw Hill, Inc.
- Morlok,E.R., An Introduction to Transportation Engineering and Planning, McGraw Hill, Inc., Kagakusha.

- Hutchinson, B., Principles of Urban transportation Planning, McGraw Hill, Inc.
- Vuchic, V. R. (1981), Urban public transportation; Systems and technology, Prentice-Hall, Englewood Cliffs, New Jersey

**CE-636 Highway Project Management 3+0+0**

Bar Charts and Milestone Charts, PERT Network and Time Estimates, Critical Path Method, Project Cost Analysis, Resource Allocation, Repetitive Activities, Repetitive Projects, Location-based Planning and Scheduling Systems, Planning and Control of Linear Projects.

**References:**

- L S Srinath, PERT and CPM Principles and Applications
- Kenley and Olli Seppanen, Location-Based Management for Construction

**PROGRAMME ELECTIVES**

**CE-701 Fuzzy Logic, Artificial Intelligence and Neural Network 3+ 0+ 0**

Introduction- Classification of artificial intelligence-expert systems-artificial neural networks-basic concepts-uses in functional approximation and optimization-applications in the design and analysis, building construction.

Fuzzy logic-basic concepts-problem formulation using fuzzy logic-applications

**Texts/References**

1. D.E. Rumelhart, J.L. McClelland, Parallel distributed processing Vol 1, M I T Press England 1986.
2. Fuzzy logic implementation and applications, M.J. patyra, Mlynek, Wiley Teubner 1996.

**CE-702 Optimization Methods 3+0+0**

Basics of engineering analysis and design, Need for optimal design, formulation of optimal design problems, basic difficulties associated with solution of optimal problems, Classical optimization methods, Necessary and sufficient optimality criteria for unconstrained and constrained problems, Kuhn-Tucker conditions, Global optimality and convex analysis, Linear optimal problems, Simplex method, Introduction to Karmarkar's algorithm. Numerical methods for nonlinear unconstrained and constrained problems, sensitivity analysis, Linear post optimal analysis, sensitivity analysis of discrete and distributed systems. Introduction to variational methods of sensitivity analysis., shape sensitivity, Introduction to integer programming, dynamic programming, stochastic programming and geometric programming, Introduction to genetic algorithm and simulated annealing.

**Text/References**

1. Kalyanmov Deb, Optimization for engineering design: Algorithms and examples, PHI Pvt Ltd, 1998.
2. J.S. Arora. Introduction to optimum design, McGraw Hill International editions 1989.
3. R.T. Hafta and Z. Gurdal, Elements of structural optimization, third revised and expanded edition. Kluwer academic publishers 1996.

**CE-703 Construction Planning And Scheduling 3+0+0**

**Construction Planning:** Objectives and functions, stages in construction, work breakdown structure, pre-tender stage planning, contract stage planning, methods of scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labour, and finance schedule.

**Critical Path Method (CPM):** Network techniques, element of a network, rules for developing networks, development logics, numbering events, time computations, activity floats, network updating. Resources profile, resources smoothing and resources leveling. Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization.

**Programme Evaluation and Review Technique (PERT):** Probability concept in network, optimistic time, pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem. probability of achieving completion time.

**Precedence Diagram Method (PDM**): Precedence networks fundamentals, advantages, logic and precedence networks applications, PDM versus CPM.

**Line of Balancing (LOB) technique in the construction scheduling:** Line of balance methods of scheduling repetitive construction.

**Books**

- Chitkara, K.K. "Construction Project Management, Planning scheduling and controlling."

- Moder J.J. Philips, C.R. and Davis, E.W. "Project Management with CPM and PERT, and precedence diagramming"
- Pilcher, R. "Project Cost Control in Construction",
- Brien J.J. CPM in "Construction Management", Mc. Graw Hill

**CE-704 GIS And Its Application In Civil Engineering 3+0+0**

1. **Basics of remote sensing:** Introduction to Remote Sensing, data acquisition and processing, sensor systems, Electromagnetic Radiation (EMR) and its characteristics, Radiation principles, prosperities of solar radiant energy, atmospheric windows. Interaction in the atmosphere, nature of atmospheric interaction, atmospheric effects of visible, near infra-red thermal and microwave wavelengths, interaction at ground surface, interaction with soils and rocks, effects of soil moisture, organic matter, particles, size and texture, interaction with vegetation, spectral characteristics of individual leaf, vegetation canopies, effect of leaf pigments, radiation geometry.

**2. Introduction with GIS:** Def. of GIS, Difference between GIS and CAD worlds, utility of GIS, various GIS packages and their salient features, essential components of a GIS, scanners and digitizers.

**3. Map projection and coordinate systems:** Introduction, geographic Grid, Map projection, Coordinate systems.

**4. Vector data models and Analysis:** vector data and its representation, topological data structure, non-topological vector data structure, TIN, Region, vector data editing and analysis.

**5. Raster data models and Analysis:** acquiring and handling of raster data storage, function of raster based GIS data analysis.

**6. Engineering applications of GIS:** applications of GIS in civil engineering.

**Books**

1. Remote Sensing and Image Interpretation : T.M. Lillensand and R.W. Keifer
2. Principles of Remote Sensing : P.J. Curren
3. Concept and Techniques of Geographical Information systems : C.P. Lo and albert K.W.Yeung
4. Introduction to Geographical Information systems : Kang-tsung Chang
5. Geographical Information systems- A Management Perspective : Stan Aromoff

**CE-705 Finite element analysis 3+0+0**

Principles of discretization, element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence, Displacement formulation for rectangular, triangular and isoparametric elements for two dimensional and axisymetric stress analysis. Thin and thick plates and shells. Semi-analytical formulations, Three dimensional elements and degenerated forms. Stiffner elements and modifications such as use of different coordinate systems, use of non-conforming modes and penalty functions. FEM in incompressible and compressible fluid, applications of FEM in thermal problems.

**Texts/ References**

1. O.C. Zienkiewicz and R.L. Taylor, Finite element methods, Vol I & Vol II, McGraw Hill, 1989, 1992.
2. K. J. Bathe, Finite element procedures, PHI Ltd 1996.
3. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and applications of finite element analysis, Third edition, John Wiley and Sons, 1989.

**CE-731 Economic Evaluation of Transportation Project 3+0+0**

Purpose and major considerations in Economic analysis, Identification and measurement of infrastructure costs and benefits, Capital cost, inflation cost, interest during construction, maintenance cost, road user costs, vehicle operating cost, accident cost, congestion cost and pricing. Non-user cost and consequences, Savings and benefits, road user benefits and consumer surplus, Social costs and benefits from, transportation project options, Interest and vest charge, concept of interest and vest charge, rate of vest charge, compound interest equations, Methods of economic analysis, characteristics and basic understanding of the Methods, Comparisons and limitations of various methods, ranking of independent alternative projects, Techno-economic feasibility studies and evaluation of alternative projects, Welfare economics, evaluation and appraisal of transport investments, Social considerations for transportation economics in analysis for developing countries. Appraisal and evaluation of economic consequences of an urban bypass

**References**

- Fair and Williams, Economics of Transportation, Harperand Brothers, Publishers, New York, 1959. Winfrey, Robley, Economic Analysis for Highway International Textbook Co., Pennsylvania, USa, 1969.
- Harral Clell G., A Manual for the Economic Appraisal of Transport Projects, World Bank Report, Washington D.C., 1980.
- Mishan, E.T., Cost – Benefit Analysis, Praaeger Publishers, New York, 1976.
- Quade, E.S., Analysis for Public Decisions, Elsevier North-Holland, Inc., New York., 1975.


**CE-732 Ground Improvement Engineering 3+0+0**

**Introduction-** Need for ground improvement, Historical review of methods adopted in practice, Current status and the scope in the profession

**Methods of Ground Improvement** – Mechanical compaction, dynamic compaction, Impact loading, Vibro-compaction, Preloading with sand drains, dynamic consolidation, Compaction by blasting, Stone columns, Use of admixtures, Injection of grouts, Design guidelines and Quality control

**Reinforced Earth-** Basic mechanism, Constituent materials and their selection, Engineering applications, Shallow foundations on reinforced earth, Economics of reinforced earth structures

**Geo synthetics**: Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures – walls and slopes; Geosynthetics in Pavements: Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction

**References:**


- Alam Singh, "Modern Geotechnical Engineering", Geo-environ Academia, Jodhpur.
- Hock, E. and Bray, J., "Rock Slope Engineering", 3rd Edition, Institution of mining and metallurgy, London, 1980.
- Comprehensive Rock Engineering (1993), Vol. 1, Hudson, J.A. (Ed.), Pergamon, NY.
- Hoek, E. and Brown, E.J., "Underground Excavation in Rock", Institution of mining and metallurgy, London, 1980.
- Stagg, K.G. and Zienchiewicz, O.C. (1968), "Rock Mechanics in Engineering Practice", John Wiley, London.


**CE-733 Transportation Environment Interaction 3+0+0**

Transportation Safety: Pre-crash, Crash and Post-crash models; Roles of vehicle, roadway, traffic, driver and environment; Crash and injury causations

Modes of Transportation, Mixed Traffic Flow, Transport Related Pollution, Technology Vision-2020, Urban and Non-urban Traffic Noise, Noise Sources, Noise Level Factors, Effects of Traffic Noise, Noise Standards. Measurement and Prediction, Control Measures, Noise Studies, Road Transport related air pollution, Sources of air pollution, effects of weather conditions, Vehicular emission parameters, Pollution standards, measurement and analysis of vehicular emission, Mitigative measures, EIA requirements of Highway Projects, procedures, Ministry of Environment and Forests (MOEF)/World Bank/IRC/UK Guidelines, EIA Practices in India.

**References:**


- Alexandra, A., Lamure, C. and Langdon, F.J. , "Road Traffic Noise", Applied Science Publishers Limited, London, 1975.
- Salter, R.J., "Highway Traffic Analysis and Design", Macmillan Press Limited, London, 1974.
- Wilson, C.E., "Noise Control Management, Analysis and Control of Sound and Vibration', Harper and Row Publishers, New York, 1989.
- Grand Jean, E., and Gilgen, A., "Environmental Factors in Urban Planning", Taylor and Francis Limited, London, 1976.
- IRC/IS Standards and Practices.


**CE-734 Quality Control in Pavement Construction 3+0+0**

Introduction to Network techniques, Use of computer aided CPM and PERT for Planning, scheduling and control of construction activities

Computerized network scheduling and bar chart Errors in network, Types of nodes and node numbering

Planning for construction and site facilities using networks; Preparation of construction schedule for man, material, equipment, job and budget using CPM, Network crashing time-cost trade off; Resource allocation and leveling, Preparation of project quality plan, control during planning, mobilization state and construction stage

Inspection and testing procedures/methodology measuring & testing equipments. Significance of variability and estimation of risk, Internal quality audits, estimation of risk

Types of statistical analysis in construction, Interpretation of test data and its regression analysis

**References:**


- Bennett J. "Construction Project Management"
- Moder J.J. & Philips C.R. "Project Management with CPM & PERT"
- Benjamin J.R. & Cormell, G.A. "Probability Statistics & Decision for Civil Engineers".
- John J. "Cost and Optimization Engineering".
- Nee P.A. "ISO 900 in Construction"
- Wah L.S. et. Al. "ISO 900 in Construction".


**CE-735 Design of Airports and Waterways 3+0+0**

Air Transport-structure and organization, the challenges and the issues, Forecasting air travel demand-trend forecasts and analytical methods; Air freight demand, Characteristics of the aircraft as they affect airport; Airport planning-requirements: site selection, layout plan and financial plan; Air traffic control lighting and signing; Airport capacity and configuration; Geometric design of runway, taxiway and aprons; passenger terminal functions, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; Air cargo facilities-flow through cargo terminals, unitized systems; Airport drainage and pavement design; Airport access problem; Environmental impact of airports.

Syncrolift equipment in ports (General definition consideration and aspects in planning and design of ports and terminals) physical planning, location and orientation of major port components, access channels, basins, breakwaters, wharfs, quays piers, jetties, fendors, simulation modeling, analytical solutions, cargo handling systems, economic feasibility and evaluation

**Texts/References**


- Aegerschou, Lundgren et. al., Planning, Designing of Port and Marine Terminals, John Wiley and Sons, 1983.
- Port Engineering and Operations: Proc. Conference of British Ports, New Castle upon Tynes, March, 1985, Thomas Telford, London, 1985.
- Hennes and Eske, Fundamentals of Transportation Engineering, McGraw-Hill Book Co., 1955.


**CE-736 Hill Roads, Earth Dams and Stability of Slopes 3+0+0**

Slope Stability: Short term and long term stabilities; Limit equilibrium methods; Infinite slopes; Finite height slopes – Swedish method, Bishop's simplified method, other methods; Stability charts; Conditions of analysis – steady state, end of construction, sudden draw down conditions; Factor of safety; Codal provisions; Earthquake effects; Seepage Analysis: Types of flow; Laplace equation; Flownet in isotropic, anisotropic and layered media; Entrance-exit conditions; Theoretical solutions; Determination of phreatic line; Earth Dams: Introduction; Factors influencing design; Design of components; Construction;

Instrumentation – piezometer, settlement gauge, inclinometer; Road and rail embankments. Reinforced Slopes: Steep slopes; Embankments on soft soils; Reinforcement design; Landslides: Remedial measures for unstable slopes – soil nailing, gabions, drainage.

**References:**


1. Y.M Cheng, C.K. Lau, Slope Stability Analysis and Stabilization, New Methods and Insight
2. J. Edward, Stability of Rock Slopes


**CE- 737 Earth Pressure and Retaining Structures 3+0+0**

Earth Pressure: Types – at rest, active and passive; Rankine's theory; Backfill features – soil type, surface inclination, loads on surface, soil layers, water level; Coulomb's theory; Effects due to wall friction and wall inclination; Graphical methods; Earthquake effects; Rigid Retaining Structures: Types; Empirical methods; Stability analysis; Flexible Retaining Structures: Types; Material; Cantilever sheet piles; Anchored bulkheads – free earth method, fixed earth method, moment reduction factors, anchorage; Braced Excavation: Types;

Construction methods; Pressure distribution in sands and clays; Stability – bottom heave, seepage, ground deformation; Reinforced Soil Walls: Elements; Construction methods; External stability; Internal stability; Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions; Underground Structures in Soils: Pipes; Conduits; Trench-less technology; Tunneling techniques – cut-and-cover method, shield tunneling.

**References:**


- Alam Singh, Basic Soil Mechanics and Foundations
- C.R. Spon, R. Clayton, Woods, Earth Pressure and Earth Retaining Structures


**CE-738 Geotechnical Investigations 3+0+0**

Introduction – Methods of Geotechnical Investigations

Boring and Ground Water Observation

Sampling Techniques for Geotechnical Investigation

Various Tests – Penetration Tests: SPT, Direct Cone Penetration Test (DCPT), Shear Cone Penetration Test (SCPT), Load Tests, In-situ Shear Tests, Dynamic Tests, In-situ Permeability Tests, Odometer tests, Shear Box Tests, Triaxial Tests

Critical evaluation of India Standard Codes on site investigations and in-situ testing

Planning of Investigations and testing program for different types of infrastructural projects. Case histories of failure

Testing and design techniques for geotechnical investigations of rural infrastructure projects

**Practical**: Boring, Penetration Tests, Load tests, In-situ Shear Tests, Dynamic tests, In-situ Permeability test, Low Cost Tests, Odometer and Shear tests.

**References:**


- Penetration testing – Institution of Civil Engineers, 1988, Thomas Tolford, London.
- Alam Singh, Soil Engineering in Theory and Practice, Geotechnical Testing and Instrumentations, Asia Publishing House (P) Ltd., New Delhi.
- Relevant Indian Standards.