M. Tech. DEGREE
TRANSPORTATION ENGINEERING AND MANAGEMENT

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(2009-2010)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015, INDIA.
The total minimum credits required for completing the M. Tech (Transportation Engineering and Management) Course is 64.

**SEMESTER I**

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**SUMMER TERM**

Practical Training (4 weeks) - - - -

**SEMESTER III**

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ELECTIVES (II Semester)

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Note: Student may also choose any other elective courses relevant to their degree with the consent of the course coordinator.
MA601 NUMERICAL METHODS AND APPLIED STATISTICS

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion –
interpolation – Newton’s and Lagrange’s interpolation

Linear Programming – Graphical and Simplex methods – Measures of central tendency,
dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes’ theorem

Random variable – two dimensional random variables – standard probability distributions –
Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of
hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test –
curve fitting-method of least squares

Regression and correlation – rank correlation – multiple and partial correlation – analysis of
variance-one way and two way classifications – experimental design – Latin square design –
Time series analysis.


CE601 HIGHWAY TRAFFIC ANALYSIS AND DESIGN

Elements of Traffic Engineering - road user, vehicle and road way. Vehicle characteristics -
IRC standards - Design speed, volume. Highway capacity and levels of service - capacity of
urban and rural roads - PCU concept and its limitations - Road user facilities - Parking
facilities - Cycle tracks and cycleways - Pedestrian facilities.

Traffic volume studies, origin destination studies, speed studies, travel time and delay studies,
Parking studies, Accident studies.

Elements of design - Alignment - Cross sectional elements - Stopping and passing sight

Traffic regulation and control - Signs and markings - Traffic System Management - Design of
at-grade intersections – Principles of design – Channelisation - Design of rotaries - Traffic
signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing
diagram – Signal co-ordination.

Grade separated intersections - Geometric elements for divided and access controlled
highways and expressways – Road furniture - Street lighting. Traffic Safety – Principles and
Practices – Road Safety Audit.

2. AASHTO A Policy on Geometric Design of Highway and Streets
CE602 PAVEMENT ANALYSIS AND DESIGN

Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components

Pavement Design Factors: Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, aircraft loading, gear configuration and tyre pressure. Drainage – Estimation of flow, surface drainage, sub-surface drainage systems, design of sub-surface drainage structures

Flexible Pavement Design: Empirical, semi-empirical and theoretical approaches, design of highway and airport pavements by IRC, AASHTO Methods, applications of pavement design software

Rigid Pavement Design: Types of joints and their functions, joint spacing; design of CC pavement for roads, highways and airports as per IRC, AASHTO, design of joints. Design of continuously reinforced concrete pavements. Reliability; Use of software for rigid pavement design

Pavement Management: Pavement failures, maintenance of highways, structural and functional condition evaluation of pavements, pavement management system.

1. Yoder and Witczak, Principles of Pavement Design, John Wiley and Sons
5. Relevant IRC Codes

CE603 TRANSPORTATION SYSTEMS


Planning of railway - Passenger and goods terminals - layout - passenger facilities - traffic control.

Airport Planning, requirements and components. Design of runway and taxiway - Apron - parking configuration - terminal requirements - Airport marking and lighting - Air traffic control.

Planning of Harbours and ports - cargo handling - Containerization - Navigation aids - Inland waterways - Pipeline transportation.

Urban transportation systems - Mass rapid transit system - Light rail transit - Personal rapid
transit, guided way systems, cabin taxi, dual mode bus - Para transit systems - Demand responsive system - Intermediate public transport.


**CE604 TRAFFIC AND PAVEMENT ENGINEERING LABORATORY**

Traffic Surveys: Volume count, Speed study, Parking study, Intersection turning movements, Speed and Delay study, Moving observer survey, Traffic noise measurement, Vehicle emission testing, Road lighting, User perception surveys, Road side and house hold interviews

Tests on sub grade soil, aggregates, bitumen, modified binders - Soil stabilization - Pavement evaluation.

Mix Design: Granular Sub-base, Bituminous – DBM, SDBC, BC, etc., Cement concrete.

Mini project report based on field and laboratory studies and data collected

**CE605 ROAD TRANSPORT MANAGEMENT AND ECONOMICS**

Motor Vehicles Act - statutory provision for road transport and connected organisations. Route scheduling, Freight transport, Vehicle scheduling, Optimum fleet size, Headway control strategies, Crew scheduling.

Depots and Terminals - Principles and types of layout, Depot location, Twin depot concept, Crew facilities. Design of parking facilities – Bus terminal, bus stops and bus bays

Transportation costs - Supply and demand - elasticity of demand; Supply of transport services - Economics of traffic congestion - Pricing policy. Vehicle operating costs - Fuel costs - Maintenance and spares - Depreciation - Crew costs - Value of travel time savings - Accident costs.

Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects.


2. CRRI, *Road User Cost Study in India*, New Delhi, 1982
CE606 TRANSPORTATION PLANNING

Urban Transportation Planning - Goals and objectives - Hierarchical levels of transportation planning - Forecast - Implementation - Constraints. UTP survey - Inventory of land use

Trip generation - Trip classification - productions and attractions - Multiple regression models - Category analysis - Trip production models - Trip distribution models - Linear programming approach.

Modal split models - Behavioural models - Probabilistic models - Utility functions - logit models - Two stage model. Traffic assignment - Assignment methods - Route-choice behaviour - Network analysis.


Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – Case studies.


CE607 COMPUTER SIMULATION APPLICATIONS IN TRANSPORTATION ENGINEERING

Introduction to systems approach - Typical transportation systems - Mathematical models. Fundamentals of simulation - Monte Carlo method - Analog and digital simulation - Continuous and discrete models - Simulation languages - Introduction to CSMP.

Probability concepts - Random numbers - Pseudo random generators - Arrival patterns - Service time distributions, Queue discipline – Manual simulation of simple queuing system

Creating and moving transactions - Queues and facilities - Event scheduling - Internal logic of GPSS processor - Program control statements.


Applications of GPSS - Simple queuing problems - Inventory problems - Simulation of ports - Railway platforms and level crossings - Traffic signals. Analysis of simulation results - Model validation - Replication of random conditions - Time series analysis.

CE608 CAD IN TRANSPORTATION ENGINEERING

Transportation Software – Mx Road, REI heads, HDM4, TRIPS, MIGRAN
GIS and Remote Sensing Packages – ArcGIS, Geo-Concept, GRAM++, ENVI, ERDAS
Imagine


Development of C programs to solve problems using numerical techniques

b. Solution of linear simultaneous equations using Gauss elimination.
c. Matrix inversion using Gauss Jordan method
d. Linear regression line of given points.

1. Rajaraman, V., Computer Oriented Numerical Methods, Prentice – Hall of India, 1995
3. Software Manuals

ELECTIVES (I Semester)

CE611 GEOGRAPHICAL INFORMATION SYSTEMS AND REMOTE SENSING

GIS Definition – Map and map analysis – Automated cartography – History and development of GIS – Hardware requirement – Type of data – Spatial and non- spatial data – Data structure – Vector and raster – Files and data formats – Data compression.


Concepts and foundations of remote sensing - electromagnetic spectrum - EMR interaction with atmosphere, water vapour, ozone - Basic principles of photogrammetry – Spectral Signature and Spectral Signature curves - Remote sensing platforms and sensors.


Applications in Survey, mapping and monitoring of land use/land cover - Transportation planning - Infrastructure development - Natural resources management - Urban Planning, Environment - Coastal Zone Management – Air Quality - Development of Resources Information Systems.


Department of Civil Engineering, National Institute of Technology, Tiruchirappalli – 620 015.
CE612 INTELLIGENT TRANSPORTATION SYSTEMS


Automated Highway Systems – Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.

CE613 PAVEMENT MATERIALS

Subgrade soil - Soil composition and structure - Soil classification for engineering purposes - Origin, Classification, requirements, properties and tests on road aggregates

Origin, preparation, properties and tests, constitution of bituminous road binders, requirements - Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests

Bituminous Mixes: Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes.

Weathering and Durability of Bituminous Materials and Mixes - Performance based Bitumen Specifications - Superpave mix design method
Cement Concrete for Pavement Construction: Requirements, design of mix for CC pavement, joint filler and sealer materials.

1. RRL, DSIR, Bituminous Materials in Road Construction, HMSO Publication, 1955
2. IS and IRC Publications on relevant topic.

**CE614 GROUND IMPROVEMENT TECHNIQUES**


2. Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi

**ELECTIVES (II Semester)**

**CE615 BRIDGE ENGINEERING**

Components of Bridges – Classification – Importance of Bridges – Investigation for Bridges – Selection of Bridge site – Economical span – Location of piers and abutments – Subsoil exploration – Scour depth – Traffic projection – Choice of bridge type

Specification of road bridges – width of carriageway – loads to be considered – dead load – IRC standard live load – Impact effect
General design considerations – Design of culvert – Foot bridge - slab bridge – T-beam bridge – Pre-stressed concrete bridge – Box Culvert-Fly over bridges

Evaluation of sub structures – Pier and abutments caps – Design of pier – Abutments – Type of foundations


Construction and Maintenance of bridges – Lessons from bridge failures


**CE616 THEORY OF TRAFFIC FLOW**


Macroscopic models - Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.

Microscopic models - Application of queuing theory - regular, random and Erlang arrival and service time distributions - Waiting time in single channel queues and extension to multiple channels.

Linear and non-linear car following models - Determination of car following variables - Acceleration noise.


**CE617 TRANSPORTATION NETWORK ANALYSIS AND OPTIMIZATION**

Network flows: Applications, definitions, graphs, paths, trees, cycles, loops, walk, network representation (adjacency list and matrices) and basic network transformations; Network algorithms; Complexity, Search Algorithms, Strategies for designing polynomial algorithms.

Shortest Path Algorithms: Label setting, Dijkstra's and Dial's algorithms, Optimality conditions, label correcting algorithms and optimality conditions, detecting negative cycles,
all-pair shortest path algorithms; pre-flow push polynomial time algorithms, capacity scaling techniques.

Minimum cost network assignment: optimality conditions, cycle-canceling algorithm, Successive shortest path algorithm, other polynomial time variants; Network equilibrium analysis; principles and optimisation formulations, Frank-Wolfe algorithm; Special cases and variants.

Applications: Applications of min-cost, max-flow, and shortest path algorithms to transportation and infrastructure networks: transportation networks, airline, freight, facility location, logistics, network design, project scheduling, reliability of distribution systems, telecommunication/power networks etc.

Computer Software: Principles of TRIPS, SATURN, EMME/2, CUBE; Demo Versions, Case studies


**CE618 ADVANCED HIGHWAY MATERIALS**


