Transportation Engineering

Transportation systems and their classification; Role of transportation

with respect to socio-economic conditions; Transportation planning

process; Road user and the vehicle; Geometric design of roads:

horizontal alignment, vertical alignment, cross-section elements;

Relevant geometric design standards; Pavements: flexible and

rigid; Characterization of pavement materials; Analysis and design

of pavement systems; Pavement design specifications; Pavement

construction process; Pavement performance; Traffic engineering:

Traffic characteristics; Fundamental relationships; Theories of

traffic flow; Intersection design; Design of traffic signs and signals;

Highway capacity.

Program Core

CVL740 Pavement Materials and Design of Pavements 3 0 2 4

CVL741 Urban and Regional Transportation Planning 3 0 2 4

CVL742 Traffic Engineering 3 0 2 4

CVS852 Advanced Topics in Transportation Engineering 0 0 6 3

Total Credits 36

Restricted Electives (6 Credits)

CVL763 Analytical & Numerical Methods in 3 0 0 3

Structural Engineering

CVL729 Environmental Statistics and 2 0 2 3

Experimental Design

MCL761 Probability and Statistics 3 0 0 3

CVL731 Optimization Techniques in 3 0 0 3

Water Resources

Program Electives

CVL743 Airport Planning and Design 3 0 0 3

CVL744 Transportation Infrastructure Design 2 0 2 3

CVL745 Modeling of Pavement Materials 2 0 2 3

CVL746 Public Transportation Systems 3 0 0 3

CVL747 Transportation Safety and Environment 3 0 0 3

CVL750 Intelligent Transportation Systems 3 0 0 3

CVL840 Planning and Design of Sustainable 3 0 0 3

Transport Systems

CVL841 Advanced Transportation Modelling 2 0 2 3

CVL842 Geometric Design of Roads 2 0 2 3

CVL844 Transportation Infrastructure Management 3 0 0 3

CVL845 Viscoelastic Behavior of Bituminous Materials 3 0 0 3

CVL846 Transportation System Management 3 0 0 3

CVL847 Transportation Economics 3 0 0 3

CVL849 Traffic Flow Modelling 3 0 0 3

CVL850 Transportation Logistics 3 0 0 3

CVL851 Special Topics in Transportation Engineering 3 0 0 3

CVL740 Pavement Materials and Design of Pavements

4 Credits (3-0-2)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Components of pavement structure and its requirements; Materials

used in pavement construction: aggregate, Portland cement, asphalt,

Portland cement concrete, asphalt concrete; Aggregates: production,

properties, testing procedures, gradation and blending; Portland

cement based materials: mixture design, production, properties,

testing, construction; Asphalt binder: refining process, properties,

testing procedures, grading systems; Asphalt concrete mixture

design: fundamentals of mix design procedure, mixture volumetrics,

current mix design procedures; Production and construction practices;

Stresses and strains in pavement system: traffic, environment

considerations; Design of pavements: new, overlay; Pavement

performance; Drainage consideration.

CVL741 Urban and Regional Transportation Planning

4 Credits (3-0-2)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

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 models. Integration

of landuse transport models. Comparison and evaluation of various

models. Simultaneous travel demand models: Parameter Estimation

and Validation. Travel Data collection and use of surveys. The

role of transportation planning in the overall regional system.

Methodology and models for regional transportation system,

planning, implementation framework and case studies. Applications

to passenger and freight movement in urban area. Implications for

policy formulations and analysis.

CVL742 Traffic Engineering

4 Credits (3-0-2)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Introductory concepts of traffic engineering, road user and vehicle

characteristics, Road way geometric characteristics, traffic stream

characteristics, and traffic flow theory basics. Statistical applications

in traffic engineering. Traffic data collection methods - speed, volume,

travel time and delay studies. Parking studies. Highway safety and

statistics. Capacity analysis of freeway and multilane highways -

fundamental concepts, freeway segment analysis, two-way highways.

Intersections concepts of intersection control, intersection layout,

signalization basics, signal timing. Analysis of signals and coordination

under undersaturated and oversaturated conditions.

CVS852 Advanced Topics in Transportation Engineering

3 Credits (0-0-6)

Pre-requisites: CVL740, CVL741, CVL742

This is an advanced course for M.Tech. Transportation engineering

program where students will study a specialized topic within

transportation engineering (including but not limited to transportation

planning, traffic engineering and pavement engineering). The topic

shall be announced by instructor at the beginning. The performance

of student in this course will be evaluated through presentation(s)

and report(s) made by student during the registered term.

CVL763 Analytical and Numerical Methods for Structural

Engineering

3 Credits (3-0-0)

Introduction: Mathematical foundations of structural theory. Linear

algebra: vector spaces and linear transformations. Linear differential

equations and function spaces. Partial differential equations; Elliptic,

parabolic and hyperbolic PDEs. Nonlinear differential equations.

Gaussian Elimination; Factorization Techniques - LU, Cholesky;

Iterative Methods of Solution of Linear Simultaneous Equations.

Properties of Eigenvalues and Eigenvectors; Similarity Transforms;

Diagonalization and Numerical Techniques to Compute Eigenvalues

- Vector Iteration, QR algorithm, Jacobi Method. Time Marching

Schemes (Step by Step Solutions); Euler’s Method; Runge KuttaMethod; Newmark Beta Method. Numerical Solution of Boundary

Value Problems - Finite Difference Method, Explicit and Implicit

Approaches; Method of Weighted Residuals, Galerkin’s Method.

Numerical Integration: Gauss- Legendre Method, Newton-Cotes

Method. Regression Analysis and Curve Fitting. Applications of

mathematical and numerical methods to static, dynamic and stability

analysis of elastic structures and cables.

CVL729 Environmental Statistics and Experimental

Design

3 Credits (2-0-2)

Introduction on environmental data, environmental statistics

estimation (concentration, frequency of detection,minimum detection

limit, sample size), frequency and probability distributions, inferences

concerning mean and variance, confidence Interval estimation,

hypotheses test, ANOVA, regression, goodness of fit, factoral

experimentation, exceedance factor, intervention model, Case studies.

MCL761 Probability and Statistics

3 Credits (3-0-0)

Probability Laws, Random Variables, Conditional Probability and

Bayes Theorem, Important Random Variables and their properties,

Joint Probability Distributions, Law of Total Probability, Law of Large

Numbers, Central Limit Theorem, Estimation Theory, Parameter

Estimation, Hypothesis Testing using Parametric and Non-Parametric

Methods, Goodness of fit tests, ANOVA, Linear Regression (Simple,

Generalized) and Logistics Regression.

CVL731 Optimization Techniques in Water Resources

3 Credits (3-0-0)

Optimization techniques commonly used in water resources planning

& management, water infrastructures, and irrigation and hydropower

projects; Linear programming and duality, Network flow algorithms,

Dynamic programming, Nonlinear programming, Geometric and Goal

programming, Introduction to modern heuristic methods like genetic

algorithm and simulated annealing, Multiobjective optimization,

Applications and case studies in water resources, agriculture,

environment and other areas of science & engineering.

CVL743 Airport Planning and Design

3 Credits (3-0-0)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Overview of air transport; Forecasting demand-passenger, freight;

Aircraft characteristics; Airport planning-requirements site selection,

layout plan; Geometric design of runway, taxiway and aprons; Airport

capacity-airside, landside; Passenger terminal-functions, passenger

and baggage flow; Airport pavement design and drainage; Parking

and apron design; Air cargo facilities; Air traffic control lighting and

signing; Airport safety; Environmental impact of airport; airport financing and economic analysis

CVL744 Transportation Infrastructure Design

3 Credits (2-0-2)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Transportation infrastructure: components, structural and functional

requirements, capacity, level of service; Highway infrastructure: grade

intersections, rotaries, interchanges; Railway infrastructure: trackbed

design, grade-crossing design, embankment, retaining walls; Drainage

infrastructure: culverts, bridges; Pedestrian infrastructure: pedestrian

sideways, foot bridges; Miscellaneous: bus and truck terminals,

parking facilities, guard rails, tunnels, underpasses;.

CVL745 Modeling of Pavement Materials

3 Credits (2-0-2)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Role of constitutive modeling; Laboratory testing in relation to

constitutive modeling: elastic modulus, resilient modulus, complex

modulus, creep, rheological tests; Introduction to continuum

mechanics: strain tensor, stress tensor, isotropy, anisotropy,

constitutive relationships; Factors affecting material behavior:

temperature, rate, time, confining pressure; Unbound materials:

soil, aggregate; Bound materials: binding using asphalt, water, lime,

polymer, fly ash, cement; Constitutive models: unbound materials,

bound materials; Field performance of pavement materials: fatigue,

rutting, temperature issues, moisture damage, permeability; Transfer

functions to relate laboratory performance with field performance.

CVL746 Public Transportation Systems

3 Credits (3-0-0)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

This course discusses the role of urban public transportation modes,

focusing on bus and rail systems. Operational and Technological

characteristics are described, along with their impacts on capacity,

service quality, and cost. Current practice and methods for data

collection and analysis, performance evaluation, route and network

design, frequency determination, and vehicle and crew scheduling

are covered. Main topics include: Transit System; Estimation of

Transit Demand; Route planning techniques; Bus Scheduling; Transit

Corridor identification and planning; Mass Transport Management

Measures; Integration of Public Transportation Modes. Public transport

Infrastructure; Case Studies. Multimodal Transportation Systems.

CVL747 Transportation Safety and Environment

3 Credits (3-0-0)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Scientific management techniques in planning, implementing, and

evaluating highway safety programs, strategies to integrate and

amplify safety in transportation planning processes., multidisciplinary

relationships necessary to support effective traffic safety initiatives.

Traffic Safety as public health problem, Injury indices and costing

, emergency care, pollution inventory in urban areas, environment

and safety standards.

CVL750 Intelligent Transportation Systems

3 Credits (3-0-0)

Pre-requisites: M.Tech: Nil; B.Tech: Instructor's permission

Introduction to Intelligent Transportation Systems (ITS); ITS

Organizational Issues, the fundamental concepts of Intelligent

Transportation Systems (ITS) to students with interest in engineering,

transportation systems, communication systems, vehicle technologies,

transportation planning, transportation policy, and urban planning.

ITS in transportation infrastructure and vehicles, that improve

transportation safety, productivity, environment, and travel reliability.

Mobile device applications of ITS such as trip planners, ETA s of

public transit vehicles.

CVL840 Planning and Design of Sustainable Transport

Systems

3 Credits (3-0-0)

Pre-requisites: M.Tech: CVL741; B.Tech: Instructor's permission

Sustainable Transportation Planning and Design including:

Consideration of bicycles, pedestrian, mass transit modes, and

private vehicles like cars and two wheelers as well as how these

modes interrelate. Applicability at varying scales, from a downtown

street to a neighborhood to a regional network Case studies are

discussed from different parts of the world. Various indicators for

measuring sustainability index of transport system including public

health, resource consumption, local and global pollution and equity

considerations are discussed.

CVL841 Advanced Transportation Modelling

3 Credits (2-0-2)

Pre-requisites: M.Tech: CVL741; B.Tech: Instructor's permission

Systems Approach to Travel demand models, Trip generation Models

Using Different Statistical techniques, Trip distribution,Discrete Choice

Logit, Nested Logit and other Models,Network Assignment,Traffic

Assignment Using User Equilibrium and Systems Optimization

Techniques, Revealed preference and Stated Preference surveys,

Analysis of Ranked and Rated data, Demand models for Nonmotorised

transport and Public Transport systems.

CVL842 Geometric Design of Roads

3 Credits (2-0-2)

Pre-requisites: M.Tech: CVL741, CVL742; B.Tech: CVL261 and

one TE elective

Introduction to basic road geoemetric design elements and

methodology - design philosophy and design techniques; Design

controls - human, vehicle and speed related factors. Road vehicle

performance - road vehicle dynamics - tractive and resisting forces.

Braking forces. Theoretical and practical stopping distances. Elements

of geometric design - cross section elements; Horizontal Alignment

- tangents, curves, transitions, superelevation; Vertical Alignment -

grades and curves; Coordination of Horizontal and Vertical Alignment.

Design of Intersections at-grade- design principles, channelization,

roundabouts, Interchanges- types, warrants, lane balancing; Road

side safety- hazards and clear zone concept, traffic safety barriers,

impact attenuation.

CVL844 Transportation Infrastructure Management

3 Credits (3-0-0)

Pre-requisites: M.Tech: CVL740; B.Tech: Instructor's permission

Transportation infrastructure components; Deterioration phenomena;

Effect of external factors like environment, traffic loading,material

properties on deterioration mechanisms; Evaluation techniques

to evaluate damage: destructive, nondestructive; Performance

models: development, calibration; Infrastructure management

systems; Serviceability of condition and safety; Decision making and

optimization techniques applied to infrastructure management; Life cycle cost analysis techniques.

CVL845 Viscoelastic Behavior of Bituminous Materials

3 Credits (3-0-0)

Pre-requisites: M.Tech: CVL740; B.Tech: Instructor's permission

Overview of material behavior-elastic, plastic, viscoelastic, Viscoplastic

response; Aging; Issues in representative volume element; Mechanical

analogs for viscoelastic response; Fundamental viscoelastic response-

creep compliance, relaxation, complex modulus; Interconversion

techniques to obtain fundamental viscoelastic responses; Time-

temperature superposition; linear viscoelastic constitutive

equations; Elastic-viscoelastic correspondence principle; Predicting

material behavior-undamaged, damaged state conditions,

Introduction to nonlinear viscoelasticity, Viscoelastoplastic behavoir,

fracture mechanics.

CVL846 Transportation System Management

3 Credits (3-0-0)

Pre-requisites: M.Tech: CVL741 and CVL742; B.Tech:

Instructor's permission

Transportation systems - resource management, approaches to

funding. Asset and demand management - Integrated network

design, changing travel behaviour, optimising asset management, role

of technology; Optimizing the investment outcomes - movement of

freight and passenger, traffic. Land use planning and urban growth

management - land use and its effect on infrastructure and efficient

network operations. Congestion, systemic congestion improvement

and system-wide efficiency, Transit oriented development, safety

considerations; evaluation of strategies; case studies.

CVL847 Transportation Economics

3 Credits (3-0-0)

Pre-requisites: M.Tech: CVL741; B.Tech: Instructor's permission

Overview of Transportation Economics; Transportation Investments

and economic Development. Basics of Engineering economics,

marginal analysis, opportunity cost, shadow price, money value

of time, discounted cash flow, NPV, ROR, benefit-cost analysis.

Road User Costs; Public transportation economics; Social Cost

of Transportation;Cost of congestion, pollution, traffic accidents.

Taxation, regulations, financing Transport Systems; Legal framework

for transportation sector, case studies.

CVL849 Traffic Flow Modelling

3 Credits (3-0-0)

Pre-requisites: CVL742

Descriptors of traffic flow: Macroscopic and Microscopic, time, space

and generalized measurement regions. Cumulative plots. Traffic Flow

models - General classification and typology. Macroscopic Flow Models

- continuity equation, LWR model, higher order models, numerical

schema, Mesoscopic Flow Models - gas kinetic theory, Microscopic

and Submicroscopic Flow Models - car following and lane changing;

Pipes and forbes models; General motors-Gazis-Herman-Rothery

(GHR) models, Stability analysis, macro-micro bridge. Modelling at

Junctions/Intersections; Un-signalized and Signalized; Roundabouts;

Pedestrian Modelling - normal and panic movements; variations across

infrastructure; Simulation - simple and complex traffic conditions.

CVL850 Transportation Logistics

3 Credits (3-0-0)

Pre-requisites: M.Tech: CVL742 else Instructor's permission

(including B.Tech)

Evolution of freight and logistics; Interrelationships between

society, environment and freight transport; Survey methodologies

to understand freight movement; Cost measurement: Production,

Holding, Transportation, Handling; Effect of internal and external

variables on cost; Demand forecasting; Inventory planning and

management; Transportation and distribution network: Design,

Reverse Logistics. Development, Management; Ware house

operations; Pricing: Perishable, seasonal demand, uncertainty

issues; Vehicle routing: One-to-one distribution, One-to-many

CVL851 Special Topics in Transportation Engineering

3 Credits (3-0-0)

Pre-requisites: CVL740 or CVL741 or CVL742 or Instructor's

permission

Course details shall be announced by the instructor at the time

of offering of the course. The lectures will be supplemented by

reading materials. The assessment will be based on a combination

of assignments, quizzes, and term papers and tests.