M. TECH. DEGREE
TRANSPORTATION ENGINEERING AND MANAGEMENT

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(With effect from 2016 - 2017)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620015 INDIA
VISION AND MISSION OF THE INSTITUTE

Vision of the Institute
To provide valuable resources for industry and society through excellence in technical education and research.

Mission
To offer state-of-the-art undergraduate, postgraduate and doctoral programmes
To generate new knowledge by engaging in cutting-edge research
To undertake collaborative projects with academia and industries
To develop human intellectual capability to its fullest potential

VISION AND MISSION OF THE DEPARTMENT

Vision of the Department
Shaping infrastructure development with societal focus

Mission
Achieve International Recognition by:

- Developing Professional Civil Engineers
- Offering Continuing Education
- Interacting with Industry with emphasis on R&D
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates of the Programme will contribute to the development of transportation infrastructure that is sustainable.

2. Graduates of the Programme, as part of an organization or as Entrepreneurs, will continue to learn to harness evolving technologies.

3. Graduates of the Programme will be professional Transportation Engineers with ethical and societal responsibility.

PROGRAMME OUTCOMES (POs)

Post-Graduates of the Transportation Engineering and Management Programme will be able to:

a) Acquire in-depth knowledge of Transportation Engineering, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b) Analyse complex Transportation Engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

c) Think laterally and originally, conceptualise and solve Transportation Engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in Transportation Engineering.

d) Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually and in groups to the development of scientific and technological knowledge in Transportation Engineering.

e) Create, select, learn and apply appropriate techniques, resources, and modern engineering tools such as CAD, GIS and ITS including prediction and modeling to complex Transportation Engineering activities with an understanding of the limitations.
f) Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

g) Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to efficiently manage Transportation Engineering projects and in multidisciplinary environments after consideration of economical and financial factors.

h) Communicate effectively and confidently on complex Transportation Engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

i) Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

j) Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

k) Observe and examine critically the outcomes of one’s actions and make corrective measures subsequently, and learn to improve without depending on external feedback.
M. Tech. (TRANSPORTATION ENGINEERING AND MANAGEMENT)

The total minimum credits required for completing the M. Tech. (Transportation Engineering and Management) Course is 66.

## SEMESTER I

<table>
<thead>
<tr>
<th>Code</th>
<th>Course of Study</th>
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<tbody>
<tr>
<td>MA601</td>
<td>Numerical Methods and Applied Statistics</td>
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<tr>
<td>CE601</td>
<td>Highway Traffic Analysis and Design</td>
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<tr>
<td>CE603</td>
<td>Pavement Materials and Design</td>
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<td>Elective – I</td>
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<td>Elective – III</td>
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<tr>
<td>CE609</td>
<td>Traffic and Pavement Engineering Laboratory</td>
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## SEMESTER II

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<tr>
<th>Code</th>
<th>Course of Study</th>
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<tbody>
<tr>
<td>CE602</td>
<td>Urban Transportation Systems</td>
<td>3</td>
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<tr>
<td>CE604</td>
<td>Transportation Planning</td>
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<tr>
<td>CE606</td>
<td>Pavement Construction and Management</td>
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<td>Elective – IV</td>
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<td>Elective – VI</td>
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<tr>
<td>CE610</td>
<td>CAD in Transportation Engineering</td>
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## SUMMER TERM

Practical Training (4 weeks) -

## SEMESTER III

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<tr>
<th>Code</th>
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<td>Project Work – Phase I</td>
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## SEMESTER IV

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<tr>
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<td>Project Work – Phase II</td>
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# PROGRAMME ELECTIVES

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>CE611</td>
<td>Traffic Flow Theory</td>
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<td>CE612</td>
<td>Computational Techniques in Transportation Engineering</td>
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<td>CE613</td>
<td>Transportation Network Analysis and Optimization</td>
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<td>CE614</td>
<td>Transportation Systems Reliability and Safety</td>
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<td>CE615</td>
<td>Transportation Economics</td>
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<td>CE616</td>
<td>Waterway Transportation</td>
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<td>CE617</td>
<td>Airport Planning and Design</td>
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<td>CE618</td>
<td>Advanced Highway Materials</td>
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<tr>
<td>CE619</td>
<td>Intelligent Transportation Systems</td>
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<tr>
<td>CE620</td>
<td>Advanced Surveying and Cartography</td>
<td>3</td>
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<tr>
<td>CE621</td>
<td>Geospatial Techniques</td>
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<tr>
<td>CE622</td>
<td>Ground Improvement Techniques</td>
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<td>CE623</td>
<td>Bridge Engineering</td>
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<tr>
<td>CE624</td>
<td>Urban Planning Techniques and Practice</td>
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# ELECTIVES OFFERED FROM OTHER DEPARTMENTS

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<th>Code</th>
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<tbody>
<tr>
<td>MA608</td>
<td>Resource Management</td>
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<td>HS601</td>
<td>Human Resource Management</td>
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<tr>
<td>HS602</td>
<td>Project Management</td>
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<tr>
<td>MB601</td>
<td>Systems Analysis</td>
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# OPEN ELECTIVES

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<tr>
<td>CE621</td>
<td>Geospatial Techniques</td>
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</tr>
<tr>
<td>CE624</td>
<td>Urban Planning Techniques and Practice</td>
<td>3</td>
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Any other elective with the approval of the Chairman Board of Studies
SEMESTER I

MA601 NUMERICAL METHODS AND APPLIED STATISTICS

Course Objectives:
- To learn the different numerical techniques
- To be introduced to the fundamentals of probability
- To know the concepts of sampling and regression

Course Content:


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


References:

Course Outcomes:
Upon completion of this course, the students should be able to:
- apply the different numerical techniques to transportation problems
- demonstrate applications of probability theory
- use regression and correlational analysis to process transportation data
CE601 HIGHWAY TRAFFIC ANALYSIS AND DESIGN

Course Objectives:
- To be aware of various methods of collecting traffic data
- To understand the basics of highway planning and design, and workout problems in design of road geometrics
- To learn the importance of road safety.

Course Content:
Elements of Traffic Engineering - road user, vehicle and road way and driver characteristics. - Design speed, volume. Passenger Car Units - Static and Dynamic- Highway capacity and level of service - capacity of urban and rural roads - Road user facilities - Parking facilities - Cycle tracks - Pedestrian facilities.

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


Design of intersections – At-grade intersections- Principles of design – Channelization - Design of rotaries - Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram – Signal co-ordination – Area traffic Control System. Grade separated interchanges - Geometric elements for divided and access controlled highways and expressways.


References:
2. AASHTO A Policy on Geometric Design of Highway and Streets
5. Relevant IRC codes

Course Outcomes:
Upon completion of this course, the students should be able to:
- apply the concept of capacity
- conduct traffic surveys
- design the links and intersections
- build safety into every aspect of design
CE603 PAVEMENT MATERIALS AND DESIGN

Course Objectives:
- To learn the characteristics, properties and testing procedures of highway materials
- To study the behaviour of pavements under various loads
- To design the flexible and rigid pavements using different Empirical, semi-empirical and theoretical approaches

Course Content:
Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airfield pavements, Pavement Materials – Superpave - Bituminous mix design methods Bituminous Mixes: Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Performance based Bitumen Specifications - Superpave mix design method

Stresses in Pavements: Flexible pavement - Layered system concepts, Stress solution for one, two and three layered systems, Fundamental design concepts. Rigid Pavements - Westergaard’s theory and assumptions, Stresses due to curling, stresses and deflections due to loading, frictional stresses. Stresses in dowel bars and tie bars

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, Mechanistic –Empirical design, 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

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

Course Outcomes:
Upon completion of this course, the students should be able to:
- understand the properties and the various test for the highway materials and perform Bituminous Mix design
- analyze the stresses, strains and deflections in rigid and flexible pavements
- design both rigid and flexible pavements
CE609 TRAFFIC AND PAVEMENT ENGINEERING LABORATORY

Course Objectives:
- To organise traffic surveys and collect wide variety of traffic data, subjecting them to analysis and interpretation.
- To conduct various standard tests on soil, aggregate and bitumen.

Course Content:
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, Origin Destination (O-D) Surveys, Roadside and Household interviews

Tests on sub grade soil, aggregates, bitumen, modified binders – as per BIS/ASTM

Soil stabilization – soil: lime stabilization. Soil: cement stabilization, mechanical stabilization

Pavement evaluation, Structural and functional condition evaluation of pavements

Mix Design: Granular Sub-base, Bituminous Mixes – DBM, BC, SMA etc.,

Cement concrete Mixes - Mix design, NDT tests

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

References:

Course Outcomes:
Upon completion of this course, the students should be able to:
- conduct the traffic surveys, roadside and household interviews
- perform laboratory tests on subgrade soil, aggregates and bitumen
- carry out mix design for the CC pavement, GSB, DBM, SDBC, BC, etc.

SEMESTER II

CE602 URBAN TRANSPORTATION SYSTEMS

Course Objectives:
- To understand the characteristics of various urban transportation systems
- To learn the concepts of route network design and scheduling
- To study the planning aspects of terminals
- To be acquainted with sustainable urban transportation systems

Route Network Design: Transportation Demand estimation, Data requirements, Network planning - Corridor identification - Route Systems and Capacity

Scheduling: Components –Scheduling procedure and patterns –Fleet Requirement – Bus and Crew scheduling - Rail operation design – Scheduling – Frequency and Headway

Terminal Planning: Planning and design of terminals - Bus stop capacity – Depot location - Depot layout, Parking patterns, Rail Transit: Station Arrangements - Way capacity and Station Capacity

Sustainable Urban Transportation: Preferential treatment for high occupancy modes, promoting non-motorized modes of transport - Integrated land use and transport planning – Demand management techniques - Integrated public transport planning; case studies- Smart Cities.

References:
4. National Urban Transport Policy

Course Outcomes:
Upon completion of this course, the students should be able to:
- Compare and select suitable urban transportation systems
- Design route network and scheduling
- Apply the concepts of terminal planning
- Have a knowledge of sustainable transportation systems

CE604 TRANSPORTATION PLANNING

Course Objectives:
- To learn the fundamentals of transportation planning
- To understand the classical methods of urban transportation planning
- To be acquainted with the transportation landuse interaction

Course Content:

Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models - Utility functions - Logit models - Two stage model. Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior.


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

References:

Course Outcomes:
Upon completion of this course, the students should be able to:
- interpret the urban activity system and travel patterns
- demonstrate the classical methods of urban transportation planning
- apply four stage travel demand modeling

CE606 PAVEMENT CONSTRUCTION AND MANAGEMENT

Course Objectives:
- To learn the concept of pavement construction
- To evaluate the pavements based on the functional and structural characteristics
- To understand the concept of Pavement Management System, pavement failures and its evaluation

Course Content:
Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers and their choice.

Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints.
Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilisation methods. Use of additives, Numerical problems on mix design and applications.

Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements- Roughness, Skid Resistance. Structural evaluation of pavements - non destructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques.

Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction – concepts, modelling techniques– AASTHO, CRRI and HDM models, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, life cycle costing,

References:
6. Relevant IRC codes and Ministry Specifications.

Course Outcomes:
Upon completion of this course, the student will be able to:
- carry out the construction of flexible and rigid pavements
- understand the structural and functions failure and the evaluation of pavements
- do develop pavement management systems

CE610 CAD IN TRANSPORTATION ENGINEERING

Course Objectives:
- To be acquainted with transportation software, and the latest developments such as GIS and Remote sensing
- To be introduced to various software packages on Windows.
- To learn the fundamentals of CAD and DBMS.

Course Content:
Traffic related Software – VISSIM, VISWALK, TRANSYT, Mx Road
Transportation Planning Software – NLOGIT, CUBE, CUBE VOYAGER
Pavement Engineering Software – KENPAVE, IITPAVE, HDM4, GAMS
GIS and Remote Sensing Packages – ArcGIS, ERDAS Imagine,
Spreadsheet concepts – Worksheet calculations in Civil Engg. - Regression & Matrix Inversion, Transportation Planning
Development of C programs to solve problems using numerical techniques

**References:**
3. Software Manuals

**Course Outcomes:**
Upon completion of this course, the students should be able to:
- employ various transportation software
- operate various GIS and Remote Sensing packages
- develop C programs for various numerical techniques

**ELECTIVES**

**CE611 TRAFFIC FLOW THEORY**

**Course Objectives:**
- To be introduced to traffic flow theory.
- To study macroscopic and microscopic modeling.
- To learn the fundamentals of ITS.

**Course Content:**

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 - Queue discipline - 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.


**References:**
Course Outcomes:
Upon completion of this course, the student will be able to:
- analyze the traffic stream parameters.
- apply the queuing theory
- define the significance of ITS under Indian conditions.

CE612 COMPUTATIONAL TECHNIQUES IN TRANSPORTATION ENGINEERING

Course Objectives:
- To be introduced to systems approach.
- To learn the fundamentals of simulation and the GPSS language.
- To be introduced to advanced computational techniques such as GA and ANN.

Course Content:


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.


References:
2. GPSS/PC, User Manual, Minuteman Software, USA, 2005

Course Outcomes:
Upon completion of this course, the students should have:
- a working knowledge of simulation and GPSS programming.
- a good understanding of GA applications
- the ability to apply ANN
CE613 TRANSPORTATION NETWORK ANALYSIS AND OPTIMIZATION

Course Objectives:
- To learn the fundamental definitions of networks.
- To study the different Shortest Path Algorithms and network assignment techniques.
- To be exposed to various network analysis software.

Course Content:
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

References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- define and analyze different types of networks.
- apply the Shortest Path and Minimum cost algorithms
- have a working knowledge of various network analysis software.

CE614 TRANSPORTATION SYSTEMS RELIABILITY AND SAFETY

Course Objectives:
- To learn the planning, operation and maintenance of different modes of transport and their integration, interaction and impact on environment.
- To be aware of the development of transport, various road development plans and policies in India.
To study the terminal operational controls of urban transportation systems.

Course Content:

Transportation and Society- Role of Transport in Society and Economy - Functions and Problems in Transportation Planning - Economic, Geographical, Political, Technological, Social and Cultural Factors in Planning of Transportation System. Transport Technology: System Classification and their Variation; Conventional Systems and Unconventional Systems - Air, Water and Ground Modes

Modes of Transport and their Characteristics, Propulsion Forces - Factors in Operation - Levels of Service and Performance Criteria - Quality of Service: Capacity and Levels of Service of different Transportation Systems; mobility and accessibility – Flexibility - Speed, Acceleration, Deceleration - Comfort and Environmental Effects - Time Spent and Cost – Integration of modes.

A Brief Historical Development of Transportation Systems in India: Growth of Transport - Road Development Plans - Imbalances in Transport System - National Transport Policy Recommendations - Optimum Inter Model Mix-Study - Vision 2021, NHDP, PMGSY, Rural Roads Vision 2025 - IRC, CRRI etc. - Inland waterways in India

Planning of passenger and goods terminal facilities of Air, Water, Railway and Highway Transportation Systems – requirements and typical layouts - passenger facilities - parking configuration - terminal requirements – goods facilities and containerization


References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- understand different transport plans and policies
- characterize different modes of transport and their impact
- controls and terminal facilities of transportation system

CE615 TRANSPORTATION ECONOMICS

Course Objectives:
- To be aware of the concepts in transportation decision making.
- To learn about transportation cost.
- To understand economic analysis of transport projects.
Course Content:
Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation.

Transportation costs - Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing. Estimating Transportation Demand and Supply - supply equilibration, dynamics of transportation demand and supply, elasticity of travel demand and supply, classification of elasticity.

Vehicle operating costs: Fuel costs - Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs. Economics of traffic congestion - Pricing policy.

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.


References:
2. CRRI, *Road User Cost Study in India*, New Delhi, 1982

Course Outcomes:
Upon completion of this course, the students should be able to:
- understand the decision making and financing in transportation projects
- calculate transportation demand, vehicle operation cost and accident cost.
- formulate the economic evaluation of transportation projects including the Private Public Partnership

CE616 WATERWAY TRANSPORTATION

Course Objectives:
- To know about water transport and harbour planning
- To learn about different docks and repair systems
- To understand the navigational aids, coastal protection and ports

Course Content:

Harbour Planning: Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site
investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

**Docks and Repair Facilities:** Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles. Harbour docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of lock, lock gates, types of gates.

**Navigational Aids:** Requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

**Dredging and Coastal Protection:** Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile.

**Port facilities:** Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities. Inland waterways, Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways

**References:**

**Course Outcomes:**
Upon completion of this course, the students should be able to:
- understand the aspects of harbour design
- design and construction of breakwater and docks
- plan port and other facilities in the port

**CE617 AIRPORT PLANNING AND DESIGN**

**Course Objectives:**
- To be aware of aircraft characteristics and airport planning
- To understand the geometrics of airport infrastructure and terminal area planning
- To learn the importance of air traffic management

**Aircraft Characteristics:** Aircraft characteristics related to airport design - Landing gear configurations, aircraft weight, engine types. Atmospheric conditions affecting aircraft performance: air pressure, temperature, wind speed and direction. Aircraft performance characteristics: speed, payload and range, runway performance, declared distances, wingtip vortices.
Airport planning and air travel demand forecasting: Airport system planning - Hierarchy of Planning - Airport Master Plan - Elements of Airport Master Plan - Airport Layout Plan - Forecasting methods: time series method, market share method, econometric modelling. Facilities requirements – Design alternatives - Financial plans- Land use planning – Environmental planning - Air Transport Planning in India – Airport Site Selection


Planning and Design of the Terminal Area: Components of airport terminal - Function of Airport Passenger and Cargo Terminal - Facilities Required at Passenger Terminal - Design considerations: terminal demand parameters, facility classification, level of service criteria. Terminal planning process: overall space requirements, concept development, horizontal distribution concepts, vertical distribution concepts. Passenger and Baggage Flow - Apron gate system: number of gates, ramp charts, gate size, aircraft parking type, apron layout, apron circulation, passenger conveyance to aircraft, apron utility requirements Design of Air Freight Terminals - Airport access - Airport Landside planning - Capacity

Air Traffic Management: Navigational aids: ground based systems, satellite based systems – Air traffic control and surveillance facilities – Weather reporting facilities - Requirements of visual aids, Air field lighting - approach lighting system configurations, visual approach slope aids, threshold lighting - Runway lighting, taxiway lighting. Runway and taxiway marking, airfield signage - Air traffic separation rules: vertical separation, flight altitudes, longitudinal separation, and lateral separation – future enhancements to air traffic management.

References:

Course Outcomes:
Upon completion of this course, the students should be able to:
- apply the concept of airport planning
- design the runways, taxiways and airport terminal facilities
- plan air traffic management
CE618 ADVANCED HIGHWAY MATERIALS

Course Objectives:
- To study the properties and test on aggregate, bituminous materials, composites and recycled waste products
- To be introduced to the principles of bituminous pavement construction
- To learn the procedure for bituminous and PCC mix design

Course Content:


References:
2. RRL, DSIR, Soil Mechanics for Road Engineers, HMSO, London, 1995

Course Outcomes:
Upon completion of this course, the students should be able to:
- understand the properties and test procedures of aggregate, bituminous materials, composites and recycled waste products
- know the different types of bituminous pavement construction and its principles
- do bituminous and PCC mix design

CE619 INTELLIGENT TRANSPORTATION SYSTEMS

Course Objectives:
- To learn the fundamentals of ITS.
- To study the ITS functional areas
- To have an overview of ITS implementation in developing countries
Course Content:


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.

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

Course Outcomes:
Upon completion of this course, the students should be able to:

- understand the sensor and communication technologies.
- apply the various ITS methodologies
- define the significance of ITS under Indian conditions

CE620 ADVANCED SURVEYING AND CARTOGRAPHY

Course Objectives:

- To understand the basics of advanced surveying and cartography
- To understand in detail the different types of maps, coordinate systems and coordinate transformation
- To be introduced to working principles of topographical survey, geodesy and basis of GPS.
Course Content:

Cartography – Definition – Maps – Map Scale – Map Type - co-ordinate system - Thematic maps - map projections - classification - properties, uses and choice of projections - UTM system - projection used in SOI topographical sheets, map reproduction – Coordinate Transformation

Topographical Surveying - Introduction to topographical mapping, scale of topographical maps, Indian topographical series and their numbering system - topographical survey methods – Triangulation and precise leveling – Photogrammetry – Parameter Measurement using Photos

Geodesy – Figure of earth – Classification – Datums – Reference frames – Coordinate systems – computation of spherical coordinates – Space Geodesy – VLBI, SLR.


References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- describe the methods and applications of advanced surveying in the field of transportation engineering.
- define the correct coordinate system and methods of transformation.
- define the significance of topographical survey, geodesy and GPS in transportation engineering.

CE621 GEOSPATIAL TECHNIQUES

Course Objectives:
- To understand the basics of advanced tools such as Remote sensing, GIS and GPS
- To highlight their applications in the field of Civil engineering
- To be introduced to various Remote Sensing/GIS/GPS equipment & processing packages.

Course Contents:


References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- describe the methods and applications of remote sensing in Civil engineering,
- define and summarize surveying techniques using global positioning systems
- define the significance of GIS in civil engineering.

**CE622 GROUND IMPROVEMENT TECHNIQUES**

Course Objectives:
- To learn how to improve weak soils by modern ground improvement techniques
- To study the role of soil reinforcement in soil stabilization
- To know the importance of geo-synthetics in ground improvement

Course Content:


References:

Course Outcomes:
Upon completion of this course, the students should be able to:
- understand the importance of ground improvement techniques in civil engineering construction activities.
- do reinforced wall design using steel strip or geo-reinforcement
- perform any modern ground improvement design including soil stabilization

CE623 BRIDGE ENGINEERING

Course Objectives:
- To develop an understanding of basic concepts in bridge engineering like components, classification, importance, investigation of bridges and loading conditions.
- To study the design of Culvert, Foot Bridge, Slab Bridge, T-beam Bridge and Box Culvert using IRC.
- To study the design of various sub-structures like piers, abutments, foundations and study the importance of the bearing and joints in construction of the bridge.

Course Content:
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


References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- prepare a detailed project report for the construction of bridge giving hydraulic particulars of the river and soil details and be able to select the suitable site and type of the bridge.
- design various types of bridges like Culvert, Slab Bridge and T-beam Bridge using provisions of IRC.
- design pier, abutment, foundations, bearing and detailing of joints.

CE624 URBAN PLANNING TECHNIQUES AND PRACTICE

Course Objectives:
- To understand the different types of plans
- To know the different analytical techniques of plan
- To expose to different experience of planning of new towns

Course Content:

Planning Surveys: Type of planning surveys, data identification for various plan preparation. Aerial photo and remote sensing techniques in planning. Formulation of standards for various urban functions.

Analytical Techniques: Delphi, Trade off-game, simulation models, gravity analysis, Lowry model, Threshold analysis, Multivariate analysis. Techniques of delineation of planning areas and planning regions. Land use models.

New Towns and Global Trends: Role and Functions, Planning and development considerations, Asian and Indian experience of planning and development of new towns. Recent trends in international planning.

References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- plan for smart city
- use different planning surveys
- renew the urban areas and plan new towns

MA608 RESOURCE MANAGEMENT

Course Objectives:
- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
- To introduce fundamentals of non-linear optimization theory and methods.
- To introduce problems such as shortest paths within the minimum cost flow framework.

Course Content:
Non-Linear Programming Problems: One variable unconstrained optimization, multivariable unconstrained optimisation, Karush-Kuhn-Tucker (KKT) conditions for constrained optimization, quadratic programming, separable programming, convex and non convex programming, steepest and Quasi-Newton method.

Dynamic Programming: Characteristics of dynamic problems, deterministic dynamic programming and probabilistic dynamic programming

Network Analysis: Shortest path problems, minimum spanning tree problem, maximum flow problem, minimum cost flow problem, network simplex, interior point methods.

Stochastic programming, Nonlinear goal programming applications, Geometric Programming.

Reference Books:
1. Ehrgott M. *Multi-criteria Optimization*, Springer
2. Collette Y. and Siarry P. *Multiobjective Optimization*, Springer
5. Deb K. *Multi-objective evolutionary optimization for product design and manufacturing*, Springer

Course Outcomes:
Upon completion of this course, the student will be able to:
- formulate optimization problems
- apply basic concepts of mathematics to formulate an optimization problem
- apply basic knowledge of optimization to formulate and solve engineering problems.

HS601 HUMAN RESOURCE MANAGEMENT

Course Objectives:
- To learn the basic concepts and frameworks of human resource management.
- To define the process of job analysis and discuss its importance as a foundation for human resource management practice.
- To look into numerous problems of HRM and their causes and the action plans to be implemented to save these problems.

Course Content:


References:

Course Outcomes:
Upon completion of this course, the student will be able to:
- discuss how to strategically plan for the human resource needed to meet organizational goals and objectives.
- provide innovative solutions to problems in the fields of HRM.
- compare the common methods for recruiting and selecting human resources.

HS602 PROJECT MANAGEMENT

Course Objectives:
- To introduce the key components and techniques of project management.
- To understand the concepts of project definition, life cycle and systems approach.
- To handle the tasks of time estimation and project scheduling including PERT and CPM.

Course Content:


PERT, CPM and Resources: Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System

Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects

**Project Termination, Follow-up, Software:** Project Close-out, Steps for Closing the Project, Project Termination, and Project Follow-up, Advantages of using Project Management Software, Software Illustration, and Case Studies in Project Management

**References:**

**Course Outcomes:**
Upon completion of this course, the students should be able to:
- gain concepts to address specific management needs at the individual, team, division and/or organizational level.
- conduct project planning activities that accurately forecast project costs, timelines and quality.
- understand and use risk management analysis techniques that identify the factors that put a project at risk.

**MB601 SYSTEM ANALYSIS**

**Course Objectives:**
- To introduce students to fundamental concepts involved in using sample data to make inferences about populations.
- To know the basics and consecutive model studies in a database.
- To understand the theory and application of generalized linear models and related statistical topics.

**Course Content:**
Descriptive statistics, interval estimation, hypothesis testing, and population comparisons. Introduction to multivariate statistics- Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

Linear regression –Single and two variables, Assumptions, Regression fundamentals, Manipulating variables in regression, Stepwise, Forward, backward procedure. Logistic regression, Box-Cox regression, Violations of regression assumptions, Discriminant analysis and MANOVA.

Simultaneous Equation Models, Panel data analysis, Time series analysis- Smoothing Methodologies, ARIMA family of models, Non-linear time-series models, Multivariate Time-series models and Measures of Forecasting Accuracy.


References:

Course Outcomes:
Upon completion of this course, the students should be able to:
• develop deeper understanding of statistics, linear regression models and its limitations.
• construct simultaneous equation models and interpret the results.
• ascertain whether a generalized linear model can be used in a given situation and carry out statistical analysis.